Illiquidity and stock returns: the moderating role of investors' holding period in Central and Eastern European markets

Investor holding period and liquidity premium

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Abstract

Purpose – The positive illiquidity–return relationship (so-called liquidity premium) is a well-established pattern in international developed stock markets. The magnitude of liquidity premium should increase with market illiquidity. Existing studies, however, do not confirm this conjecture with regard to frontier markets. This may result from applying different approaches to the investors' holding period. The paper aims to identify the role of the holding period in shaping the illiquidity–return relationship in emerging and frontier stock markets, which are arguably considered illiquid.

Design/methodology/approach – The authors utilise the data on stocks listed on fourteen exchanges in Central and Eastern Europe. The authors regress stock returns on liquidity measures variously transformed to reflect the clientele effect in a liquidity–return relationship.

Findings – The authors show that the investors' holding period moderates the illiquidity–return relationship in CEE markets and also show that the liquidity premium in these markets is statistically and economically relevant.

Practical implications – The findings may be of great interest to investors, companies and regulators. Investors and companies should take liquidity into account when making decisions; regulators should employ liquidity-enhancing actions to decrease companies' cost of capital and expand firms' investment opportunities, which will improve growth perspectives for the entire economy.

Originality/value – These findings enrich the understanding of the role that the investors' holding period plays in the illiquidity–return relationship in CEE markets. To the best knowledge, this is the first study which investigates the effect of holding period on liquidity premium in emerging and frontier markets.

Keywords Liquidity premium, Holding period, CEE countries

Paper type Research paper

1. Introduction

Risk-averse investors prefer to hold less risky stocks until they are compensated for bearing additional risk. Similarly, investors prefer to allocate their capital into liquid investments until they are compensated for lower liquidity. Thus, in equilibrium, less liquid investments must offer higher expected returns to ensure efficient capital allocation in the market. In their seminal paper, Amihud and Mendelson (1986a) prove that expected capital assets returns are functions of both, liquidity and investment holding period. As up-to-date research concerns mainly the liquidity itself as a driver of expected stock returns, in this paper we aim to

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empirically test the role the holding period plays in a liquidity–return relationship. If the holding period significantly affects this relationship, assuming an inappropriate holding period may result in biased estimation of the liquidity premium, which may thus result in an inefficient capital allocation in the economy.

The negative liquidity–return relationship (hereafter also referred to as the liquidity premium) is quite a well-established cross-sectional pattern within international developed stock markets. Similar studies carried out on emerging or frontier capital markets still yield ambiguous results. Bekaert *et al.* (2007) and Amihud *et al.* (2015) found that the liquidity premium in emerging markets is higher than in developed ones, which is the result of the overall lower level of liquidity in these markets. One should thus expect the liquidity premium in frontier markets, which are arguably far less liquid than even emerging markets, to be higher than in emerging markets. However, Batten and Vo (2014) and Stereńczak *et al.* (2020) found the liquidity–return relationship to be insignificantly positive in frontier equity markets. So why does the positive illiquidity–return relationship not hold in the least liquid (frontier and some of the emerging) markets?

The liquidity effect on stock returns depends not only on the amount of liquidity costs themselves, but also on the frequency of trading and, in turn, the frequency of incurring these costs (Amihud and Mendelson, 1986a; Anginer, 2010; Chalmers and Kadlec, 1998; Florackis *et al.*, 2011; Næs and Ødegaard, 2009). Thus, investors with a short investment horizon hold highly-liquid assets while long-term investors prefer less liquid shares (*clientele effect*) (Amihud and Mendelson, 1986a; Anginer, 2010; Atkins and Dyl, 1997).

The liquidity clientele effect causes the liquidity–return relationship to be nonlinear, and stock returns to be a growing and concave function of liquidity costs. The most common approach to the concavity of the illiquidity–return relationship is the log-transformation of illiquidity measures. However, as the results of the study by Gniadkowska-Szymańska (2016) suggest, the log-transformation of the illiquidity measure may not fully reflect the clientele effect in less liquid (emerging or frontier) markets. This could imply that simply taking the log of spread (and other liquidity measures) when analysing the liquidity–return relationship in emerging and frontier markets, that are considered illiquid, may lead to biased results.

Thus, the paper aims to identify the role of the investors' holding period in shaping the illiquidity–return relationship in arguably less liquid (emerging and frontier) stock markets. To this end, we utilise the data on stocks listed on stock exchanges in fourteen Central and Eastern European (also CEE herein) countries (Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Serbia, Slovenia, Slovakia and Ukraine). CEE markets provide a good empirical setting to study the role of the investors' holding period in the liquidity premium. While similar in their history, geographical location, investors' profile and legal framework, CEE markets differ significantly in terms of size (measured by both the number of listed companies and capitalisation), liquidity, integration with the global economy, and development. According to the MSCI classification, CEE markets are either emerging (Czechia, Hungary, Poland and Russia) or frontier (Bulgaria, Croatia, Estonia, Lithuania, Romania, Serbia, Slovenia and Ukraine). Latvia and Slovakia are not covered by any MSCI index.

All these countries share a common history, as the market economy appeared there only after 1989. The capital markets of Central and Eastern Europe may not seem attractive, as their capitalisation constitutes only a small fraction of global capitalisation and they are very illiquid. The average bid-ask spread on CEE markets equals 5.61%, as compared to an average of 1.96% in developed markets (Fong *et al.*, 2017). CEE markets are also characterised by highly concentrated trading and ownership. In Poland and Russia the 3 largest shareholders hold about 85% of shares on average, and the percent free-float is 20% on average (De La Cruz *et al.*, 2019). However, while being less integrated with the global economy, CEE markets may offer some diversification benefits for global investors. Thus, these markets are an important area of research, as they offer a unique opportunity for international investors and yet, surprisingly, are under-researched. In addition, their importance may be set to grow.

All the features of CEE stock markets, especially low liquidity and shareholders' structure, allow us to conjecture that the investors' holding period may play a significant role in liquidity effects in these markets. Moreover, the geographic proximity of these countries allows us to conjecture that CEE markets have common pricing factors. As the group of CEE markets consists of both emerging and frontier markets, our results could possibly be expanded to other emerging and frontier markets that are definitely less liquid than developed stock markets.

The study provides several important contributions to the literature. Our first contribution is an examination of the liquidity premium in fourteen CEE stock markets. The existing research does not cover most of the markets covered by our study and reports ambiguous results. Moreover, studies covering some of the markets included in our sample apply filters that discard a significant number of firms. For example, Stereńczak *et al.* (2020) dropped on average 54% of stock-month observations in the countries covered by their study and ours, while we discard only 27%. Our study suggests that the liquidity premium in CEE markets is both statistically significant and economically relevant. One standard deviation increase in the illiquidity measure causes an increase in monthly stock return by about 0.3 p.p.

Our second contribution emerges from the analysis of the role the investors' holding period plays in shaping the stock liquidity–return relationship in emerging and frontier markets. While most research is focused on various transformations of liquidity measures to reflect the clientele effect, our study shows that such a transformation is insufficient, as the relationship between the stock illiquidity investors' holding period is much more complex when markets are illiquid and the ownership concentrated. Our study shows that one should use liquidity measures amortised over the holding period to analyse the liquidity premium in emerging and frontier markets.

Furthermore, the contribution of the paper comes from the fact that the study utilises a unique methodology. We study the relationship between liquidity and returns on a single stock level, rather than on a portfolio level. As pointed out by Amihud and Noh (2021b), testing the asset pricing patterns on individual stocks has some advantages over testing on stock portfolios. The use of portfolios sorted on stock characteristics as test assets may impart a strong factor structure across them, which in turn may lead to biased results. Moreover, such results may be sensitive to a subjective choice of sorting stock characteristics. Using single stock as test assets may lead to bias due to errors-in-variables, though we address this problem by employing estimators designed for panel data analysis.

The remainder of the paper is structured as follows. The next section presents a brief literature overview. Then we move to the presentation of the methodology of the study, followed by the empirical results. The final section concludes.

2. Literature review and hypothesis development

2.1 Illiquidity–return relationship

In their seminal paper, Amihud and Mendelson (1986a) developed the model of the relationship between the return expected on stock and its liquidity, and found that stock returns are an increasing and concave function of the spread. This results from the liquidity clientele effect, i.e. that short-term investors prefer more liquid shares while long-term investors allocate relatively illiquid stocks to their portfolios. This is in line with Constantinides' (1986) proposition that investors tend to rebalance their portfolios less frequently when they face high illiquidity. Both a longer holding period and less frequent portfolio rebalancing are aimed at reducing the overall liquidity costs incurred.

