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# Liquidity and Asset prices: An Empirical Investigation of the Nordic Stock Markets

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**Abstract**

*This paper presents a simplified single period asset-pricing model adjusted for liquidity and tests it for the Nordic markets. The detailed empirical evidence is presented from Finnish test case. Empirical testing of small yet developed markets is motivated by the increased relevance of the illiquidity effect for illiquid assets/markets. The main evidence reports liquidity risk makes sufficiently larger part of predicted factor risk premium than the market risk, contrary to comparable U.S. evidence. This highlights the ability of liquidity related model betas in capturing the time variation in expected returns across illiquid (Nordic) markets than market beta.*

**Keywords**: Asset-pricing model, illiquidity effect, predicted factor risk premium, model betas

**JEL Classifications:** G10, G12, G15**.**

## 1. Introduction

Studies connecting liquidity to asset pricing have evolved over time and are currently based on a twofold proposition that the level of illiquidity and illiquidity risk are priced and both are mutually reinforcing. One of the initial studies pioneering the former aspect of liquidity is of Amihud and Mendelson (1986), they showed a positive relationship between an asset's level of illiquidity and expected returns. Then Pastor and Stambaugh (2003) elaborated upon later aspect of illiquidity and demonstrated a link between the asset returns and liquidity risk. Furthermore, Amihud (2002) investigated systematic illiquidity risk and proposed that expected market illiquidity is priced positively, while shocks to market illiquidity lower contemporaneous returns. Amihud (2002) provided this evidence for the U.S. market whereas, Bakaert et al. (2007) tested these hypotheses for emerging markets and broaden the evidence.

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Around this general conclusion that liquidity risk is priced; there is another associated aspect of liquidity risk, that is, its various dimensions. Historically, a flight to liquidity/quality risk[1] (Amihud (2002), Pastor and Stambaugh (2003), Sadka (2006), Fujimoto and Watanabe (2005) and others) has been explored more, in which an impact of changing market-wide liquidity is seen on different asset classes. Another dimension of illiquidity risk is commonality in liquidity as proposed by Chordia et al. (2002), Hasbrouck and Seppi (2001) among others. Karolyi et al. (2012) extended this evidence of commonality in liquidity for the stocks in 40 developed and emerging countries. All the above, along with an additional dimension of systematic liquidity risk (depressed wealth effect), are neatly presented in the theoretical equilibrium model of Acharya and Pedersen (2005). Besides, another dimension of modeling systematic liquidity risk follows Fama and French (1993) type construction of risk mimicking liquidity factor under the equilibrium assumption of no arbitrage (Liu, 2006).

We simplify the model developed by Acharya and Pedersen (2005) by making the liquidity adjustment in a single period model rather than using an overlapping generation model (OLG). The model proposes that a market index, spanned from a mean-variance efficient asset space net of asset-specific liquidity costs, is a better candidate to reduce the reported mispricing associated with standard mean-variance CAPM. The generalization of the model allows for the determination of asset prices inside the model and accounts for the total cost of trade rather than exogenously determined prices and model agents confronting the cost of selling, as in Acharya and Pederson (2005).[2] Importantly, the adjusted theoretical model and its tested specification in this study both are one period, whereas in Acharya and Pedersen model in each generation agents are effectively assumed to have one period utility maximization for the specification testing of the model.

As is generally acknowledged, illiquidity effects are pronounced for illiquid assets/markets. However, with few exceptions, most liquidity-related studies are conducted for the U.S. markets. Arguably, the U.S. market is the most liquid equity market (Bakaert et al., 2007) and therefore may not be as suitable for empirical testing as other illiquid markets. The reported diminishing illiquidity premium in the U.S. stock returns over time (Ben-Rephael et al., 2010) then should come as no surprise. We argue that it is more appropriate to test liquidity-related models in markets that are sufficiently illiquid to diagnose the level and strength of bearing such risks in comparison to other pertinent risks, such as market risk even if they are developed. Li, Sun and Wang (2011) report liquidity risks are priced over and above market risk for the 2nd largest global equity market (Japan) after the equity markets in the U.S.

In order to stress the importance of illiquid markets for the relevance of liquidity premium, we test the adjusted model for four Nordic capital markets namely, Denmark, Finland, Norway and Sweden.[3] The main test is the quantification of premium related with liquidity risk(s) when compared with diminishing liquidity premium for US stock returns. Furthermore, we select a representative market that is, Finland. The test case selection is to make generalizations across Nordic (illiquid) markets: 1) how liquidity evolves over time; 2) success of different measures in capturing effect of liquidity and 3) importance of a particular liquidity risk across different liquidity risks. The Finnish stock market is a small, developed market that, over the course of a decade, transformed from an illiquid to a liquid market; yet, the prospect of finding illiquidity remains a possibility due to the peculiar setting in which the market operates.[4]

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[1] The liquidity crises affect the illiquid asset the most.

[2] Selling costs can only be deduced when data for each trade, which allows buy and sell orders to be distinguished, is available, but this method requires substantial microstructure data. However, even the distinction between buy orders and sell orders is at times obscured in low frequency data. Thus no exact procedure exists to approximate the cost of selling using any illiquidity measure.

[3] We especially note the suggestions from the Editor John A. Doukas in the developments in this direction.

[4] The empirical literature on the Finnish market studying the relationship between stock returns and different illiquidity proxies is extensive. For instance, Swan and Westerholm (2002) found that the level of illiquidity has a positive and strong effect on the cross-section of stock returns from 1993–1998. Vaihekoski (2009) tested for market specific and asset specific liquidity risks for a cross-section of six size portfolios and found that asset specific risk is not priced, whereas the portfolio risk sensitivities reveal a flat relationship across the size of the portfolios. In the latter study, the illiquidity risk was captured by one factor that only accounts for Amihud's

The cross-section of 25 test portfolios, based on five different (three) liquidity and (two) non-liquidity stock characteristics, tests the real strength of the proposed model, as suggested in Lewellen et al. (2010). Furthermore, we calculate the measure of illiquidity for the stocks listed in the Finnish market in two distinct ways: the measures proposed in Lesmond et al. (1999) and Amihud (2002). Both of these illiquidity measures are highly correlated with finer spread and price impact proxies estimated from low frequency data (Goyenko et al., 2009). The primary purpose of measuring illiquidity in different ways is to report which illiquidity proxy better captures the unobserved illiquidity effect that explains the cross-sectional return differences. Finally, we also check for time variation in illiquidity and test all of the models, excluding the periods with high illiquidity, using the reduced sample.

The results show that the illiquidity portfolios' returns are more related to the systematic illiquidity risks than the systematic market risk. The impact of this relationship is substantial; the percentage of the illiquidity premium in the total modeled risk compensation is approximately 92 percent for a model with highest $R^2$ and restrictions on model intercept. In comparison, only 17 percent of the total risk premium is attributed to illiquidity risks for U.S. stock returns (Acharya and Pederson,2005). The remainder of the factor risk premium is attributed to CAPM risk in both markets. The stronger association of model-predicted factor risk premia with liquidity risks remains intact even during calmer periods – that is, 60 percent of the aggregate model premium is the reward for bearing illiquidity risks. The main empirical finding confirms our hypothesis that liquidity effects are more pronounced for illiquid assets/markets. Therefore, the evidence suggests that liquidity related theories should prioritize illiquid markets over/along with the usual examinations of the U.S. market.

The remaining evidence from the Finnish test case can be summarized in three levels. First, the two measures of illiquidity perform equally well in reducing cross-sectional mispricing. However, the overall model effect may be driven by a different model risk (dimension) altogether. Second, the illiquidity effect is time varying. The Amihud (2002) price impact measure is more responsive in capturing these (time) variations to the extent that model estimates using a proxy price impact measure are more stable under the model's assumptions. Third, the liquidity-adjusted model performs well relative to a simple CAPM, even when the asset space of test portfolios includes non-illiquidity portfolios in model estimates. For illiquidity test portfolios, this improvement is substantial in the full sample rather than in the calmer period.

However, the generalization that both the liquidity measures across the remaining markets (Denmark, Norway and Sweden) provide distinguishable return dispersion across illiquidity portfolios is not as prominent as we have for the Finnish stock returns. Given the differences in market microstructure, we resort to a variant zero measure that intersects the stock zero return days with zero return in a respective market currency (rate) market against US dollar, see Butt (2013) for details. The measure helps generalizing the evidence for liquidity effect as reported for the Finnish stock returns: the magnitude of liquidity risk compensation in the total model risk premium is even higher in the total model risk premium than we report for the Finnish market. Other reported empirical generalizations from Finnish market remain intact across remaining three Nordic candidate (illiquid) markets.

This paper is organized as follows. Section 2 describes the methodology used in this paper. Section 3 discusses the data and constructs and elaborates the portfolio and different measures of illiquidity. Section 4 provides empirical analysis, and Section 5 concludes the study.

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(2002) flight to liquidity notion. As noted previously, other illiquidity risks, such as commonality effect and depressed wealth effect on asset's illiquidity, exist; therefore, the results contribute supplemental empirical evidence for other risk types affecting the Finnish stock return variations.

## 2. Methodology

The presence of the law of one price (LOP) provides a stochastic discount factor, $M_t$, such that all the assets are correctly priced implying,

$$E_t(M_{t+1}X_{t+1}) = P_t \,. \quad (1)$$

Equation (1) could also provide a representation of gross returns if we divide the equality by the non-zero stock price $P_t$, such that $E_t(M_{t+1}R^i_{t+1}) = 1$. $R^i_{t+1}$ is the period return on asset *i*, and if $R^i_{t+1}$ is the excess period return over the risk free rate, then the relationship can also take the form $E_t(M_{t+1}R^i_{t+1}) = 0$. All subsequent equations will represent $R^i_{t+1}$ as the excess return for expositional convenience. If the discount factor is a function of the mean-variance efficient market factor return $(R^m_{t+1})$, equation (1) converges to the standard CAPM. One shortcoming of CAPM includes the model's implication for stocks with similar expected cash flows that differ only in their ability to be traded or transacted quickly (Pastor & Stambaugh, 2003; Sadka, 2006). The model implies theoretically equal prices for such stocks; however, we observe violations to the model's implications and LOP in the real world. Therefore, these noted shortcomings demand that illiquidity-adjusted CAPM be proposed under more generalized assumptions, in which asset returns could be priced subject to the overall effect of illiquidity.

Here, we derive a simple pricing equation adjusted for liquidity related costs following the mean-variance optimizations discussed in Lo et al. (2004), assuming that investors observe the net asset returns of the transaction costs accrued in the inherent asset specific illiquidity constraints.[5] We use a proportional transaction cost measure such that $E(I^i) = \upsilon^i E(C^i)$. In the equality, $E(I^i)$ represents expected illiquidity, $\upsilon^i$ is a constant of proportionality that should be positive, and $E(C^i)$ is the expected relative transaction cost. Similarly, we can represent the relationship between market illiquidity and transaction cost to hold for all the assets in the market as $E(I^m) = \upsilon^m E(C^m)$. The expected illiquidity is a function of the actual transaction costs. The expected asset illiquidity and expected market illiquidity are equal to the respective transaction cost relative for $\upsilon = 1$, such that theoretical costs are precisely identified. The subsequent model equations omit the terms $\upsilon^i$ and $\upsilon^m$ for clarity.

