Microstructure of the Financial Market

Illiquidity Effects in the Russian Stock Market

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Motivation

- The paradigm of market microstructure invariance proposed by A. Kyle and A. Obizhaeva (2016) allows researchers to better understand the link between market microstructure effects and asset pricing.
- The theory suggests that using an asset-specific illiquidity measure offers several advantages compared to using alternative low-frequency proxies (Amihud's index).
- There is an ambiguity about existence of the illiquidity premium in some emerging markets.

Research Questions

- Is illiquidity a determinant of asset returns in the Russian stock market?
- How large are biases in the estimates of the illiquidity premium?
- What are the potential profits of trading on a measure of stock illiquidity?
- Do the Fama-French and momentum factors fully explain illiquidity premium?

Market Microstructure

"Market microstructure economics focuses on how prices adjust to new information and how the trading mechanism affects asset prices." (J. R. Russell & R. F. Engle, 2010)

Topics:

- Price discovery
- Market transparency
- Transaction costs
- Liquidity
- High-frequency trading
- Financial stability

Overview

- Securities are different with respect to returns volatility, bid-ask spread, order size, trading volume, etc.
- "Business time" measures the speed at which new bets (sequences of orders of the same direction) arrive.
- **The main idea of the MMI framework:** the distribution of bets and transactions costs are invariant across assets and across time when measured per unit of business time.
- Strong empirical evidence: portfolio transitions by U.S. institutional investors, Thomson Reuters data on financial news articles, intraday patterns for S&P500 E-mini Futures, U.S. stock market trades, etc.

Invariance-Implied Illiquidity Measure

$$\frac{1}{L_{it}} = \left(\frac{C \cdot \sigma_{it}^2}{m^2 \cdot P_{it} \cdot V_{it}} \right)^{1/3}$$

Notation:

- C - Ruble costs of executing a bet (e.g., 1700 rubles per bet)
- σ_{it}^2 - Return variance (unitless per day, e.g., 0.06/day)
- m^2 - Moment ratio for the distribution of bet sizes (unitless)
- P_{it} - Price (rubles per stock, e.g., 100 rubles/share)
- V_{it} - Volume (stocks per day, e.g., two million stocks per day)

Kyle and Obizhaeva (2016) calibrate $C = \$2000$ and $m^2 = 0.25$ for the U.S. stock market using a large sample of portfolio transitions (proxies for bets) over the period 2001–2005.

Comparison Between Metrics

Amihud's illiquidity measure (a proxy for the response of price to order flow) is similar to

$$\frac{1}{L_{it}^{Amihud}} = \frac{|\sigma_{it}|}{P_{it} \cdot V_{it}} \cdot 10^6.$$

- Kyle and Obizhaeva (2016): the Amihud's ratio implies that the most actively traded and least actively traded assets have the same number of bets per day.
- The Amihud metric does not satisfy Time Clock Irrelevance. By contrast, $1/L_{it}$ remains the same regardless of whether a researcher measures market characteristics using different time horizons. Moreover, $1/L_{it}$ also satisfies Modigliani-Miller equivalence: if each share is bundled with the same amount of cash (levered down by a factor of 2), then $P_{it} \to 2 \cdot P_{it}; V_{it} \to V_{it}; \sigma_{it} \to \frac{\sigma_{it}}{2}$, and L_{it} doubles as well.

What $1/L$ Measures

Kyle and Obizhaeva (2018):

- The percentage bid-ask spread may be proportional to $1/L$;
- The ruble-weighted average market impact cost of executing bets of the size they are actually executed in the market, expressed as a fraction of the ruble value traded, is exactly equal to $1/L$;
- Market resiliency (the rate at which past pricing errors decay) may be proportional to $\sigma^2 \cdot L^2$, etc.