A positive illiquidity–return relationship (liquidity premium) is a quite well-established pattern within developed stock markets. Recent studies by Amihud (2019), Amihud *et al.* (2015), Amihud and Noh (2021a, b), Guo *et al.* (2017), Hsieh and Nguyen (2021), Chulia *et al.* (2021), among others, confirm that lower stock liquidity results in higher stock returns in the US and other developed markets. Studies on international markets suggest that the liquidity premium is stronger in emerging markets than in developed ones (Amihud *et al.*, 2015; Bekaert *et al.*, 2007; Ben-Rephael *et al.*, 2015). A higher liquidity premium in emerging markets results from the overall lower level of liquidity in these markets. This is in line with Jensen and Moorman (2010), Ben-Rephael *et al.* (2015), He and Kryzanowski (2006) and Hsieh and Nguyen (2021), who prove that when market liquidity is low, the illiquidity return premium tends to be high.

Generally speaking, the liquidity premium in emerging markets should be higher than in developed markets as emerging markets exhibit higher illiquidity. One should thus expect the liquidity premium in frontier markets to be higher than in emerging markets, as frontier markets are even less liquid than emerging ones. Surprisingly, Batten and Vo (2014) and Stereńczak *et al.* (2020) found the illiquidity–return relationship to be insignificantly negative in frontier markets. However, the studies presented above differ in the approach to the investors' holding period, which could influence the results.

2.2 Different approaches to the investors' holding period and illiquidity–return relationship

Standard procedures applied in asset pricing studies seem to neglect the liquidity clientele effect, as they assume frequent portfolio rebalancing, which means that they assume holding periods equal to all stocks. Assuming an inappropriate holding period may result in biased estimation of the liquidity premium. Neglection of the clientele effect in asset pricing studies may be the cause of the ambiguity about the liquidity premium in recent studies. As an example, a recent study by Cakici and Zaremba (2021) has proved that liquidity premium is observable only among microcap, hardly investable stocks. Since large stocks are most heavily traded (their holding periods are relatively short), assuming that their holding periods are equal to the holding periods of microcap stocks may lead to biased results.

To incorporate the holding period into the analysis of the relationship between liquidity and stock returns (liquidity premium), in several studies stock (or portfolio) returns have been regressed on stock characteristics. In such regressions, measures of stock liquidity are one of the explanatory variables and are transformed to reflect the concavity of the relationship. The most popular transformation is the logarithmic one (Amihud and Mendelson, 1986b; Eleswarapu and Reinganum, 1993; Harris and Amato, 2019), but the square-root transformation of liquidity measures is also applied (see, e.g. Chordia *et al.*, 2009; Hasbrouck, 1999, 2009). The log or square-root transformation of liquidity measure has an additional advantage in regression analysis. Raw values of liquidity measures often reveal elevated skewness and kurtosis, and taking the logarithm makes their distributions closer to normal.

Another way to include a holding period in the analysis of the relationship between stock liquidity and returns is by amortising liquidity measures. Amortised liquidity measures are simply liquidity measures over investors' holding periods. The essence of amortisation is because liquidity costs are incurred by investors only at the moment of the purchase and the moment of sales. Thus, the longer the holding period is, into more periods liquidity costs can be divided. Therefore, the required compensation for liquidity costs (liquidity premium) per one period should decrease with an increase in the investment horizon. As evidenced by He and Kryzanowski (2006), stock returns should be growing and linear functions of amortised spread, not growing and concave functions of the spread itself.

The amortisation of liquidity measure was first used by Chalmers and Kadlec (1998) who have used amortised spreads as the measure of liquidity for NYSE and AMEX stocks and found that the observed liquidity premium is stronger when one uses an amortised spread (bid-ask spread scaled by the holding period) instead of a simple spread (even log-transformed to reflect the concavity of the relationship). However, Marshall and Young (2003) have found a significantly negative relationship between spread and returns, as well as a positive (though insignificant) relationship between amortised spread and returns in the

Australian Stock Market. Concerning emerging markets, recent studies by Stereńczak (2021) have utilised amortised liquidity measures to analyse the liquidity premium in the Warsaw Stock Exchange. He found a significantly positive relationship between amortised liquidity measures and stock returns.

2.3 Hypothesis development

Amortising the liquidity measures in order to take investors' holding periods into account may have some advantages over the logarithmic transformation of liquidity measures, especially in non-developed markets. As evidenced by Anginer (2010), liquidity clientele effect is stronger among more sophisticated investors. Karolyi *et al.* (2020) in turn suggest that investors in emerging economies are presumably less sophisticated than those in developed economies. Combining the two studies, one may conjecture that the liquidity clientele effect is less pronounced in emerging and frontier markets, which is empirically evidenced by Gniadkowska-Szymańska (2016), who found log spreads (together with some control variables) have explained only from 9.4% to 20% (dependent on the data frequency) of the variations in investors' holding periods in the Warsaw Stock Exchange. In a comparable study by Atkins and Dyl (1997), log spreads explained 27.2% (for NYSE stocks) and 43.4% (for Nasdaq firms) of the variation in holding periods. Thus, a relationship between liquidity and holding periods may be more complex in relatively less liquid markets. This may result in biased estimation of the liquidity premium when applying log liquidity measures instead of amortised ones.

Also, some recent theoretical studies put stress on the role that investment horizon plays in estimating the liquidity premium. Beber *et al.* (2021) demonstrate that the investment horizon has a considerable impact on the way liquidity affects asset prices. Pereira and Zhang (2010) and Stereńczak (2020), by calibrating their models for different investment horizons showed that, keeping liquidity costs constant, a change in investment horizon results in a significant change in liquidity premium.

Equally important, as evidenced by Daryaei and Fattahi (2022), with an increase in institutional ownership up to a certain level, the relationship between liquidity and stock returns strengthens. However, when institutional ownership exceeds a certain level, its further increase results in a weakening of the liquidity–return relationship. As ownership structure is closely related to the investors' holding period, one could conjecture that the investors' holding period impacts the strength of the illiquidity–return relationship. The above considerations lead us to the following hypothesis.

Hypothesis. The investors' holding period moderates the relationship between illiquidity and stock returns in CEE markets.

3. Methodology and data

3.1 Research sample

Our study covers companies listed on exchanges located in fourteen countries in Central and Eastern Europe: Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Serbia, Slovenia, Slovakia and Ukraine. Our basic source of data is S&P Capital IQ and our initial coverage encompasses CEE markets companies available in this database, both survivors and non-survivors. Our sample period runs from January 2007 to December 2020, and its length is dictated by the availability of data on the bid and ask prices. Including an earlier period in our sample would cause a higher overrepresentation of Polish companies. Overall, our initial sample comprises 2,142 firms and 206,544 stock-month observations.

To be included in the research sample in month *t*, we require a company to have a complete set of financial data and meet our requirements for having estimated at least one of our liquidity measures for month *t-1*, and a return for month *t*. To calculate a liquidity measure, we require data on at least 10 trading days for a stock-month observation. We do not exclude micro- and small-capitalisation firms, penny stocks and least liquid stocks, as CEE exchanges are densely populated with such firms, and this would considerably reduce our research sample. Our final sample consists of 1,552 firms and 159,807 stock-month observations. The structure by country of our sample is presented in Table 1. The fraction of discarded stock-month observations (23%) is much smaller than in recent studies on frontier markets (see, e.g. Stereńczak *et al.*, 2020; Zaremba and Maydybura, 2019), in which 61% of observations have been discarded due to the filters applied.

3.2 Variables

To encompass more than just one liquidity dimension, we utilise two liquidity measures. First, we use the Percent Quoted Closing Spread (*PQCS*), which is the relative bid-ask spread quoted at the end of the trading day (Chung and Zhang, 2014). Recent studies indicate this measure as the best performing proxy for transaction costs (Chung and Zhang, 2014; Fong *et al.*, 2017). Most research suggests that the best proxy of a price impact dimension is the Amihud (2002) illiquidity measure (ILLIQ). This has been proved true for developed (Fong *et al.*, 2017), emerging (Ahn *et al.*, 2018) and frontier (Marshall *et al.*, 2013) stock markets. Thus, we use Amihud's (2002) *ILLIQ* as our second liquidity measure; we calculate it with the daily value of shares traded expressed in millions of EUR and the return in the numerator replaced by the log of the daily price range. This helps us to capture the short-lived price pressure that disappears before the end of the trading day. As indicated in recent studies, such a modification overperforms the standard Amihud measure in CEE markets (Będowska-Sójka, 2018; Stereńczak, 2019). To account for the outliers, we cross-sectionally winsorise computed liquidity measures at 2.5 and 97.5 percentile.