Therefore, an asset-pricing model adjusting for the liquidity effect can be derived from expected excess net returns on stocks such that the pricing kernel is a function of net excess market return [6]:

$$E_t(M_{t+1}(R^m_{t+1} - C^m_{t+1})R^i_{t+1} - C^i_{t+1}) = 0 \quad (2)$$

Equation (2) accounts for the expected level of stock illiquidity, which for an illiquid asset is higher than the level of illiquidity of a liquid asset, such that $C^{ILLIQ} > C^{LIQ}$. Furthermore, the effect of market illiquidity $C^m$ on pay-offs from illiquid assets is also higher. Therefore, even if the expected excess returns on both illiquid assets and liquid assets are identical, the observed price of the illiquid asset is lower, such that $P^{ILLIQ}_t < P^{LIQ}_t$ for having additional exposure to illiquidity. This follows from the simple risk-return relationship that if two assets have equal excess returns but one is (liquidity-

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[5] $TC^i_{t+1}$ is the total cost of the trade in our model, but when we convert the pricing relationship, as in equation (4), in terms of net returns; the component $\frac{TC^i_{t+1}}{P^i_t}$ represents the relative cost of trade for stock *i*, such that $C^i_{t+1} = \frac{TC^i_{t+1}}{P^i_t}$ and similarly follows for total market portfolios, such that $C^M_{t+1} = \frac{TC^M_{t+1}}{P^M_t}$.

[6] The terms liquidity and illiquidity are used interchangeably throughout the paper – for example: liquidity effect, risks, or betas and illiquidity effect, risks, or betas.

adjusted) riskier, then the illiquid stock's price is set to be lower than the liquid stock because investors demand additional compensation for bearing higher risk. Consequently, pricing equation (2) can gauge the relationship between expected returns and aggregate risks, for any proxy measure of liquidity, catering all systematic dimensions of illiquidity risks.

We argue that agents hypothetically assign equilibrium prices to all stocks while having homogenous expectations for conditional expected net returns.[7] Therefore, in any period, agents choose consumption and portfolios to maximize expected utility. Assuming exogenously determined illiquidity related costs, net returns are identified in each period, provided that all agents are price takers and short selling is not allowed. The agents identifying net returns determine the new feasible set and the efficient asset combinations that will hold in equilibrium. The net return adjustment will re-establish the capital market line tangent, given the poor empirical performance of the standard CAPM, to the efficient frontier at the position of the net market (risk, return) tradeoff point in the reduced mean-variance space. The agents will take long positions in the net market portfolio, similar to the imagined CAPM economy. Moreover, the net return on the market portfolio may not be the imagined CAPM economy optimal solution because our proposed model adjusts for the observed mispricing.[8]

The proposed model perceives liquidity risk as including the total cost of trade, and thus is more liberalized than Acharya and Pederson's (2005) liquidity-adjusted model, although it generates a similar model in terms of model risks.[9] The proposed generalization of the Acharya and Pederson (2005) liquidity-adjusted CAPM, following Lo et al. (2004), can provide better real world predictions when pricing assets in lieu of a net mean-variance portfolio. Furthermore, similar to CAPM theory, the expected (net) rate of return on the stocks is systematically related to the return on a well-diversified market portfolio. The testable cross-sectional restriction on the assets will imply a single beta representation such that:

$$E_t(R^i_{t+1} - C^i_{t+1}) = \lambda_t \beta^{net}_i, \qquad (3)$$

where $\lambda_t = E_t(R^m_{t+1} - C^m_{t+1})$ and $\beta^{net}_i = \dfrac{Cov_t(R^i_{t+1} - C^i_{t+1}, R^m_{t+1} - C^m_{t+1})}{Var_t(R^m - C^m)}$.

The proposed model will converge to CAPM: (i) in the absence of illiquidity related costs (ii) if the rank of an imagined CAPM opportunity space given the constraints is equal to the proposed model rank; and (iii) if the reduced investment set is an efficient subset of the imagined CAPM economy and shares the same solution space. The simplified one-period model improves the Acharya and Pederson (2005) OLG model for the endogenous determination of asset prices and the determination of total trade cost. The solution to this pricing equation extends the applicability of the Acharya and Pedersen (2005) theoretical model for any measure of illiquidity and maintains a similar effect of the level of illiquidity and (unconditional) separation among model risks. The separation among model risks enables the determination of the relative impact of a particular risk on expected returns. The proposed model should be considered an abridgment of CAPM theory designed to ameliorate its limitations while allowing for liquidity-related costs (risks). Equivalently, we can decompose $\beta^{net}_i$ into CAPM beta and three illiquidity related betas such that the unconditional representation of equation (3) expands to:

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[7] We assume expected net returns are jointly normally distributed.

[8] The non-conformability follows if one asset exists that is given positive weights under the imagined CAPM economy; such inclusion drives the optimal solution under the CAPM sub-optimal in the reduced net return investment set, owing to greater trading cost.

[9] However, the feasible solution in their model is also applicable to the imagined CAPM economy, provided prices are exogenously determined. The other notable assumption in their OLG model is that the illiquidity discount incurred by the terminal period agents is revealed in the cost of selling. They described that agents can buy at $P^i_t$ but must sell at $P^i_t - C^i_t$ (page 379), where $C^i_t$ is the cost of selling an asset.

$$E(R^i)=E(C^i)+\lambda\left(\frac{Cov(R^m,R^i)}{Var(R^m-C^m)}+\frac{Cov(C^m,C^i)}{Var(R^m-C^m)}-\frac{Cov(R^i,C^m)}{Var(R^m-C^m)}-\frac{Cov(C^i,R^m)}{Var(R^m-C^m)}\right). \quad (4)$$

Equation (4) shows that expected excess returns are sensitive to the expected level of liquidity market risk and the three liquidity beta risks. We can also write equation (4) as:

$$E(R^i)=E(C^i)+\lambda^1\beta^{i1}+\lambda^2\beta^{i2}-\lambda^3\beta^{i3}-\lambda^4\beta^{i4}. \quad (5)$$

The purport of equation (5) is to adjust $\beta^{i1}$, the market beta, with the other illiquidity-related betas – $\beta^{i2}$, $\beta^{i3}$, and $\beta^{i4}$ – such that the excess returns on liquid and illiquid assets match what we observe in the market. Arguably, the illiquidity-related betas increase (or decrease) the exposure of the expected returns on illiquid assets (or liquid assets) while accounting for the systematic risk of liquidity. The empirical estimation of the model is executed assuming all that investors have a one-month trading horizon. The model risks can be estimated with the constrained price of risk as implied in equations (4) and (5) under restriction, such that $\lambda^1=\lambda^2=\lambda^3=\lambda^4$. The success of the proposed model, in reducing equilibrium mispricing, is estimated with the following specification:

$$E(R^i)=\alpha+\psi^i E(C^i)+\lambda\beta^{i1}+\lambda\beta^{i2}-\lambda\beta^{i3}-\lambda\beta^{i4}. \quad (6)$$

In equation (6), $\beta^{i1}$ is a CAPM related beta, whereas the other three betas are liquidity related. All of these betas signify liquidity risks that have been studied extensively in the literature. The unconstrained estimation of equation (6) enables us to analyze all of the liquidity risks and the liquidity level under a simple model. We refer to Acharya and Pederson (2005) for a detailed discussion of the economic intuition behind the different liquidity betas. The betas for estimation of cross-sectional analysis are calculated using following equation (7) to (10) using respective time series:

$$\beta^{i1}=\frac{Cov(R_t^i,R_t^m-E_{t-1}(R^m))}{Var(R_t^m-E_{t-1}(R_t^m)-\left[C_t^m-E_{t-1}(C_t^m)\right])}. \quad (7)$$

$$\beta^{i2}=\frac{Cov(C_t^i-E_{t-1}(C_t^t),C_t^m-E_{t-1}(C^m))}{Var(R_t^m-E_{t-1}(R_t^m)-\left[C_t^m-E_{t-1}(C_t^m)\right])}. \quad (8)$$

$$\beta^{i3}=\frac{Cov(R_t^i,C_t^m-E_{t-1}(C^m))}{Var(R_t^m-E_{t-1}(R_t^m)-\left[C_t^m-E_{t-1}(C_t^m)\right])}. \quad (9)$$

$$\beta^{i4}=\frac{Cov(C_t^i-E_{t-1}(C_t^t),R_t^m-E_{t-1}(R^m))}{Var(R_t^m-E_{t-1}(R_t^m)-\left[C_t^m-E_{t-1}(C_t^m)\right])}. \quad (10)$$

## 3. Data

The first problem in this study for testing the illiquidity effect, across Nordic markets in general and in particular for the Finnish test case, is the limited number of listed stocks compared to other developed markets (see Butt and Virk, 2013 for details). This limitation constrains the study to a large cross-section of portfolios with respect to a particular stock characteristic. Therefore, based on prior period sorting criteria, for each month we divide the available stocks into five quintile portfolios using five different stock characteristics. The asset characteristics related to illiquidity are the zero measure (Lesmond et al., 1999), size, and price inverse (PI) ratio. The rest are generated using prior year momentum returns and book-to-market (BM) ratios. First, the availability of 25 characteristic portfolios enables the study to report the relative role of illiquidity in pricing illiquidity and non-illiquidity test portfolios. Second, it provides an adequate number of test portfolios for the statistical power of cross-sectional tests.

Prior to constructing of test portfolios, data are retrieved from DataStream from January 1994 through May 2009. We prefer monthly information sorting criteria for ranking the characteristic stock returns. This method increases the informational content (Vaihekoski, 2004) and provides a monthly partition of the data for illiquidity related and other available sorting criteria, such as momentum returns.[10] Only the BM-ratio portfolios are ranked on the year-end information. The retrieved stock prices are adjusted for dividends, splits, and other cash payouts.

The first five portfolios are sorted on the basis of the previous month's incidences of zero returns (zero measure onwards) for all available firms. The quintile portfolio increases in the zero measure; that is, L-1 is the portfolio containing the 20 percent of the partitioned stocks with the lowest value for the percentage zero return days. Subsequently, L-2, L-3, L-4, and L-5 are increasing in the relative illiquidities. In a similar fashion, the size and the stock's PI ratio-based quintile portfolios are generated based on the prior month's firm capitalizations and PI ratios, respectively.[11] The chronological order for the size quintiles is such that S-1 represents the smallest capitalized firms, and S-5 contains the firms with the highest capitalization in the data. The price inverse portfolios are such that PI-1 contains the highest priced 20 percent of the stocks, and PI-5 represents the lowest priced 20 percent of the stocks.

Subsequently, we construct the 10 non-illiquidity-based portfolios. The five momentum portfolios are constructed employing the standard practice in the literature. The previous eleven-month rolling average returns (excluding the most recent monthly return) are estimated each month across all stocks and are then used to create five momentum partitions, iteratively. The generated portfolios indicate that each succeeding quintile contains the firms for which the previous eleven month rolling average returns are higher than the preceding quintile; that is, M-1 are the loser stock portfolios, and M-5 are the winner stock portfolios. For the construction of the BM portfolios, we rank the next year's stock returns into five portfolios, which are increasing in the BM ratios; that is, BM-1 represents growth (overpriced) stocks, and BM-5 are value (underpriced) stocks.

We use equal weighting for portfolio returns and portfolio-specific illiquidity measures for the Finnish market. Numerous liquidity-related studies have followed the equal weighting scheme for the test portfolio. The selection of equally-weighted portfolios is even more relevant for the Finnish market (Butt & Virk, 2012), as the capitalized portfolios severely suffer in the presence of few large firms. Therefore, the empirical analysis with the value-weighted portfolios may miss the liquidity effect altogether, which is usually pronounced for small firms.

