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Master Essay

Asset-Specific and Systematic Liquidity on the Swedish Stock Market

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Abstract

This essay studies the effect of liquidity on stock returns on the Swedish stock market. Liquidity is addressed both as a market risk factor and an asset characteristics. We use the relative bid-ask spread as a proxy for liquidity level. The aggregate liquidity factor Illiquid-Minus-Liquid is constructed in a similar way to Fama-French SMB and HML factors. Using monthly time-series regressions on the three-factor Fama-French model and the four-factor model including aggregate liquidity, we find that liquidity is priced as a systematic source of risk on the Swedish stock market. Moreover, monotonic increase in the regression intercepts for test portfolios arranged in the order of decreasing liquidity indicates the presence of characteristic illiquidity premium after controlling for systematic liquidity. In addition, we observe that the same models explain twice as much variation of stock returns in the more liquid groups, which suggests there is an omitted factor that has more impact on illiquid stocks. However, using monthly cross-sectional regressions of stocks' excess returns on the various combinations of stock characteristics and factor loadings, we find that liquidity level proxied by relative bid-ask spread is not significant on average.

Key words: systematic liquidity, characteristic liquidity, asset pricing, Fama-French model

Contents

1 Introduction

In 1986 Amihud and Mendelson were the first to discover the effect of liquidity on asset pricing. They show that expected asset return is an increasing and concave function of illiquidity measured by quoted bid-ask spread. Since then, lots of other liquidity measures were introduced and all of them supported the illiquidity premium concept using the data from different markets. Brennan et al. (1998) find the negative effect of the dollar trading volume on stocks' excess returns using a multi-factor model with factor loadings as the regressors. Datar et al. (1998) document the same results using stock turnover as liquidity measure. Amihud (2002) employs the ratio of the daily return to a dollar volume. Most recently, the effective daily spread was introduced by Hasbrouck (2009). Despite the variety of reasonable proxies invented so far, capturing the effect of liquidity on asset pricing faces a major problem. Liquidity has many dimensions, which cannot be fully reflected by a single measure.

Until 2000, the research focused on the liquidity *per se* as the characteristic quality of every asset. Starting with the papers by Chordia, Roll and Subrahmanyam (2000), and Hasbrouck and Seppi (2001) commonality in liquidity was discovered in the US stock market. The fact that fluctuations across different measures of liquidity were proved to be significantly correlated across different stocks gave raise to the question whether the market-wide liquidity is also priced. Pastor and Stambaugh (2003) suggest that stock's sensitivity to liquidity of the market should be compensated with a return premium: the more exposed a stock is to the systematic liquidity shocks, the higher return it should earn. The Pastor-Stambaugh aggregate liquidity factor is based on the fact that illiquid stocks have higher price elasticity to changes in dollar volume than liquid stocks. Martinez et al. (2005) construct another market-wide liquidity factor. They define it as the difference between returns of stocks highly sensitive to changes in the relative bid-ask spread and stocks with low sensitivities to those changes, in analogy to Fama-French SMB and HML factors. However, Martinez et al. (2005) do not find the existence of systematic liquidity premium in the Spanish stock market.

Nguyen and Puri (2009) examine the question whether liquidity level and liquidity risk should be addressed separately, or systematic liquidity risk captures the traditional characteristic illiquidity premium. This question was partially examined before. Acharya and Pedersen (2005), within the framework of the liquidity-adjusted CAPM, show that the expected return of a security is increasing in its expected illiquidity and its liquidity risk. However, they do not control for Fama-French factors. After running time-series regressions both on the Fama-French three-factor model, and the four-factor model that includes Fama-French and Pastor-Stambaugh market liquidity factors, Nguyen and Puri (2009) document a generally consistent decrease in the intercepts from low liquidity portfolios to high liquidity portfolios. The Gibbon-Ross-Shanken statistics rejects the null hypothesis that the time-series intercepts are jointly equal to zero, which suggests that the market-wide liquidity factor doesn't capture the effect of liquidity level. In cross-sectional testing Nguyen and Puri regress dollar volume, which is chosen as a measure of idiosyncratic liquidity, on the different combinations of stock characteristics, and different combinations of Fama-French and Pastor-Stambaugh factor loadings. They find that after controlling for size, dollar volume is statistically significant and negatively correlated with stock returns. If adding book-to-market variable, the illiquidity premium still exists, but the magnitude of t-statistics decreases. Finally, when β is also included, dollar volume becomes insignificant. However, all the regressions on factor loadings prove the significant and negative impact of liquidity level on the cross-section of stock returns. Analysis is performed on the US data, both on the NYSE-AMEX and NASDAQ stocks.

The main **purpose** of this study is to examine if liquidity is priced as a systematic source of risk on the Swedish stock market, and whether the market-wide liquidity factor captures characteristic liquidity. If there was a measure of aggregate liquidity incorporating the idiosyncratic liquidity levels of the individual stocks, for Swedish investors that would mean they should care only about the exposure to non-diversifiable liquidity, analogously to the market risk factor of the CAPM. There have been previous studies on the Swedish stock market, but none of them addresses the above mentioned issue. The most closely related is Söderberg (2007), which shows that innovations in illiquidity and innovations in returns are negatively correlated, suggesting that illiquidity is higher in down markets.

We conduct our analysis within the Fama-French three-factor model, and also several four-factor models including Fama-French factors and the market liquidity risk factor computed in different ways. Our data comprises 106 observations on monthly returns of 198 stocks from AFGX index, from July 2001 to April 2010. We use the relative bid-ask spread as the measure of asset-specific liquidity. The absolute spread values would not be an adequate proxy, as long as we have stocks with highly different price ranges. Our systematic liquidity factor IML (illiquid-minus-liquid) is constructed in a similar way to Fama-French SMB and HML factors. However, we form this factor-mimicking portfolio by sorting the stocks in three different ways, namely, into three portfolios according to relative spread alone; into four portfolios according to size and spread; and into twelve portfolios according to size, book-to-market and spread. The variations of IML factor are formed as the difference between the returns on the least liquid 30% of stocks and the returns on the most liquid 30%.

Similarly to Nguyen and Puri (2009), we explore the issue both in time-series and cross-section. In time-series testing we examine the pattern of intercepts in different liquidity groups to find out whether any of the tested models subsumes the effect of characteristic liquidity. We allocate the stocks into liquidity groups based on relative bid-ask spread alone, and on book-to-market ratio and spread. In addition, we test whether our aggregate liquidity factor IML has significant impact on stock returns in the Swedish market, in other words, whether liquidity risk is priced. In cross-sectional analysis the two-stage Fama-MacBeth method (1973) is used. We check for the sign and significance of the average relative bid-ask spread coefficient, after controlling for individual stock characteristics (namely, market betas, book-to-market ratios and size), and the loadings on Fama-French factors and market liquidity factor.

The study is organized in the following way. Section 2 presents the theoretical background of liquidity-based asset pricing. Section 3 describes the methodology. Section 4 contains the empirical analysis, and Section 5 concludes and interprets practical implications of the obtained results.

2 Theoretical background

2.1 The concept of liquidity

Amihud et al. (2006) define *liquidity* as "the ability to trade large quantities of an asset quickly, at low cost, and without moving the price". By and large, liquidity indicates how easily a particular security can be traded. When securities are illiquid, investors may be unable to attain their optimal portfolios, and the potential diversification benefits could be lost. Financial crises are often associated with market-wide liquidity breakdowns.

Söderberg (2009) suggests three dimensions of liquidity. The first one is *immediacy*, which refers to how quickly assets can be traded. The second dimension is *breadth*, or *width*, and it reflects the cost of doing the trade. The bid-ask spread is considered to be the usual measure of breadth. The third dimension is *depth*, which refers to the size of trades that can be conducted without having a significant impact on the price. Often the fourth dimension of liquidity is addressed, namely *resiliency*. According to Hasbrouck (2007), a resilient market quickly returns to equilibrium, and a small change in demand or supply doesn't affect the price significantly.

