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Systematic illiquidity, characteristic illiquidity, and stock returns: Time-series analysis

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ABSTRACT

The objective of this research is to investigate the relationship between illiquidity and stock prices on the Tunisian stock exchange. While previous researches tended to focus on one form of illiquidity to examine this relationship, our study unifies three forms of illiquidity at the same time. Indeed, we simultaneously consider illiquidity as systematic risk, as a characteristic of the market, and as a characteristic of the stock. The aggregate illiquidity of the market is the average of individual stock illiquidity. The illiquidity risk is the sensitivity of the stock price to illiquidity shocks. Shocks of market illiquidity are estimated by the innovations in the expected market illiquidity. Results show that investors on the Tunisian stock exchange do not require higher returns when they expect a rise of market illiquidity, whereas investors on U.S markets are compensated for higher expected market illiquidity. In addition, shocks of market illiquidity provoke a fall in stock prices of small caps, while large caps are not sensitive to market illiquidity shocks. This differs slightly from results based on U.S. data where illiquidity shocks reduce all stock prices but most notably those of small caps. Robustness tests validate our findings. Our results are consistent with previous studies which reported that the "zero-return" ratio predicts significantly the return-illiquidity relationship on emerging markets.

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1. Introduction

The relationship between illiquidity and asset prices has been studied in two ways: either by considering the illiquidity as a characteristic, or as a systematic risk. The effect of illiquidity as a stock characteristic on expected stock returns has initially been investigated by Amihud and Mendelson (1986). The two authors show that investors are averse to the costs of illiquidity and require compensation for bearing them. Therefore, the higher a stock's illiquidity, the higher its observed return should be. The positive and significant relationship between illiquidity as a stock attribute and stock returns is empirically confirmed in several studies using various measures of illiquidity on different markets (Brennan and Subrahmanyam, 1996; Datar et al., 1998; Loukil et al., 2010).

Further research has revealed the systematic component in the time-series of illiquidity measures across stocks (Chordia et al., 2000; Hasbrouck and Seppi, 2001; Huberman and Halka, 2001; Brockman et al., 2009; Tissaoui et al., 2015). The existence of illiquidity commonalities suggests that stock returns may also be related to the market-wide illiquidity. Indeed, Amihud (2002) proved that stock excess return is increasing in the expected illiquidity of the stock market. The expected stock excess return includes compensation for expected market illiquidity. However, he also finds that market-wide illiquidity strongly fluctuates over time. Focusing on fluctuations of market illiquidity that investors cannot expect, market illiquidity can be also viewed as an important systematic risk factor.

Illiquidity risk is measured by illiquidity beta and is defined by the sensitivity of stock returns to unexpected market illiquidity (Pastor and Stambaugh, 2003). The risk view of illiquidity has attracted much attention and led to several works confirming the pricing of illiquidity risk. Assets with higher illiquidity betas exhibit higher expected returns (Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005). The positive relationship between expected returns and illiquidity risk implies a

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negative relationship between contemporaneous returns and unexpected market illiquidity (shocks). When illiquidity is high, the future expected return is also high, which depresses the current price, leading to a low contemporaneous return. In addition, illiquidity shocks affect stock returns of small firms more strongly. Unexpected illiquidity-returns relationships have been verified for stocks by Amihud (2002), Pastor and Stambaugh (2003), Acharya and Pedersen (2005), Bekaert et al. (2007), Amihud and Noh (2021), Amihud (2019), and for bonds by Bongaerts et al. (2012) and Acharya et al. (2013). Our research contributes to these studies by investigating the illiquidity-return relationships in the emerging market while simultaneously considering the three forms of illiquidity (stock characteristic, market characteristic, and systematic risk).

The Tunisian stock market provides an interesting setting for studying these relationships because it is very different from the U.S. markets. Tunisian stock market is smaller and less liquid than the U.S. stock market that is the most liquid market in the world. Illiquidity is a challenge for the Tunisian stock market. At the start of 2011, Tunisian Stock Exchange suspended trading twice for 15 sessions due to the fall of its index value.

The main finding of this paper can be summarized as follows. Unlike investors in U.S markets and some emerging markets, investors on the Tunisian stock exchange are not compensated for expected market illiquidity. In fact, expected market illiquidity lowers expected returns of small caps, while returns of large caps are not affected. All stocks on the Tunisian stock exchange are exposed to illiquidity risk. However, returns of small caps are more sensitive to systematic illiquidity. We also find that the "zero returns" measure is more appropriate to the study of the illiquidity-returns relationship on Tunisian stock exchange than Amihud (2002)'s measure.

The paper proceeds as follows: Section 2 presents the data and the methodology of the research. Our empirical results are described in section 3. Section 4 provides some robustness tests. Section 5 summarizes and concludes.