### *3.1. The (il)liquidity measures for the Finnish market*

Generally, illiquidity measures constructed from the daily observable data fall into two categories; either the measure is a proxy for effective spread or a proxy for price impact. The first measure of illiquidity used in the study is the zero measure, which was proposed by Lesmond et al. (1999). The premise of the zero measure is that higher incidences of zero return days for any firm proxy for higher illiquidity. The construction of the zero measure is begun by recording the frequency of the zero return days in a month across all stocks. Then, for each stock we take a simple ratio of the zero return days in a given month over the total number of trading days in that month:

*Zero Measure = Number of days with zero return / Total number of trading days,*

[10] However, using yearly sorting may not change the overall results because illiquidity is a persistent characteristic, and an illiquid asset is likely to be illiquid at monthly or yearly frequencies. Brennan and Subramanyam (1996) assumed one-year illiquidity estimates to be constant for the three subsequent years in their study.

[11] The size and PI ratio based test portfolios have been extensively used in the literature to proxy for illiquidity related characteristics. Amihud (2002) use size portfolios to determine the illiquidity premium. While the price inverse ratio is suggested by Brennan and Subrahmanyam (1996) because illiquid stocks generally have lower prices compared to liquid stocks.

The underlying simplicity of the proposed measure enables us to construct the longest possible illiquidity series for the Finnish market. The zero measure accommodates all of the assets in the sample, which might have been omitted under some other proxy measure of illiquidity because they require additional requirement, such as traded volume and type of trade.

The second measure of illiquidity is volume related and measures the response of absolute return to unit traded Euro volume for a particular stock, as proposed by Amihud (2002). The measure is constructed provided that the traded volume for a particular stock is available. Consequently, the absolute return $|R_{imd}|$ on stock *i* on day *d* of month *m* is divided by the traded volume (in euros) for the corresponding day $VOLD_{imd}$ in the same month such that $|R_{imd}|/VOLD_{imd}$. We estimate the monthly measure such that:

$$ILLIQ_{im} = 1/D_{im}\sum_{t=1}^{Dim}|R_{imd}|/VOLD_{imd}, \tag{11}$$

where $D_{im}$ is the number of trading days for stock *i* in any month *m*.

The calculated average monthly illiquidity $AILLIQ_m$ is the average price impact of the traded volume sensitivities across Finnish stocks:

$$AILLIQ_m = 1/N_m\sum_{t=1}^{N_m} ILLIQ_{im}, \tag{12}$$

where $N_m$ is the number of stocks in a month. Amihud (2002) placed few restrictions on the construction of the price impact measure. For instance, illiquidity is calculated for stocks that are traded on at least 15 days in a month. By imposing similar construction constraints as Amihud (2002), this measure remained available for only 40 percent of the stocks in the Finnish market. To increase the number of assets for which we could estimate price impact based illiquidity, the restrictions are waived.

We also estimate monthly market illiquidity while imposing all of the restrictions in Amihud (2002) and find that, compared to the unrestricted measure, the restricted measure only provides approximations for the (relatively) liquid stocks in the Finnish market. In order to accommodate illiquid stocks in Amihud (2002) measure we also include those stocks which are not traded for at least 15 days. We rationalize their inclusion on two accounts, first if these stocks are not traded frequently then as per Lesmond et al. (1999), it is owed to higher transaction cost involved in trading. Secondly we conjecture even if those stocks were traded then their likely price impact to traded volume could have not been that different which we had with available volume. On these two accounts, therefore these stocks are candidate for inclusion in the Amihud (2002) price impact measure and thus waving 15 days to trade restrictions may help to capture additional illiquidity-related information with the price impact measure.

### *3.2. Illiquidity of the Finnish market*

Because illiquidity is a primary characteristic of any small market, understanding how illiquidity evolves over time in Finland is important. Figure 1 plots the series of price impact measures during 1994–2009. Periods of illiquidity and liquidity are evident in the Finnish market. The periods spanning 1994–1996 and 2008–2009 exhibit clear patterns of increased illiquidity such that the absolute return impact of one Euro traded is exaggeratedly higher than the remaining (calm) period in the sample. Otherwise, the market is quite liquid during 1996–2007, when the market (absolute) return shows an impact of only 0.012 € for one Euro traded, on average, whereas the price impact estimate increases to 0.070 € in the full sample, which is nearly six times higher than the estimate for the calm period. The difference conveys an impression of higher illiquidity for the total sample period.

When the market is most liquid, we find that, especially for Nokia, the return impact of one Euro traded is as low as $2.1x10^{-7}$. Vaihekoski (2009) also reported that the bid-ask spread for Nokia was 0.2 percent during his period of study. The use of the zero measure highlights similar patterns in illiquidity across samples but in a less vigorous manner than the Amihud measure. We divide the zero measure illiquidity series into three subsamples on the basis suggested by the results for the Amihud (2002) price impact measure in Figure 1. We report increasing incidences of zero return days during

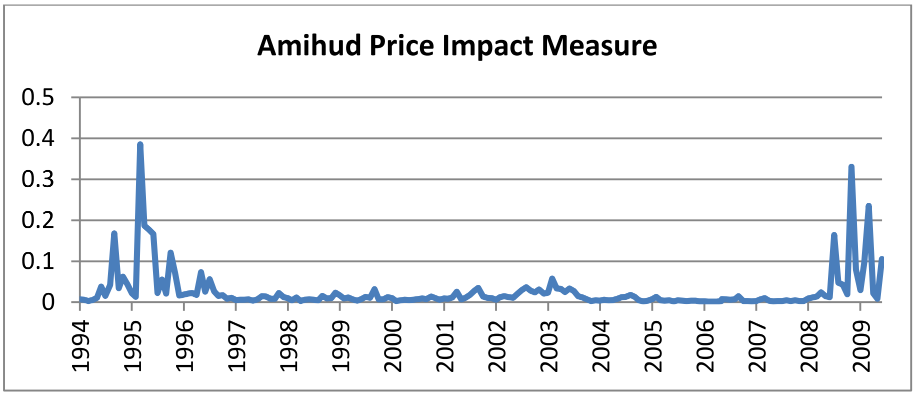


**Figure 1.** Amihud measure of illiquidity for the Finnish market 1994-2009

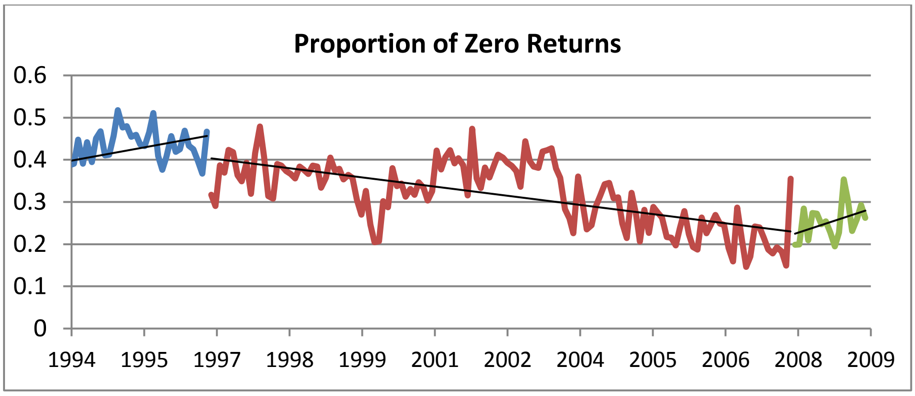


**Figure 2.** Zero measure of illiquidity for the Finnish market 1994-2009

1994–1996 and 2008–2009, as indicated by the steepness of the relevant trend line. The increased incidences of zero return days are a sign of increasing illiquidity.

Furthermore, to illustrate the point that the Finnish market is more illiquid then many large capitalized (developed) markets, we rely on the illiquidity estimates from studies on the U.S. market. The reported price impact measure for U.S. stock returns in Amihud (2002) is $3.37x10^{-7}$ with a standard deviation of $5.12x10^{-7}$.[12] Under similar criteria for the Finnish market, which stipulate that a stock is traded at least for 200 days in a year and has a price above five Euro, generates in an annual mean price impact of $3.79x10^{-4}$ for all firms with a standard deviation of $5.69x10^{-4}$. The comparable sample (1993–2005) price impact measure for the U.S. market is $6.31x10^{-6}$ with a standard deviation of $9.12x10^{-7}$, as provided in Goyenko et al. (2009).[13] The comparable estimates show that the Amihud

[12] See Table 1 in Amihud (2002) for the U.S. market price impact measure descriptive statistics during 1963–1999.

[13] Table 1 panel A and panel D in Goyenko et al. (2008) provided detailed descriptive statistics for the price impact measure and percentage zero measure for the U.S. market for 1993–2005, respectively. For the Finnish market, the corresponding estimates of the price impact measure and zero measure, in a similar period to that

(2002) measure for the U.S. markets is significantly lower than the corresponding Finnish market estimates.

Goyenko et al. (2009) also calculated the average zero measure for the U.S., which is 14.3 percent with a standard deviation of 14.7 percent, whereas the corresponding zero measure for the Finnish market is 33.15 percent with a standard deviation of 8.5 percent in the full period. The average zero measure for the Finnish market is comparable to the average zero measure for nineteen emerging markets, as reported in Bekaert et al. (2007). The reported zero measure for the emerging markets is 30.8 percent with a standard deviation of 13.5 percent for the time period ranging from 1987 to 2003. This result indicates that, regarding liquidity measures, the Finnish market is too illiquid relative to the U.S. market and is similar to emerging markets in terms of the zero measure. The illiquidity characteristics and the hybrid nature of the Finnish (Nordic) market make the empirical contribution of the study more interesting and relevant.[14]

## 4. Estimations

### *4.1. Testing portfolios and innovation in return and illiquidity series*

We use innovations instead of original series in our empirical analysis because the literature indicates that liquidity is predictable; an illiquid portfolio is expected to be illiquid for a considerable length of time. Moreover, employing innovations also circumvents the stationarity issues, given the high persistence in the levels of illiquidity series. The innovations in illiquidity are gathered by imposing ARMA structures of varying order in (*p, q*), where *p* is the lag length for the autoregressive term, and *q* is the lag length of the moving average term:

$$L_t^i = c + \sum_{i=1}^{p} \Phi_i L_{t-i}^i + \sum_{i=1}^{q} \Theta_i \varepsilon_{t-i}^i + \varepsilon_t^i . \qquad (13)$$

$L_t^i$ is the expected level of illiquidity of each test portfolio and market portfolio. The innovations in the asset-specific illiquidities are collected for both measures of illiquidity. We also collect innovations in the aggregate market illiquidity and market return series. In imposing the ARMA structure across all illiquidity series, we ensure that no predictability remains in the respective innovation series. We retrieve innovation in the market return series using an AR (1) model and Fama and French (1993) factors, illiquidity measures, and volume as explanatory variables. Subsequently, the illiquidity related betas are calculated using innovations in portfolio and market illiquidity series.

### *4.2. Liquidity related betas over time*

We present the descriptive statistics for the test portfolios and the key characteristics and estimated beta risks in Table 1 and Table 2 for the initial analysis using the zero and price impact measures, respectively.

First, as shown in Table 1, the illiquidity-based test portfolios provide adequate results in terms of sharing key illiquidity characteristics. The expected portfolio illiquidities estimated with the zero and price impact measures are given under the headings $E(L^i)$ and $E(A^i)$, respectively. The estimated illiquidities are increasing in the odd numbered illiquidity and PI portfolios and show pertinence of illiquidity across the portfolio returns, whereas for size related portfolios both illiquidity measures are

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employed by Goyenko et al., are $3.84\text{x}10^{-4}$ with a standard deviation of $6.36\text{x}10^{-4}$ and 36 percent with a standard deviation of 4.31 percent, respectively.

[14] All the Nordic stock markets are developed capital markets that are included in the MSCI global index. Yet all of them share the illiquidity features of emerging markets as established in the Finnish case in section 3.2.