As pointed out by Amihud et al. (2006), there are various *sources of illiquidity* due to market imperfections, which brings up liquidity to a high concern, especially for investors. Among the main sources of illiquidity are:

- *Exogenous transaction costs (*brokerage fees, transaction taxes etc.) Transaction costs are always a part of the trade. Moreover, any deal is associated with the costs of the future sale.
- *Demand pressure* and *inventory risk*. Demand pressure occurs when not all the agents are present in the market, which means that there is a need for market makers, because buyers are not always immediately available when a seller wants to sell a security. In addition, a market maker is exposed to inventory risk, which stands for the potential loss he can bear if the price of a security changes while he holds it in the inventory. Usually, these costs are imposed on the seller.
- *Information asymmetry.* Private information about the characteristics of a security or about the order flow may be costly for the uninformed traders.

- *Difficulty of locating a counterparty* (over-the-counter markets). It may not be easy to find a counterparty to trade a particular security, or large volumes of a certain asset. Consequently, a searching trader bears the opportunity costs of time delay and possible price concessions, as long as the market is no longer competitive. In general, a trader is forced to choose between searching and quick trading with a dealer but at a discount.

In order to avoid bearing the unforeseen costs, investors should account for the illiquidity costs while planning their strategies.

Liquidity has a wide range of *effects on financial markets*. According to Amihud et al. (2006), it has an impact on both the cross-section and time-series of stock returns, after controlling for other asset characteristics and market risks. Liquidity affects the pricing of stocks and corporate bonds, the returns on hedge funds, and the valuation of funds as well. A number of financial puzzles can be explained from the liquidity perspective, such as why stocks require higher returns than bonds (the equity premium puzzle), why risk-free securities earn low returns (the risk-free rate puzzle), and why small stocks are usually more profitable (the small firm effect).

2.2 Exogenous changes in stock's liquidity

If liquidity has an impact on asset prices, then changes in liquidity should affect asset prices too. Stocks that are transferred to a more *liquid trading system* become more expensive. That was the case with European exchanges, where the entire markets, or most of them, were transferred from an auction market to continuous trading. Amihud et al. (1997) find that the transferred stocks' trading volumes increased significantly relative to the market's volume, and the average return per dollar of trade declined, which implies that their prices rose.

The US evidence shows that changes in the *composition of the S&P 500* lead to changes in stock liquidity. A stock's price usually increases when it is included in the index, and vice versa. This may be due to the fact that the S&P 500 stocks are widely traded by index funds and hedgers of index derivatives, which increases their liquidity irrespectively of the asset-specific characteristics. These changes are associated with demand pressure.

Liquidity is also exogenously affected by exchange listing. If a stock is delisted from an exchange, which happens mainly in case of requirement violations, it is then traded in a less liquid environment. As long as delisting is involuntary, the decline in liquidity is induced by the change of the trading market rather than by new information.

It has also been noted that corporate events can cause changes in stock's liquidity. Amihud et al. (1999) examine the case when some Japanese companies imposed the limit on the trading unit of their stocks, which led to the increase in the number of shareholders. As the ownership became more dispersed, the stocks became more frequently and easily traded. Further, Amihud et al. (2003) find the evidence that exercise of the stock warrants induces liquidity rise through increasing the stock's float. This produces abnormal returns.

2.3 Liquidity measures

Liquidity is not an observable variable. There exist, however, many *proxies for liquidity*. These proxies can be categorized into two basic types: trade-based measures such as volume, frequency of trading, dollar value of shares traded, turnover ratio, etc., and order-based measures such as quoted spread, effective spread, quoted depth, etc.

Some proxies, such as the *bid-ask spread*, are based on the market microstructure data, which is not available for a time-series as long as it is usually desirable for studying the effect on expected returns. Further, as pointed out by Acharya and Pedersen (2004), the bid-ask spread measures well the cost of selling a small number of shares, but it does not necessarily measure well the cost of selling many shares.

Datar et al. (1998) were the first to use *stock turnover* as a liquidity proxy. Stock turnover is the ratio of stock volume to the number of shares outstanding. The average holding period of the stock, which is the reciprocal of the stock turnover, also indicates the level of liquidity. As Amihud documents, if the market is in equilibrium, less liquid stocks are held by the investors with longer holding periods. This phenomenon is known as the Amihud clientelle effect.

Illiquidity can be measured by *Kyle's (1985)* λ**,** which is estimated using high-frequency data. Brennan and Subrahmanyam find λ as the loading of the trade-by-trade price change on the signed size of transaction. In other words, λ reflects to which extent a unit of trade influences the price of a stock, and obviously, the impact is larger for less liquid stocks.

Among other liquidity measures are the *stock's trading volume* (Brennan et al. 1998), *Pastor and Stambaugh (2003)* market liquidity factor that reflects the return reversal in response to volume shocks, which is larger for less liquid stocks, and some combined liquidity measures such as the *amortized spread*. The amortized is spread is calculated as the product of the stock turnover and the effective relative spread.

As pointed out, liquidity is difficult to measure. High-frequency data, such as intra-daily quotes, is hard to collect. That is why proxies based on the daily data are more widely used. In addition, for the results to be robust, the wide range of observations is a necessary condition.

To conclude, there is hardly any unbiased liquidity measure for the following reasons:

1) liquidity has many dimensions, which cannot be embraced by a single measure;
2) using empirically obtained measures as inputs to the further analysis creates errors-in-variables problem, which causes underestimation of the regression coefficients;
3) the low-frequency data increases the measurement noise.

2.4 Previous research

Despite the recent progress made in understanding the effects of liquidity (both market-wide and stock-specific), our knowledge of what causes its time variation is still limited, especially over the long horizons. Due to the data availability problems, most of the research is based on the US stock market, though tendencies have started to change over the last ten years. The first paper on the effects of liquidity on asset prices was written by Amihud and Mendelson in 1986. In this study they use quoted bid-ask spread as a measure of liquidity, and conclude that it has positive significant effect on stock returns. The paper induced the search of different liquidity proxies, and of the model which can fully capture the liquidity effect on stock returns. All these studies were focused mostly on characteristic liquidity, but relatively little on the determinants of market-wide liquidity. The issue of systematic liquidity rose in 2000 when Chordia, Roll and Subrahmanyam discovered commonality in liquidity. In 2003 Pastor and Stambaugh introduced their market-wide liquidity measure based on the fact that illiquid stocks have higher price elasticity to changes in dollar volume than liquid stocks. After all these openings, researchers started to examine the interrelation between systematic and characteristic liquidity, and the first noticeable study in this area was made by Nguyen and Puri in 2009.

The previous findings are summarized in the following table.

Table 1: The summary of research in liquidity-based asset pricing

Authors	**Liquidity measure**	**Methods, Models**	**Data**	**Result**
Liquidity as stock characteristics				
Amihud and Mendelson (1986)	Quoted bid-ask spread	Time-series and cross-sectional GLS regression	NYSE, AMEX 1961-1980	Expected asset return is an increasing and concave function of illiquidity
Brennan and Subrahmanyam (1996)	Kyle's λ (the sensitivity of trade-by-trade price change to the signed transaction size)	Time-series and cross-section GLS regression, Fama-French model	NYSE 1984-1991	Illiquidity is significantly positively related to average returns (after controlling for firm size and price reciprocal)
Chalmers and Kadlec (1998)	Amortized bid-ask spread	CSR	NYSE, AMEX 1983-1992	Significant positive effect on stock returns
Datar, Naik, and Radcliff (1998)	Share turnover	CSR, Fama and Macbeth method	NYSE 1963-1991	The cross-section of stock returns is negatively and significantly related to share turnover
Brennan, Chordia, Subrahmanyam (1998)	Dollar trading volume	Multi-factor asset pricing model, CSR	NASDAQ, NYSE, AMEX 1966-1995	Negative and significant effect on stock returns
Loderer and Roth (2005)	Bid-ask spread	CSR	Swiss Stock exchange 1995-2001	Positive and significant effect on stock returns
Hasbrouck (2005)	Effective spread in daily data	CSR, Fama-French model, Fama and Macbeth method	NASDAQ, NYSE, AMEX 1962-2003	Positive and significant effect (seasonality in the liquidity effect)
Nguyen et al. (2006)	Share turnover	Fama-French, CSR, GLS, Fama and Macbeth method	NYSE, AMEX 1970-2002	Negative and significant coefficient
Market-wide liquidity in explaining stock returns				
Chordia, Roll, Subrahmanyam (2000-2001)	Trading activity (dollar trading volume or turnover)	CSR	NYSE 1984-1991	The extent and volatility of trading activity have a negative effect on stock returns
Amihud (2002)	AILLIQ (aggregate illiquidity) – the average of stocks' ILLIQs, the daily ratios of absolute return to dollar volume	TSR	NYSE 1962-1997	Average stock excess return is positively affected by AILLIQ at period *t-1* and negatively affected by unexpected AILLIQ at period *t* (residual from AR model) Both effects are stronger for the less liquid stocks