For the purpose of the study, we calculate excess (over risk-free return) monthly log returns (*ret*), based on the closing prices denominated in EUR on the last trading day in a month. We assume the risk-free is equal to one-month EURIBOR. We also include other firm characteristics as a set of control variables in our analyses. We use the logarithm of capitalisation expressed in millions of EUR (*Size*) as our proxy for firm size. Growth opportunities are proxied by the book-to-market ratio (*B-MV*), computed as the book value of equity scaled by capitalisation. *Risk* is an annualised standard deviation of weekly returns from the previous twelve months. *Momentum* is a cumulative log return from the months from $t-12$ to $t-2$, and *Reversal* is a return from month $t-1$.

Table 2 presents the summary statistics for all the variables used in our study as well as statistics of the Fisher-type ADF test of the unit-root for panel data. It is visible that liquidity measures exhibit elevated skewness and kurtosis, especially amortised ones. However, log-transformed liquidity measures' distributions are close to normal. Noticeably, the mean *PQCS* in our sample equals 5.61% and is higher than in the Stereńczak *et al.* (2020) sample of frontier markets (4.4%), which may be a result of the filters that excluded the least liquid stocks from their sample. The statistics of the Fisher-type ADF tests (Choi, 2001; Maddala and Wu, 1999) of the panel unit-root indicate that all variables are stationary. We are not able to apply other tests of the panel unit-root (e.g. Harris and Tzavalis, 1999; Im *et al.*, 2003; Levin *et al.*, 2002) as they are designed for balanced panels and in our sample the number of periods varies between panel units.

Table 3 reports the correlations among the variables for the pooled sample. Log-transformed liquidity variables are highly correlated with *Size*, which is evidenced in the

Table 1. Structure of the research sample

Country	Unfiltered sample				Filtered sample				% of discarded	
	Firms	Observations	% of firms	% of observations	Firms	Observations	% of firms	% of observations	Firms	Observations
Bulgaria	236	21,150	11.02%	10.24%	102	8,093	6.57%	5.06%	57%	62%
Croatia	115	13,872	5.37%	6.72%	76	10,019	4.90%	6.27%	34%	28%
Czechia	62	3,018	2.89%	1.46%	24	1,831	1.55%	1.15%	61%	39%
Estonia	24	2,633	1.12%	1.27%	20	2,405	1.29%	1.50%	17%	9%
Hungary	103	7,701	4.81%	3.73%	56	5,840	3.61%	3.65%	46%	24%
Latvia	34	3,274	1.59%	1.59%	19	2,276	1.22%	1.42%	44%	30%
Lithuania	41	4,465	1.91%	2.16%	35	3,893	2.26%	2.44%	15%	13%
Poland	864	96,217	40.34%	46.58%	831	85,862	53.54%	53.73%	4%	11%
Romania	90	11,542	4.20%	5.59%	76	9,525	4.90%	5.96%	16%	17%
Russia	251	24,813	11.72%	12.01%	210	20,941	13.53%	13.10%	16%	16%
Serbia	181	7,899	8.45%	3.82%	41	2,679	2.64%	1.68%	77%	66%
Slovakia	31	2,591	1.45%	1.25%	10	1,154	0.64%	0.72%	68%	55%
Slovenia	70	4,344	3.27%	2.10%	27	2,980	1.74%	1.86%	61%	31%
Ukraine	40	3,025	1.87%	1.46%	25	2,309	1.61%	1.44%	38%	24%
Total	2,142	206,544	100%	100%	1,552	159,807	100%	100%	28%	23%

Note(s): The table presents the structure by country of a research sample

Variable	Mean	Std.Dev	Skewness	Kurtosis	5th percentile	Median	95th percentile
Panel A: Raw values							
ret	−0.0017	0.075	0.371	38.500	−0.1027	−0.0012	0.1010
PQCS	0.0561	0.110	7.536	78.587	0.0030	0.0278	0.1725
ILLIQ	98.796	500.21	28.085	1,417	0.027	10.477	388.31
Turnover	0.0258	0.178	60.309	5425.3	0.0002	0.0055	0.0841
free float	0.329	0.253	0.744	−0.017	0.0000	0.294	0.843
amPQCS	0.00095	0.0084	68.700	7249.9	0.000005	0.00013	0.00299
amILLIQ	1.640	23.684	90.888	12,630	0.0003	0.046	4.037
amPQCS^{FF}	0.00377	0.082	148.97	29,264	0.000028	0.00045	0.0101
amILLIQ^{FF}	7.839	319.03	210.58	48,698	0.0009	0.181	16.383
Size	3.348	2.507	0.417	0.055	−0.464	3.164	7.925
B-MV	1.614	20.849	57.603	8919.7	0.032	0.925	4.912
Risk	0.534	0.425	5.562	90.699	0.171	0.416	1.266
Momentum	−0.015	0.260	0.238	7.8114	−0.424	−0.005	0.361
Reversal	−0.0015	0.075	0.351	38.543	−0.103	0.000	0.101
Panel B: Logarithms of liquidity variables							
PQCS	−3.649	1.268	−0.306	0.750	−5.800	−3.584	−1.757
ILLIQ	2.008	2.851	−0.762	0.741	−3.610	2.349	5.962
amPQCS	−8.945	1.933	−0.097	0.507	−12.169	−8.924	−5.812
amILLIQ	−3.195	2.890	−0.164	0.012	−8.220	−3.075	1.396
amPQCS^{FF}	−7.632	1.809	0.143	0.343	−10.479	−7.691	−4.594
amILLIQ^{FF}	−1.839	2.970	−0.192	−0.080	−7.005	−1.711	2.796

Variable	*t*-statistic	χ^2-statistic
Panel C: Unit-root Fisher-type ADF statistics		
ret	−640.412***	9.10e+04***
PQCS	−297.381***	4.24e+04***
ILLIQ	−450.826***	6.30e+04***
Log(PQCS)	−238.101***	3.41e+04***
Log(ILLIQ)	−298.792***	4.19e+04***
amPQCS	−426.250***	5.91e+04***
amILLIQ	−532.985***	7.27e+04***
Size	−31.286***	6530.002***
B-MV	−45.872***	7944.434***
Risk	−13.986***	4857.202***
Momentum	−47.907***	8270.745***
Reversal	−638.147***	9.06e+04***

Note(s): The table presents the descriptive statistics for the entire research sample. Variables' definitions are given in the methodological section. Panel A shows statistics for raw values of variables, while Panel B shows the logarithms of liquidity variables, and Panel C presents statistics of the Fisher-type ADF test of the unit-root and asterisks denote the statistical significance at the 0.1 (*), 0.05 (**) and 0.01 (***) levels

Table 2.
Descriptive statistics

literature. However, raw and amortised liquidity measures are much less correlated with *Size*. Also, *Risk* highly correlates with liquidity measures and *Size*. High correlation among variables could raise collinearity concerns in our regressions. However, the Variance Inflation Index (VIF) and BKW diagnostics (Belsley *et al.*, 1980) suggest no collinearity concerns in our models.