**Table 1**

**Properties of portfolios with liquidity betas calculated by zero measure**

This table reports the properties of 25 equally weighted portfolios formed monthly for the period from 1994 to 2009 on the basis of different characteristics. First five portfolios are based on measure of illiquidity constructed by number of zero returns in a month for a given firm. Each succeeding portfolio consists of 20% of firms with higher number of zero returns. This construction of portfolio for illiquidity also guides formation of other portfolios with different characteristics which in the order of Table are as, L represents illiquidity, S represents Size, P represents price inverse ratio, M represents momentum and lastly BM represents book to market ratio portfolios. $\beta^{i1}$ is usual market beta whereas, $\beta^{i2}$ , $\beta^{i3}$ and $\beta^{i4}$ illiquidity based betas, these betas are calculated using equation (7), (8),(9) and (10). $E(L^i)$ , $E(A^i)$ , $E(TO^i)$ are the expected illiquidity calculated from Lesmond zero measure of illiquidity, Amihud measure of price impact, and turnover. Size shows average market capitalization of each portfolio and $E\ (R^e)$ is average excess returns. The sampling distribution for the beta risks is calculated from yearly beta risks using the formula $\sigma/\sqrt{T}$ , where $\sigma$ is the standard deviation of the yearly series of beta risks. The t-statistics based on the standard errors are reported in ().

| Portfolios | $\beta^{i1}$ (.100) | $\beta^{i2}$ (.100) | $\beta^{i3}$ (.100) | $\beta^{i4}$ (.100) | $E(L^i)$ (%) | $E(A^i)$ (,1000) | $E(TO^i)$ (%) | Size Ml.€ | E (R) |
|---|---|---|---|---|---|---|---|---|---|
| L-1 | 60.13 | 26.76 | -7.53 | 5.78 | 12.16 | 0.71 | 5.95 | 3703.92 | 1.009 |
| | (6.83) | (5.70) | (-0.39) | (2.82) | | | | | |
| L-3 | 49.79 | 45.10 | -11.02 | -3.62 | 29.84 | 4.26 | 3.12 | 277.82 | 1.011 |
| | (8.82) | (7.89) | (-2.01) | (0.18) | | | | | |
| L-5 | 66.71 | 29.81 | -22.56 | -7.59 | 67.10 | 85.29 | 1.54 | 39.26 | 1.022 |
| | (4.36) | (6.14) | (-1.74) | (-0.52) | | | | | |
| S-1 | 68.85 | 35.10 | -21.38 | -7.54 | 57.40 | 72.61 | 2.41 | 13.07 | 1.020 |
| | (7.13) | (7.10) | (-2.18) | (-0.97) | | | | | |
| S-3 | 52.69 | 38.18 | -12.32 | -4.81 | 31.07 | 5.21 | 2.71 | 139.67 | 1.014 |
| | (7.82) | (6.60) | (-2.68) | (0.19) | | | | | |
| S-5 | 52.13 | 29.64 | -3.50 | 6.20 | 11.13 | 0.27 | 6.21 | 5090.61 | 1.010 |
| | (6.47) | (6.08) | (0.17) | (1.85) | | | | | |
| P-1 | 48.88 | 37.67 | -5.11 | -2.42 | 20.82 | 1.36 | 4.87 | 3668.69 | 1.004 |
| | (6.94) | (6.97) | (-0.32) | (0.09) | | | | | |
| P-3 | 48.11 | 37.72 | -10.79 | -2.45 | 31.87 | 5.55 | 3.18 | 405.19 | 1.013 |
| | (8.07) | (6.82) | (-1.44) | (0.22) | | | | | |
| P-5 | 83.33 | 33.74 | -23.54 | -7.54 | 46.99 | 76.52 | 2.96 | 93.15 | 1.026 |
| | (8.01) | (6.63( | (-2.19) | (-1.10) | | | | | |
| M-1 | 65.96 | 34.28 | -13.18 | -0.97 | 35.55 | 25.80 | 3.76 | 891.13 | 1.008 |
| | (6.59) | (6.68) | (-2.32) | (0.51) | | | | | |
| M-3 | 44.11 | 40.24 | -9.83 | -2.47 | 31.85 | 17.72 | 3.35 | 951.74 | 1.010 |
| | (7.86) | (6.64) | (-1.65) | (0.23) | | | | | |
| M-5 | 61.94 | 37.24 | -12.26 | -1.70 | 32.12 | 34.36 | 4.16 | 2038.92 | 1.021 |
| | (6.34) | (5.63) | (-1.53) | (0.06) | | | | | |
| BM-1 | 60.11 | 40.28 | -13.26 | -8.89 | 26.18 | 6.36 | 3.88 | 3336.37 | 1.003 |
| | (7.81) | (8.63) | (-2.73) | (-0.75) | | | | | |
| BM-3 | 59.01 | 37.21 | -13.74 | -3.52 | 35.45 | 14.57 | 3.53 | 698.15 | 1.015 |
| | (6.89) | (6.46) | (-1.14) | (0.23) | | | | | |
| BM-5 | 57.47 | 28.63 | -10.41 | 6.48 | 35.26 | 72.44 | 2.88 | 619.05 | 1.018 |
| | (5.97) | (5.43) | (-1.02) | (1.98) | | | | | |

## Table 2

**Properties of portfolios with liquidity betas calculated by price impact measure**

This table reports the properties of 25 equally weighted portfolios formed monthly for the period from 1994 to 2009 on the basis of different characteristics. First five portfolios are based on measure of illiquidity constructed by number of zero returns in a month for a given firm. Each succeeding portfolio consists of 20% of firms with higher number of zero returns. This construction of portfolio for illiquidity also guides formation of other portfolios with different characteristics which is order of Table are as, L represents illiquidity, S represents Size, P represents price inverse ratio, M represents momentum and lastly BM represents book to market ratio portfolios. $\beta^{i1}$ is usual market beta whereas, $\beta^{i2}$ , $\beta^{i3}$ and $\beta^{i4}$ illiquidity based betas, these betas are calculated using equation (7), (8),(9) and (10). $E(L^i)$ , $E(A^i)$ , $E(TO^i)$ are the expected illiquidity calculated from Lesmond zero measure of illiquidity, Amihud measure of price impact, and turnover. Size shows average market capitalization of each portfolio and $E\ (R^e)$ is average excess returns. The sampling distribution for the beta risks is calculated from yearly beta risks using the formula $\sigma/\sqrt{T}$ , where $\sigma$ is the standard deviation of the yearly series of beta risks. The t-statistics based on the standard errors are reported in ().

| Portfolios | $\beta^{i1}$ (.100) | $\beta^{i2}$ (.100) | $\beta^{i3}$ (.100) | $\beta^{i4}$ (.100) | $E(L^i)$ (%) | $E(A^i)$ (.1000) | $E(TO^i)$ (%) | Size Ml.€ | E (R) |
|---|---|---|---|---|---|---|---|---|---|
| L-1 | 63.48 | 0.00 | -9.08 | 0.05 | 12.16 | 0.71 | 5.95 | 3703.92 | 1.009 |
| | (9.34) | (0.57) | (-4.58) | (0.59) | | | | | |
| L-3 | 52.56 | 0.19 | -13.93 | -0.92 | 29.84 | 4.26 | 3.12 | 277.82 | 1.011 |
| | (9.48) | (1.18) | (-3.70) | (0.04) | | | | | |
| L-5 | 70.43 | 70.37 | -10.05 | -13.80 | 67.10 | 85.29 | 1.54 | 39.26 | 1.022 |
| | (3.54) | (1.52) | (-4.19) | (-1.45) | | | | | |
| S-1 | 72.68 | 58.39 | -9.93 | -11.32 | 57.40 | 72.61 | 2.41 | 13.07 | 1.020 |
| | (5.46) | (1.56) | (-3.20) | (-1.51) | | | | | |
| S-3 | 55.62 | 0.22 | -12.26 | -0.33 | 31.07 | 5.21 | 2.71 | 139.67 | 1.014 |
| | (10.01) | (1.06) | (-3.39) | (0.01) | | | | | |
| S-5 | 55.03 | 0.02 | -10.57 | -0.01 | 11.13 | 0.27 | 6.21 | 5090.61 | 1.010 |
| | (8.47) | (-0.07) | (-4.39) | (-0.75) | | | | | |
| P-1 | 51.59 | 0.08 | -10.80 | -0.24 | 20.82 | 1.36 | 4.87 | 3668.69 | 1.004 |
| | (8.98) | (0.39) | (-4.03) | (-2.08) | | | | | |
| P-3 | 50.79 | 0.21 | -11.37 | -0.26 | 31.87 | 5.55 | 3.18 | 405.19 | 1.013 |
| | (9.69) | (2.02) | (-4.19) | (0.01) | | | | | |
| P-5 | 87.97 | 63.00 | -10.80 | -10.47 | 46.99 | 76.52 | 2.96 | 93.15 | 1.026 |
| | (6.24) | (1.47) | (-3.16) | (-0.64) | | | | | |
| M-1 | 69.63 | 13.27 | -12.19 | -3.87 | 35.55 | 25.80 | 3.76 | 891.13 | 1.008 |
| | (7.74) | (1.44) | (-2.95) | (-0.26) | | | | | |
| M-3 | 46.56 | 43.32 | -9.88 | -7.24 | 31.85 | 17.72 | 3.35 | 951.74 | 1.010 |
| | (8.28) | (1.05) | (-3.55) | (0.02) | | | | | |
| M-5 | 65.38 | 18.93 | -11.56 | 9.20 | 32.12 | 34.36 | 4.16 | 2038.92 | 1.021 |
| | (7.08) | (1.39) | (-3.78) | (1.08) | | | | | |
| BM-1 | 63.45 | 1.31 | -11.30 | -0.92 | 26.18 | 6.36 | 3.88 | 3336.37 | 1.003 |
| | (8.13) | (2.61) | (-4.09) | (-1.13) | | | | | |
| BM-3 | 62.29 | 1.75 | -11.11 | -2.05 | 35.45 | 14.57 | 3.53 | 698.15 | 1.015 |
| | (6.04) | (2.31) | (-4.56) | (0.07) | | | | | |
| BM-5 | 60.66 | 128.05 | -11.64 | -35.65 | 35.26 | 72.44 | 2.88 | 619.05 | 1.018 |
| | (8.22) | (1.18) | (-5.43) | (-1.47) | | | | | |

decreasing in the capitalization of size portfolios.[15] Moreover, the portfolio expected turnovers, $E(TO^i)$, decrease as the illiquidity of the portfolios increases.

The average illiquid portfolio returns are higher than those of the liquid portfolios. Importantly, the previous month's zero measure sorting produces a wide spread in the extreme portfolio returns. The

[15] The results also hold for even numbered portfolios, but to conserve space the results are only presented for odd numbered portfolios. These results are also consistent with the notion that size factor also proxy for transaction cost (Demsetz (1968), Roll (1984), Lesmond et al. (1999) among others)

annual return differential between the most illiquid portfolio (L-5) and liquid portfolio (L-1) is approximately 15.37 percent.[16] This result highlights the greater illiquidity effect in the Finnish market. A similar return differential for the odd numbered momentum portfolios is also present, and the annual return difference between winners (M-5) and losers (M-1) is approximately 15.6 percent, although the average illiquidity levels captured in columns $E(L^i)$, $E(A^i)$, and $E(TO^i)$ are not precisely co-correspondent. The varying illiquidity characteristics imply that the portfolios with approximately equal return differentials are not necessarily holding similar firms such that the proposed model is not estimated with redundant test portfolios.