2. Data and methodology

We employ daily price and volume data from the database of the Tunisian Stock Exchange. The Tunisian Stock Exchange (TSE) was established in 1969 as a public institution. It is a small market with a market capitalization of USD 8.82 Billion in 2018. TSE Activities are regulated by the Financial Market Council (CMF). The main reference index of TSE is the TUNINDEX index. It was launched on December 31, 1997, with a base of 1000. It listed 81 stocks of companies from different sectors in 2018. We are interested in all stocks that are included in the TUNINDEX to get more generalized results and findings. We select those that are continuously listed since the establishment of the TUNINDEX on January 1st, 1998. The period that contains the minimum of zero market data is from January 8th, 2007 to February 5th, 2015 (8 years). In addition, the stock should have at least a non-zero daily volume per week to be included in the final sample. This condition makes the estimated parameters of the return-illiquidity relationship more reliable. Finally, our data consists of the daily price and trading volume of the TUNINDEX and of 20 stocks covering 400 weeks, from January 8th, 2007 to February 5th, 2015.

We use the Amihud ratio, *illiq*, to measure illiquidity. *Illiq* is the most commonly used proxy of asset illiquidity in the finance literature (Lou and Shu, 2017). It can be easily obtained from daily data. Also, it has a simple construction that uses the absolute value of the daily return-to-volume ratio to capture price impact. In addition, it was shown to have a strong positive relationship with asset returns (Amihud, 2002; Chordia et al., 2009; Lou and Shu, 2017). Specifically, *illiq* gives the average response of daily asset price to trading volume. In our empirical study, the illiquidity degree of stock i in week t is defined as:

$$illiq_{i,t} = \frac{1}{D_{i,t}} \sum_{d=1}^{D_{i,t}} \frac{|R_{i,d}|}{Vol_{i,d}} \quad (1)$$

where:

$$R_{i,d} = \frac{P_{i,d} - P_{i,d-1}}{P_{i,d-1}} \times 100 \quad (2)$$

$P_{i,d}$ and $P_{i,d-1}$ denote the daily prices of stock i on day d (d-1). $R_{i,d}$ and $Vol_{i,d}$ are respectively the return and the volume (in hundred thousand Tunisian dinars) of stock i on day d. $D_{i,t}$ is the number of trading days (with nonzero volume) in week t.

The higher value of $illiq_{i,t}$, the higher the price impact of the stock, which means that the higher level of stock illiquidity during the week t. In other words, the stock price moves a lot in response to little volume trading during the week t. Market illiquidity in a given week is determined by the equally-weighted average of illiquidity ratio of individual stocks similarly to Amihud (2002), Acharya and Pedersen (2005), Liu (2006), Watanabe and Watanabe (2008), Lee (2011), Acharya et al. (2013):

$$Milliq_t = \frac{1}{N} \sum_{i=1}^{N} illiq_{i,t} \quad (3)$$

where N is the total number of stocks.

Fig. 1 plots the time series of weekly market illiquidity on TSE from January 1st, 2007 until February 5th, 2015.

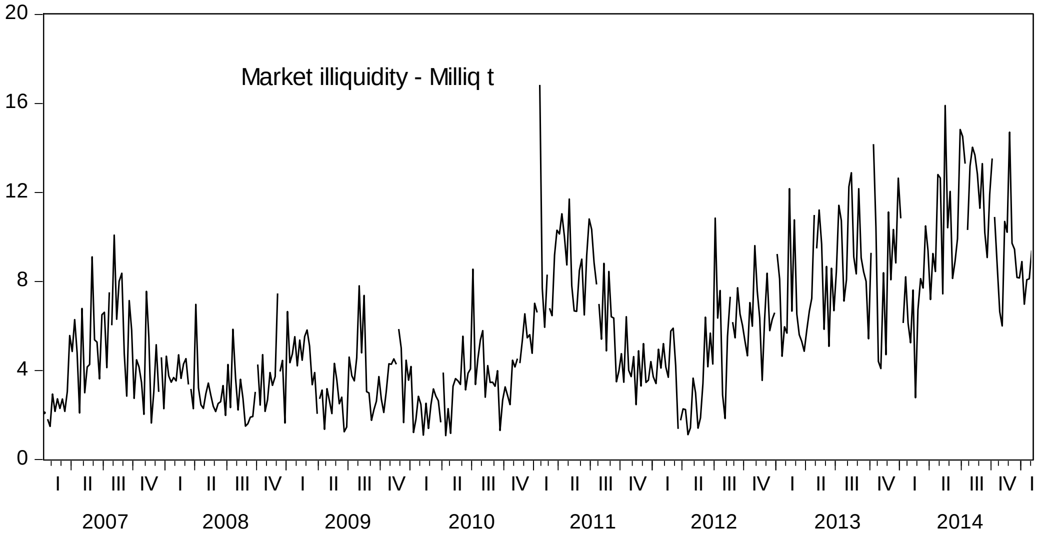

Fig. 1: Time series of weekly market illiquidity on TSE (01/01/2007–05/02/2015)