Authors	Liquidity measure	Methods, Models	Data	Result
Pastor and Stambaugh (2003)	*L* - the residual from the AR1 model of Δγ, where γ is the averaged sensitivity of the stocks' excess returns to their signed lagged dollar volumes	TSR, Fama-French model	NASDAQ, NYSE, AMEX 1966-1999	Stocks whose returns are more sensitive to market liquidity factor command higher required rates of return than the less sensitive ones
Liu (2004)	Factor-mimicking portfolio (illiquid minus liquid) Illiquidity is measured by the 250-day average of the reciprocal of daily turnover the sum of no-trading days	Fama-French model	NASDAQ, NYSE, AMEX 1963-2003	Consistent and significant increase in the regression intercepts for test portfolios arranged in the order of decreasing liquidity
Acharya and Pedersen (2005)	Three liquidity-related factors based on the pairwise covariances between returns and illiquidity costs (both market and idiosyncratic)	CSR, GMM	NYSE, AMEX 1964-1999	Expected return of a security is increasing with its expected illiquidity and its liquidity risk
Chan and Faff (2005)	Share turnover	GMM, Augmented Fama-French model, Fama -MacBeth method	Australian stock market 1991-1999	Significant negative impact on returns
Martinez et al. (2005)	Pastor and Stambaugh market liquidity, Amihud AILLIQ, and return differential between the stocks based on their sensitivity to bid-ask spread changes	CSR	Spanish stock market 1993-2000	The systematic liquidity risk is not priced (P&S) Positive relationship between liquidity betas and expected returns
Systematic versus characteristic liquidity				
Nguyen and Puri (2009)	Systematic - Pastor and Stambaugh factor Characteristic - dollar volume	TSR, CSR, Fama-French model	NYSE, AMEX, NASDAQ 1963-2004	Generally consistent decrease in the intercepts from low liquidity portfolios to high liquidity portfolios. Market liquidity factor alone does not capture the impact of liquidity level

To sum up, the fact that illiquidity has a positive and significant effect on stock returns was proved in a number of independent studies, and by using different data and various liquidity measures. Furthermore, most of the researchers discovered the existence of the premium for the exposure to systematic liquidity risk. However, the interrelation between non-diversifiable and idiosyncratic liquidity hasn't been fully explored so far, and the search for a rational asset pricing model which can subsume the effect of liquidity level is still open.

3 Methodology

3.1 Time-series framework

The purpose of time-series testing is twofold. Similarly to Nguyen and Puri (2009), we control for characteristic liquidity by sorting out the stocks into 11 liquidity groups, each containing 18 stocks, based on the relative bid-ask spread. The relative spread is defined as the ratio of the absolute spread to the average of the bid and ask prices. To ensure that liquidity effect is not distorted by other variables, we also form 18 value-weighted portfolios based on book-to-market ratio and spread. Within each month, the stocks are allocated into three BM groups. Afterwards, each of these groups is subdivided into six liquidity portfolios according to spread values.

Then we perform time-series regressions for these liquidity portfolios using both the Fama-French model, and the four-factor model with market risk premium, SMB, HML and systematic liquidity IML factor:

$$r(i,t) = \alpha_i + \beta_i\left(R_{mt} - R_{ft}\right) + \delta_i SMB_t + \gamma_i HML_t + \varphi_i IML_t + e_{it} \quad (1)$$

where $r(i,t)$ is the excess return on portfolio i in month t, $\left(R_{mt} - R_{ft}\right)$, SMB_t, and HML_t, are Fama-French (1993) factors related, respectively, to market premium, firm size, and book-to-market ratio, and IML_t is the systematic liquidity mimicking portfolio (illiquid-minus-liquid) in month *t*.

Fama-French factors are constructed using 6 value-weighted portfolios formed on size and book-to-market ratio. SMB (small-minus-big) is the average return on the three small capitalization portfolios minus the average return on the three big capitalization portfolios:

SMB = 1/3 (Small Value + Small Neutral + Small Growth) – 1/3 (Big Value + Big Neutral + Big Growth) (2)

HML (high-minus-low) is the average return on the two value portfolios (with high book-to-market ratio) minus the average return on the two growth portfolios (with low book-to-market ratio):

HML = ½ (Small Value + Big Value) – ½ (Small Growth + Big Growth) (3)

The market risk premium $(R_{mt} - R_{ft})$ is the value-weighted monthly return on the stocks in the sample in excess of the 1M Treasury Bill yield.

As the measure of systematic liquidity we use the factor-mimicking portfolio IML (illiquid-minus-liquid), constructed in a similar way to Fama-French SMB and HML factors. We form three versions of the factor by classifying the assets into groups in three different ways. First, we divide the stocks into three equally-weighted portfolios based on the relative spread only. The ranking is changed every month according to the spread at the end of the previous month. The liquidity factor is defined as the differential between the average return on the least liquid 30% of stocks and the average return on the most liquid 30%. As long as large capitalization stocks tend to be more liquid than small stocks, the size effect can distort the effect of liquidity *per se*. That's why we also classify the stocks according to the relative spread and size simultaneously, and define the IML(2) factor as the average return on small illiquid and big illiquid portfolios minus the average return on small liquid and big liquid portfolios. As a check for robustness, we also sort out the stocks based on spread, size and book-to-market ratio, and construct the systematic liquidity factor as follows:

IML(3) = 1/6 (Illiquid Small Value + Illiquid Small Neutral + Illiquid Small Growth + Illiquid Big Value + Illiquid Big Neutral + Illiquid Big Growth) – 1/6 (Liquid Small Value + Liquid Small Neutral + Liquid Small Growth + Liquid Big Value + Liquid Big Neutral + Liquid Big Growth) (4)

The time-series regression provides validity of the asset pricing model. The intercepts of regressions being significant indicate the presence of the characteristic liquidity premium. As pointed out in Nguyen and Puri (2009), if market liquidity and Fama-French factors cover the effect of characteristic liquidity, there will be no consistent increase in the intercepts from highly liquid portfolios to those with the lower liquidity. In addition, if the intercepts are jointly equal to zero, then the specified asset pricing model reflects the liquidity level effect and is able to explain stock returns. Otherwise, the model does not capture liquidity. To test whether the intercepts are jointly equal to zero, we use the statistics developed by Gibbon, Ross, and Shanken (1989).

Gibbon, Ross, and Shanken F-test procedure (GRS hereafter) can be summarized as follows.

Let T be the number of time-series observations, N be the number of test portfolios, and L be the number of factor portfolios. The GRS F-test statistic is given by

$$\left(\frac{\mathrm{T}}{\mathrm{N}}\right)\times\left(\frac{\mathrm{T-N-L}}{\mathrm{T-L-1}}\right)\times\left(\frac{\hat{\boldsymbol{\alpha}}'\boldsymbol{\Sigma}^{-1}\hat{\boldsymbol{\alpha}}}{1+\overline{\boldsymbol{\mu}}'\boldsymbol{\Omega}^{-1}\overline{\boldsymbol{\mu}}}\right), \tag{5}$$

where $\hat{\boldsymbol{\alpha}}$ is the N x 1 vector of regression constants, $\boldsymbol{\Sigma}$ is the unbiased estimate of the residual covariance matrix (N x N), $\overline{\boldsymbol{\mu}}$ is the L x 1 vector of the factor portfolios' sample means, and $\boldsymbol{\Omega}$ is the unbiased estimate of the factor portfolios' covariance matrix (L x L).

Under the null hypothesis that regression constants are equal to zero, this statistics is F-distributed with N and (T – N – L) degrees of freedom. If $\alpha_i = 0 \ \forall \ i$, the GRS statistics is equal to zero. The larger the absolute values of the intercepts are, the greater GRS statistics is.

3.2 Cross-sectional framework

To further examine whether there is a liquidity premium after controlling for the stock characteristics and factor loadings, we perform regression analysis using the two-stage Fama-MacBeth methodology (1973).