Larger per annum return differentials are noted for PI (26 percent) and BM (18 percent) portfolios. The lowest return differential is observed for size portfolios (S-1 minus S-5), which still average a substantial 12 percent per annum, importantly with visibly different characteristic patterns than the others. This result reinforces our motivation for sorting portfolios based on five stock characteristics, given the limitations of the Finnish stock market, such that the Lewellen et al. (2010) criticism of the success of asset-pricing models is incorporated to address numerous related issues. The reported statistics regarding the three illiquidity betas in Table 1 show that the beta risks are a function of the portfolio's illiquidity level and increase in portfolio illiquidity.

Furthermore, the zero measure based illiquidity betas in Table 1 are monotonically linked to the mean returns of the illiquidity portfolios, with the exception of the commonality risk $\beta^{i2}$. Notably, the illiquidity portfolios exhibit substantial monotonic sensitivity to $\beta^{i3}$. It may be inferred that the most important illiquidity risk, in explaining cross-sectional variations in the test portfolios, is captured by flight to liquidity risk (Amihud, 2002) when quantified for the Finnish market. The most illiquid (L-5) portfolio has a beta sensitivity of -22.56 for $\beta^{i3}$, whereas for the most liquid portfolio (L-1) the beta sensitivity is -7.53. The higher negative exposure for illiquid portfolio signifies a larger drop in their returns when market illiquidity suddenly increases.

The non-responsiveness of the non-illiquidity portfolios to liquidity risks is also exhibited in Table 1. The illiquidity-related betas for the momentum and BM portfolios do not have any monotonic sensitivity towards illiquidity beta risks. Because these return differentials are not a function of the level of illiquidity, the liquidity-related betas are also not increasing.

In Table 2, the analyses for model risks are reported with the price impact measure. The only differences from Table 1 are in the four model beta risks. The reported beta risks show that $\beta^{i3}$ is not noticeably increasing with the mean returns of the illiquidity portfolios. However, $\beta^{i2}$ and $\beta^{i4}$, in comparison to the zero measure based corresponding liquidity betas, are increasing in the anticipated direction across the illiquidity portfolios. Another notable difference is the monotonic relationship between the price impact based illiquidity risks and BM portfolio average returns compared to what we reported in Table 1. The monotonic increases across illiquidity beta risks are such that value stocks show the largest price impact sensitivity compared to all other test portfolios. The price impact sensitivity for BM portfolios is also larger for BM-1 and BM-3 compared to the corresponding values for illiquidity portfolios L-1 and L-3 reported in column $E(A^i)$ of Tables 1 and 2. We also estimated the beta risks for the tranquil period, that is, the sample period 1996–2007, to compare the performance of illiquidity-related betas and the market beta during different liquidity periods.

Moreover, in model equation (6) the returns are shown to be function of level of liquidity and liquidity betas. It further imposes the restriction that the unconditional price of risk associated with all four beta risks remains identical. However, establishing the theoretical separation among the model explanatory variables in the empirical estimation of the model is a difficult undertaking. In Table 3

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[16] In Acharya and Pedersen (2005), in Table 1 column $E\ (r^{e,p})$, the yearly difference between the most illiquid and liquid portfolios, is 7.44 percent (portfolios are sorted with Amihud (2002) measure of illiquidity), which is approximately half the size if the corresponding value for the Finnish market. First, this result implies that liquidity compensation is large with respect to the severity of illiquidity in the market. Second, necessarily return differentials may not be comparable while sorting with a particular measure across markets for generalization of liquidity effect. To, elucidate this point a return dispersion between L-5 and L-1 for Denmark is 2.98, for Norway it is even -4.65, however for Sweden it is 13.41.

and 3A, we estimated correlation structure among level of liquidity, separate betas and net beta for 15 illiquidity related portfolios using both measures[17]. It is obvious the strong correlation exist among model based variables. This eludes the empirical obscurity confronted in tracing segregated illiquidity risks and, therefore, in testing the implications of the proposed model requiring uncorrelated factor risks in the regression analysis.

**Table 3**

**Correlation by zero measure of illiquidity**

This table reports the correlation among $E(L^i)$, $\beta^{i1}$, $\beta^{i2}$, $\beta^{i3}$, $\beta^{i4}$ *and* $\beta^{net,i}$ for 15 portfolios for a period of 1994-2009. Where $E(L^i)$ is expected illiquidity of some portfolio and $\beta^{i1}$, $\beta^{i2}$, $\beta^{i3}$, $\beta^{i4}$ are model based risk and $\beta^{net,i}$ is calculated as $\beta^{net,i} = \beta^{i1} + \beta^{i2} - \beta^{i3} - \beta^{i4}$.

| | $E(L^i)$ | $\beta^{i1}$ | $\beta^{i2}$ | $\beta^{i3}$ | $\beta^{i4}$ | $\beta^{net,i}$ |
|---|---|---|---|---|---|---|
| $E(L^i)$ | 1.000 | 0.488 | 0.002 | -0.918 | -0.771 | 0.794 |
| $\beta^{i1}$ | | 1.000 | -0.469 | -0.747 | -0.391 | 0.816 |
| $\beta^{i2}$ | | | 1.000 | 0.123 | -0.313 | 0.013 |
| $\beta^{i3}$ | | | | 1.000 | 0.746 | -0.934 |
| $\beta^{i4}$ | | | | | 1.000 | -0.813 |
| $\beta^{net,i}$ | | | | | | 1.000 |

**Table 3A**

**Correlation by Amihud (2002) measure of illiquidity**

This table reports the correlation among $E(L^i)$, $\beta^{i1}$, $\beta^{i2}$, $\beta^{i3}$, $\beta^{i4}$ *and* $\beta^{net,i}$ for 15 portfolios for a period of 1994-2009. Where $E(L^i)$ is expected illiquidity of some portfolio and $\beta^{i1}$, $\beta^{i2}$, $\beta^{i3}$, $\beta^{i4}$ are model based risk and $\beta^{net,i}$ is calculated as $\beta^{net,i} = \beta^{i1} + \beta^{i2} - \beta^{i3} - \beta^{i4}$.

| | $E(L^i)$ | $\beta^{i1}$ | $\beta^{i2}$ | $\beta^{i3}$ | $\beta^{i4}$ | $\beta^{net,i}$ |
|---|---|---|---|---|---|---|
| $E(L^i)$ | 1.000 | 0.841 | 0.994 | 0.268 | -0.992 | 0.983 |
| $\beta^{i1}$ | | 1.000 | 0.866 | 0.276 | -0.802 | 0.921 |
| $\beta^{i2}$ | | | 1.000 | 0.323 | -0.985 | 0.991 |
| $\beta^{i3}$ | | | | 1.000 | -0.261 | 0.281 |
| $\beta^{i4}$ | | | | | 1.000 | -0.968 |
| $\beta^{net,i}$ | | | | | | 1.000 |

Nonetheless, Acharya and Pederson (2005) estimated the unconstrained (unequal) premia to track the (theoretically) segregated impact of each risk on the cross-sectional return variations. They acknowledged that the empirical evidence is weak. There are two possible scenarios to get around the issues of multi-collinearity, first is, to rely on the validity of the model (3) and estimate an overall effect of illiquidity by estimating illiquidity risk by $\beta^{net,i} = \beta^{i1} + \beta^{i2} - \beta^{i3} - \beta^{i4}$ and calibrate the coefficient on expected illiquidity by taking an average of turnover across all the stocks.[18] Second is, to gauge separate effect of each of illiquidity related betas as it can also be interpreted as showing the overall effect of illiquidity, which in otherwise ideal situation of no collinearity should be manifested by level of illiquidity and separate illiquidity related risks. Therefore we also explore nested model

[17] We estimated these correlations for 25 portfolios and for a different period of 1996-2007 as well and these tables can be provided upon request. However results are similar to the one reported.
[18] Acharya and Pedersen (2005) followed this approach in their paper.

specifications that only consider a single beta risk at a time, which are not reported in Acharya and Pederson (2005). [19]

As we used two different measures of illiquidity therefore, the related model betas have different correlation patterns in Table 3 and 3A. With Table 3A, our results are very similar to the one provided in Acharya and Pedersen (2005), possibly because these correlations are calculated for portfolios by estimating their illiquidity as per Amihud (2002). Obviously $\beta^{net,i}$ seems to be the most representative and it is correlated the most across all model risks and also with level of illiquidity of the portfolios. Therefore it is suggestive of manifesting overall effect of illiquidity when illiquidity is estimated by Amihud (2002). In Table 3, $\beta^{i3}$ seems to be the most correlated across all model risk[20] and with level of illiquidity. Arguably when illiquidity is estimated by zero measure Lesmond et al. (1999), $\beta^{i3}$ is seemingly capable of depicting overall effect of illiquidity.

### *4.3. Model testing*

We proceed with the estimation of the proposed models in equation (3) to the equally testable model equation:

$$E(R^i) = \alpha + \psi^i E(C^i) + \lambda\beta^{net,i} , \tag{14}$$

where $\beta^{net,i} = \beta^{i1} + \beta^{i2} - \beta^{i3} - \beta^{i4}$ shows that the net beta $\beta^{net,i}$ is an overall market risk when illiquidity risk is incorporated. The model in equation (3) is expressed in terms of excess returns, which implies that the constant $\alpha$ should be zero. However, we estimate equation (14) by allowing a nonzero constant for robustness. The estimations using the zero measure of illiquidity in all 25 test portfolios are reported in Table 3 at panel A. The success of the model specifications is gauged under a joint criterion of higher cross-sectional $R^2$ and ability to suppress pricing errors (cross-sectional intercept).

Using the level of illiquidity alone, the cross-sectional regression in line 1 yields the expected positive estimate and insignificant pricing errors. The lower adjusted $R^2$ could be argued to be due to the low variability in the zero measure based illiquidity levels for the PI, momentum, and BM portfolios (see Table 1 under column heading $E(L^i)$). Nonetheless, the significance of the level of illiquidity shows that the portfolio returns are linked to their illiquidity levels. In line 2, the net beta specification also has a positive and significant price of risk. However, the net beta specification yields significantly large pricing errors. The next specification estimates level of illiquidity and net beta simultaneously. The estimation output shows insignificant pricing errors with only a relatively higher $R^2$ of 0.45 than the results reported in lines 1 and 2. The coefficient on the expected illiquidity is significant at the 10 percent level, and the coefficient on the net beta is insignificant, although it retains the positive sign. However, the results show, through lines 1 to 3, that a joint criterion of higher $R^2$ and insignificant pricing errors is not met.

The relatively poor performance of the net beta specification demonstrates the empirical difficulties of making accurate model-based predictions when the component beta risks do not capture the underlying theoretical direction (for example, the commonality effect $\beta^{i2}$ for all portfolios; depressed wealth effect $\beta^{i4}$ for momentum (M) and book to market (BM) portfolios see Table 1). Nonetheless, the plausible coefficient estimates on expected illiquidity levels are an improvement on Acharya and Pederson (2005), as the illiquidity level, when allowed to have a free parameter value, was often implausibly estimated in their work.

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[19] Lee (2011) in his study "The world price for liquidity risk" notes this problem of multi-collinearity for the Acharya and Pederson model liquidity risks and also test single beta specifications including level of liquidity and market risk.

[20] Lower correlation with $\beta^{i2}$ is understandable as this particular illiquidity related beta is not increasing for illiquid portfolios as per Table 1.