Literature Review

- **Positive cross-sectional and/or time-series relationship between illiquidity and asset returns:**
  The U.S. stock market: Amihud and Mendelson (1986), Brennan and Subrahmanyam (1996), Chordia et al. (2001), Pastor and Stambaugh (2003), Acharya and Pedersen (2005), Huh (2014)
  International developed markets: Lee (2011), Amihud (2015)
  Emerging markets: Bekaert et al. (2007), Amihud et al. (2015)
- **No illiquidity premium:**
  Emerging markets: Hearn and Piesse (2008), Hearn et al. (2010), Stereńczak et al. (2020)
- **Positive liquidity premium:**
  Emerging markets: Batten and Vo (2014), Phong (2016)

Borisenko & Gelman (2012), Mikova (2013):
Liquidity is one of the determinants of asset pricing in the Russian stock market (proxies: trading volume, bid-ask spread, Amihud's ratio)

Data

- Thomson Reuters Eikon provides trade-level data (daily opening and closing prices, daily volume) and information about market capitalization and book-to-market ratios.
  Period: January 2010 - December 2019.
  Coverage: 234 ordinary and preferred stocks traded on the Moscow Exchange (before December 2011: MICEX).
- The Moscow Exchange provides historical market data (all trades and best orders) throughout January 2014 - July 2018.

Liquidity Estimates

The data used for the analysis does not enable us to accurately estimate the m^2 and Cq parameters for the Russian stock market because they do not contain information on bets.

Assumptions:

1. $m^2_{RU} \approx m^2_{US} = 0.25$

2. Kyle and Obizhaeva (2017): $C = c \cdot w/b$, where b - a finance professional's productivity measured as the number of bets processed per day, w - the nominal wage for finance professionals per day. C, w, and b may vary across countries, but c is a dimensionless constant. We use occupational employment statistics and data on the total number of shares traded.

The final result: $C_{RU} = C_{US} \cdot \frac{b_{US}}{w_{US}} \cdot \frac{w_{RU}}{b_{RU}} \approx 1700$ rubles. This allows us to redefine the Kyle and Obizhaeva illiquidity measure:

$$1/L_{it} = 30 \cdot \left(\frac{\sigma^2_{it}}{P_{it} \cdot V_{it}}\right)^{1/3}.$$

Asset-Pricing Tests

We exclude firms with negative book values and set BM, $1/L$, $1/L^{Amihud}$ values outside the 0.005 and 0.995 fractiles equal to these fractiles, respectively. For each month in the period February 2012 - December 2019, we run the following cross-sectional regression:

$$R_{it} = \alpha_{0t} + \alpha_{1t}\hat{\beta}_p + \alpha_{2t}SIZE_{it-1} + \alpha_{3t}BM_{it-1} + \alpha_{4t}\Lambda_{it-1} + \epsilon_{it},$$

where R_{it} is the excess return of stock i in month t, $\hat{\beta}_p$ - portfolio betas estimated from the full period using 10 portfolios (preranking portfolio betas are estimated for individual stocks using monthly returns from 24 previous months), $SIZE_{it-1}$ and BM_{it-1} - logarithms of market capitalization and book-to-market ratios, calculated at the end of the month $t-1$, Λ_{it-1} is the mean value of $1/L_{it-1}$ or $1/L_{it-1}^{Amihud}$ for the month $t-1$. The coefficients from the cross-sectional regressions are averaged over time, using the Fama-MacBeth (1973) methodology.

Descriptive Statistics

Variable	Mean	Median	Min	Max
Return	-7.13	-8.19	-210.66	255.88
$\hat{\beta}_p$	0.49	0.51	-0.21	1.01
Size	23.43	23.45	16.50	29.45
BM	0.23	0.29	-3.33	2.73
$1/L \cdot 10^{-4}$	291	184	7.99	1932
$1/L^{Amihud} \cdot 10^{-4}$	406	28	0.003	880

Table: This table displays means, medians, minimum values, and maximum values on the variables included in the asset-pricing tests. All statistics are calculated from the full sample. *Return* - percentage monthly return in excess of the Russia's 1 month government bond yield; $\hat{\beta}_p$ - portfolio betas estimated from the full period using 10 portfolios; *Size* - logarithm of market capitalization; *BM* - logarithm of the book value of equity divided by the market value of equity; $1/L$ and $1/L^{Amihud}$ are the Kyle-Obizhaeva measure and the Amihud illiquidity ratio, respectively.

