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Liquidity risk and stock returns: empirical evidence from industrial products and services sector in Bursa Malaysia

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Abstract

This study investigates the impact of liquidity risk on stock returns of 149 firms in the industrial products and services sectors of Bursa Malaysia from January 2000 to December 2018 with a monthly frequency dataset. This study employed the two-stage standard procedures in asset pricing to estimate the significant effect of liquidity risk on industrial products and services stock returns. The results show that the investors require liquidity premium for stocks whose illiquidity co-moves with market illiquidity and market return while shifting their investment to liquid stocks when the market becomes illiquid, thus positive premium for stocks whose return is higher during the illiquid market. It suggests that two liquidity risks, namely commonality in liquidity and the covariances between stock illiquidity and market returns, and aggregate liquidity risk explain the cross-sectional returns variations across stocks in the industrial products and services sector, thus partly support the LCAPM model. We provide evidence on the important role of liquidity risks on the cross-sectional industrial products and services stock returns in Bursa Malaysia in the LCAPM framework. The findings of this study may be useful for investment decision-making and portfolio allocation strategy under the liquid and illiquid securities conditions. For policymakers, understanding the impact of liquidity risks on stock returns for the industrial products and services sectors may help enhance market liquidity for economic growth. Therefore, our findings contribute to the practical and policy implications.

Keywords: Liquidity risk, Stock returns, LCAPM, Industrial products and services, Bursa Malaysia

Introduction

The CAPM developed by Sharpe [55], Lintner [41], and Mossin [44] is the well-known and widely employed asset pricing model in financial theory [42]. It describes how it measures risk and the relationship between risk and expected returns. In the traditional CAPM, the market is assumed to be frictionless. This assumption implies that the asset prices are not affected by the trading activity, and securities are traded at no costs, which is almost not met in practice [25]. In fact, trading in the financial market involves many frictions such as trading cost, inventory risk, and asymmetric information that could affect the bid-ask spread and price volatility [56].

In market-microstructure theory, the transaction cost is often linked to a reduction in stock liquidity. Indeed, (Easley and O'Hara [20]: p. 1036) assert that *"liquidity relates to trading costs, with more liquid markets having lower costs."* Liquidity determines how fast the assets can be traded at the prevailing market price with a limited impact on the stock price movement, commonly measured by the bid-ask spread known as illiquidity cost [6]. A higher spread indicates that the stocks are illiquid. Hence, investors require a higher return as compensation when investing in a less liquid (illiquid) stock. Fundamentally, market microstructure explains how investor's behavior is translated into volume and prices under specific trading rules [9, 21, 47]. It focuses on how different

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market components affect the individual stock liquidity measured by the bid-ask spread or transaction cost, influencing investors' trading behavior and strategy. The various components include price formation and discovery, market structure and design issues, and information and disclosure. These market-microstructure components affect the stock's liquidity and market quality through the inventory risk and information asymmetry, and thus to the asset prices alike, which, eventually, to investors behavior and investment strategy [3]. Therefore, considering liquidity in asset pricing is crucial for investment decision-making.

The effect of liquidity on stock returns was first empirically investigated by Amihud and Mendelson [6]. They found that the illiquidity measured by bid-ask spread is an increasing function of the returns with a concave spread-return relation. Besides, their study also indicates a clientele effect with high illiquid stock allocated to long-term investors at equilibrium. Regarding the positive correlation between stock return and spread, other researchers who support this notion are Eleswarapu and Reinganum [23] and Eleswarapu [22]. However, Eleswarapu and Reinganum's [23] study shows that spread is only significant for the January effect.

Nonetheless, Eleswarapu [22] found that the spread is significantly explaining the Nasdaq equities return. Other studies demonstrating the substantial impact of spread on stock returns are Brennan and Subrahmanyam [13] and Cipriani et al. [18]. Their studies have proven that trading in the financial market involves many frictions such as trading cost, inventory risk, and asymmetric information that could affect the bid-ask spread and price volatility [56].

In the early studies, market-microstructure literature focused on the impact of individual stock liquidity on its stock return. However, studies such as Chordia et al. [16], Huberman and Halka [33], and Hasbrouck and Seppi [29] on the commonality in liquidity and studies done by Amihud [5] on time-varying properties of liquidity had portended a shift of emphasis from individual stock to broader determinants that is, market liquidity. Based on this notion, many studies suggested that a lack of liquidity affects asset prices both as a direct cost [6, 13, 34] among others and a systematic risk factor [1, 8, 49]. Among studies that focus on the impact of liquidity as a risk factor in asset pricing is Pastor and Stambaugh [49], Jones [34], and Acharya and Pedersen [1].