As argued previously that price of risk associated with either of the beta risks can also be interpreted as capturing the overall model effect. The individual beta risk specification incorporates the possibility of determining which beta is a more relevant risk in suppressing cross-sectional pricing errors. Therefore, given the highlighted estimation difficulties and the strong correlation patterns among beta risks, we test the following cross-sectional specifications and the nested single beta representations for the described analysis:

$$E(R^i) = \alpha + \psi^i E(C^i) + \lambda^1 \beta^{i1} + \lambda^2 \beta^{i2} - \lambda^3 \beta^{i3} - \lambda^4 \beta^{i4} . \qquad (15)$$

In line 4, a CAPM specification is employed, and the price of risk associated with $\beta^{i1}$ is positively significant. The significant model pricing errors over predict the average portfolio returns by 1.20 percent per month, which is substantially large. The price of risk for the commonality effect is expected to be positive. However, we find an insignificantly negative coefficient, which again highlights the inability of the commonality effect to not account for the particular contemporaneous association between idiosyncratic and aggregate illiquidity shocks. The specification with flight to liquidity risk produces insignificantly small pricing errors. It also yields the highest adjusted $R^2$ across specifications using only one explanatory variable. The estimated price of risk for $\beta^{i4}$ is insignificantly plausible. Acharya and Pedersen (2005) reported that the depressed wealth effect risk has the largest and most significant compensation across all illiquidity risks for U.S. stock returns.

The regression in line 8 again finds a strong impact of $\beta^{i3}$, as in line 6, and is significant even in the presence of other model risks. The comparison of the models, under the established criteria, suggests that the specification using only flight to liquidity risks performs better than the others. The $\beta^{i3}$ risk can explain the largest variability in mean portfolio returns while maintaining the model's parsimony with a similar adjusted $R^2$ to lines 8 and 9. In brief, when illiquidity is measured using the zero measure, illiquidity risk is best captured through $\beta^{i3}$ to proxy the overall illiquidity effect in the Finnish market. The result signifies the pervasiveness of illiquidity risk, which is attributed to a flight to liquidity, also reported in Vaihekoski (2009) for the Finnish market.

The estimations using price impact measure based illiquidity risks are reported in panel A of Table 5. The results show that the level of illiquidity is significantly related to expected returns with a larger model $R^2$ than the corresponding zero measure specifications. The increased explanatory power demonstrates the increased variability (information content) in the price impact measured portfolio illiquidity levels in conjunction with expected portfolio returns compared to the zero measure (see column headers $E(L^i)$ and $E(A^i)$ in Tables 1 and 2). However, the specification with expected illiquidity has significant pricing errors and fails to meet the model success criteria. The net beta specification does not have a high $R^2$, although it has insignificantly estimated small pricing errors. Using the level of illiquidity in conjunction with the net beta hampers the model in terms of the significant cross-sectional pricing errors.

The $\beta^{i2}$ has positive and significant coefficients in the single beta risk specifications. However, the commonality risk alone is not a sufficient risk factor for significant pricing errors. The flight to liquidity specification cannot replicate its performance under the zero measure and is neither significant nor plausible. In line 7, the last illiquidity-related risk also has a negative, significant estimate of the price of risk. The performance of the net beta specification, among the other single beta specifications, is relatively better under the model selection criterion for suppressing cross-sectional mispricing. The model estimations highlight the key differences in measuring illiquidity between zero measure and price impact through the significance of alternating illiquidity betas to explain expected portfolio returns, as hypothesized above.

**Table 4**

**Equally weighted portfolios using zero measure of illiquidity**

This table reports the estimates for the illiquidity related betas and market beta using cross-sectional regression analysis for the period of 1994-2009. In panel A we estimate coefficients for all 25 test portfolios using different variants of following relation between excess returns and explanatory factors

$$E(R^i) = \alpha + \psi^i E(C^i) + \lambda^1 \beta^{i1} + \lambda^2 \beta^{i2} - \lambda^3 \beta^{i3} - \lambda^4 \beta^{i4}$$

where $\beta^{net,p} = \beta^{i1} + \beta^{i2} - \beta^{i3} - \beta^{i4}$ , the total of nine models from above relation are estimated .In panel B the cross-section regressions are performed for equally weighted 15 portfolios which are ranked with some illiquidity related characteristics. The *t*-statistics is reported in parentheses and these are with corrected standard deviation using Newey and West (1987) method with two lags. $R^2$ is obtained for each of the estimated model and adjusted $R^2$ is reported in parentheses.

| | *Constant* | *E(L^i)* | $\beta^{net,i}$ | $\beta^{i1}$ | $\beta^{i2}$ | $\beta^{i3}$ | $\beta^{i4}$ | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| *Panel A: equally weighted 25 portfolios:* | | | | | | | | |
| 1 | 0.0002 | 0.0282 | | | | | | 0.386 |
| | (0.09) | (5.77) | | | | | | (0.359) |
| 2 | -0.0130 | | 0.0214 | | | | | 0.372 |
| | (-2.29) | | (3.91) | | | | | (0.345) |
| 3 | -0.0092 | 0.0175 | 0.0123 | | | | | 0.454 |
| | (-1.08) | (1.69) | (1.19) | | | | | (0.404) |
| 4 | 0.0120 | | | 0.0392 | | | | 0.425 |
| | (-3.93) | | | (6.56) | | | | (0.400) |
| 5 | 0.0198 | | | | -0.0283 | | | 0.047 |
| | (2.12) | | | | (-1.18) | | | (0.006) |
| 6 | 0.0008 | | | | | -0.0756 | | 0.495 |
| | (0.59) | | | | | (-7.44) | | (0.473) |
| 7 | 0.0087 | | | | | | -0.0282 | 0.046 |
| | (7.67) | | | | | | (-0.83) | (0.005) |
| 8 | -0.0047 | | | 0.0109 | 0.0002 | -0.0782 | 0.0347 | 0.573 |
| | (-0.61) | | | (0.92) | (0.01) | (-2.93) | (0.99) | (0.487) |
| 9 | -0.0230 | 0.0257 | | 0.0308 | 0.0203 | -0.0067 | 0.0465 | 0.620 |
| | (-1.30) | (1.08) | | (1.50) | (0.67) | (-0.11) | (1.01) | (0.520) |
| *Panel B: equally weighted 15 illiquidity related portfolios.* | | | | | | | | |
| 1 | 0.0008 | 0.0267 | | | | | | 0.530 |
| | (0.50) | (5.64) | | | | | | (0.493) |
| 2 | -0.0206 | | 0.0288 | | | | | 0.819 |
| | (-8.24) | | (12.31) | | | | | (0.805) |
| 3 | -0.0202 | 0.0009 | 0.0282 | | | | | 0.819 |
| | (-6.96) | (0.17) | (7.21) | | | | | (0.789) |
| 4 | -0.0169 | | | 0.0482 | | | | 0.751 |
| | (-6.16) | | | (10.50) | | | | (0.732) |
| 5 | 0.0210 | | | | -0.0315 | | | 0.059 |
| | (1.55) | | | | (-0.91) | | | (-0.014) |
| 6 | 0.0001 | | | | | -0.0823 | | 0.809 |
| | (0.05) | | | | | (-7.78) | | (0.795) |
| 7 | 0.0078 | | | | | | -0.0771 | 0.379 |
| | (9.12) | | | | | | (-3.55) | (0.332) |
| 8 | -0.0131 | | | 0.0271 | 0.0061 | -0.0485 | -0.0019 | 0.897 |
| | (-2.19) | | | (4.13) | (0.51) | (-2.47) | (-0.09) | (0.856) |
| 9 | -0.010 | -0.0055 | | 0.0228 | 0.0036 | -0.0649 | -0.0041 | 0.898 |
| | (-0.67) | (-0.30) | | (1.22) | (0.19) | (-0.98) | (-0.22) | (0.842) |

**Table 5**

**Equally weighted portfolios using Amihud (2002) price impact**

This table reports the estimates for the illiquidity related betas and market beta using cross-sectional regression analysis for the period of 1994-2009. In panel A we estimate coefficients for all 25 test portfolios using different variants of following relation between excess returns and explanatory factors

$$E(R^i) = \alpha + \psi^i E(C^i) + \lambda^1 \beta^{i1} + \lambda^2 \beta^{i2} - \lambda^3 \beta^{i3} - \lambda^4 \beta^{i4}$$

where $\beta^{net,p} = \beta^{i1} + \beta^{i2} - \beta^{i3} - \beta^{i4}$ , the total of nine models from above relation are estimated .In panel B the cross-section regressions are performed for equally weighted 15 portfolios which are ranked with some illiquidity related characteristics. The *t*-Statistics is reported in parentheses and these are with corrected standard deviation using Newey and West (1987) method with two lags. $R^2$ is obtained for each of the estimated model and adjusted $R^2$ is reported in parentheses.

| | *Constant* | $E(L^i)$ | $\beta^{net.i}$ | $\beta^{i1}$ | $\beta^{i2}$ | $\beta^{i3}$ | $\beta^{i4}$ | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| *Panel A: equally weighted 25 portfolios:* | | | | | | | | |
| 1 | 0.0061 | 0.017 | | | | | | 0.605 |
| | (7.32) | (6.58) | | | | | | (0.588) |
| 2 | 0.0020 | | 0.0083 | | | | | 0.433 |
| | (0.86) | | (3.08) | | | | | (0.409) |
| 3 | 0.0085 | 0.020 | -0.0041 | | | | | 0.623 |
| | (5.42) | (3.52) | (-1.55) | | | | | (0.586) |
| 4 | -0.0120 | | | 0.0371 | | | | 0.425 |
| | (-3.93) | | | (6.56) | | | | (0.400) |
| 5 | 0.0077 | | | | 0.011 | | | 0.386 |
| | (9.352) | | | | (2.69) | | | (0.360) |
| 6 | 0.0096 | | | | | 0.0008 | | 0.000 |
| | (0.92) | | | | | (0.01) | | (-0.043) |
| 7 | 0.0085 | | | | | | -0.0257 | 0.137 |
| | (8.13) | | | | | | (-1.76) | (0.100) |
| 8 | -0.0091 | | | 0.0186 | 0.0182 | -0.0579 | 0.0430 | 0.622 |
| | (-1.37) | | | (2.40) | (3.91) | (-1.54) | (3.23) | (0.547) |
| 9 | -0.0029 | 0.017 | | 0.0029 | 0.0069 | -0.0677 | 0.0378 | 0.698 |
| | (-0.48) | (2.87) | | (0.28) | (1.58) | (-2.67) | (3.73) | (0.619) |
| *Panel B: equally weighted 15 illiquidity related portfolios.* | | | | | | | | |
| 1 | 0.0064 | 0.017 | | | | | | 0.791 |
| | (8.51) | (5.97) | | | | | | (0.775) |
| 2 | -0.0015 | | 0.0131 | | | | | 0.826 |
| | (-0.97) | | (8.29) | | | | | (0.812) |
| 3 | -0.0025 | -0.022 | 0.0147 | | | | | 0.826 |
| | (-0.756) | (-0.31) | (2.68) | | | | | (0.797) |
| 4 | -0.0169 | | | 0.0457 | | | | 0.751 |
| | (-6.16) | | | (10.50) | | | | (0.732) |
| 5 | 0.0071 | | | | 0.0196 | | | 0.780 |
| | (9.15) | | | | (5.88) | | | (0.763) |
| 6 | 0.0128 | | | | | 0.0281 | | 0.005 |
| | (1.00) | | | | | (0.28) | | (-0.072) |
| 7 | 0.0067 | | | | | | -0.105 | 0.722 |
| | (8.58) | | | | | | (-5.10) | (0.701) |
| 8 | -0.0126 | | | 0.0123 | 0.0352 | -0.120 | 0.102 | 0.884 |
| | (-2.23) | | | (1.74) | (3.12) | (-4.60) | (1.81) | (0.838) |
| 9 | -0.0105 | 0.038 | | 0.0126 | 0.0071 | -0.091 | 0.191 | 0.907 |
| | (-2.25) | (1.68) | | (1.80) | (0.28) | (-4.70) | (4.01) | (0.855) |

*4.4. Model testing for illiquidity-related portfolios*

Numerous studies report that illiquidity risk matters for asset returns, which are a function of the level of idiosyncratic illiquidity. Accordingly, we reduce the cross section of twenty-five portfolios to fifteen and test the hypothesis for the Finnish market. All of the regressions reported in panel A of Tables 4 and 5 are re-estimated and presented in panel B of Tables 4 and 5. The estimations with the zero measure retain the overall trends in significance or insignificance for particular beta risks and pricing errors, as shown across specifications in panel A. The notable differences in the panel B of Table 4 specifications include the significant risk premium on the net beta in line 3 with significantly large cross-sectional pricing errors, the significance of market risk in line 8 also comes with significant cross-sectional errors. However, the most striking difference is the larger cross-sectional $R^2$ values across all specifications. Importantly, the flight to liquidity risk specification at line 6 exhibits greater ability in suppressing the pricing errors (insignificantly estimated) and obtains an $R^2$ of 80.90 percent. Further this effect is also quite robust and retains its significance once level of illiquidity is included[21].