3.3 Methods

In our study, we test the effect of stock liquidity on monthly returns. To this end, we estimate the following basic regressions:

Table 3. Correlation matrix

Variable	*PQCS*	*ILLIQ*	*Log(PQCS)*	*Log(ILLIQ)*	*Turnover*	*Free float*	*amPQCS*	*amILLIQ*	*amPQCS*^{FF}	*amILLIQ*^{FF}	*Size*	*B-MV*	*Risk*	*Momentum*	*Reversal*
ret	−0.003	0.002	−0.007	−0.003	0.034	−0.009	0.045	0.046	0.020	0.011	−0.012	0.007	−0.003	0.020	−0.008
PQCS		0.314	0.624	0.404	−0.026	−0.130	0.071	0.097	0.038	0.037	−0.281	0.031	0.300	−0.080	−0.018
ILLIQ			0.242	0.312	−0.011	−0.036	0.038	0.226	0.017	0.072	−0.199	0.002	0.206	−0.075	−0.018
Log(PQCS)				0.793	−0.043	−0.213	0.087	0.082	0.044	0.031	−0.675	0.009	0.391	−0.145	−0.038
Log(ILLIQ)					−0.054	−0.214	0.054	0.103	0.030	0.037	−0.751	0.011	0.035	−0.164	−0.050
Turnover						0.053	0.716	0.218	0.450	0.048	−0.067	0.108	0.078	−0.003	−0.004
free float							0.019	0.013	−0.025	−0.016	0.124	−0.015	−0.070	−0.045	−0.011
amPQCS								0.367	0.636	0.113	−0.131	0.087	0.118	−0.034	−0.014
amILLIQ									0.141	0.257	−0.108	0.055	0.089	−0.037	−0.014
amPQCS^{FF}										0.497	−0.055	0.075	0.050	−0.015	−0.008
amILLIQ^{FF}											−0.035	0.002	0.028	−0.017	−0.014
Size												−0.033	−0.419	0.192	0.043
B-MV													−0.001	−0.024	−0.005
Risk														−0.058	0.101
Momentum															0.003

Note(s): The table presents the correlations among variables for the entire research sample. Variables' definitions are given in the methodological section

$$ret_{it+1} = \alpha + \beta * Liquidity_{it} + \gamma * Controls_{it} + \varepsilon_{it} \tag{1}$$

where *ret* denotes monthly excess log return on the stock, *Liquidity* denotes one of our liquidity measures, and *Controls* are the control variables as described in the previous subsection. To detect the role of the holding period in estimating the liquidity premium in our research sample, beyond using the raw values we also use logarithms of liquidity measures and their amortised versions as well. The differences in estimated βs for differently captured holding periods allow us to indicate how it should be taken into account when estimating the liquidity premium in markets we consider.

We amortise liquidity measures by dividing their values by the average holding period as proxied by the inverse of the turnover ratio in the following month:

$$amLIQ_{it} = \frac{LIQ_{it}}{HP_{it}} = \frac{LIQ_{it}}{(NoS_{it+1}/V_{t+1})} = LIQ_{it} * \frac{V_{it+1}}{NoS_{it+1}} \tag{2}$$

where *amLIQ* is the amortised value of our liquidity measure (*PQCS* or *ILLIQ*), *HP* is the average holding period, *V* denotes the volume of shares traded and *NoS* is the number of outstanding shares.

In this way, the amortised liquidity measure is indeed averaged across investors with different investment horizons. In fact, as ownership concentration may vary between various stocks, one should take it into account. If not all shares are freely tradeable (are held by long-term investors), the average holding period as computed with the simple inverse of the turnover ratio may be biased upwards. To omit this problem, we also adjust the method of computing the holding period by adjusting the number of outstanding shares by the stock held by long-term investors. We use percent free float for that purpose:

$$amLIQ_{it}^{FF} = \frac{LIQ_{it}}{HP_{it}^{FF}} = \frac{LIQ_{it}}{((NoS_{it+1} * ff_{it})/V_{t+1})} = LIQ_{it} * \frac{V_{it+1}}{NoS_{it+1} * ff_{it}} \tag{3}$$

where ff_{it} denotes the percent of free float shares.

As liquidity measures amortised over the holding period exhibit elevated skewness and kurtosis, in our regressions we also include log-transformations of these variables. Log transformations of the amortised liquidity measures also help us to indicate whether significantly positive coefficients on amortised liquidity measures are not simply the result of dividing the liquidity measure by the holding period. To this end, we could assume the equal value of *PQCS*/*ILLIQ* for all stocks (e.g. equal to 1) and regress stock returns on the reciprocal of the holding period. However, if we take into account that the logarithm of the ratio of two variables is equal to the difference in the logs of these variables, i.e.:

$$log(amLIQ_{it}) = log\left(\frac{LIQ_{it}}{HP_{it}}\right) = log(LIQ_{it}) - log(HP_{it}) \tag{4}$$

we are able to include both the log transformed liquidity measure and the log transformed holding period in the regression.

4. Empirical results

In model (1) the coefficient on *Liquidity* (β) denotes the "per unit" liquidity premium, i.e. the liquidity premium required for the unit of liquidity costs incurred (Stereńczak, 2021). In line with the theory, the estimated β is expected to be significantly positive, as higher values of our liquidity measures denote lower liquidity. Thus, a positive coefficient results in the fact that less liquid stocks yield higher returns than more liquid shares. As our dataset constitutes an unbalanced panel of data, we carry out a series of panel diagnostic tests to indicate the most appropriate method of estimation. Due to the results of the Welch's *F*-test, the Breusch–Pagano test, and the Hausman test, we utilise the fixed effects (FE) estimator with time dummies in all the estimated models. To account for the potential heteroskedasticity and autocorrelation of residuals, we use robust standard errors clustered at the firm level. The results of the estimation are presented in Table 4.

In general, the coefficients on control variables seem to be consistent with the theory and previous research on stock markets. The negative coefficient on *Size* indicates that smaller firms yield higher returns. Though we should expect a positive coefficient on *Risk*, a negative relationship between risk and future returns was reported in some earlier studies (Ang *et al.*, 2006, 2009; e.g. Chalmers and Kadlec, 1998; Stereńczak *et al.*, 2020). Significantly positive coefficients on *Momentum* are also in line with previous findings (e.g. Jegadeesh and Titman, 1993). The coefficients on *Reversal* are consistent with our expectations, though statistically insignificant.

The estimated coefficients on raw (non-transformed) liquidity measures are statistically insignificant, suggesting no clear relationship between liquidity and stock returns. However, coefficients on log-transformed liquidity measures are negative and statistically significant with *t*-statistics equal to 3.421 (*PQCS*) and 2.667 (*ILLIQ*). Significantly negative coefficients on log-transformed *PQCS* and *ILLIQ* suggest the returns are decreasing and concave functions of illiquidity, which is contrary to the theory. All the theoretical models produce propositions stating that returns are increasing functions of stock illiquidity, some models show this function is concave (e.g. Amihud and Mendelson, 1986b), and some – convex (Jacoby *et al.*, 2000), but no theoretical model indicates the illiquidity–return relationship is negative.

The estimated coefficients on amortised liquidity measures are positive and statistically significant at a 0.05 level. This suggests that the amortisation of liquidity measures results in an estimated per unit liquidity premium of a value which is in line with the theory. Only the coefficient on *ILLIQ* amortised over the holding period adjusted for free float is insignificantly positive. This is hardly surprising, as *ILLIQ* measures stock liquidity in terms of the price impact dimension and reflects the liquidity costs for large volume trades, which are frequently carried out by large, often long-term investors. Since $amILLIQ^{FF}$ reflects *ILLIQ* amortised over the average holding period of short-term investors, an insignificantly positive coefficient suggests short-term investors are not concerned about the price impact of their trades (that are rather of small volume).

Taken all together, we can summarise as follows. As the use of raw (non-transformed) liquidity measures neglects the liquidity clientele effect, and the coefficient on non-transformed *PQCS* and *ILLIQ* is (contrary to our expectations) insignificant, we can conjecture that we should take the liquidity clientele effect into account when analysing the illiquidity–return relationship. However, as evidenced by the (contrary to the theory) significantly negative coefficient on log-transformed *PQCS* and *ILLIQ*, log-transformation does not reflect the clientele effect in a liquidity–return relationship in CEE markets. If it did so, the estimated coefficient would be significantly positive. Significantly positive coefficients on amortised *PQCS* and *ILLIQ* seem to support this conjecture.

Not less important, the estimated coefficients on amortised liquidity measures are of economically relevant values. One standard deviation increase in amortised liquidity measure results in an increase in a monthly excess return of about 0.333% (0.119% if we adjust the holding period for free float), which is 195% (66.5%) of the mean excess return and 4.44% (1.51%) of its standard deviation.