Acharya and Pedersen [1] developed an augmented CAPM version of a liquidity-adjusted capital asset pricing model (LCAPM). Different from previous studies such as Pastor and Stambaugh [49] and Jones [34], who studies the impact of single liquidity risk on stock returns, the LCAPM model incorporates three different channels of liquidity risks to which it may affect asset prices into the traditional CAPM framework along with the market risk and individual stock's illiquidity cost as control variables. Their studies have shown the co-movement between liquidity and returns where illiquid securities have higher liquidity risk, possess a lot of commonality in liquidity, and are sensitive to market returns. Further, they provide evidence that liquidity is persistent, implying that returns are predictable. Although the economic effect of the commonality on expected returns is small, thus far, their model has proven that the three liquidity betas, in addition to market beta, explain the liquidity premium on stock returns and, hence, is vital in making portfolio decisions. Their result is consistent with the study of Chordia et al. [16], Jones [34], Amihud [5], and Pastor and Stambaugh [49]. Notwithstanding these findings, Acharya and Pedersen [1] suggest that expected returns are significantly affected by systematic liquidity risk, thus conveys liquidity is a priced risk factor. In this case, the two recognized security attributes are market beta and liquidity betas compared to the standard CAPM.

The importance of the LCAPM model in explaining the effect of liquidity risk in stock returns also documented in other countries, including in Greek stock market [48], Finish market [15], Australian market [60], Portugal stock market [43], Istanbul stock market [4], Japanese stock market [36], and at a global level [38]. Although Holden and Nam [31] and Kazumori et al. [36] do not entirely support the LCAPM model's notion, each liquidity risk coefficient sign is consistent with the theory. Acharya and Pedersen [2] argued that because liquidity is a latent variable that cannot be observed directly, thus the estimation issue could explain the insignificant liquidity risk found in the study of Holden and Nam [31] and Kazumori et al. [36]. Despite this fact, Acharya and Pedersen [2] claimed liquidity risk matters for assets pricing due to its broad economic implications, including the firm's and government's cost of capital. Indeed, the impact of liquidity as a risk factor in asset pricing has attracted greater attention, especially after the 2008 global financial crisis. Studies such as Rosch and Kaserer [53] provide evidence on the critical link between liquidity evaporation and stock market crash. Recent studies on LCAPM such as Pastor and Stambaugh [50] and Altay and Çalgıcı [4] show that amid a period of dramatic liquidity shocks, the investors shifted their investment into more liquid assets which affect stock prices. Pastor and Stambaugh [50] argued that after the 2008 global financial crisis, the investors are more sensitive to liquidity risk and looking to rebalance their portfolio by investing in safer and more liquid assets, a phenomenon is known as "flight-to-liquidity." Meanwhile, Hodrea [30] argued that lacking market liquidity could give many market impediments, including reducing market efficiency, inefficient asset allocation, despairing price discovery function, and hindering economic growth. Hence, liquidity is crucial for both asset pricing and the viability of a financial market.

Besides, Watanabe and Watanabe [58] reported that liquidity risk differs with economic states. Their finding suggested that liquidity risk is higher during a poor economy associated with increased volatility and lower during a booming economy. Further, Faff et al.[24] claimed that different industries have different variability in the business cycle and command distinct risk properties. Therefore, it is expected that the liquidity risk is higher for stocks in cyclical sectors such as industrial products and services sector whose returns are sensitive to the economic states. This study aims to investigate the effect of liquidity risk on the industrial products and services sector in Bursa Malaysia. In practice, an industry portfolio (holding a portfolio based on industry membership of stocks) is popularly used by fund managers as strategic and tactical asset allocation strategies [10]. Therefore, understanding the effect of liquidity risk on this industry might be helpful for the portfolio allocation strategy.

Further, Brockman and Chung [14] argued that the impact of liquidity risk differs across different market structures of either a quote-driven or an order-driven market. Bursa Malaysia is an order-driven market structure where no market makers act as a liquidity provider of last resort. This type of market depends on public limit orders to provide liquidity and requires the market to be active to execute the order. Unlike the quote-driven market structure, the market participants in an order-market structure are not obliged to provide liquidity upon unfavorable market conditions. Hence, liquidity risks are more prominent in an order-driven market structure with a less liquid market and in times of poor market states [60].

We provide evidence on the important role of two liquidity risks on the cross-sectional industrial products and services' stock returns in Bursa Malaysia under the LCAPM framework. Previously, the LCAPM was tested in a quote-driven or market with a dual structure of order-driven and quote-driven. Given that Bursa Malaysia practices only an order-driven market structure, thus this study has helped extend the application of LCAPM in industrial products and services sectors with an order-driven market structure. Besides, the findings of this study may be useful for investment decision-making and portfolio allocation strategy under liquid and illiquid securities conditions. For policymakers, understanding the impact of liquidity risks on stock returns for the industrial products and services sectors may help enhance market liquidity for economic growth. Therefore, contributing to the theoretical, practical, and policy implications.