In panel B of Table 5, we report that the regression specifications using the price impact measure based illiquidity risks. Here again, in line 2, the net beta significantly affects the cross-sectional return variations, with insignificantly small pricing errors and an adjusted $R^2$ of 81.20 percent. In line 3, the specification using the level of illiquidity and the net beta, yields insignificant pricing errors, but the coefficient on expected illiquidity is implausibly estimated and counter-intuitive. Furthermore, the adjusted $R^2$ in line 3 is actually reduced relative to the specification with net beta alone. Generally, individual liquidity risks with the price impact measure perform better for illiquidity-related portfolios. The main difference between the estimations reported in panel A compared to those in panel B of Tables 4 and 5 is that the employed risk specifications explain a greater share of the cross-sectional variance in the mean returns. To highlight this effect, see the model $R^2$ for the specifications in Table 4 and 5 across the panels (line 6 and line 2). The estimations in the B panels have approximately 78 percent and 100 percent higher model $R^2$ values than the corresponding $R^2$ levels in the A panels of these tables.

The model predictions, regarding the return differentials between the most illiquid and liquid portfolios, highlight the importance of illiquidity risk for illiquidity-related portfolios. We employ of the most successful price of risk specification[22] across Tables 4 and 5 (panel B). The reported price of risk associated with $\beta^{i3}$ is -0.0823. Using the flight to liquidity price of risk, a predicted return differential on the most illiquid and illiquid is estimated as:

$$\lambda^3(\beta^{3,L-5} - \beta^{3,L-1})12 = 14.84\% \, ,$$

where $(\beta^{3,L-5} - \beta^{3,L-1})$ is the difference between the betas of these two portfolios. The subsequent calculations yield an annualized return differential of 14.84 percent. The prediction is near the yearly difference between the realized returns on these portfolios, which is 15.37 percent for the period of 1994–2009.

We repeat the procedure using our second measure of illiquidity. The price of risk associated with $\beta^{net,i}$, in panel B line 2 of Table 4, is 0.0131. This yields a predicted return differential of:

$$\lambda(\beta^{net,L-5} - \beta^{net,L-1})12 = 14.48\%,$$

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[21] These unreported results can be provided upon request.

[22] We have also estimated return prediction based on other specifications presented in Panel B of Table 4 and 5, the specification that are not successful either on account of significant pricing errors or for having lower adjusted $R^2$. We then estimated for these models when possible, the upper and lower bounds for the magnitudes of illiquidity and market premium for the most illiquid and liquid portfolio and also then across all portfolios constructed in this paper. The overall picture remains the same, these results are available upon request.

the tested specifications explain nearly all of the difference in returns across illiquidity portfolios. Imposing the constancy constraint on the net beta price of risk, we determine which beta best explains the return differentials. To conserve space, we only present the results for the component that best explains the return differential, which is $\beta^{2i}$, the commonality effect in illiquidity. Using the reported net beta specification price of risk, the component resulting from the commonality effect (while using commonality betas) is calculated as follows:

$$\lambda(\beta^{2,L-5} - \beta^{2,L-1}) = 11.06\%$$

Similarly, the market beta represents 1.09 percent of the overall return differential, whereas the flight to liquidity explains only 0.15 percent. The remaining difference of 1.34 percent is attributed to $\beta^{4i}$. The combined premium on liquidity risks account for nearly 92 percent of the total model-predicted risk premium, and only 8 percent is associated with the market (CAPM) risk. Acharya and Pederson (2005) reported a comparable return differential between the most illiquid and liquid portfolios for the U.S. stock returns as follows:

$$\lambda(\beta^{net,L-25} - \beta^{net,L-1})12 = 6.40\% .$$

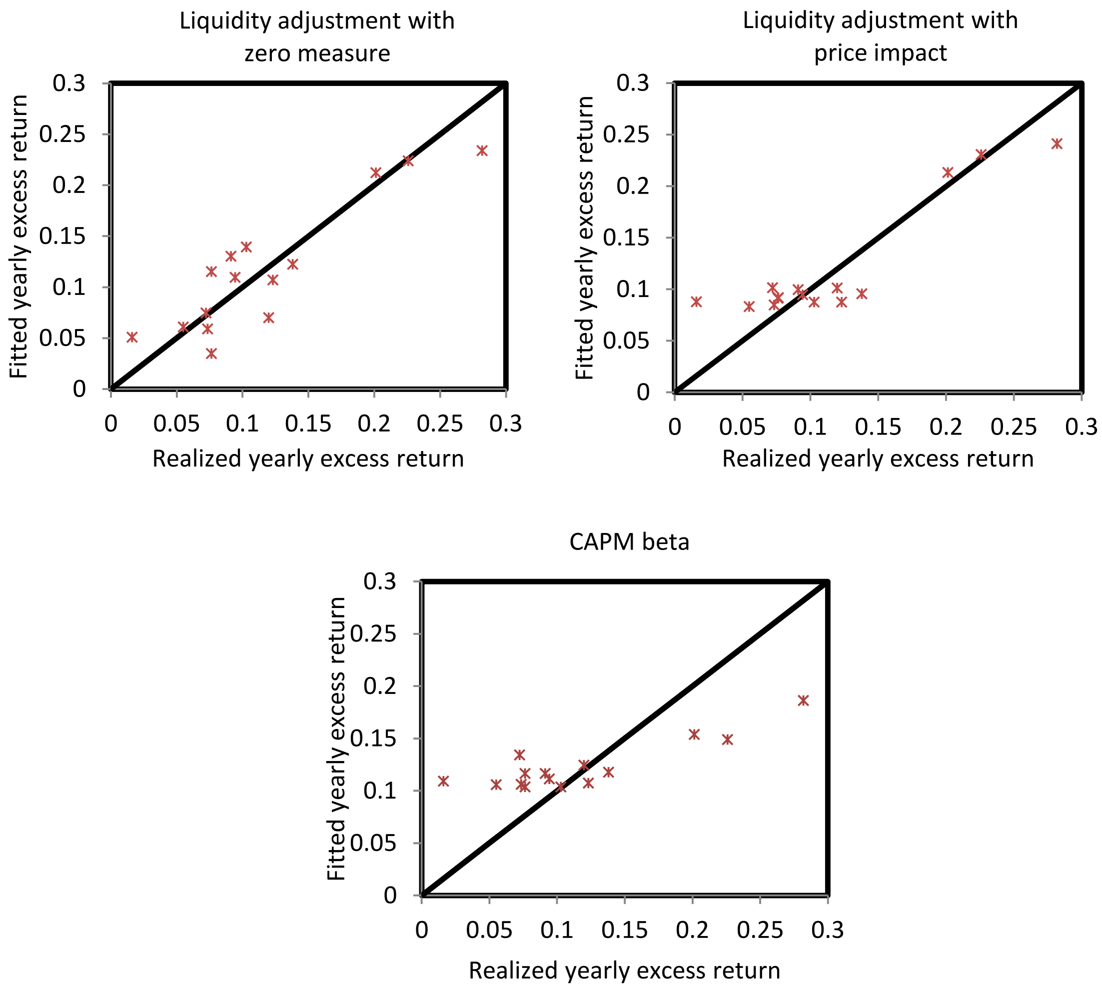


**Figure 3.** Empirical fit for 15 portfolios: the empirical fit depicted at the top left corner is when a relevant measure of illiquidity is estimated as zero measure, at the right of it is an empirical fit when relevant measure of illiquidity is estimated by Amihud (2002) price impact. Below is empirical fit by CAPM beta. The period of estimation is 1994-2009.

Of this yearly return differential, the three illiquidity-related betas explain nearly 1.10 percent, whereas the market beta explains 5.30 percent. The illiquidity premium only accounts for 17 percent of the model projection compared to the 92 percent reported for the Finnish stock market, given the equality of model premia across the beta risks. These results clearly suggest that market-related risk is dominant in the U.S. market, while this is not the case for the Finnish stock returns. The larger liquidity premium rather than market premium demonstrates the importance of accounting for liquidity risk, as argued by numerous theories. Furthermore, the evidence also confirms our hypothesis that illiquidity effects can be more pronounced in illiquid markets, even if the markets are developed[23], as in our case.

In Figure 3, we provide the empirical fits of the models against actual portfolio returns. The model projections that include liquidity adjustment clearly outperform the market beta. The graphs indicate much better empirical fits. The zero measure yields a yearly difference of 2.5 percent, whereas with price impact, the yearly difference is 2.8 percent.

*4.5. Model testing for 1996–2007*

To test for the pervasiveness of the illiquidity-related betas across samples, we run cross-sectional regressions for the sample period spanning from 1996–2007.[24] Table 6 reports the results with the zero measure beta risks. The coefficient on expected illiquidity is positive and significant, implying higher expected returns for illiquid assets. Nonetheless, the specification with expected illiquidity again fails to suppress mispricing. The problem of significant pricing errors also undermines the specifications with net beta alone and the net beta combined with the level of illiquidity. Other comparable differences from the full sample estimations include reduced pricing errors equaling -0.45 percent per month for the market model specification and the larger pricing errors from the $\beta^{3,i}$ specification. Moreover, the cross-sectional pricing errors from both specifications are significant at 1% critical t-values.

The best model in the reduced sample is in line 8, in which all the beta risks are taken together, whereas only $\beta^{3i}$ is significantly priced. Under the employed model selection criteria, none of the single beta specifications outperform the others on both fronts. However, for the largest adjusted $R^2$ across all specifications and, economically, the smallest pricing errors among single beta specifications – the flight to liquidity risk specifications– remains noteworthy. Nonetheless, the specification including illiquidity-related betas with market risk reduces the cross-sectional mispricing (insignificantly estimated), although it suffers from employing additional degrees of freedom and thus lower adjusted $R^2$ values.

The results for the price impact based liquidity risk estimations in the tranquil period, reported in Table 7 are similar to the results in Table 5 panel B. Notable differences include the reduced significance of net beta in line 3 at 10 percent critical t-value, the significance of the flight to liquidity risk, and insignificantly estimated pricing errors for the specifications in lines 8 and 9. Moreover, the specifications in lines 8 and 9 do not have significant prices for the model risks, when compared to the results presented for the full sample for the same portfolios.

To see the model based predictions in Figure 4 we plot the empirical fit of the successful models in the calmer period. The evidence implies that a CAPM beta may be a better candidate for explaining

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[23] Lee (2011) provided an evidence of non-significance of liquidity premium in Table 3 of his study for number of developed markets in which Finland is included, using a same measure of illiquidity (zero measure) we find that $\beta^{i3}$ is significantly priced for Finland. This suggests that generalizing among all developed markets can be misleading in case of Finland, and in one of next section it is shown in the case of other Nordic markets.