Though we find evidence that, unlike raw or log transformations of liquidity measures, amortised liquidity measures are priced coherently with the theory, we should also take into

Table 4.
The effects of stock market liquidity on returns

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
const	0.030***	0.024***	0.029***	0.033***	0.029***	0.031***	0.029***	0.032***
	(8.783)	(6.602)	(9.194)	(10.08)	(8.488)	(8.819)	(9.214)	(9.904)
Size	−0.011***	−0.012***	−0.011***	−0.012***	−0.011***	−0.012***	−0.011***	−0.012***
	(21.28)	(21.30)	(20.28)	(21.20)	(21.09)	(20.88)	(20.37)	(21.29)
B-MV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.362)	(0.360)	(0.009)	(0.0204)	(0.357)	(0.352)	(0.134)	(0.355)
Risk	−0.002	−0.002	−0.002**	−0.002*	−0.002**	−0.002**	−0.002**	−0.002*
	(1.330)	(1.358)	(2.048)	(1.866)	(2.102)	(2.112)	(2.518)	(1.708)
Momentum	0.009***	0.008***	0.009***	0.011***	0.009***	0.009***	0.009***	0.011***
	(6.708)	(6.640)	(7.021)	(7.909)	(7.302)	(7.112)	(7.354)	(7.959)
Reversal	−0.003	−0.004	−0.007	−0.007	−0.003	−0.004	−0.006	−0.008
	(0.590)	(0.604)	(1.502)	(1.544)	(0.539)	(0.609)	(1.376)	(1.580)
PQCS	−0.009							
	(1.221)							
log(PQCS)		−0.002***						
		(3.421)						
amPQCS			0.399**					
			(2.126)					
amPQCS^{FF}				0.014**				
				(2.011)				
ILLIQ					0.000			
					(1.234)			
log(ILLIQ)						−0.0005***		
						(2.667)		
amILLIQ							0.0001**	
							(2.526)	
amILLIQ^{FF}								0.000
								(1.152)
Stock Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	142,767	142,767	137,052	129,240	143,063	143,063	137,379	128,691
LSDV *R*-squared	0.084	0.084	0.087	0.086	0.087	0.087	0.090	0.087
Within *R*-squared	0.073	0.073	0.076	0.075	0.076	0.076	0.079	0.076

Note(s): The table presents the estimated effect of market liquidity on stock returns with different approaches to taking the holding period into account. The dependent variable is the monthly excess (over risk-free return) return on the stock. *t*-statistics are given in the parentheses and asterisks denote the statistical significance at the 0.1 (*), 0.05 (**) and 0.01 (***) levels account that they reveal highly non-normal distribution, which could bias our results. As depicted in Panel A of Table 2, liquidity measures amortised over the holding period exhibit elevated skewness and kurtosis. To check whether our results are not driven mainly due to the non-normal distribution of amortised liquidity measures, we log-transform them to alleviate concerns related to skewness and kurtosis. As presented in Panel B of Table 2, log transformation vividly reduces the skewness and kurtosis of amortised liquidity measures.

The results of the estimation for log transformations of amortised liquidity measures are delivered in Table 5, columns (1)–(4). Coefficients on a log of amortised *PQCS* and *ILLIQ* remain significantly positive. This effect is not only statistically significant but also economically relevant. One standard deviation increase in log-transformed amortised liquidity measures results in an increase of monthly excess return by 1.18–1.28%, which constitutes 15.64–17.05% of its standard deviation.

By log transformation of the amortised liquidity measure we are able to indicate whether significantly positive coefficients on amortised liquidity measures are not simply the result of dividing the liquidity measure by the holding period. To this end, based on equation (4), we include both the log transformed liquidity measures and the log transformed holding period in the regressions. If both variables are significant in the liquidity–return relationship, we should expect significantly positive coefficients on *log(PQCS)* and *log(ILLIQ)* and significantly negative coefficient on *log(HP)* and $log(HP^{FF})$. The results of the estimation are presented in Table 5, columns (5)–(8).

The estimated coefficients are in line with our expectations: in all the regressions, the coefficients on log-transformed liquidity measures are significantly positive, and the coefficients on the log-transformed holding period (also adjusted for free float) are significantly negative. This means that both the level of liquidity and the investors' holding period play a significant role in the liquidity–return relationship, as both are significantly priced. We can thus claim that investors take their expected holding period into account when forming their expectations as to compensations for holding illiquid stocks. Our results are in line with the theory, i.e. the shorter the investment horizon, the higher the compensation for illiquidity (liquidity premium).

Keeping the investors' holding period constant, a one standard deviation increase in *log(PQCS)* (*log(ILLIQ)*) results in an increase of monthly excess return by 0.32–0.35% (0.46–0.56%), which constitutes about 4.5% (6.7%) of its standard deviation. One should remember that an increase in illiquidity would result in an increase in the investors' holding period, hence the above numbers may seem overestimated. However, these numbers (at least for *PQCS*) are similar to respective values for the amortised illiquidity measures. This suggests that the effect of stock liquidity on returns is not only statistically relevant, but also economically.

It is worth noticing that the investors' holding period seems to moderate the relationship between the log-transformed liquidity measure and stock returns, as including the holding period in the regressions changes the value of the estimated coefficient on the log-transformed illiquidity measure from negative to positive. While the coefficient on log-transformed illiquidity measures without controlling for the holding period is significantly negative, this coefficient becomes significantly positive when we control for the investors' holding period. This directly supports our hypothesis on the moderating role of the investors' holding period in the illiquidity–return relationship.

Our results imply that, at least in the CEE stock markets, the effect of liquidity clientele in a liquidity–return relationship cannot be simply reduced to a logarithmic transformation of the liquidity measure. As evidenced, even after the log transformation of *PQCS* and *ILLIQ*, the holding period remains statistically significant in shaping the effect of illiquidity on stock returns. This in turn suggests that assuming a holding period equal for all stocks in asset pricing studies on relatively illiquid markets can lead to a biased estimation of liquidity premium.

Table 5.
The effects of stock market liquidity on returns – the role of the holding period

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
const	0.080***	0.077***	0.033***	0.031***	0.070***	0.066***	0.055***	0.052***
	(18.58)	(18.89)	(10.41)	(9.299)	(16.43)	(15.95)	(14.59)	(13.73)
Size	−0.009***	−0.010***	−0.008***	−0.009***	−0.010***	−0.011***	−0.009***	−0.010***
	(15.88)	(16.82)	(14.36)	(15.22)	(16.51)	(17.23)	(15.03)	(16.07)
B-MV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.256)	(0.195)	(0.307)	(0.291)	(0.245)	(0.200)	(0.244)	(0.206)
Risk	−0.005***	−0.006***	−0.003***	−0.003***	−0.005***	−0.005***	−0.005***	−0.005***
	(4.203)	(4.706)	(3.309)	(2.744)	(4.037)	(4.415)	(4.562)	(3.963)
Momentum	0.009***	0.010***	0.010***	0.011***	0.008***	0.010***	0.009***	0.010***
	(6.775)	(7.267)	(8.021)	(8.057)	(6.383)	(6.774)	(6.950)	(6.906)
Reversal	−0.008*	−0.009*	−0.005	−0.007	−0.009*	−0.010**	−0.008	−0.009*
	(1.772)	(1.904)	(1.098)	(1.369)	(1.860)	(2.018)	(1.593)	(1.913)
log(amPQCS)	0.006***							
	(19.52)							
log(amPQCS^{FF})		0.007***						
		(20.68)						
log(amILLIQ)			0.004***					
			(18.64)					
log(amILLIQ^{FF})				0.004***				
				(18.82)				
log(PQCS)					0.003***	0.003***		
					(5.398)	(4.783)		
log(ILLIQ)							0.002***	0.002***
							(8.397)	(6.822)
log(HP)					−0.007***		−0.007***	
					(19.49)		(20.38)	
log(HP^{FF})						−0.007***		−0.007***
						(20.76)		(21.01)
Stock Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	137,052	129,240	137,379	128,691	137,052	127,240	137,379	128,691
LSDV *R*-squared	0.093	0.095	0.093	0.092	0.093	0.096	0.097	0.097
Within *R*-squared	0.083	0.085	0.083	0.082	0.083	0.085	0.087	0.086

Note(s): The table presents the estimated effect of market liquidity and holding period on stock returns. The dependent variable is the monthly excess (over risk-free return) return on the stock. *t*-statistics are given in the parentheses and asterisks denote the statistical significance at the 0.1 (*), 0.05 (**) and 0.01 (***) levels

5. Robustness tests

To check the robustness of our results we apply a series of tests. First, to ensure that our results are not due to the choice of the specific liquidity measures, we consider two alternative liquidity measures. Thus, we re-estimate equation (1) with two different proxies for liquidity, namely Percent Effective Closing Spread (*PECS*) (Chung and Zhang, 2014) and Amihud's (2002) illiquidity ratio with its original definition (*Amih*). The results of the estimation are presented in Table 6. As presented, the coefficients on log-transformed *PECS* and *Amih* are significantly negative in regressions without controlling for the investors' holding period and become significantly positive after controlling for the holding period. This confirms that the investors' holding period moderates the relationship between stock liquidity and returns, and our conclusions remain unchanged when liquidity is measured differently.