Methods

Dataset

The data comprises 149 firm-level equity data involving all continuously listed firms in Bursa Malaysia classified under the industrial products and services sector from January 2000 to December 2018. This study focuses on this sector due to several reasons. First, the industrial products and services sector has the largest companies listed in Bursa Malaysia (as of 2018, there are 213 listed companies under the main market) with the second largest total volume traded until 2018, indicating its significant contribution to Bursa Malaysia growth. Second, the industrial products and services sector is one of the cyclical industries, where their performance is closely tied to the overall economy's performance and thus less stable [57]. Hence, they are more sensitive to the business cycle than a non-cyclical industry due to their speculative nature and susceptibility to liquidity risks [7]. The data used in the study were obtained from Bloomberg services. Our screening rule is restricted for the securities with the last return recorded and adjusted for stock delisting to negate survivorship bias [1]. Besides, any stocks with unique characteristics, including Depository Receipts (DRs), Real Estate Investment Trust (REIT), and preferred stocks, are excluded from the sample [38]. The data set in this study contained monthly return data, the monthly rate of return on the 3-month Treasury Bills rates as a proxy for the risk-free rate, and Kuala Lumpur Composite Index (KLCI) proxied the market return. Daily data on the closing bid price, closing ask price, closing stock price, and the number of shares traded were required to construct stock's and market's monthly illiquidity measures.

Returns and Liquidity measures

Stock returns and Market returns

Following Acharya and Pedersen [1] and Lee [38], the monthly returns of firm stock are calculated by dividing the closing price of firm stock i in month t by the closing price of firm stock i in the month t_{-1}. A similar process was done for the market returns by using the monthly closing price of KLCI. Both stock and market returns are adjusted with a risk-free rate.

Liquidity measures

Different from the previous studies under the LCAPM framework, this research employed closing percent quoted spread impact (CPQS Impact) of Chung and Zhang [17] to estimate stock's illiquidity cost $(c_{i,t})$ since it is a good substitute of Amihud's ILLIQ ratio [40]. Further, CPQS impact is an efficient liquidity measure because it utilizes a bid-ask spread that captures the impact of order flow on stock prices resulting from inventory and information risks [5]. Besides, the validity of the CPQS impact as a good proxy for liquidity in the Malaysian stock market has been proven in the study of Liew et al. [40] and Fong et al. [28]. The following Eq. (1) shows how CPQS impact is derived. Where $CPQS\ Impact_{i,t}$ is the stock illiquidity cost ($c_{i,t}$) at time t, $P_{i,t}$ and $\text{Volume}_{i,t}$ is the closing price and the number of shares traded of firm stock i on day t, respectively. Since the CPQS impact measures the cost of trade per dollar of trading volume, a higher degree of illiquidity is assumed for a higher value of CPQS impact estimated. The mean daily illiquidity ratio is required to construct the monthly illiquidity measure of each stock i. It is done to overcome the peculiarities in intraday data and thus have synchronous data and ensure it is more manageable [16].

$$CPQS\ \text{Impact}_{i,t}(c_{i,t}) = \frac{CPQS_{i,t}}{P_{i,t} \times \text{Volume}_{i,t}} \tag{1}$$

The closing percent quoted spread ($CQPS_{i,t}$) in Eq. (1) measures the stock illiquidity cost ($c_{i,t}$) and is estimated below. The $CPQS_{i,t}$ is the ratio between the difference of daily closing ask price ($\text{Closing ask}_{i,t}$) and the daily closing bid price ($\text{Closing bid}_{i,t}$) of stock i on day t to the midpoint of the ask and bid prices. A higher value of CPQS indicates that the asset is illiquid. Specifically, a higher CPQS value shows a wider bid-ask spread, making it difficult to trade the assets due to the imbalance in supply and demand. As the spreads become wider, the investors will incur higher transaction costs and higher liquidity risk assumed for the assets. The following procedure was employed to derive the market's illiquidity cost, similar to Liew et al. [40].

i) Each relative illiquidity cost ($c_{i,t}$) of individual security i was estimated for each month t of the 419 stocks filtered based on the screening procedures mentioned before. These 419 stocks selected must not be classified under the financial institutions due to their unusual nature of having high leverage that likely indicates distress and is a highly regulated institution [19, 26].
ii) From above, the monthly illiquidity was then averaged across stock by using equal weights to obtain the monthly illiquidity measure of the Malaysian stock market.

$$CPQS_{i,t} = \frac{\text{Closing ask}_{i,t} - \text{Closing bid}_{i,t}}{\left(\text{Closing ask}_{i,t} + \text{Closing bid}_{i,t}\right)/2} \tag{2}$$