First, for each month t in the sample we run the following CSRs:

$$r(i,t) = \gamma_{0t} + \gamma_{1t}\beta_i + \gamma_{2t}Size_i + \gamma_{3t}BM_i + \gamma_{4t}Spread_i + e_{it}\ , \tag{6}$$

where $r(i,t)$ is the excess return on stock i in month t, β, *Size*, *BM* and *Spread* are, respectively, the market β, the natural logarithm of the market value of equity, the natural logarithm of the book-to-market ratio, and the natural logarithm of relative bid-ask spread (as a proxy for characteristic liquidity) of firm *i*.

We construct the book-to-market variable (natural logarithm of book value to market value for individual firms) as suggested by Fama and French (1992). The log of firm size is defined as the natural logarithm of total market capitalization of firm *i*, at the end of the prior month (*t-1*).

The standard Fama-Macbeth procedure (1973) implies estimating parameters with OLS and averaging them over time by computing the arithmetical mean. The t-statistics of the average parameter is given by the following formula:

$$\text{t-stat}\,(\overline{\gamma_j}) = \frac{\overline{\gamma_j}}{\sqrt{\frac{1}{T}\times\frac{1}{T-1}\times(\widehat{\gamma_j t}-\overline{\gamma_j})^2}} \sim t\,(T-1) \tag{7}$$

The methodology is rather simple, and encounters a number of econometrical problems:

1) *EIV (errors in variables)*

   As long as true market β isn't observable, it has to be estimated by a following single index model (SIM):

$$R_{is} = \alpha_{it} + \beta_{it} R_{ms} + e_{is}, \tag{8}$$

   where R_{is} denotes the excess return on risky asset *i* at time *s*, R_{ms} is the excess return on the market portfolio, and s = t − S, ..., t − 1.

   The estimated beta for each asset in period *t*, $\widehat{\beta_{it}}$, is included into (6) for period *t*. The estimation error in market betas causes a downward bias in estimation of γ_1 from equation (6), and overestimation of the other coefficients.

2) *Heteroscedasticity and cross-correlation*

   Since the variances of the returns at time *t* may vary across assets, and the returns may be correlated, the error terms in CSR equations may be heteroscedastic and correlated, which would make the OLS estimator inefficient.

3) *Market portfolio is not observable*

Roll and Ross (1994) show that if the true market portfolio is efficient, the cross-sectional relation between expected returns and betas can be very sensitive to even small deviations of the market portfolio proxy from the true market portfolio. To deal with this issue, we assume that the residuals ε_{is} from the equation (8) are uncorrelated with the true market portfolio, and that the proxy for market portfolio has a unit beta. Provided this holds, the beta of an asset against the true market portfolio is equal to its beta against the index, chosen as a proxy for the market portfolio.

Returning back to equation (6), we are particularly interested in the sign and significance of γ_4. If it is significant, it means that liquidity, proxied by bid-ask spread, influences stock returns after controlling for other stock characteristics.

In the same way, the effect of bid-ask spread on the stock returns can be examined after controlling for factor loadings on Fama-French factors, and the IML factor of aggregate liquidity. The following regression equation is used:

$$r(i,t) = \gamma_{0t} + \gamma_{1t}F_{Rm-Rf} + \gamma_{2t}F_{SMB} + \gamma_{3t}F_{HML} + \gamma_{4t}F_{IML} + \gamma_{5t}Spread + e_{it} \ , \qquad (9)$$

where $r(i,t)$ is the excess return on stock *i* in month *t*, F_{Rm-Rf}, F_{SMB}, and F_{HML} are the factor loadings of firm *i* on the Fama-French factors, F_{IML} is the factor loading of firm *i* on the IML systematic liquidity factor, and *Spread* is the relative bid-ask spread of the firm *i*. The factor loadings on SMB, HML, and IML factors aren't given explicitly, as well as the market beta (F_{Rm-Rf}), and have to be estimated using individual regressions of returns on factor observations.

If γ_5 turns out to be significant, it will indicate the presence of characteristic liquidity premium even after controlling for Fama-French and IML factor loadings.

4 Empirical Analysis

4.1 Constructing Factors

Our data set consists of 106 end-of-month return observations on 198 stocks from the Swedish AFGX index. The sample range is from Jul 2001 to Apr 2010. As a risk-free rate we use the yield on the Swedish Treasury Bill with 1 month maturity.

At first, we sort out the stocks into 6 market value weighted portfolios based on their size and book-to-market ratio. These portfolios contain different number of stocks, and are rebalanced each month according to the stock characteristics at the end of the prior month. Among the small capitalization companies there are more those with high book-to-market ratios than with the low ones: out of 99 stocks in the "small" group, 28 on average belong to "low BM" group, compared to 34 in the "high BM" group. The big stocks are more centred around the medium book-to-market values (41 out of 99), which is between 0,36 and 0,79 on average. In general, big companies tend to have lower BM ratios, because they are more often expected to have profitable growth opportunities. The difference would be more distinct if the statistical definitions of "big-small" and "high-low", based on our sample distribution, coincided with the financial definitions. Our distribution of the market value variable is significantly positively skewed (the average median is SEK 822 million while the average mean is SEK 11,5 billion), and therefore there is a number of stocks which belong to the "big" portfolio but are not big from the financial point of view.

The Small-High portfolio has the highest average return among the 6 Fama-French portfolios (2,25%), which is consistent with the theory. However, the lowest average return (-0,62%) pertains to the Small-Low portfolio. Out of 106 monthly observations on SMB returns, only 44 are greater than zero, which means that there is no systematic premium for size variable in our sample. In addition, the average return on SMB portfolio is -0,14%. The HML return series we obtained, is closer to what the Fama-French framework suggests. There are 67 premiums for value stocks over the growth stocks, with the average one being equal to 2,06%.

The market risk premium factor is constructed as the value-weighted return on all the stocks in the sample less the yield on the 1M Treasury Bill. During the periods from Jul 2001 till the end of 2003, and Jul 2006 – Oct 2008, the monthly yield is quite high, reaching up to 4,26% and not differing much from the one-year risk-free rate. Thus, there are only 48 positive market excess returns, and the average one is -1,79%, which is counterintuitive.

In order to construct the aggregate liquidity factor we form 3 portfolios based on the relative spread only, 4 portfolios based on the size and spread, and 12 portfolios based on the size, spread and book-to-market ratio[1]. The spread and BM variables are split 30/40/30, and the size variable is split 50/50. All the portfolios' returns are value-weighted in order to minimize the asset-specific variance, and the summary is presented in the following table.

Table 2: The structure of the aggregate liquidity factor

	Portfolio	*Average Return (across 106 months)*	*Liquidity Factor*	
			Average Return	*Number of Positive Returns*
IML	Liquid	0,73%	0,25%	57
	Illiquid	0,98%		
IML2	Liquid Small	1,33%	0,065%	58
	Liquid Big	0,73%		
	Illiquid Small	1,17%		
	Illiquid Big	1,02%		
IML3	Liquid Small Low	-1,17%	-0,016%	54
	Liquid Small Medium	1,66%		
	Liquid Small High	1,36%		
	Liquid Big Low	0,46%		
	Liquid Big Medium	0,44%		
	Liquid Big High	2,12%		
	Illiquid Small Low	-0,54%		
	Illiquid Small Medium	1,20%		
	Illiquid Small High	2,15%		
	Illiquid Big Low	0,06%		
	Illiquid Big Medium	0,63%		
	Illiquid Big High	1,37%		

[1] Hereafter, the aggregate liquidity factor based on the spread only will be referred to as IML, the one based on the spread and size – as IML2, and the one based on the spread, size, and BM – as IML3.

Notes: This table shows the components of our aggregate liquidity factor. Stocks are allocated to a certain portfolio based on the spread only, spread and size simultaneously, and spread, size and book-to-market simultaneously. For example, Liquid Small Low portfolio contains stocks which are in the lowest 30% according to spread, in the first 50% according to size, and in the lowest 30% according to book-to-market at the same time. Thus, portfolios can contain different number of stocks. The third column of the table reports the value-weighted returns on the liquidity groups averaged over time. The fourth column presents the average return on the aggregate liquidity factor formed in three ways: 1) IML = Illiquid - Liquid; 2) IML2 = 1/2 x (Illiquid Small + Illiquid Big) - 1/2 x (Liquid Small + Liquid Big); 3) IML3 = 1/6 x (Illiquid Small Low + Illiquid Small Medium + Illiquid Small High + Illiquid Big Low + Illiquid Big Medium + Illiquid Big High) - 1/6 x (Liquid Small Low + Liquid Small Medium + Liquid Small High + Liquid Big Low + Liquid Big Medium + Liquid Big High). The last column of the table contains the number of time periods out of 106 in which the return on the aggregate liquidity factor is positive, i.e. there is an illiquidity premium.