Variability of market illiquidity is high during this period. Values vary between 1% and 16% (Tables 1 to 3). Market illiquidity level of TSE also seems persistent. The auto-correlation of *Milliq* values equals 0.73. It equals to that on the Malaysian stock exchange and the Argentinean stock exchange at the monthly frequency for the period from 01/1987 to 12/2003 according to Bekaert et al. (2007). Therefore, we focus on the unexpected market illiquidity, $Milliq_t - E_{t-1}(Milliq_t)$, to estimate the illiquidity risk. As explained in section 1, the illiquidity risk, measured by the illiquidity beta, is defined by the stock return sensitivity to unexpected market illiquidity (i.e., shocks). Shocks in market illiquidity are estimated by the residuals extracted from the autoregressive model that predicts market illiquidity (Amihud, 2002; Acharya and Pedersen, 2005; Acharya et al., 2013; Amihud and Noh, 2021). We use the weekly difference in Milliq to make it stationary similarly to Pastor and Stambaugh (2003). We run the following autoregressive model:

$$\Delta Milliq_t = \alpha_0 + \sum_{i=1}^{10} \alpha_i \times \Delta Milliq_{t-1} + u_t \quad (4)$$

The lag length, which is equal to 10, is selected to ensure that residuals are serially uncorrelated. This is proved by their autocorrelation coefficient that equals -0,004. Extracted residuals u_t, i.e. the estimated market illiquidity innovations, reflect the market illiquidity shocks, called *Silliq*:

$$u_t = Silliq_t \quad (5)$$

Since studies on U.S. markets show that the effect of illiquidity shocks on returns is stronger for more illiquid, i.e. smaller stocks (Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005; Acharya et al., 2013; Amihud and Noh, 2021), we test whether Tunisian market illiquidity effects also depend on stock illiquidity degree. To do this, we sort stocks into two portfolios based on their firm size, i.e. the logarithm of the firm's market capitalization. This is due to the negative relationship between size and illiquidity, i.e. larger stock has a smaller price impact for a given order flow and a smaller bid-ask spread (Amihud, 2002; Acharya and Pedersen, 2005; Watanabe and Watanabe, 2008; Acharya et al., 2013). The weekly value-weighted average return of each portfolio R_t is computed as follows:

$$R_t = \sum_{i=1}^{n} w_{i,t} \times R_{i,t} \quad (6)$$

$$R_{i,t} = 100 \times \frac{(P_{i,d} - P_{i,d-4})}{P_{i,d-4}} \quad (7)$$

$$w_{i,t} = \frac{V_{i,t-1}}{\sum_{i=1}^{n} V_{i,t-1}} \quad (8)$$

where $R_{i,t}$ is the return of stock i at week t; each stock return is weighted by its market capitalization at the end of the preceding week as in Amihud et al. (2015); $w_{i,t}$ is the stock weight in the portfolio in week t, n is the number of stocks in each portfolio, $P_{i,d}$ and $P_{i,d-4}$ are respectively the stock return on day d and day d-4.

To verify whether small-cap portfolios have a greater illiquidity degree than the large-cap portfolio, we determine the illiquidity degrees of each portfolio. Portfolio illiquidity is computed by the equally-weighted average of illiquidity levels of the stocks that are included in the portfolio. The time series of illiquidity of both portfolios are plotted in Fig. 2.

The illiquidity level of a small-cap portfolio appears over time higher than that of a large-cap portfolio. This is confirmed by statistics that reveal that the illiquidity level of the small-cap portfolio is an average equal to 8,41 % while that of the small-cap portfolio is equal to 3,53 %.