The LCAPM empirical models

LCAPM of Acharya and Pedersen [1] translates the original CAPM with free cost into an equilibrium model with illiquidity costs. In particular, the LCAPM is developed based on the assumption of mean–variance return similar to the standard CAPM except that the model is built claiming in the economy with frictions. The model assumes that the investors are risk-averse and thus maximize their expected returns under the budget constraints considering illiquidity costs and yields the following conditional version of LCAPM, where the respective $r_{i,t}$ and r_f is the return for stock i at month t and the risk-free rate. The $c_{i,t}$ denotes the illiquidity cost for stock i at month t. The model above is made conditional to information at month t and estimates that the expected return $E_{t-1}\left(r_{i,t} - r_f\right)$ depends on its expected illiquidity cost $E_{t-1}\left(c_{i,t}\right)$ and its four betas times the risk premium λ_{t-1}.

$$\begin{aligned} E_{t-1}\left(r_{i,t} - r_f\right) = E_{t-1}\left(c_{i,t}\right) &+ \lambda_{t-1}\text{cov}_{t-1}\left(r_{i,t}, r_{M,t}\right) \\ &+ \lambda_{t-1}\text{cov}_{t-1}\left(c_{i,t}, c_{M,t}\right) \\ &- \lambda_{t-1}\text{cov}_{t-1}\left(r_{i,t}, c_{M,t}\right) \\ &- \lambda_{t-1}\text{cov}_{t-1}\left(c_{i,t}, r_{M,t}\right) \end{aligned} \tag{3}$$

The risk premium is derived as follows, where $r_{M,t}$ is the market return and $c_{M,t}$ is the market illiquidity. $R_{it} - R_{ft} = \alpha_i + \beta_{im}(R_{Mt} - R_{ft}) + \varepsilon_{it}$. Without the illiquidity cost terms, Eq. (3) reflects the original CAPM.

$$\lambda_{t-1} = E_{t-1}\left(r_{M,t} - c_{M,t} - r_f\right)$$

By assuming constant conditional variances or a constant relative risk aversion (constant risk premium), the following unconditional LCAPM is derived

$$E\left(r_{i,t} - r_{f,t}\right) = E\left(c_{i,t}\right) + \lambda\beta_{1,i} + \lambda\beta_{2,i} - \lambda\beta_{3,i} - \lambda\beta_{4,i} \tag{4}$$

While the betas in Eq. (4) are estimated as below:

$$\beta_{1,i} = \frac{cov\left(r_{i,t}, r_{M,t} - E_{t-1}\left(r_{M,t}\right)\right)}{var\left(\left[r_{M,t} - E_{t-1}\left(r_{M,t}\right)\right] - \left[c_{M,t} - E_{t-1}\left(c_{M,t}\right)\right]\right)} \tag{5}$$

$$\beta_{2,i} = \frac{cov\left(c_{i,t} - E_{t-1}\left(c_{i,t}\right), c_{M,t} - E_{t-1}\left(c_{M,t}\right)\right)}{var\left(\left[r_{M,t} - E_{t-1}\left(r_{M,t}\right)\right] - \left[c_{M,t} - E_{t-1}\left(c_{M,t}\right)\right]\right)} \tag{6}$$

$$\beta_{3,i} = \frac{cov\left(r_{i,t}, c_{M,t} - E_{t-1}\left(c_{M,t}\right)\right)}{var\left(\left[r_{M,t} - E_{t-1}\left(r_{M,t}\right)\right] - \left[c_{M,t} - E_{t-1}\left(c_{M,t}\right)\right]\right)} \tag{7}$$

$$\beta_{4,i} = \frac{cov\left(c_{i,t} - E_{t-1}\left(c_{i,t}\right), r_{M,t} - E_{t-1}\left(r_{M,t}\right)\right)}{var\left(\left[r_{M,t} - E_{t-1}\left(r_{M,t}\right)\right] - \left[c_{M,t} - E_{t-1}\left(c_{M,t}\right)\right]\right)} \tag{8}$$

where the respective $r_{i,t}$ and $r_{M,t}$ is the return for stock i at month t and the market return at month t. The $c_{i,t}$ is the illiquidity cost of stock i at month t and $c_{M,t}$ is the market illiquidity cost at month t. The following Fig. 1 illustrates the interaction between three liquidity betas and market beta between the firm return, market return, firm liquidity (firm variance), and market liquidity (market variance).