Correlations

	$\hat{\beta}_p$	$SIZE$	BM	$1/L$	$1/L^{Amihud}$
$Return$	-0.053	-0.066	-0.049	0.183	0.134
$\hat{\beta}_p$		0.100	0.024	-0.148	-0.105
$SIZE$			-0.233	-0.668	-0.404
BM				0.091	0.019
$1/L$					0.852

Table: This table displays the time-series means of monthly bivariate correlations of the variables in the asset-pricing tests.

Fama-MacBeth Regression Estimates

	2012-2019		2012-2019 (Excl. January)	
	$\Lambda = 1/L$	$\Lambda = 1/L^{Amihud}$	$\Lambda = 1/L$	$\Lambda = 1/L^{Amihud}$
Constant	-12.515	0.312	-11.172	1.451
	(-4.543)	(0.139)	(-4.442)	(0.611)
$\hat{\beta}_p$	-1.657	-1.949	-1.886	-2.2072
	(-2.327)	(-2.775)	(-2.568)	(-3.054)
SIZE	0.154	-0.304	0.099	-0.351
	(1.454)	(-3.157)	(0.991)	(-3.357)
BM	-0.226	-0.259	-0.400	-0.377
	(-0.879)	(-1.049)	(-1.232)	(-1.416)
$1/L$	**90.815**		**88.895**	
	(8.951)		(8.190)	
$1/L^{Amihud}$		**20.411**		**19.145**
		(6.800)		(6.147)
R-squared (overall)	0.0236	0.0171	0.0251	0.0186
Stocks	203	203	203	203
Time periods	95	95	88	88
No. Obs.	12065	12065	11221	11221

T-values (in parentheses) are adjusted with the Newey-West procedure with 3 lags.

Discussion

- Interpretation of the estimate of the $1/L$ coefficient: a difference of 1 percentage point in the average price impact cost (expressed in percentage terms) between two stocks translates into a difference in required return of **0.908%** per month.
- Interpretation of the estimate of the $1/L^{Amihud}$ coefficient: a difference of 1 percentage point in the time-series average of the monthly ratios (as multiples of 10^{-4}) of percentage returns in absolute magnitute to ruble volume between two stocks translates into a difference in required return of **0.204%** per month. Implicit assumption: the number of bets across assets is constant.
- The coefficients on $1/L$ and $1/L^{Amihud}$ remain positive and significant for each of the two subperiods (2012-2015 and 2016-2019).
- Some coefficients on other variables are inconsistent with the standard asset-pricing theory. Errors-in-variables bias because of estimation errors in the betas from the first stage?
  T.Teplova & V.Rodina suggest using an approach to calculating beta with liquidity adjustment: a shift from historical to predicted beta.

Further Research

- The cross-sectional/time-series illiquidity effects in the U.S. stock market with the Kyle and Obizhaeva measure as a proxy.
- The time-series regression approach of Fama and French (1993) for studying illiquidity factors in the Russian stock market.
- The trading cost model of Kyle and Obizhaeva (2016) for investigating the “true” profitability of strategies that require a regular rebalancing of the portfolio (e.g., momentum).

Conclusions

- Our tests support the predictions of the cross-sectional relationship between stock return and stock illiquidity in the Russian equity market.
- Of particular importance is conducting several robustness checks: alternative estimation procedures (e.g., GMM), different approaches to calculating beta (e.g., with liquidity adjustment) and return variance (e.g., the log-ARIMA model).