Table 1: Descriptive statistics of Milliq (from 08/01/2007 to 05/02/2015)

Descriptive statistics	
Mean	5.723855
Median	4.878677
Max	16.83456
Min	1.072113
Standard deviation	3.186267
Skewness	0.857216
Kurtosis	3.214287
Observations	400

Table 2: The ADF test results on portfolio returns series

On Large-cap portfolio return series				
	With trend and constant		t-Stat	Prob
	Statistic of ADF test		-17.89828	0.0000
	Critical values	1%	-3.981225	
		5%	-3.421126	
		10%	-3.133309	
Variable	Coefficient	Std-erreur	t-Stat	Prob
C	0.271005	0.196945	1.376047	0.1696
Trend	-0.001007	0.000853	-1.181285	0.2382
	With constant		t-Stat	Prob
	Statistic of ADF test		-17.85221	0.0000
	Critical values	1%	-3.446525	
		5%	-2.868565	
		10%	-2.570578	
Variable	Coefficient	Std-erreur	t-Stat	Prob
C	0.069185	0.098019	0.705834	0.4807
	No constant, no trend		t-Stat	Prob
	Statistic of ADF test		-17.84961	0.0000
	Critical values	1%	-2.570771	
		5%	-1.941619	
		10%	-1.616167	
On small-cap portfolio return series				
	With trend and constant		t-Stat	Prob
	Statistic of ADF test		-9.497188	0.0000
	Critical values	1%	-3.981343	
		5%	-3.421183	
		10%	-3.133343	
Variable	Coefficient	Std-erreur	t-Stat	Prob
C	-0.015068	0.237654	-0.063405	0.9495
Trend	-0.000146	0.001028	-0.141772	0.8873
	With constant		t-Stat	Prob
	Statistic of ADF test		-9.510204	0.0000
	Critical values	1%	-3.446608	
		5%	-2.868601	
		10%	-2.570597	
Variable	Coefficient	Std-erreur	t-Stat	Prob
C	-0.044333	0.117631	-0.376879	0.7065
	No constant, no trend		t-Stat	Prob
	Statistic of ADF test		-9.513125	0.0000
	Critical values	1%	-2.570800	
		5%	-1.941623	
		10%	-1.616164	

Table 3: The ADF test results on market illiquidity series

	With trend and constant		t-Stat	Prob
	Statistic of ADF test		-4.726954	0.0007
	Critical value	1%	-3.981402	
		5%	-3.421212	
		10%	-3.133360	
Variable	Coefficient	Std-erreur	t-Stat	Prob
C	0.579844	0.230583	2.514685	0.0123
Trend	0.003856	0.001198	3.219966	0,0014
	With constant		t-Stat	Prob
	Statistic of ADF test		-3.420378	0.0108
	Critical value	1%	-3.446650	
		5%	-2.868620	
		10%	-2.570607	
Variable	Coefficient	Std-erreur	t-Stat	Prob
C	0.734964	0.228180	3.220983	0.0014

Finally, to assess the effects of market illiquidity on returns of each portfolio, we add to the CAPM (Capital Asset Pricing Model) two illiquidity factors, i.e. the expected market illiquidity and the innovations in the market illiquidity (illiquidity shocks). In that way, we attempt to verify three hypotheses:

H1: An increase in expected market illiquidity has an impact on the return required by investors, suggesting that expected market illiquidity is priced on TSE.

H2: Unexpected market illiquidity has an impact on contemporaneous returns, suggesting that illiquidity shocks on TSE affect immediately prices (illiquidity risk).

H3: Effects of both expected and unexpected market illiquidity on stock returns differ from small-cap portfolio to large-cap portfolio, suggesting that both effects depend on illiquidity degrees.

The three-hypothesis discussed above are tested in these time-series specifications (Eq. 9).

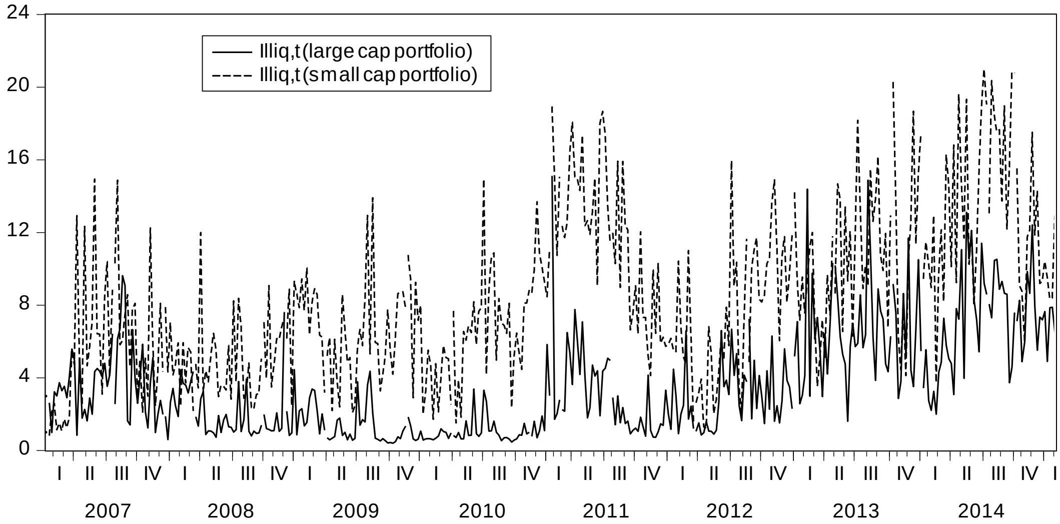

Fig. 2: Time series of illiquidity levels of the small-cap portfolio (the dashed curve) and large-cap portfolio