The four betas define the various channel through which illiquidity costs have an impact on stock returns. The first beta $\beta_{1,i}$ follows the standard CAPM assumption that is the expected stock return increases linearly with the covariance between firm's stock return and market return $cov_{t-1}\left(r_{i,t}, r_{M,t}\right)$, thus, a positive relationship is expected. Another three betas are the liquidity betas regarded as liquidity risk. The liquidity beta $\beta_{2,i}$ assumes that the expected stock return increases with the covariance between the firm's stock illiquidity and the market illiquidity $cov_{t-1}\left(c_{i,t}, c_{M,t}\right)$, hence, a positive relationship is expected. While the liquidity beta $\beta_{3,i}$ estimates the negative relationship between expected stock return and the covariance between firm's stock return and market liquidity $cov_{t-1}\left(r_{i,t}, c_{M,t}\right)$. The expected negative relationship explains that the investors pay a premium for stocks that give higher returns when the market is illiquid. The liquidity beta $\beta_{4,i}$ represents the negative correlation between expected stock returns and the covariance between a firm's stock illiquidity and market return $cov_{t-1}\left(c_{i,t}, r_{M,t}\right)$. This final beta assumes that the investors are willing to accept a lower expected return for a liquid stock during poor states of the market return. Combining all three liquidity betas formed an aggregate liquidity risk ($\beta_{5,i}$) and defined as the following Eq. (9). Using Eq. (9), the LCAPM with aggregate liquidity risk can be estimated as follows.

$$\beta_{5,i} = \beta_{2,i} - \beta_{3,i} - \beta_{4,i} \tag{9}$$

$$E\left(r_{i,t} - r_{f,t}\right) = \alpha + E\left(c_{i,t}\right) + \lambda\beta_{1,i} + \lambda\beta_{5,i} \tag{10}$$

The LCAPM models were estimated using the conventional Fama and Macbeth [27] regression methodology, which involved two-stage analysis. In the first stage, Eq. (5) to (8) was estimated by regressing each firm's stock returns and individual stock's illiquidity costs against market returns and market illiquidity time series to get the beta coefficient. It was performed using 60-month rolling windows following Fama and Macbeth [27], Lee [39], and Vu et al. [60] starting from January 2000 to allow time variations in the estimated betas. Specifically, each month the regression was carried out employing the last 60-month observations, and one beta was created through one new observation out of 60 observations.

Acharya and Pedersen [1] have used AR(2) fittings to obtain innovation of illiquidity. However, AR(2) fittings exhibit *look-ahead bias* in time-series settings made on ex-post [39]. Therefore, this study employed illiquidity change for individual and market-level to estimate market beta and liquidity betas. This is done to resolve the discontinuous time series of individual stock data resulting from the data screening procedures described in the dataset and also any missing data presented during the sample period. Thus, addressing the issue of *look-ahead* bias in AR(2) specifications. The use of liquidity change to obtain innovation in liquidity is also observed in the studies of Chordia et al. [16], Lee [39], and Kumar and Misra [37].

The second stage of Fama and Macbeth [27] is to perform cross-sectional regression. It was performed to

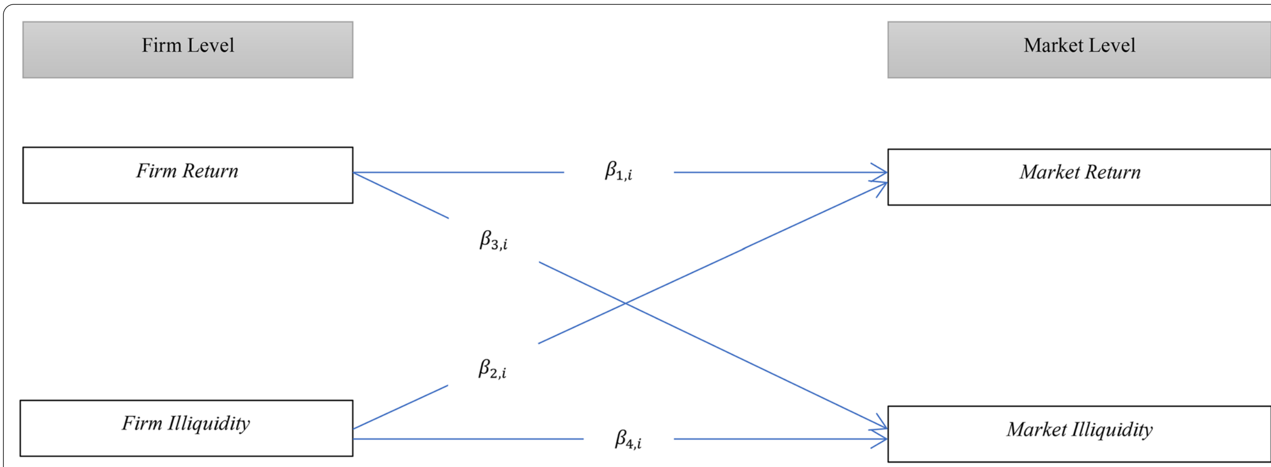

Fig. 1 Illustration of the four betas. Source: Adopted from Musneh et al. [45]