As we can see, the biggest illiquidity premium is observed when the stocks are sorted according to the spread value only. Controlling for size effect reduces the average return on the liquidity factor, while controlling for both the size and book-to-market ratio leads to the negative on average premium for illiquidity. The “illiquid small high” portfolio has the highest return, in accordance with the asset pricing theory. However, there is no evidence of the systematic premium for the small capitalization and illiquid stocks. The premium for high book-to-market is the most consistent: all the “high” portfolios yield higher average returns than the “low” and the “medium” ones, the other two characteristics being equal.

The following table contains the correlations between the constructed factors.

Table 3: Factor correlations

	SMB	*HML*	*Rm-Rf*	*IML*
SMB	1			
HML	-0,218	1		
Rm-Rf	-0,156	0,066	1	
IML	0,649	-0,077	-0,328	1
	SMB	*HML*	*Rm-Rf*	*IML2*
SMB	1			
HML	-0,218	1		
Rm-Rf	-0,156	0,066	1	

IML2	0,079	-0,061	-0,405	1
	SMB	*HML*	*Rm-Rf*	*IML3*
SMB	1			
HML	-0,218	1		
Rm-Rf	-0,156	0,066	1	
IML3	0,151	-0,085	-0,326	1

As table 3 indicates, when controlling for size effect, the correlation between SMB and liquidity factors declines from 64,9% to 7,9%, which indicates success of the procedure suggested in Fama and French (1993). IML2 liquidity mimicking portfolio is largely free from the influence of the size factor, and better focuses on the return behaviour explained by liquidity. Controlling for size and book-to-market doesn't significantly influence the correlations compared to controlling for size only. This implies that liquidity of a stock almost doesn't relate to its book-to-market ratio, but is considerably affected by its market value. The premium for illiquidity is positively related to the premium for size, but negatively related to the premiums for book-to-market and market risk. Therefore, when the market is in the down-state, there is a greater premium for illiquidity, which is intuitive. The premiums for illiquidity and small size move in the same direction.

4.2 Time-series Testing

In order to examine whether market-wide liquidity factor captures the asset-specific liquidity we, firstly, run time-series regressions on the 11 equally-weighted portfolios of AFGX stocks sorted according to the relative bid-ask spread in the order of decreasing liquidity. Each portfolio contains 18 stocks, and is rebalanced monthly from Jul 2001 till Apr 2010 based on the spread values at the end of the prior month. Relative bid-ask spread is defined as a ratio of the absolute spread to the average of bid and ask prices.

Regression results are presented in Table 4.

Table 4: Intercepts of the time-series regressions of 11 portfolios arranged by relative bid-ask spread in the order of decreasing liquidity for the three-factor and four-factor models

spread group	1	2	3	4	5	6	7	8	9	10	11
Panel A: Three-factor Fama-French model											
intercept	-2,099%	-2,110%	-2,053%	-2,133%	-2,126%	-2,116%	-2,118%	-2,107%	-2,120%	-2,045%	-2,127%
t-stat	-18,64	-17,93	-17,53	-18,14	-17,80	-18,03	-18,22	-18,58	-15,89	-17,67	-15,74
p-value	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Adjusted R^2	57,22%	54,94%	57,96%	56,58%	58,25%	59,35%	57,89%	60,37%	50,55%	57,55%	46,65%
F-value for GRS test that the intercepts are jointly equal to zero is 31,22 (p-value = 0,000)											
Panel B: Four-factor model with IML liquidity factor											
intercept	-2,080%	-2,087%	-2,034%	-2,115%	-2,106%	-2,096%	-2,101%	-2,083%	-2,095%	-2,025%	-2,108%
t-stat	-19,34	-18,96	-18,10	-18,65	-18,42	-18,68	-18,66	-19,73	-16,57	-18,40	-16,01
p-value	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Adjusted R^2	61,15%	60,67%	61,42%	59,73%	61,87%	62,95%	60,65%	65,72%	55,69%	61,76%	49,51%
F-value for GRS test that the intercepts are jointly equal to zero is 33,67 (p-value = 0,000)											
Panel C: Four-factor model with IML2 liquidity factor											
intercept	-2,076%	-2,082%	-2,027%	-2,111%	-2,105%	-2,092%	-2,098%	-2,078%	-2,089%	-2,020%	-2,101%
t-stat	-19,31	-18,97	-18,29	-18,69	-18,23	-18,59	-18,58	-19,76	-16,65	-18,42	-16,14
p-value	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Adjusted R^2	61,17%	60,99%	62,50%	60,11%	61,18%	62,74%	60,41%	66,01%	56,47%	62,05%	50,67%
F-value for GRS test that the intercepts are jointly equal to zero is 35,14 (p-value = 0,000)											
Panel D: Four-factor model with IML3 liquidity factor											
intercept	-2,080%	-2,087%	-2,034%	-2,115%	-2,106%	-2,096%	-2,101%	-2,083%	-2,095%	-2,025%	-2,108%
t-stat	-19,34	-18,96	-18,10	-18,65	-18,42	-18,68	-18,66	-19,73	-16,57	-18,40	-16,01
p-value	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000
Adjusted R^2	61,15%	60,67%	61,42%	59,73%	61,87%	62,95%	60,65%	65,72%	55,69%	61,76%	49,51%
F-value for GRS test that the intercepts are jointly equal to zero is 35,52 (p-value = 0,000)											

Notes: This table reports the obtained values of intercepts and the corresponding statistics. Coefficients are estimated by the OLS method. Panel A presents the results from the time-series regressions on the Fama-French three-factor model as in equation $r(i,t) = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \delta_i SMB_t + \gamma_i HML_t + e_{it}$, where $r(i,t)$ is the excess return on portfolio *i* in month *t*, $(R_{mt} - R_{ft})$, SMB_t, and HML_t, are Fama-French (1993) factors related, respectively, to market premium, firm size, and book-to-market ratio in month *t*. Panels B-D present the results from the time-series regressions on the four-factor model as in equation (1), containing Fama-French factors and the aggregate liquidity mimicking portfolio constructed in three different ways, as discussed in the previous section. The bottom of each panel reports the GRS test statistics of the null hypothesis that the intercepts of the 11 regressions are jointly equal to zero.

Based on the results obtained, there is no evidence of the consistent increase in the intercepts from the highest to the lowest liquidity group. Instead, the intercepts from our regressions follow a mean-reverting process, as Figure 1 shows.

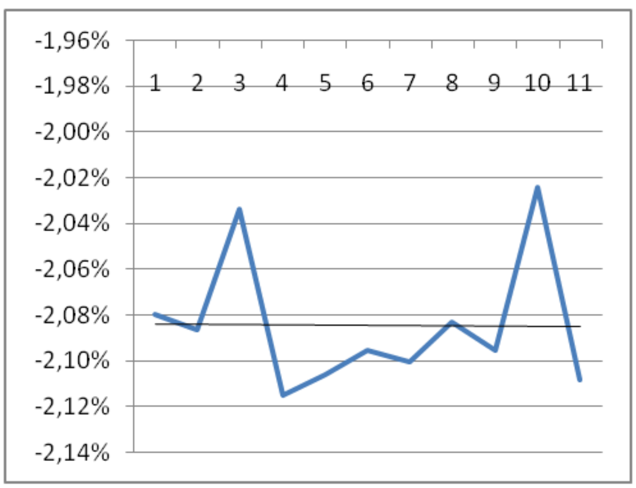

Figure 1: The intercepts from Panel B. The flat line represents the trend.

The intercepts from the other models follow exactly the same process only with the means being slightly different. Given such a pattern, the impact of the relative bid-ask spread on stock returns is not clear. In addition, the results indicate that neither of the tested models fully explains the variation of stock returns, and captures the liquidity effect. The GRS test declines the null hypothesis that the intercepts of regressions are jointly equal to zero at the infinitely small significance level for all the models. However, as the adjusted R^2 values point out, adding the aggregate liquidity factor increases the quality of approximation by 3-4%.