$$\begin{cases} R_t^L - R_{f,t} = \alpha^L + \left(\beta_m^L \times (R_{m,t} - R_{f,t})\right) + \left(\gamma_{Milliq}^L \times \Delta BMilliq_{t-1}\right) + \left(\beta_{Silliq}^L \times Silliq_t\right) + \varepsilon_t^L \\ R_t^S - R_{f,t} = \alpha^S + \left(\beta_m^S \times (R_{m,t} - R_{f,t})\right) + \left(\gamma_{Milliq}^S \times \Delta BMilliq_{t-1}\right) + \left(\beta_{Silliq}^S \times Silliq_t\right) + \varepsilon_t^S \end{cases} \quad (9)$$

where; $R_t^L - R_{f,t}$ and $R_t^S - R_{f,t}$ are respectively large-cap portfolio return and small-cap portfolio return at week t, in excess of the risk-free return $R_{f,t}$; $R_{m,t} - R_{f,t}$ is the market excess return at week t, $B\Delta Milliq_{t-1}$ is a dummy variable that equals to 1 if market illiquidity has increased at week t-1 (increased market illiquidity predicts that the increase will continue next week), and equals to zero otherwise; $Silliq_t$ are the estimated market illiquidity shocks; β_m measures in each regression the sensitivity of portfolio excess return to market return; similarly, β_{Silliq} measures the sensitivity of portfolio contemporaneous return to illiquidity shocks; γ_{Milliq} measures the effect of an expected increase in market illiquidity on portfolio excess return; α and ε_t are, respectively, model intercept and residuals (residuals are assumed to be independent and identically distributed, and follow the normal distribution of zero mean and constant variance).

3. Empirical results

Table 4 reports the summary on the value-weighted returns of both portfolios, the market returns, and the illiquidity shocks.

Returns of the large-cap portfolio are on average higher than those of the small-cap portfolio. The mean of illiquidity shocks is practically zero. Market return and illiquidity shocks are negatively correlated (correlation=-0.21). This is consistent with the findings of Amihud (2002) which shows that market illiquidity shocks affect negatively contemporaneous market returns on the New York Stock Exchange from 1964 to 1997. Results of the Augmented Dickey-Fuller Root Unit test indicate that the time series of the four variables are stationary.

Table 4: Descriptive statistics of weekly returns of large-cap portfolio and small-cap portfolio, market returns, and illiquidity shocks

	Small	Large	Rm	Silliq
No. of Obs	400	400	400	400
Mean	-0.076	0.053	0.214	0.034
Medium	-0.094	0.109	0.208	-0.024
Maximum	9.213	9.030	8.886	10.767
Minimim	-9.976	-21.684	-9.143	-5.514
Std-Dev	2.254	2.280	1.677	1.945
Skewness	-0.220	-2.355	-0.738	0.697
Kurtosis	5.531	25.567	10.656	5.396

The estimation results of Eq. 9 are presented in Table 5. They show that loadings on (Rm-Rf) are positive and highly statistically significant, for both portfolios. Tunisian large-cap portfolio seems more volatile than the overall market, while Tunisian small-cap portfolio seems less. Our primary interests in this paper are the loadings on expected market illiquidity, γ_{Milliq} and the systematic illiquidity risk loadings, β_{Silliq}. Estimates of γ_{Milliq} are negative for both portfolios but not statistically significant. This means that expected market illiquidity has no effect on required returns. In others words, Tunisian investors do not require compensation for an increase in expected market illiquidity. This is inconsistent with the results of Amihud (2002) and Amihud et al. (2015) based on U.S. markets where the expected market illiquidity has a positive effect on ex-ante returns, specifically for small-cap portfolios.