examine the priced risks, each month over the sample period, the excess returns on the test assets were regressed 169 cross-sectionally (Dec 2004 to Dec 2018) against the pre-estimated beta (market beta and illiquidity betas) obtained in the time-series regression (first stage) in order to estimate the intercept and the risk premium. The analysis starts from Dec 2004 because the market beta and illiquidity betas are estimated using the previous 60 monthly returns data, resulting in a total of 169 different values. These estimated 169 risk premia values are then averaged across time to obtain the average alpha (intercept—$\hat{\alpha}$) and average lambda (risk premium -$\hat{\lambda}$). The Fama–Macbeth two-stage regression analysis was estimated using the STATA 12 software. The full regression model is denoted as follows:

$$E\left(r_{i,t} - r_{f,t}\right) = \alpha + kE_t\left(c_{i,t}\right) + \lambda_1\hat{\beta}_{1,i} + \lambda_2\hat{\beta}_{2,i} + \lambda_3\hat{\beta}_{3,i} + \lambda_4\hat{\beta}_{4,i} + \varepsilon_i \tag{11}$$

For Eq. (11), the study does not put any restrictions model's coefficient (k) and risk premium. E(c) measured the individual stock's illiquidity cost and computed it by taking the average monthly closing percent quoted spread impact as a proxy of the expected illiquidity costs computed from the previous 12 months following Lee [39]. The $\hat{\beta}_{1,i}$, $\hat{\beta}_{2,i}$, $\hat{\beta}_{3,i}$, and $\hat{\beta}_{4,i}$ is the pre-estimated beta computed as per Eqs. (5) to (8). Further, for robustness, the estimations are corrected for both heteroscedasticity and autocorrelation problems according to the Newey–West [46] procedure. Table 3 reports the outputs from estimating the four different LCAPM specifications using the Fama–Macbeth cross-sectional regression.

Results and discussion

Descriptive statistics

The analysis is performed on 149 stocks continuously traded on Bursa Malaysia from 2000:01 to 2018:12 in industrial products and services. The data are obtained from Bloomberg services. The study sample represents about 70 percent of the total industrial products and services stocks listed on Bursa Malaysia (as of December 2018, there were about 213 total listed companies on the stock exchange). Table 1 reported the descriptive statistics of the seven variables involved. Referring to Table 1, β_5 has the largest statistical value of maximum, mean, and standard deviation, and β_2 has the largest minimum statistical value. Notably, β_5 is the most influential stock return component with a mean value of 10.39 compared to E(C), $\beta_1, \beta_2, \beta_3$, and β_5. Table 1 reports that r_i, E(c), β_3, and β_4 are negatively skewed. Following Kallner [35] that a standard normal distribution has a kurtosis of 3, all variables in the series are leptokurtic except for E(c), with the stock return (r_i), possess the highest peak and tallest relative to the normal distribution.

Correlation analysis

The correlation analysis was performed to study the association among variables involved in the study. The correlation coefficient values ranging from − 1.00 to + 1.00, with a value of + 1.00 indicating a perfect positive correlation and a value of − 1.00, shows a perfect negative correlation. Meanwhile, the 0.00 coefficient value represents no linear relationship between variables.

Referring to Table 2, except β_2, other independent variables (i.e., E(C), $\beta_1, \beta_3, \beta_4, \beta_5$) are significantly correlated with stock returns (r_i). The findings indicate that stock returns (r_i) have a significant positive association with the covariances between stock's return and the market illiquidity (β_3), and aggregate liquidity risk (β_5) by 0.26 and 0.02, respectively. Nonetheless, expected stock illiquidity cost *(E(c))* (r_i = − 0.297), the stock market beta (β_1) (r_i = − 0.24); the covariance between the stock return and the market return, and the covariance between stock's illiquidity and the market return (β_4)(r_i = − 0.032) are inversely correlated with the stock return (r_i), and the association is significant at the 1% and 5% level. The correlation value presented in Table 2 is lower than 0.40

Table 1 The descriptive statistics

Variables	N	Max	Mean	Min	SD	Skewness	Kurtosis
r	20,956	1.820	− 0.285	− 30.50	0.901	− 13.29	314.1
E(c)	20,956	8.202	1.678	− 7.659	2.891	− 0.405	2.792
β_1	20,894	46.55	2.080	− 31.41	3.781	4.433	37.13
β_2	20,884	4.659	0.955	− 2.722	0.849	0.293	3.922
β_3	20,894	0.882	− 0.157	− 9.704	0.454	− 7.845	91.08
β_4	20,884	29.28	− 9.280	− 52.75	9.196	− 0.178	3.885
β_5	20,884	55.10	10.39	− 29.29	9.788	0.241	3.842

This table provides the descriptive statistics of monthly stock returns, expected illiquidity costs, market stock beta, three liquidity risks, and aggregate liquidity risks. N, max, min, sd represent the number of observations, maximum, and standard deviation, respectively. r_i monthly stock returns, E(c) expected illiquidity costs, β_1 market stock beta, $\beta_2, \beta_3, \beta_4$ liquidity risk, β_5 aggregate liquidity risk