Table 5 contains the regression betas, and the corresponding p-values from our test models. According to the obtained results, stock returns are most sensitive to changes in the market risk premium. Market risk premium and liquidity factors are significant at 5% level for all the models and all portfolios. The size mimicking portfolio is insignificant for 7 portfolios of Panel B. This can be explained by the fact that IML liquidity factor is not controlled for size effects, and is correlated with SMB by 65% (see Table 3). Therefore, it can capture the variation of stock returns attributed to size differences, and make the size factor redundant. We can see that in Panels A, C, and D SMB is significant in 9 cases out of 11. However, the HML factor is insignificant at 5% level for all the portfolios, which means that the sensitivity of stock returns to the book-to-market premium is too small to be considered.

Table 5: Factor loadings of the time-series regressions of 11 portfolios arranged by relative bid-ask spread in the order of decreasing liquidity for the three-factor and four-factor models

spread group	1	2	3	4	5	6	7	8	9	10	11
Panel A: Three-factor Fama-French model											
Rm-Rf	0,165	0,165	0,173	0,167	0,172	0,173	0,166	0,171	0,163	0,162	0,147
	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)
SMB	**0,039**	**0,042**	0,063	0,089	0,112	0,110	0,111	0,103	0,122	0,116	0,129
	(0,080)	(0,067)	(0,007)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)
HML	**-0,030**	**-0,026**	**-0,024**	**-0,016**	**-0,016**	**-0,021**	**-0,015**	**-0,030**	**0,008**	**-0,022**	**-0,024**
	(0,161)	(0,257)	(0,277)	(0,467)	(0,480)	(0,356)	(0,489)	(0,170)	(0,743)	(0,328)	(0,365)
Panel B: Four-factor model with IML liquidity factor											
Rm-Rf	0,176	0,181	0,188	0,181	0,186	0,184	0,175	0,186	0,178	0,175	0,158
	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)
SMB	**-0,009**	**-0,025**	**0,002**	**0,030**	**0,055**	0,064	0,073	**0,041**	**0,060**	0,062	0,081
	(0,747)	(0,377)	(0,947)	(0,294)	(0,061)	(0,029)	(0,013)	(0,137)	(0,068)	(0,030)	(0,017)
HML	**-0,036**	**-0,034**	**-0,032**	**-0,023**	**-0,023**	**-0,026**	**-0,020**	**-0,037**	**0,001**	**-0,028**	**-0,029**
	(0,089)	(0,117)	(0,142)	(0,281)	(0,298)	(0,235)	(0,367)	(0,073)	(0,969)	(0,190)	(0,254)
IML	0,083	0,117	0,106	0,102	0,100	0,079	0,065	0,109	0,108	0,095	0,083
	(0,009)	(0,000)	(0,001)	(0,002)	(0,003)	(0,017)	(0,047)	(0,001)	(0,004)	(0,004)	(0,030)
Panel C: Four-factor model with IML2 liquidity factor											
Rm-Rf	0,184	0,189	0,195	0,186	0,190	0,192	0,182	0,195	0,189	0,183	0,168
	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)
SMB	**0,038**	**0,041**	0,062	0,088	0,112	0,109	0,110	0,102	0,121	0,115	0,128
	(0,073)	(0,055)	(0,005)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)
HML	**-0,028**	**-0,023**	**-0,022**	**-0,014**	**-0,014**	**-0,019**	**-0,014**	**-0,027**	**0,011**	**-0,019**	**-0,021**
	(0,173)	(0,279)	(0,302)	(0,513)	(0,525)	(0,390)	(0,533)	(0,179)	(0,634)	(0,360)	(0,400)
IML2	0,086	0,107	0,097	0,085	0,081	0,086	0,074	0,106	0,115	0,095	0,095
	(0,001)	(0,000)	(0,000)	(0,002)	(0,004)	(0,002)	(0,007)	(0,000)	(0,000)	(0,001)	(0,003)

Panel D: Four-factor model with IML3 liquidity factor											
Rm-Rf	0,179	0,182	0,188	0,180	0,187	0,188	0,179	0,188	0,181	0,177	0,161
	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)
SMB	**0,032**	**0,034**	0,056	0,082	0,105	0,103	0,105	0,095	0,113	0,109	0,123
	(0,131)	(0,116)	(0,011)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)	(0,000)
HML	**-0,027**	**-0,022**	**-0,021**	**-0,013**	**-0,013**	**-0,018**	**-0,013**	**-0,026**	**0,012**	**-0,018**	**-0,021**
	(0,187)	(0,302)	(0,322)	(0,535)	(0,554)	(0,413)	(0,557)	(0,197)	(0,612)	(0,383)	(0,416)
IML3	0,087	0,106	0,086	0,082	0,090	0,089	0,078	0,105	0,109	0,093	0,083
	(0,001)	(0,000)	(0,002)	(0,003)	(0,002)	(0,001)	(0,005)	(0,000)	(0,001)	(0,001)	(0,011)

Notes: This table reports the values of the factor loadings of the excess returns of 11 test portfolios on the Fama-French factors and aggregate liquidity factors IML, IML2, and IML3. P-values of the corresponding t-statistics are presented in parenthesis. The coefficients which are insignificant at 5% level are marked in bold.

The pattern of intercepts in different liquidity groups brings us to the conclusion that either the impact of relative bid-ask spread on stock returns is not consistent, or there are other factors which distort the liquidity effect and need to be controlled for. Therefore, we sort the stocks into 6 liquidity portfolios within each of the 3 book-to-market groups (30/40/30 split). To mitigate the size effect, we calculate the portfolio return as the market value weighted average of the stock returns in the portfolio. Each liquidity portfolio contains 10 stocks within the “high” and “low” book-to-market groups, and 13 stocks within the “medium” book-to-market group. Portfolios are rebalanced monthly according to the relative spread and book-to-market ratio values at the end of the prior month. The intercepts and the statistics are presented in Table 6.

Table 6: Intercepts from time-series regressions of 12 out of 18 portfolios sorted out by book-to-market ratio and relative bid-ask spread for the four-factor models

BM group	Liquidity group (decreasing liquidity)	1	2	3	4	5	6	6-1
Low	**Panel A: Four-factor model with IML liquidity factor**							
	intercept	-2,321%	-2,311%	-2,308%	-2,259%	-1,904%	-1,800%	0,521%
	t-stat	-19,60	-19,49	-19,46	-18,92	-12,55	-13,13	
	p-value	0,000	0,000	0,000	0,000	0,000	0,000	
	Adjusted R^2	71,13%	52,96%	34,84%	30,85%	29,75%	28,92%	
High								
	intercept	-2,316%	-2,312%	-2,315%	-2,295%	-2,204%	-2,076%	0,240%
	t-stat	-19,49	-19,39	-19,49	-19,56	-18,04	-16,41	
	p-value	0,000	0,000	0,000	0,000	0,000	0,000	
	Adjusted R^2	61,49%	41,16%	32,51%	30,02%	28,99%	28,86%	
	F-value for GRS test that the intercepts are jointly equal to zero is 36,74 (p-value = 0,000)							
Low	**Panel B: Four-factor model with IML2 liquidity factor**							
	intercept	-2,300%	-2,290%	-2,286%	-2,238%	-1,887%	-1,782%	0,517%
	t-stat	-19,77	-19,65	-19,64	-18,90	-12,42	-13,12	
	p-value	0,000	0,000	0,000	0,000	0,000	0,000	
	Adjusted R^2	71,81%	53,07%	36,13%	33,67%	32,47%	31,67%	
High								
	intercept	-2,294%	-2,290%	-2,294%	-2,273%	-2,181%	-2,053%	0,241%
	t-stat	-19,66	-19,56	-19,64	-19,81	-18,24	-16,86	
	p-value	0,000	0,000	0,000	0,000	0,000	0,000	
	Adjusted R^2	64,46%	43,92%	35,72%	32,69%	31,79%	31,66%	
	F-value for GRS test that the intercepts are jointly equal to zero is 38,23 (p-value = 0,000)							
Low	**Panel C: Four-factor model with IML3 liquidity factor**							
	intercept	-2,300%	-2,290%	-2,286%	-2,238%	-1,887%	-1,782%	0,517%
	t-stat	-19,77	-19,65	-19,64	-18,90	-12,42	-13,12	
	p-value	0,000	0,000	0,000	0,000	0,000	0,000	
	Adjusted R^2	71,81%	53,07%	36,13%	33,67%	32,47%	31,67%	
High								
	intercept	-2,294%	-2,290%	-2,294%	-2,273%	-2,181%	-2,053%	0,242%
	t-stat	-19,66	-19,56	-19,64	-19,81	-18,24	-16,86	
	p-value	0,000	0,000	0,000	0,000	0,000	0,000	
	Adjusted R2	64,46%	43,92%	35,72%	32,69%	31,79%	31,66%	
	F-value for GRS test that the intercepts are jointly equal to zero is 37,9 (p-value = 0,000)							