Table 5: Estimation results of the CAPM adjusted to illiquidity in Eq. 9

	Small-cap portfolio		Large-cap portfolio	
Coef	Estimates	t-stat	Estimates	t-stat
α	-0.18	-1.62	-0.1	-0.97
β_m	0.88	17.44	1.04	23.42
γ_{Milliq}	-0.19	-1.17	-0.15	-1.03
β_{Silliq}	-0.12	-2.68	-0.04	-1.06
R^2	47%	47%	60%	60%

Table 5 also indicates that beta illiquidity is negative for both portfolios. However, the negative effect of illiquidity shocks on returns is statistically significant only for small-cap portfolios. This implies that market illiquidity shocks lower prices of small caps on the Tunisian stock exchange, but does not affect those of large caps. These findings differ slightly from previous studies on U.S and developed markets where market illiquidity shocks decrease significantly returns of small and large caps, but more strongly those of small caps (Amihud, 2002; Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005; Bekaert et al., 2007; Watanabe and Watanabe, 2008; Lee, 2011; Acharya et al., 2013; Amihud et al. 2015; Amihud and Noh, 2021; Amihud, 2019). To verify the robustness of our results, we carry out three tests in the next section.

4. Robustness testing

We conduct three robustness tests to verify results found about the relationship between illiquidity and stock returns. In the first test, we use different weighting methods to compute portfolios returns and we estimate Eq. 9 separately for each method. In the second test, we make the illiquidity effects on stock returns not conditioned to market performance, i.e., without taking into account the effect of illiquidity shock on market returns. In the third test, we employ an alternative measure of stock illiquidity and we estimate Eq. 9 based on different illiquidity measures.

4.1. First robustness test (computing portfolio returns using different weighting methods)

- Return-weighted average, each weekly stock return Ri,t is multiplied by a weight proportional to its prior-week gross return. This method used by Amihud et al. (2015) and Asparouhova et al. (2013) corrects for microstructure noise bias pointed out by Blume and Stambaugh (1983):

$$w_{i,t} = \frac{1+R_{i,t-1}}{\sum_{i=1}^{n} 1+R_{i,t-1}} \tag{10}$$

- Volume-weighted average, each weekly stock return is weighted by the monetary trading volume of the preceding week. This method, used by Amihud et al. (2015), also helps to reduce bias due to microstructure noise.

$$w_{i,t} = \frac{Vol_{i,t-1}}{\sum_{i=1}^{n} Vol_{i,t-1}} \tag{11}$$

Results in Table 6 show that effects of both expected and unexpected market illiquidity on portfolio returns are stronger and more statistically significant when the return-weighted method is used. The effect of expected market illiquidity on returns of both portfolios remains negative and statistically insignificant, except for small-cap portfolios when the return-weighting method is used. The effect of unexpected market illiquidity (illiquidity shocks) on small-cap portfolio returns remains negative and significant, except for small-cap portfolios when the stock returns are weighted by trading volume. However, the effect of illiquidity shocks on large-cap portfolio returns becomes significant when portfolio returns are computed by return-weighted and volume-weighted methods.

Table 6: Estimation results of the CAPM adjusted to market illiquidity factor and risk

	Small-Cap Portfolio		Large-Cap Portfolio	
	Return weighting	Volume weighting	Return weighting	Volume weighting
α	-0.049 (-0.388)	0.080 (0.485)	-0.097 (-1.316)	-0.025 (-0.187)
β_m	0.852 (15.161)	0.978 (13.267)	0.973 (29.776)	1.110 (18.279)
γ_{Milliq}	-0.391 (-2.134)	-0.392 (-1.630)	-0.061 (-0.572)	-0.057 (-0.289)
β_{Silliq}	-0.152 (-3.148)	-0.097 (-1.531)	-0.054 (-1.922)	-0.091 (-1.749)
R^2	41%	34%	71%	48%

Note: values in parentheses indicate the t-student

4.2. Second robustness test: Effects of market illiquidity are not conditioned to market performance

To appreciate parsimoniously the effects of both expected and unexpected market illiquidity on portfolio returns, we do not consider the effect of illiquidity shocks on market returns. We remove the market risk factor from Eq. 9. The pair of regressions become as follows:

$$\begin{cases} R_t^L - R_{f,t} = \alpha'^L + \left(\gamma'^L_{Milliq} \times \Delta BMilliq_{t-1}\right) + \left(\beta'^L_{Silliq} \times Silliq_t\right) + \varepsilon'^L_t \\ R_t^S - R_{f,t} = \alpha'^S + \left(\gamma'^S_{Milliq} \times \Delta BMilliq_{t-1}\right) + \left(\beta'^S_{Silliq} \times Silliq_t\right) + \varepsilon'^S_t \end{cases} \tag{12}$$

Estimation results of Eq. 12 are summarized in Table 7. Even without conditioning market illiquidity effects to the market risk, the effects of expected market illiquidity on returns of both portfolios remains insignificant, except for small-cap portfolio under the return-weighting method. In addition, the effect of illiquidity shocks on small-cap portfolio returns remains negative and highly statistically significant, but it becomes significant on large-cap portfolio returns. Effects of market illiquidity shocks on both portfolios become stronger. Indeed, estimates of beta Silliq are almost double those of the model including the beta market (Eq. 9). This corroborates the findings of Amihud (2002).