Table 2 The correlation analysis

Var	r_i	E(c)	β_1	β_2	β_3	β_4	β_5
r_i	1						
E(c)	− 0.297***	1					
β_1	− 0.235***	0.247***	1				
β_2	0.0026	0.147***	0.216***	1			
β_3	0.257***	− 0.288***	− 0.712***	− 0.233***	1		
β_4	− 0.032***	− 0.093***	− 0.291***	− 0.562***	0.161***	1	
β_5	0.018**	0.114***	0.326***	0.626***	− 0.218***	− 0.996***	1

This table provides the correlation analysis between stock returns, expected illiquidity costs, market stock beta, three liquidity risks, and aggregate liquidity risks. *10% level of significance, **5% level of significance, ***1% level of significance

Table 3 The LCAPM regression

Variables	Expected sign	Model 1	Model 2	Model 3	Model 4
α		− 0.146*** (0.0178)	− 0.0958*** (0.0149)	− 0.155*** (0.0155)	− 0.153*** (0.0154)
E(c)	+	− 0.0679*** (0.0030)	− 0.0374*** (0.0041)	− 0.0647*** (0.0030)	− 0.0652*** (0.0030)
β_1	+	− 0.0650*** (0.0166)	0.0332* (0.0191)	− 0.0709*** (0.0170)	− 0.0715*** (0.0171)
β_2	+	0.125*** (0.0166)			
β_3	–		1.629*** (0.308)		
β_4	–			-0.0136*** (0.0014)	
β_5	±				0.0124*** (0.0012)
R^2		0.297 (0.285)	0.417 (0.408)	0.307 (0.295)	0.307 (0.295)
N		20,884	20,894	20,884	20,884

This table provides the LCAPM regression showing the impact of liquidity risk on stock returns. r_i monthly stock returns, E(c) expected illiquidity costs, β_1 market stock beta, β_2, β_3, β_4 liquidity risk, β_5 aggregate liquidity risk. The number in parentheses with each coefficient represents the *t*-statistic estimated using the robust Newey-West method. The asterisks (*, **, ***) in the respective coefficients represent a significant level of 10%, 5%, and 1%, respectively. The R-squared (R^2) is derived from the time-series average of all single cross-sectional regression and the adjusted R^2 is in the parentheses.

shows weak association but is statistically significant [54], suggesting that the E(C), β_1, β_3, β_4, and β_5 have an association with the stock returns, but that there are other determinants associated with the stock returns in the industrial products and services stock returns in Bursa Malaysia.

The LCAPM estimations

Table 3 presents some evidence that partly supports the LCAPM. For liquidity-related risks (Model 1 to Model 4), with market risk and individual stock's illiquidity presence as a control variable in the model, the result shows only β_2 and β_4 have risk premia of a correct sign as predicted by LCAPM. The positive risk premium of β_2 (0.125) indicates that the investors are willing to pay a premium for a stock that remains liquid when the market generally becomes illiquid. The negative risk premium of β_4 (− 0.0136) represents that investors demand a higher liquidity premium for stocks whose liquidity is sensitive to the market states.

While β_3 shows the opposite coefficient sign though it is significant, which contrasts with what the model proposes. It indicates that the investors require a premium for industrial products and services stocks when the market is illiquid. The positive premium of $\beta_3\left(r_{M,t} - c_{M,t} - r_f\right)$ reasonably suggests that returns on industrial products and services stocks are more sensitive to liquidity risk. The industrial products and services sector is a cyclical industry whose performance is closely tied to the overall economy's performance. Thus, it is less stable and more volatile than a non-cyclical industry due to its speculative nature [57]. Therefore, any liquidity shock inflicts more significant drops on the illiquid stocks than the liquid stocks, thus the positive premium. The findings on the positive effect of β_3 highlighted in this study supported Altay and Çalgıcı [4] and Pastor and Stambaugh [50]. Among other variables, β_3 has a strong effect on stock returns after being tested individually in Model 2 (premium = 1.63 percent). The net liquidity beta or aggregate liquidity risk (β_5) is also significant in explaining the cross-sectional returns variations and correctly priced as expected by the theory with a positive premium of 0.0124. The results conclude that liquidity risk matters for asset pricing, but the risk premium of liquidity risk is slightly lower than market risk by 5.91 percent.