Notes: This table reports the values of intercepts, the corresponding t-statistics, p-values and the adjusted R^2 coefficients obtained from the time-series OLS regressions as in equation (1) for 12 portfolios of AFGX stocks sorted out by book-to-market ratio and relative bid-ask spread. The relative bid-ask spread is defined as the ratio of the absolute spread to the simple average of the bid and ask prices. Within each month, all the stocks are allocated into three groups based on their book-to-market ratios at the end of the prior month. Each book-to-market group is then subdivided into six liquidity portfolios according to the relative bid-ask spread values. The table presents the results for "high" and "low" BM groups. The last column reports the difference between the intercepts of the least liquid and the most liquid groups. The bottom of each panel contains the F-values of GRS test of the null hypothesis that the intercepts are jointly equal to zero.

Figure 2 plots the intercepts from the four-factor model with IML liquidity factor.

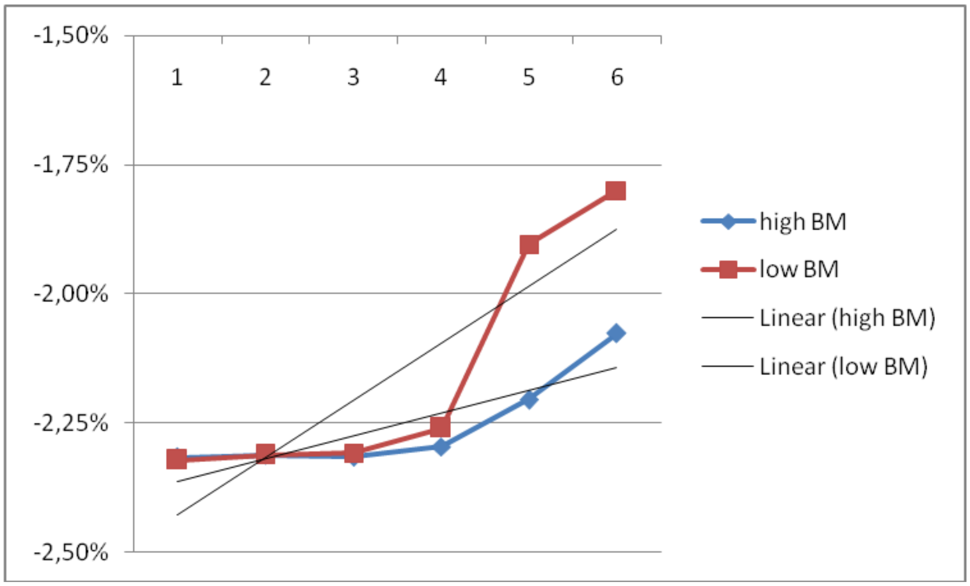

Figure 2: The intercepts from Panel A.

As expected, after controlling for book-to-market and size factors, the illiquidity premium notion holds. Similarly to Nguyen and Puri (2009), we observe systematic increase in the intercepts from the most liquid to the least liquid group. The intercepts are significant, both separately and jointly, which suggests that neither of the models captures the asset-specific liquidity. The difference between the intercepts for the two extreme liquidity portfolios is more than twice as big for the "low" BM than for the "high" BM group, which is explained by the fact that in our sample the range of spreads for growth stocks is wider than for value stocks. In other words, the difference between the fifth and the first percentiles is mostly bigger for the “low” BM group.

Moreover, we also observe a consistent decrease in the adjusted R^2 coefficients for all the models when moving from group 1 to group 6 (see Table 6). The same models explain twice as much variation of stock returns in the most liquid group than in the least liquid. Therefore, there must be some omitted factor which affects illiquid stocks much more than the liquid ones. In addition, this factor doesn’t relate to book-to-market ratio, as long as the R^2 coefficients follow the same pattern both in the “high” and “low” BM groups.

To conclude, the results of time-series testing, using the data on stocks from the Swedish AFGX index, indicate that augmenting Fama-French three-factor model with the systematic liquidity factor allows to capture more variation of stock returns, although there is still much unexplained. When sorting out the stocks based on the relative spread only, we do not find evidence of the stable characteristic liquidity premium after controlling for the systematic liquidity. The intercepts of portfolios arranged in the order of decreasing liquidity do differ, but they follow a mean-reverting process rather than a consistently increasing one. As long as the intercepts are jointly significant according to GRS test, the models don’t capture liquidity effect. In addition, the regression coefficients indicate that market risk premium is, not surprisingly, the most priced factor. The systematic liquidity mimicking portfolio has a significant impact on stock returns too, but the loadings are smaller. The book-to-market premium is insignificant, and the size premium is significant provided that the aggregate liquidity factor is free of size effects. In order to make the asset-specific liquidity impact more clear, we also perform regressions for the 18 value-weighted portfolios sorted out by book-to-market ratio and spread. In this case, similarly to Nguyen and Puri (2009), we do observe systematic increase in the intercepts for portfolios arranged in the order of decreasing liquidity. We also find that the same models explain twice as much variation of stock returns in the most liquid group than in the least liquid, which suggests the presence of some omitted factor that affects illiquid stocks more than liquid ones.

4.3 Cross-sectional Testing

In order to investigate the relationship between liquidity and stock returns after controlling for other stock characteristics and factor loadings, we run cross-sectional regressions. We use 198 AFGX stocks over the period July 2004 – April 2010 (70 regressions). In each month, a cross-sectional regression is estimated wherein the individual stock return is the dependent variable, and the independent variables comprise various combinations of the relative bid-ask spread with other stock characteristics or factor loadings on the Fama-French factors and aggregate liquidity factor[2]. Size, book-to-market and bid-ask spread variables used in the regressions are the natural logarithms, respectively, of the firm's total market capitalization, book-to-market ratio and relative bid-ask spread at the end of the prior month. Market betas and the other factor loadings are estimated by time-series OLS regressions. Using excess returns and factor observations from the previous 36 months we estimate the factor loadings for each month[3].

Our results are presented in Tables 7-9. Table 7 reports correlations among bid-ask spread and other stock characteristics. As we can see, size and beta are negatively correlated with factor -0.092, while beta is positively correlated with book-to-market and bid-ask spread with factors 0.013 and 0.065 respectively. Size is also negatively correlated with book-to-market ratio and spread with factors -0.047 and -0.148 respectively. As for spread and book-to-market correlation it is positive and small with factor 0.023. As the explanatory variables aren't significantly correlated, we can use them in OLS regressions, and rely on the obtained results.

Table 7: Stock characteristics correlation matrix

	Beta	*Size*	*Book-to-market*	*Spread*
Beta	1	-0,091	0,013	0,065
Size	-0,091	1	-0,047	-0,148
Book-to-market	0,013	-0,047	1	0,023
Spread	0,065	-0,148	0,023	1

[2] Refer to section 3.2 *Cross-sectional framework* for detailed methodology description
[3] Data for estimation of factor loadings starts with July 2001

Tables 8 and 9 summarize the results of all cross-sectional regressions of stock excess returns on relative bid-ask spread after controlling for various combinations of the other independent variables (stock characteristics and factor loadings). As shown in the last column of Table 8, spread is significantly positively related to stock returns in a number of periods, which is consistent with the asset pricing theory (the larger the spread, the more illiquid the stock is, and the higher the return). After averaging the estimated slopes over time by computing the arithmetical mean, we find that liquidity is still negatively related to stock returns but is no longer significant. Illiquidity turns out to be priced in 41,2% of cases within the sample when spread is the only factor, decreasing to 21,4% when additional factors are included into the model. Such a pattern is observable especially when we add the size variable. Even though we have indicated that correlations between regressors are fairly small, it appears that 14,8% negative correlation between the size and spread variables has a noticeable effect when it comes to liquidity pricing. The same tendency is observable in regressions on factor loadings.