4.3. Third robustness test: Using an alternative measure to estimate illiquidity

We employ the "Zero-return" ratio (ZR) of Lesmond et al. (1999) average over the week.

Lesmond (2005) examined the illiquidity of 31 emerging markets and prove that the zero-return ratio and the Amihud (2002) measure are the best performers within-country analysis. Bekaert et al. (2007) find that zero-returns are frequently observed and fairly persist in emerging markets. They demonstrate that ZR is highly correlated with the bid-ask spread. $ZR_{i,t}$, is defined as the proportion of zero return days within a week. Zero returns occur when informed traders are not willing to trade.

Table 7: Estimation results of illiquidity effects without conditioning illiquidity shock to market performance

	Small-cap portfolio			Large-cap portfolio		
	Return weighting	Value weighting	Volume weighting	Return weighting	Value weighting	Volume weighting
α'	0.079 (0.500)	-0.051 (-0.338)	0.227 (1.146)	0.050 (0.377)	0.060 (0.390)	0.141 (0.765)
γ'_{Milliq}	-0.454 (-1.970)	-0.257 (-1.173)	-0.463 (-1.605)	-0.132 (-0.689)	-0.226 (-1.009)	-0.138 (-0.515)
β'_{Silliq}	-0.307 (-5.199)	-0.277 (-4.925)	-0.275 (-3.717)	-0.232 (-4.705)	-0.231 (-4.014)	-0.294 (-4.260)
R^2	7%	6%	4%	5%	4%	4%

Note: Values in parentheses indicate the t-student

Illiquid stocks are more likely to exhibit zero volume days, hence zero returns. Therefore, market illiquidity, $ZR_{M,t}$, is measured by the equally weighted average of Zero returns ratios of stocks $ZR_{M,t}$. We find that the times series of market illiquidity measured by $ZR_{M,t}$ is stationary. The first order autocorrelation at a weekly frequency of $ZR_{M,t}$ is 0,62. We measure shocks in market illiquidity by the innovations extracted from the autoregressive model AR(3) that predicts market illiquidity ($ZR_{M,t}$). $Silliq_t^Z$ denotes market Illiquidity shocks. They are weakly correlated (autocorrelation coefficient is equal to -0,01). The pair of regressions become:

$$\begin{cases} R_t^L - R_{f,t} = \alpha^{L,Z} + \left(\beta_m^{L,Z} \times (R_{m,t} - R_{f,t})\right) + \left(\gamma_{Milliq}^{L,Z} \times ZR_{M,t-1}\right) + \left(\beta_{Silliq}^{L,Z} \times Silliq_{Z,t}\right) + \varepsilon_t^{L,Z} \\ R_t^S - R_{f,t} = \alpha^{S,Z} + \left(\beta_m^{S,Z} \times (R_{m,t} - R_{f,t})\right) + \left(\gamma_{Milliq}^{S,Z} \times ZR_{M,t-1}\right) + \left(\beta_{Silliq}^{S,Z} \times Silliq_{Z,t}\right) + \varepsilon_t^{S,Z} \end{cases} \quad (13)$$

where β_m^Z and β_{Silliq}^Z measure respectively sensitivity of excess return of each portfolio to the market return and to illiquidity shocks when illiquidity is measured by the zero-return ratio. γ_{Milliq}^Z measures the effect of expected market illiquidity on portfolio excess returns.

Based on ZR as an alternative measure of illiquidity, results in Table 8 show that expected market illiquidity lowers small-cap portfolio returns but has no effect on large-cap portfolio returns. This is different from findings based on Amihud's measure where the negative effect of expected market illiquidity is insignificant statistically and values of estimated coefficients are low. Regarding the unexpected market illiquidity, the effect on returns is negative and statistically significant on the small-cap portfolio, specifically when return-weighting and value-weighting methods are employed. This negative effect is stronger than that based on Amihud (2002)'s measure. This corroborates the findings of Lesmond (2005), Bekaert et al. (2007), and Lee (2011) where the "zero-return" illiquidity measure reflects significantly the relationship between returns and illiquidity. We also find that illiquidity shocks have no effect on large-cap portfolio returns. This is consistent with findings based on Amihud (2002)'s measure.