In addition to liquidity betas, the expected illiquidity cost (E(c)) is significant at 1 percent critical value, with the premium varies from − 0.0374 to − 0.0679. The significance of illiquidity cost is also consistent in all specifications, confirming that illiquidity cost is priced for the cross-sectional returns in the industrial products and services sector but with the opposite sign of coefficient, which is inconsistent with the liquidity-asset pricing theory. Similarly, the β_1 shows an opposite coefficient sign in Model 1, Model 3, and Model 4, although significant in all regression models. Nevertheless, other studies conducted in emerging markets such as Bekaert and Harvey [12], Rahim and Nor [51], Lee [38], Papavassiliou [48], and Baten and Vo [11] show the same negative coefficient. Vovchak [59] claims that the negative direction of liquidity level on stock returns changes when liquidity risk is priced in stock returns. Meanwhile, Rahim and Nor [51] argued that the negative coefficient of β_1 could be attributed to the economic and stock market uncertainties. Mainly, a negative shock like the 2008 global financial crisis causes a more significant drop in returns on the risky stocks than the riskless stocks, thus explaining the negative risk premium of β_1. Interesting to note that the coefficient sign of β_1 becomes positive when β_3 is present in the Model as shown in Model 2 due to a high association between β_1 and β_3 shown in Table 2.

In sum, stock's required return decreases in its level of illiquidity costs and level of β_4, and increasing in its level of β_2, β_3, and β_5. The empirical results support that liquidity risks of β_2 and β_4 are priced in the cross section of the industrial products and services stock returns in Bursa Malaysia; however, evidence supporting LCAPM is not apparent. In addition, the pricing error α is significantly different from zero for each model specification, indicating that the LCAPM is insufficient in entirely explaining the cross section of stock returns. In particular, other factors could be partly impacting stock return. The adjusted R^2 for each model ranging from 16.5 percent to 41.7 percent with the highest adjusted R^2 found in Model 2. Hu and Liu [32] argued that a lower value of adjusted R^2 is common in asset pricing tests. The same finding is also observed in Ramlee and Ali's [52] studies related to liquidity issues in Malaysia.

The multicollinearity test was also conducted among variables involved in four regression models using the variance inflation factor (VIF) method. The output indicates the mean value ranging from 1.41 to 1.98. Using a cut-off VIF value of less than 10, no multicollinearity problems were found between the explanatory variables in four regression models.

Conclusions

This research analyzed the impact of liquidity risks on stock returns of firms in the industrial products and services sectors of Bursa Malaysia, using the LCAPM framework of Acharya and Pedersen [1]. The results provide evidence on the importance of liquidity risk in explaining the cross-sectional stock returns variation in the industrial products and services sector.

The study emphasized three liquidity risks, namely, commonality in liquidity (β_2), the covariances between stock returns and market illiquidity (β_3), and the covariances between stock illiquidity and market returns (β_4), while controlling the effect of market risk and stock's illiquidity level. The four betas estimated in the first stage were used in the second stage of cross-sectional regression under different LCAPM specifications to understand its significant effect on stock returns in Malaysia's industrial products and services sector from 2004:12 to 2018:12. The results evidenced that two liquidity risks of β_2 and β_4 are priced in the cross section of industrial products and services' stock return, partly support the LCAPM of Acharya and Pedersen [1]. The stock returns are positively significant to the commonality in liquidity (β_2) and negatively significant to the covariances between stock illiquidity and market returns (β_4). Meanwhile, although significant, the covariances between stock returns and market illiquidity (β_3) are positively correlated with stock returns, opposed to the theory. The findings of this study may be useful for investment decision-making and portfolio allocation strategy under the liquid and illiquid securities conditions. For the policymakers, since stocks under the industrial products and services sectors are prone to liquidity risk, thus enhancing market liquidity is crucial for economic growth. Further, this study extends the application of LCAPM in industrial products and services sectors with an order-driven market structure. Therefore, our findings provide important implications to theoretical, practical, and policymakers.

This study applied the unconditional LCAPM specification, assuming constant premia and one month holding period in the industrial products and services sectorial stock returns, Bursa Malaysia. Investigating the effects of different holding periods on various industries' liquidity risk premiums may be useful for future studies. The betas estimated at the individual stock level would be noisier than those estimated at the portfolio level. Therefore, future studies are suggested to estimate beta at the portfolio level and assigned it to the individual stock. Besides, the current study's sample period is limited to data from 2000 to 2018; extending the sample period is useful to provide out-of-sample evidence.

Abbreviations

CAPM: Capital asset pricing model; CPQS: Closing percent quoted spread; KLCI: Kuala lumpur composite index; LCAPM: Liquidity-adjusted capital asset pricing model; REIT: Real-estate investment trust; VIF: Variance inflation factor.

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Authors' contributions

RM has contributed to the preliminary drafting, data analysis, and interpretation. RAK has contributed to the review of contents and conceptual article layout, and CG has contributed to the review of methods presented. All authors read and approved the final manuscript.

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Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Competing interests

This research is part of the ongoing Ph.D. (Financial Economics) studies currently undertaken by the first author at the Faculty of Business, Economics, and Accountancy, Universiti Malaysia Sabah, under the supervision of co-authors.

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