The results presented in Section 4 may be subject to bias due to the heteroskedasticity of residuals. Though we estimate *t*-statistics for the coefficients using robust standard errors clustered at the firm level, we also apply a Weighted Least Squares estimation to check whether the coefficients remain statistically significant if we take the heteroskedasticity into account. To this end, we utilise two different weighting schemes. Our first approach is based on the scheme of Asparouhova *et al.* (2010) and we use 1 plus return from the previous month as a weighting variable.

Our second approach is the Groupwise Weighted Least Squares for panel data. WLS estimates are computed with the weights based on the inverses of the estimated variances of residuals for the respective cross-sectional units in the sample. We iterate this procedure, i.e. at each round, the residuals are re-computed using the current WLS parameter estimates, which gives a rise to a new set of estimates of the variances of residuals, and a hence a new set of weights. Iteration is stopped when the maximum difference in the coefficients estimates from one round to the next falls below 0.0001 or the number of iterations reaches 20.

The results of the estimation with WLS with both weighting schemes are presented in Table 7. The coefficients on the log transformations of our liquidity measures remain significantly positive, while the coefficients on log holding periods remain significantly negative. This suggests that our previous results are not subject to bias resulting from the heteroskedasticity of residuals, and are robust to the choice of the estimation method.

6. Discussion and conclusions

The paper aimed to identify the role the investment holding period plays in a liquidity–return relationship in fourteen CEE stock markets. As CEE capital markets are very illiquid and characterised by highly concentrated trading and ownership, they provide an excellent setting to study the role of investors' holding periods in a liquidity–return relationship. As the group of CEE markets consists of both emerging and frontier markets, our results could possibly be expanded to other emerging and frontier markets that are definitely less liquid than developed stock markets. We conjecture that the investors' holding period does indeed moderate the illiquidity–return relationship in our sample.

We find no convincing evidence that would force us to reject our hypothesis. Coefficients on log-transformed liquidity measures are significantly negative when we do not control for investors' holding period and become significantly positive after controlling for it. It is worth noticing that the coefficients on other control variables remain unchanged. Also, the coefficients on liquidity measures amortised over the average investors' holding period are significantly positive. All our results suggest that investors take their investment horizon into account when forming the expected compensations for stock illiquidity (liquidity premium).

Our results also suggest that one should be careful in making assumptions about investors' holding periods when estimating the liquidity premium, as assuming an inappropriate holding

Table 6. The effects of stock market liquidity on returns – alternative liquidity measures

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
const	0.018***	0.030***	0.065***	0.062***	0.030***	0.028***	0.054***	0.050***
	(4.742)	(9.686)	(14.51)	(14.11)	(8.719)	(9.047)	(14.76)	(13.69)
Size	−0.012***	−0.012***	−0.010***	−0.011***	−0.011***	−0.011***	−0.008***	−0.009***
	(21.66)	(21.12)	(17.07)	(17.74)	(21.02)	(19.95)	(13.77)	(15.09)
B-MV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.361)	(0.355)	(0.251)	(0.208)	(0.870)	(1.072)	(0.775)	(0.588)
Risk	−0.001	−0.002*	−0.005***	−0.005***	−0.002**	−0.002***	−0.004***	−0.005***
	(1.142)	(1.755)	(3.861)	(4.229)	(2.192)	(2.604)	(4.378)	(4.173)
Momentum	0.008***	0.009***	0.008***	0.009***	0.009***	0.009***	0.009***	0.010***
	(6.427)	(7.160)	(6.172)	(6.648)	(7.047)	(7.316)	(6.844)	(7.078)
Reversal	−0.004	−0.007	−0.009*	−0.010**	−0.006	−0.010**	−0.007***	−0.011**
	(0.648)	(1.515)	(1.919)	(2.052)	(1.096)	(2.071)	(2.161)	(2.214)
log(PECS)	−0.003***		0.001**	0.001**				
	(6.253)		(2.155)	(2.006)				
log(Amih)					−0.0003*		0.002***	0.002***
					(1.866)		(11.25)	(9.263)
amPECS		0.026						
		(1.093)						
amAmih						0.0001		
						(1.427)		
log(HP)			−0.006***				−0.007***	
			(18.83)				(21.61)	
log(HP^{FF})				−0.007***				−0.007***
				(20.20)				(21.83)
Stock Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	142,895	137,193	137,193	129,363	149,640	143,657	143,657	133,210
LSDV *R*-squared	0.084	0.085	0.093	0.095	0.087	0.090	0.098	0.097
Within *R*-squared	0.073	0.074	0.083	0.085	0.077	0.080	0.089	0.087

Note(s): The table presents the estimated effect of market liquidity and holding period on stock returns using alternative measures of liquidity. The dependent variable is the monthly excess (over risk-free return) return on the stock. *t*-statistics are given in the parentheses and asterisks denote the statistical significance at the 0.1 (*), 0.05 (**) and 0.01 (***) levels

Table 7. The effects of stock market liquidity on returns – WLS estimation

Model Weighting variable	(1) *Lagged return*	(2) *Lagged return*	(3) *Lagged return*	(4) *Lagged return*	(5) *Unit variance*	(6) *Unit variance*	(7) *Unit variance*	(8) *Unit variance*
const	0.068***	0.057***	0.051***	0.054***	0.014***	0.004***	0.016***	0.007***
	(15.42)	(14.55)	(13.63)	(12.89)	(8.263)	(2.691)	(9.626)	(4.562)
Size	−0.010***	−0.009***	−0.011***	−0.010***	0.0005***	0.0007***	0.0004***	0.0005***
	(18.97)	(16.79)	(19.83)	(18.12)	(5.972)	(6.579)	(4.172)	(5.183)
B-MV	0.000	0.000	0.000	0.000	0.00003**	0.00003**	0.00003*	0.00004**
	(0.242)	(0.261)	(0.186)	(0.194)	(2.001)	(2.079)	(1.706)	(2.279)
Risk	−0.006***	−0.006***	−0.006***	−0.005***	−0.006***	−0.006***	−0.008***	−0.008***
	(3.602)	(3.659)	(3.229)	(2.980)	(10.64)	(10.46)	(13.25)	(13.26)
Momentum	0.010***	0.010***	0.011***	0.011***	0.010***	0.010***	0.010***	0.011***
	(6.662)	(7.169)	(7.108)	(7.191)	(12.79)	(13.13)	(12.82)	(13.48)
Reversal	−0.012**	−0.010**	−0.012**	−0.012**	0.001	−0.000	−0.001	−0.002
	(2.393)	(1.995)	(2.374)	(2.214)	(0.385)	(0.137)	(0.192)	(0.722)
log(PQCS)	0.002***		0.002***		0.002***		0.002***	
	(3.599)		(3.098)		(11.63)		(11.21)	
log(ILLIQ)		0.002***		0.0015***		0.001***		0.001***
		(5.662)		(4.408)		(10.63)		(10.89)
log(HP)	−0.007***	−0.007***			−0.002***	−0.002***		
	(19.71)	(19.22)			(27.30)	(27.04)		
log(HP^{FF})			−0.007***	−0.007***			−0.003***	−0.004***
			(20.08)	(19.33)			(35.10)	(35.48)
Stock Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	135,581	135,963	127,896	127,391	137,052	137,379	129,240	128,691
Adj. R-squared	0.082	0.086	0.084	0.085	0.122	0.128	0.126	0.129

Note(s): The table presents the estimated effect of market liquidity and holding period on stock returns using Weighted Least Squares estimation. The dependent variable is the monthly excess (over risk-free return) return on the stock. *t*-statistics are given in the parentheses and asterisks denote the statistical significance at the 0.1 (*), 0.05 (**) and 0.01 (***) levels period may lead to a biased estimation of the liquidity premium. We show that a simple log transformation of liquidity variables is insufficient to capture the liquidity clientele effect on the illiquidity–return relationship in the CEE markets.