Table 8: Estimation results of the adjusted CAPM to illiquidity measured by the "Zero-return" ratio

	Small-cap portfolio			Large-cap portfolio		
	Return weighting	Value weighting	Volume weighting	Return weighting	Value weighting	Volume weighting
α^z	0.169 (0.722)	0.107 (0.515)	0.283 (0.926)	-0.119 (-0.875)	-0.221 (-1.202)	-0.231 (-0.916)
β_m^z	0.886 (16.073)	0.901 (18.395)	0.990 (13.738)	0.988 (30.936)	1.054 (24.309)	1.131 (19.077)
γ_{Milliq}^z	-1.7637 (-1.890)	-1.664 (-2.008)	-1.759 (-1.443)	-0.034 (-0.062)	0.228 (0.312)	0.737 (0.735)
β_{Silliq}^z	-1.596 (-1.939)	-2.049 (-2.804)	0.966 (0.899)	-0.057 (-0.120)	-0.063 (-0.098)	-0.0153 (-0.017)
R^2	40%	47%	33%	71%	60%	48%

Note: values in parentheses indicate the t-student

5. Summary and conclusion

To the best of our knowledge, our research is the first to unify three forms of illiquidity in one study to examine the return-illiquidity relationship. We consider illiquidity as a characteristic of the stock, as a characteristic of the market, and as a systematic risk. Moreover, while the majority of previous studies on illiquidity focused on U.S markets, our study investigates illiquidity in an emerging market that often suffers from a lack of liquidity. We evaluate the effects over time of illiquidity on

Tunisian stock returns according to three hypotheses, i.e., H1: investors require compensation for expected market illiquidity, H2: market illiquidity shocks lowers contemporaneous stock prices, H3: effects of illiquidity on stock returns depends on the illiquidity degree of the stock.

We measure stock illiquidity by Amihud (2002)'s ratio at a weekly frequency. We compute the market-wide illiquidity by the average illiquidity levels of individual stocks. We measure shocks in market illiquidity by the residuals extracted from the autoregressive model that predicts market illiquidity. Illiquidity risk is reflected by the sensitivity of stock returns to illiquidity shocks. To examine the illiquidity-return relationship over time, we add to the classical capital asset pricing model two illiquidity factors related to the expected and the unexpected (shocks) market illiquidity. In addition, to detect whether this relationship varies with the degree of illiquidity of the stock, we run the adjusted capital asset pricing model separately for small-cap portfolios and large-cap portfolios.

Our findings show that expected market illiquidity has no effect on excess returns. In other words, investors on the Tunisian stock exchange do not require compensation for expected market illiquidity. This attitude is different from that of investors on U.S. markets (Amihud, 2002; Amihud et al., 2015; Amihud and Noh, 2021; Amihud, 2019) who require higher returns when they expect a rise in market illiquidity. Moreover, based on the comparison between portfolios sorted by size, we find that only small-cap portfolio is exposed to illiquidity risk. Indeed, returns of a large-cap portfolio are not sensitive to illiquidity shocks on the Tunisian Stock Exchange. This differs from previous studies on the U.S. and developed markets where illiquidity shocks affect negatively returns of all stocks and this negative effect is stronger on small caps (Pastor and Stambaugh, 2003; Acharya and Pedersen, 2005; Acharya et al., 2013; Amihud et al., 2015; Amihud and Noh, 2021; Amihud, 2019).

To verify the robustness of our results, we run three tests. In the first test, portfolios returns are computed by different weighting methods. We find that when portfolio returns are computed by the return-weighting method, the illiquidity-return relationship becomes more significant and stronger. Large and small caps are negatively affected by illiquidity shocks, but large-caps returns remain not sensitive to expected market illiquidity.

In the second test, we estimate parsimoniously the illiquidity-return relationship, i.e., without conditioning, the effect of market illiquidity shocks on market performance. Results show that both large-cap and small-cap portfolios' contemporaneous returns are negatively affected by market illiquidity shocks. This negative illiquidity effect is higher than that resulting from regression including market performance factor.

In the third robustness test, we use an alternative illiquidity measure, the "zero-returns" ratio of Lesmond et al. (1999). Estimation results indicate a stronger relationship between illiquidity and returns. The magnitude of illiquidity effects is multiplied by more than 10 compared to the effect measured by Amihud's measure. Findings show that expected and unexpected market illiquidity affect negatively small-cap portfolios, while large-cap portfolio returns remain not affected.

We conclude that the "zero returns" ratio is more suitable to evaluate the relationship between illiquidity and returns on the Tunisian stock exchange than Amihud's ratio. This is consistent with the findings of Lesmond (2005) and Bekaert et al. (2007). We also conclude that market illiquidity (as a characteristic and as a risk) on the Tunisian Stock exchange effect (negatively) prices of small caps only, while those of large caps are not sensitive to it. Overall, our research attempts to provide a complete picture of the "illiquidity-return relationship" on an emerging stock market. Examination of this relationship can be based also on the three factors model of Farna and French (1993) or the four factors model of Carhart (1997) to illiquidity.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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