Table 8: Results of monthly cross-sectional regressions of excess returns on the combinations of relative bid-ask and other stock characteristics

Independent variables	**Average spread coefficient (x10 000)**	**t-statistics**	**p-value**	**Number of significant spread coefficients (out of 70)**
Spread	13,298	0,804	0,424	29
spread, beta	8,368	0,517	0,607	26
spread, size	9,725	0,608	0,545	16
spread, book-to-market	11,511	0,697	0,488	29
spread, beta, size	7,195	0,463	0,645	16
spread, size, book-to-market	8,628	0,544	0,589	15
spread, beta, book-to-market	7,418	0,458	0,649	26
spread, beta, size, book-to-market	5,811	0,379	0,706	14

Notes: This table reports the results of monthly cross-sectional regressions of stocks' excess returns on the various combinations of stock characteristics. For example, the last row corresponds to the following equation: $r(i,t) = \gamma_{0t} + \gamma_{1t}\beta_i + \gamma_{2t}Size_i + \gamma_{3t}BM_i + \gamma_{4t}Spread_i + e_{it}$, where *Size, BM* and *Spread* are the natural logarithms, respectively, of the firm's total market capitalization, book-to-market ratio and relative bid-ask spread at the end of the prior month. Market beta (β) is estimated by regressing the stocks' excess returns on the market risk premium using the previous 36 monthly observations. Average coefficient for each regression is obtained by computing arithmetical mean over the time period July 2004 – April 2010. This table presents the values of the average coefficients multiplied by 10 000. The last column reports the number of time periods out of 70 in which the *Spread* variable is significant under 5% level.

Table 9: Results of monthly cross-sectional regressions of excess returns on the combinations of relative bid-ask spread and factor loadings

Independent variables	**Average spread coefficient (x10 000)**	**t-statistics and p-value**	**Average F_{IML} coefficient (x10 000)**	**t-statistics and p-value**	**Number of significant spread coefficients (out of 70)**
spread, F_{Rm-Rf}	8,809	0,539 (0,591)			23
spread, F_{IML}	7,531	0,455 (0,651)	20,951	1,119 (0,267)	29
spread, F_{HML}	9,931	0,626 (0,533)			27
spread, F_{SMB}	4,706	0,309 (0,759)			22
spread, F_{SMB}, F_{IML}	1,879	0,123 (0,902)	22,619	(1,083) (0,283)	20
spread, F_{SMB}, F_{HML}	1,968	0,130 (0,897)			22
spread, F_{SMB}, F_{Rm-Rf}	2,871	0,194 (0,847)			17
spread, F_{Rm-Rf}, F_{HML}	6,984	0,428 (0,670)			21
spread, F_{Rm-Rf}, F_{IML}	3,462	0,213 (0,832)	1,416	0,066 (0,947)	23
spread, F_{HML}, F_{IML}	5,202	0,324 (0,747)	5,195	0,276 (0,783)	24
spread, F_{SMB}, F_{Rm-Rf}, F_{HML}	0,759	0,050 (0,960)			18
spread,F_{SMB}, F_{Rm-Rf}, F_{IML}	0,726	0,049 (0,961)	4,536	0,200 (0,842)	18
spread,F_{HML}, F_{IML}, F_{Rm-Rf}	1,825	0,112 (0,911)	1,017	0,049 (0,961)	21
spread, F_{SMB}, F_{IML}, F_{HML}	0,373	0,025 (0,981)	5,886	0,274 (0,784)	21
spread, F_{SMB},F_{IML}, F_{HML}, F_{Rm-Rf}	0,137	0,090 (0,928)	5,381	0,242 (0,809)	18

Notes: This table reports the results of monthly cross-sectional regressions of stocks' excess returns on the various combinations of stocks' loadings on Fama-French factors and aggregate liquidity factor. For example, the last row corresponds to the following equation: $r(i,t) = \gamma_{0t} + \gamma_{1t}F_{Rm-Rf} + \gamma_{2t}F_{SMB} + \gamma_{3t}F_{HML} + \gamma_{4t}F_{IML} + \gamma_{5t}Spread + e_{it}$, where *Spread* is the natural logarithm of stock's relative bid-ask spread at the end of the prior month, F_{Rm-Rf} , F_{SMB} , F_{HML}, and F_{IML} are stock's factor loadings on, respectively, market risk premium, SMB, HML and IML aggregate liquidity factor. The loadings are estimated by running one-factor time-series regressions of stocks' excess returns on the corresponding factors using the previous 36 monthly observations. Average coefficients are obtained by computing arithmetical mean over the time period July 2004 – April 2010. This table reports the values of the coefficients multiplied by 10 000. The last column presents the number of time periods out of 70 in which the *Spread* variable is significant under 5% level.

As Table 9 indicates, stock's sensitivity to market-wide liquidity (F_{IML}) is not significant on average in neither of the models, similarly to liquidity level *per se* (*Spread*).

The obtained results of cross-sectional testing are influenced by many minor errors and methodology drawbacks. First of all, factor loadings are not observable and need to be estimated, which causes measurement error problem from the beginning and produces biased inputs. Moreover, the variables estimation procedure leads to reduction of the time-series range available for the cross-sectional testing, which affects the precision. Finally, liquidity can be measured using various proxies or their combinations, which may produce different results. Using relative bid-ask spread as the proxy for liquidity on the Swedish stock market, we find that averaged across time spread coefficient is not significant for neither of the tested models. However, our results are not robust due to the data limitations and econometrical problems of the two-stage Fama-MacBeth methodology.

5 Conclusions

In this study we examine the effect of liquidity on stock returns on the Swedish stock market during the last nine years, and the interrelation between the systematic liquidity and the asset-specific liquidity in particular. Relative bid-ask spread is chosen as a proxy for liquidity. The aggregate liquidity factor Illiquid-Minus-Liquid is constructed in a similar way to Fama-French factors.

The results of time-series testing reveal that liquidity risk is priced, and incorporating systematic liquidity into the Fama-French model increases its ability to explain stock returns by 3-4%. The systematic liquidity factor is significant for all the models, but it has a smaller effect on stock returns than the market risk premium factor. When allocating the stocks into liquidity portfolios based on relative bid-ask spread only, we find that the intercepts follow a mean-reverting process and are jointly significantly different from zero according to GRS test. This indicates that neither of the tested models captures the variation of stock returns, but leaves the impact of characteristic liquidity unclear. That's why we reform our test portfolios based not only on spread, but also on book-to-market ratio, and construct the market value-weighted portfolio returns. In this case, similarly to Nguyen and Puri (2009), we find the evidence of systematic increase in the intercepts for portfolios arranged in the order of decreasing liquidity, which is consistent with the theory that liquidity is negatively related to stock returns. These results suggest that market-wide liquidity factor doesn't subsume the effect of characteristic liquidity. Further, for Swedish investors this implies that it is not only non-diversifiable liquidity which is priced, and they should account for liquidity level even after adjusting for market-wide risk factors.

Another finding of the time-series testing is that the same models explain twice as much variation of stock returns in the most liquid group than in the least liquid. This brings us to the conclusion that the missing factor(s) in asset pricing affect(s) illiquid stocks much more than liquid ones.

In cross-sectional testing we find that illiquidity, proxied by relative bid-ask spread, is positively related to stock returns after controlling for stock characteristics and loadings on Fama-French factors and aggregate liquidity factor. However, its effect is not significant on average, which is why we cannot postulate the presence of liquidity effect on the cross-section of stock returns after controlling for other variables. But as long as our cross-sectional testing is subject to data limitations and drawbacks of the standard Fama-MacBeth procedure, its results are not robust and less reliable than the results of time-series analysis.

All in all, liquidity is not a simple concept to explore. It is not directly observable and needs to be proxied by some available measure. Since the effect of liquidity has been first discovered in 1986 by Amihud and Mendelson, lots of different measures were used in the research. However, the problem is that a single measure cannot fully reflect what liquidity is. That is the main source of dissimilarities in the studies on how liquidity affects the stock returns. The fact that investors demand a premium for holding illiquid stocks is completely intuitive. The question is whether it is the liquidity of a stock itself which is priced, or its sensitivity to market-wide liquidity, or both. Further research in this area will help to examine the liquidity from different angles and construct the measure which provides the best quality approximation of liquidity role in asset pricing.

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