The study has important practical implications for investors, companies, policymakers and regulators. As suggested by our results, the liquidity premium in the CEE stock markets is both statistically significant and economically relevant. The effect of illiquidity on stock returns may however be alleviated by lengthening the investment holding period. Thus, investors should consider stock liquidity when making investment decisions to assure their returns will exceed liquidity costs. This is especially important for short-term investors, especially high-frequency traders, as a short investment horizon or frequent trading strengthens the liquidity effects. Also, companies should consider the liquidity of their shares and recognise the investment horizon of their investors when making financing decisions as stock liquidity affects the cost of equity capital and the investors' holding period moderates the strength of this effect.

Since stock liquidity affects expected returns and companies' cost of equity capital as a consequence, low liquidity in CEE markets limits their development opportunities. Because the opportunity cost of capital is higher for firms with more illiquid stock, managers accept fewer investment projects as the supply of projects is a declining function of their expected rate of return. As a consequence, enhanced stock liquidity expands the set of investment opportunities (Amihud and Levi, 2018; Im *et al.*, 2022). Thus, liquidity-enhancing actions should be employed to decrease the cost of capital of the companies listed on the CEE markets, expand the investment opportunities and, as a consequence, improve growth perspectives for the entire economy. To improve stock liquidity, managers can consider measures aimed at increasing their investor base by attracting small investors (Amihud and Mendelson, 2000). Policymakers and regulators should strive for systemic improvement in the listed companies' disclosing quality.

Our study also shows that the stock markets of Central and Eastern Europe may be attractive for foreign investors. As they are less integrated with the global economy, CEE markets offer some diversification opportunities and benefits related to it. Furthermore, since CEE markets offer a significant liquidity premium, foreign investors, especially long-term ones, can be compensated for the low liquidity of stocks listed on them. Thus, investing in the CEE stock markets would allow investors to decrease their portfolios' risks and earn a premium for holding relatively less liquid stocks. This effect may be even more pronounced in periods of global crises, such as the 2007 crisis and COVID-19 pandemic, as CEE markets are not highly integrated, and they might not be really affected by global crises.

We perceive one serious limitation of our study, which results from the proxy for the investors' holding period that was applied. As suggested by Næs and Ødegaard (2009), the inverse of the turnover ratio may be an imperfect proxy for the investment horizon as the turnover ratio is a characteristic of a stock, while the holding period is a decision made by individual investors. However, if we take the marginal investor into account, an inverse of the turnover ratio may function quite well as a proxy for her holding period as it would reflect an average holding period of all investors for a given stock. In this way, the use of the inverse of turnover ratio as a proxy for the holding period seems to be justified.

Taking the limitations of our study into account, we also perceive a need for further research on the role the investors' holding period plays in the stock liquidity–return relationship, especially in other emerging and frontier markets. Such studies could also be of importance to developed markets. The use of more sophisticated proxies for the holding period as well as the application of other estimation techniques and liquidity measures would be desired.

References

Ahn, H., Cai, J. and Yang, C. (2018), "Which liquidity proxy measures liquidity best in emerging markets", *Economies*, Vol. 6 No. 67, pp. 1-31, doi: 10.3390/economies6040067.

Amihud, Y. and Levi, S. (2018), "The effect of stock liquidity on the firm's investment and production", *The Review of Financial Studies*, pp. 1-54. doi: 10.1093/rfs/hhac036 (In press).

Amihud, Y. and Mendelson, H. (1986a), "Asset pricing and the bid-ask spread", *Journal of Financial Economics*, Vol. 17 No. 2, pp. 223-249, doi: 10.1016/0304-405X(86)90065-6.

Amihud, Y. and Mendelson, H. (1986b), "Liquidity and stock returns", *Financial Analysts Journal*, Vol. 42 No. 3, pp. 43-48, doi: 10.2469/faj.v42.n3.43.

Amihud, Y. and Mendelson, H. (2000), "The liquidity route to a lower cost of capital", *Journal of Applied Corporate Finance*, Vol. 12 No. 4, pp. 7-25, doi: 10.1111/j.1745-6622.2000.tb00016.x.

Amihud, Y. and Noh, J. (2021a), "Illiquidity and stock returns II: cross-section and time-series effects", *The Review of Financial Studies*, Vol. 34 No. 3, pp. 2101-2123, doi: 10.1093/rfs/hhaa080.

Amihud, Y. and Noh, J. (2021b), "The pricing of the illiquidity factor ' s conditional risk with", *Journal of Financial Markets*, Vol. 56, 100605, doi: 10.1016/j.finmar.2020.100605.

Amihud, Y., Hameed, A., Kang, W. and Zhang, H. (2015), "The illiquidity premium: international evidence", *Journal of Financial Economics*, Vol. 117, pp. 350-368.

Amihud, Y. (2002), "Illiquidity and stock returns: cross-section and time series effects", *Journal of Financial Markets*, Vol. 5, pp. 31-56, doi: 10.1016/S1386-4181(01)00024-6.

Amihud, Y. (2019), "Illiquidity and stock returns: a revisit", *Critical Finance Review*, Vol. 8, pp. 203-221, doi: 10.1561/104.00000073.

Ang, A., Hodrick, R.J., Xing, Y. and Zhang, X. (2006), "The cross-section of volatility and expected returns", *Journal of Finance*, Vol. 61 No. 1, pp. 259-299, doi: 10.1111/j.1540-6261.2006.00836.x.

Ang, A., Hodrick, R.J., Xing, Y. and Zhang, X. (2009), "High idiosyncratic volatility and low returns: international and further U.S. evidence", *Journal of Financial Economics*, Vol. 91 No. 1, pp. 1-23, doi: 10.1016/j.jfineco.2007.12.005.

Anginer, D. (2010), "Liquidity clienteles", No. 5318; Policy Research Working Paper, doi: 10.2139/ssrn.1620034.

Asparouhova, E., Bessembinder, H. and Kalcheva, I. (2010), "Liquidity biases in asset pricing tests", *Journal of Financial Economics*, Vol. 96, pp. 215-237, doi: 10.1016/j.jfineco.2009.12.011.

Atkins, A.B. and Dyl, E.A. (1997), "Transaction costs and holding periods for common stocks", *Journal of Finance*, Vol. 52 No. 1, pp. 309-325.

Batten, J.A. and Vo, X.V. (2014), "Liquidity and return relationships in an emerging market", *Emerging Markets Finance and Trade*, Vol. 50 No. 1, pp. 5-21, doi: 10.2753/REE1540-496X500101.

Będowska-Sójka, B. (2018), "The coherence of liquidity measures. The evidence from the emerging market", *Finance Research Letters*, Vol. 27, pp. 118-123, doi: 10.1016/j.frl.2018.02.014.

Beber, A., Driessen, J., Neuberger, A. and Tuijp, P. (2021), "Pricing liquidity risk with heterogeneous investment horizons", *Journal of Financial and Quantitative Analysis*, Vol. 56 No. 2, pp. 373-408, doi: 10.1017/S0022109020000137.

Bekaert, G., Harvey, C.R. and Lundblad, C. (2007), "Liquidity and expected returns: lessons from emerging markets", *Review of Financial Studies*, Vol. 20 No. 6, pp. 1783-1831, doi: 10.1093/rfs/hhm030.

Belsley, D.A., Kuh, E. and Welsch, R.E. (1980), *Regression Diagnostics. Identifying Influential Data and Source of Collinearity*, John Wiley & Sons, New Jersey.

Ben-Rephael, A., Kadan, O. and Wohl, A. (2015), "The diminishing liquidity premium", *Journal of Financial and Quantitative Analysis*, Vol. 50 Nos 1-2, pp. 197-229, doi: 10.1017/S0022109015000071.

Cakici, N. and Zaremba, A. (2021), "Liquidity and the cross-section of international stock returns", *Journal of Banking and Finance*, Vol. 127, doi: 10.1016/j.jbankfin.2021.106123.

Chalmers, J.M.R. and Kadlec, G.B. (1998), "An empirical examination of the amortized spread", *Journal of Financial Economics*, Vol. 48 No. 2, pp. 159-188, doi: 10.1016/S0304-405X(98)00007-5.

Choi, I. (2001), "Unit root tests for panel data", *Journal of International Money and Finance*, Vol. 20 No. 2, pp. 249-272, doi: 10.1016/S0261-5606(00)00048-6.

Chordia, T., Huh, S.-W. and Subrahmanyam, A. (2009), "Theory-based illiquidity and asset pricing", *Review of Financial Studies*, Vol. 22 No. 9, pp. 3629-3668, doi: 10.1093/rfs/hhn121.

Chuliá, H., Koser, C. and Uribe, J.M. (2021), "Analyzing the nonlinear pricing of liquidity risk according to the market state", *Finance Research Letters*, Vol. 38 January 2020, doi: 10.1016/j.frl.2020.101515.

Chung, K.H. and Zhang, H. (2014), "A simple approximation of intraday spreads using daily data", *Journal of Financial Markets*, Vol. 17 No. 1, pp. 94-120, doi: 10.1016/j.finmar.2013.02.004.

Constantinides, G.M. (1986), "Capital market equilibrium with transaction costs", *Journal of Political Economy*, Vol. 94 No. 4, pp. 842-862, doi: 10.1086/261410.

Daryaei, A.A. and Fattahi, Y. (2022), "Stock liquidity and stock return: an asymmetric impact of institutional ownership approach", *Corporate Governance (Bingley)*, Vol. 22 No. 4, pp. 781-797, doi: 10.1108/CG-03-2021-0119.

De La Cruz, A., Medina, A. and Tang, Y. (2019), "Owners of the world's listed companies", available at: www.oecd.org/corporate/Owners-of-the-Worlds-Listed-Companies.htm

Eleswarapu, V.R. and Reinganum, M.R. (1993), "The seasonal behavior of the liquidity premium in asset pricing", *Journal of Financial Economics*, Vol. 34 No. 3, pp. 373-386, doi: 10.1016/0304-405X(93)90032-7.

Florackis, C., Gregoriou, A. and Kostakis, A. (2011), "Trading frequency and asset pricing on the London Stock Exchange: evidence from a new price impact ratio", *Journal of Banking and Finance*, Vol. 35 No. 12, pp. 3335-3350, doi: 10.1016/j.jbankfin.2011.05.014.

Fong, K.Y.L., Holden, C.W. and Trzcinka, C.A. (2017), "What are the best liquidity proxies for global research?", *Review of Finance*, Vol. 21 No. 4, pp. 1355-1401, doi: 10.1093/rof/rfx003.

Gniadkowska-Szymańska, A. (2016), "Analysis of the impact of trading liquidity on the development of investment time horizon on the example of the Warsaw Stock Exchange", *Acta Universitas Lodziensis. Folia Oeconomica*, Vol. 324 No. 4, pp. 139-150.

Guo, H., Mortal, S., Savickas, R. and Wood, R. (2017), "Market illiquidity and conditional equity premium", *Financial Management*, Vol. 46 No. 3, pp. 743-766, doi: 10.1111/fima.12162.

Harris, L. and Amato, A. (2019), "Illiquidity and stock returns: cross-section and time-series effects: a replication", *Critical Finance Review*, Vol. 8, doi: 10.1561/104.00000058.

Harris, R.D.F. and Tzavalis, E. (1999), "Inference for unit roots in dynamic panels where the time dimension is fixed", *Journal of Econometrics*, Vol. 91 No. 2, pp. 201-226, doi: 10.1016/S0304-4076(98)00076-1.

Hasbrouck, J. (1999), "The dynamics of discrete bid and ask quotes", *Journal of Finance*, Vol. 54, pp. 2109-2142.

Hasbrouck, J. (2009), "Trading costs and returns for U.S. Equities: estimating effective costs from daily data", *Journal of Finance*, Vol. 64 No. 3, pp. 1445-1477, doi: 10.1111/j.1540-6261.2009.01469.x.

He, Z.L. and Kryzanowski, L. (2006), "The cross section of expected returns and amortized spreads", *Review of Pacific Basin Financial Markets and Policies*, Vol. 9 No. 4, pp. 597-638.

Hsieh, H.C. and Nguyen, V.Q.T. (2021), "Economic policy uncertainty and illiquidity return premium", *North American Journal of Economics and Finance*, Vol. 55, 101291, doi: 10.1016/j.najef.2020.101291.

Im, K.S., Pesaran, M.H. and Shin, Y. (2003), "Testing for unit roots in heterogeneous panels", *Journal of Econometrics*, Vol. 115 No. 1, pp. 53-74, doi: 10.1016/S0304-4076(03)00092-7.

Im, H.J., Oliver, B. and Park, H. (2022), "The effect of stock liquidity on corporate cash holdings: the real investment motive", *International Review of Finance*, Vol. 22 No. 3, pp. 1-17, doi: 10.1111/irfi.12377.

Jacoby, G., Fowler, D.J. and Gottesman, A.A. (2000), "The capital asset pricing model and the liquidity effect: a theoretical approach", *Journal of Financial Markets*, Vol. 3, pp. 69-81, doi: 10.1016/S1386-4181(99)00013-0.

Jegadeesh, N. and Titman, S. (1993), "Returns to buying winners and selling losers: implications for stock market efficiency", *Journal of Finance*, Vol. 48 No. 1, pp. 65-91.

Jensen, G.R. and Moorman, T. (2010), "Inter-temporal variation in the illiquidity premium", *Journal of Financial Economics*, Vol. 98 No. 2, pp. 338-358, doi: 10.1016/j.jfineco.2010.05.008.

Karolyi, G.A., Ng, D.T. and Prasad, E.S. (2020), "The coming wave: where do emerging market investors put their money?", *Journal of Financial and Quantitative Analysis*, Vol. 55 No. 4, pp. 1369-1414, doi: 10.1017/S002210901900022X.

Levin, A., Lin, C.F. and Chu, C.S.J. (2002), "Unit root tests in panel data: asymptotic and finite-sample properties", *Journal of Econometrics*, Vol. 108 No. 1, pp. 1-24, doi: 10.1016/S0304-4076(01)00098-7.

Maddala, G.S. and Wu, S. (1999), "A comparative study of unit root tests with panel data and a new simple test", *Oxford Bulletin of Economics and Statistics*, Vol. 61, pp. 631-652, doi: 10.1111/1468-0084.0610s1631.

Marshall, B.R. and Young, M. (2003), "Liquidity and stock returns in pure order-driven markets: evidence from the Australian stock market", *International Review of Financial Analysis*, Vol. 12 No. 3, pp. 173-188, doi: 10.1016/S1057-5219(03)00006-1.

Marshall, B.R., Nguyen, N.H. and Visaltanachoti, N. (2013), "Liquidity measurement in Frontier markets", *Journal of International Financial Markets, Institutions and Money*, Vol. 27 No. 1, pp. 1-12, doi: 10.1016/j.intfin.2013.07.011.

Næs, R. and Ødegaard, B.A. (2009), "Liquidity and asset pricing: evidence on the role of investor holding period", 2007/11; Norges Bank Working Paper, doi: 10.2139/ssrn.1095226.

Pereira, J.P. and Zhang, H.H. (2010), "Stock returns and the volatility of liquidity", *Journal of Financial and Quantitative Analysis*, Vol. 45 No. 4, pp. 1077-1110, doi: 10.1017/S0022109010000323.

Stereńczak, S. (2019), "In search of the best proxy for liquidity in asset pricing studies on the Warsaw stock exchange", in Tarczyński, W. and Nermend, K. (Eds), *Effective Investments on Capital Markets. 10th Capital Market Effective Investments Conference (CMEI 2018)*, 1st ed., Springer International Publishing, doi: 10.1007/978-3-030-21274-2_3.

Stereńczak, S. (2020), "Stock liquidity premium with stochastic price impact and exogenous trading strategy", *International Review of Financial Analysis*, Vol. 71, 101345, doi: 10.1016/j.irfa.2019.04.008.

Stereńczak, S. (2021), "Conditional stock liquidity premium: is Warsaw stock exchange different?", *Studies in Economics and Finance*, Vol. 38 No. 1, pp. 67-85, doi: 10.1108/SEF-03-2020-0075.

Stereńczak, S., Zaremba, A. and Umar, Z. (2020), "Is there an illiquidity premium in Frontier markets?", *Emerging Markets Review*, Vol. 42, 100673, doi: 10.1016/j.ememar.2019.100673.

Zaremba, A. and Maydybura, A. (2019), "The cross-section of returns in Frontier equity markets: integrated or segmented pricing?", *Emerging Markets Review*, Vol. 38, pp. 219-238.

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