[24] As indicated in section 3.2, the Finnish market has a higher price impact and slightly reduced zero returns for 1996–2007. The descriptive behavior of the Finnish aggregate market illiquidities motivated the selection of the reduced sample. We only report the results for illiquidity-related portfolios. The estimations using the cross-section of 25 portfolios are available upon request.

return variations in illiquidity portfolios in calmer periods than in periods involving high illiquidity. The improvement is such that the average annualized difference between the model-predicted returns

**Table 6**

**Equally weighted portfolios using zero measure of illiquidity for the period 1996-2007**

This table reports the estimates for the illiquidity related betas and market beta using cross-sectional regression analysis for the period of 1996-2007. In this table we estimate these coefficients for all 15 test portfolios using different variants of following relation between excess returns and explanatory factors

$$E(R^i) = \alpha + \psi^i E(C^i) + \lambda^1 \beta^{i1} + \lambda^2 \beta^{i2} - \lambda^3 \beta^{i3} - \lambda^4 \beta^{i4}$$

where $\beta^{net,p} = \beta^{ip} + \beta^{2p} - \beta^{3p} - \beta^{4p}$ , the total of nine models from above relation is estimated. The *t*-statistics is reported in parentheses and these are with corrected standard deviation using Newey and West (1987) method with two lags. $R^2$ is obtained for each of the estimated model and adjusted $R^2$ is reported in parentheses.

| | *Constant* | *E(L^i)* | $\beta^{net.i}$ | $\beta^{i1}$ | $\beta^{i2}$ | $\beta^{i3}$ | $\beta^{i4}$ | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0060 | 0.0279 | | | | | | 0.561 |
| | (4.47) | (6.85) | | | | | | (0.527) |
| 2 | -0.0132 | | 0.0267 | | | | | 0.839 |
| | (-5.39) | | (12.07) | | | | | (0.827) |
| 3 | -0.0119 | 0.0042 | 0.0242 | | | | | 0.844 |
| | (-4.97) | (0.95) | (9.09) | | | | | (0.818) |
| 4 | -0.0045 | | | 0.0402 | | | | 0.746 |
| | (-2.31) | | | (10.80) | | | | (0.726) |
| 5 | 0.0263 | | | | -0.0288 | | | 0.056 |
| | (1.84) | | | | (-0.84) | | | (-0.017) |
| 6 | 0.0041 | | | | | -0.0770 | | 0.871 |
| | (5.11) | | | | | (-18.70) | | (0.861) |
| 7 | 0.0123 | | | | | | -0.0650 | 0.229 |
| | (13.26) | | | | | | (-3.17) | (0.170) |
| 8 | -0.0017 | | | 0.0126 | 0.0061 | -0.0555 | -0.0094 | 0.882 |
| | (-0.21) | | | (1.29) | (0.37) | (-2.92) | (0.49) | (0.835) |
| 9 | 0.0051 | -0.0113 | | 0.0004 | -0.0011 | -0.0927 | -0.0164 | 0.889 |
| | (0.30) | (-0.63) | | (0.02) | (-0.04) | (-1.51) | (-0.85) | (0.828) |

and the realized returns is 5.41 percent. The annualized difference when an illiquidity adjustment is included, using both measures of illiquidity, is 2.5 percent, and, on average, is similar for the 15 illiquidity test portfolios across the samples. Nevertheless, illiquidity risks still have explanatory power beyond that of the market beta in the reduced sample period and are more visible through price impact measure based model projections.

To highlight the improvement, we also check for the relative contribution of the liquidity effect to the total model risk premium in the calm period by price impact measure:

$$E(R^i) = \alpha + \lambda^{i1}\beta^{i1} + \lambda\beta^{net,p} . \quad (16)$$

We do not control for illiquidity level, as we intend to compare the price of risk for liquidity risks and for the market beta. The estimation of equation (16) yields the following results:

$$E(R^i) = 0.002 - 0.014\beta^{i1} + 0.025\beta^{net,p} . \quad (17).$$

In equation (17), pricing errors are insignificantly small and the price of risk associated with the net beta is significant with Newey and West (1987) corrected standard errors at the 10 percent level, whereas the corresponding market beta is insignificant. The negative risk premium associated with the

**Table 7**

**Equally weighted portfolios using Amihud (2002) price impact for the period 1996-2007**

This table reports the estimates for the illiquidity related betas and market beta using cross-sectional regression analysis for the period of 1996-2007. In this table we estimated these coefficients for all 15 test portfolios using different variants of following relation between excess returns and explanatory factors

$$E(R^i) = \alpha + \psi^i E(C^i) + \lambda^1 \beta^{i1} + \lambda^2 \beta^{i2} - \lambda^3 \beta^{i3} - \lambda^4 \beta^{i4}$$

where $\beta^{net,p} = \beta^{ip} + \beta^{2p} - \beta^{3p} - \beta^{4p}$ , the total of nine models from above relation is estimated. The *t*-statistics is reported in parentheses and these are with corrected standard deviation using Newey and West (1987) method with two lags. $R^2$ is obtained for each of the estimated model and adjusted $R^2$ is reported in parentheses.

| | *Constant* | *E(L^i)* | $\beta^{net.p}$ | $\beta^{i1}$ | $\beta^{i2}$ | $\beta^{i3}$ | $\beta^{i4}$ | $R^2$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 0.0113 | 0.034 | | | | | | 0.774 |
| | (16.98) | (7.55) | | | | | | (0.757) |
| 2 | -0.0009 | | 0.0155 | | | | | 0.800 |
| | (-0.66) | | (16.17) | | | | | (0.784) |
| 3 | 0.0035 | 0.014 | 0.0097 | | | | | 0.819 |
| | (0.88) | (1.26) | (1.87) | | | | | (0.788) |
| 4 | -0.0045 | | | 0.0216 | | | | 0.746 |
| | (-2.31) | | | (10.80) | | | | (0.726) |
| 5 | 0.0121 | | | | 0.122 | | | 0.783 |
| | (17.81) | | | | (7.63) | | | (0.767) |
| 6 | -0.0022 | | | | | -0.282 | | 0.741 |
| | (-1.25) | | | | | (-11.03) | | (0.721) |
| 7 | 0.0122 | | | | | | -0.0852 | 0.630 |
| | (17.14) | | | | | | (-6.99) | (0.602) |
| 8 | 0.0046 | | | 0.0044 | 0.0964 | -0.0786 | 0.0265 | 0.836 |
| | (1.02) | | | (0.64) | (1.53) | (-0.89) | (0.72) | (0.771) |
| 9 | 0.0040 | 0.024 | | 0.0066 | 0.0317 | -0.0447 | 0.0376 | 0.840 |
| | (0.94) | (0.34) | | (0.61) | (0.19) | (-0.26) | (0.60) | (0.751) |

market beta does not imply that risk is negative and is exemplified, similar to Acharya and Pederson (2005), as follows:

$$E(R^i) = 0.002 + 0.011\beta^{i1} + 0.025(\beta^{i2} - \beta^{i3} - \beta^{i4}).$$

The negative sign on market premia indicates that, under the model assumptions, a greater risk premium is associated with illiquidity beta risks. This evidence highlights the importance of liquidity adjustment in the static CAPM. The annualized difference between the returns on the illiquid portfolio, L-5, and the liquid portfolio, L-1, is 18.29 percent for the sample period from 1996–2007. Using the price of risk associated with the net beta, as shown at line 2 of Table 7, the model-predicted annualized return differential is 10.32 percent. Although the model prediction is not as precise as that reported for the full period, we focus on the proportional share due to illiquidity-related risks rather than market risk, *ceteris paribus*.

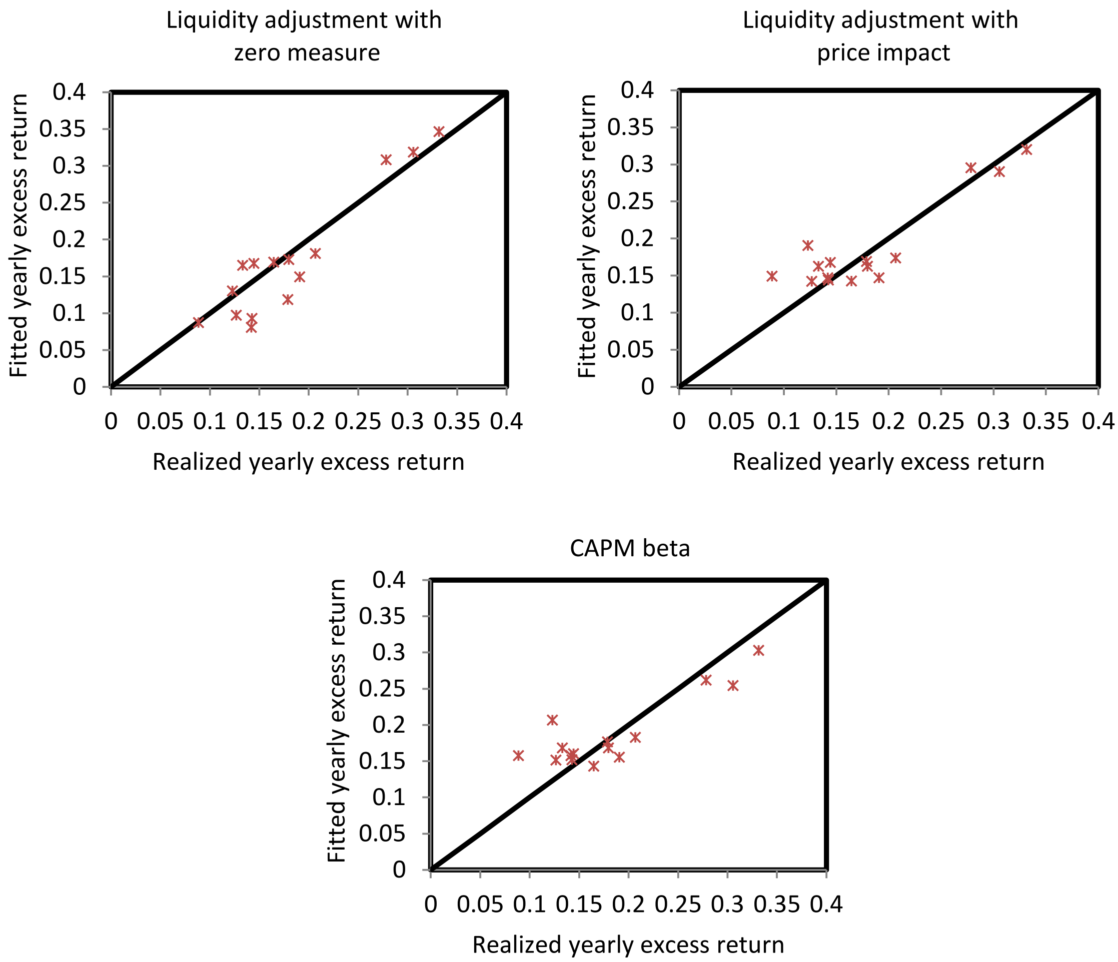


**Figure 4.** Empirical fit for 15 portfolios: the empirical fit depicted at the top left corner is when a relevant measure of illiquidity is estimated as zero measure, at the right of it is an empirical fit when relevant measure of illiquidity is estimated by Amihud (2002) price impact. Below is empirical fit by CAPM beta. The period of estimation is 1996-2007.

The calculations demonstrate that market-related risk explains 4.34 percent of the annual return differential for the prediction for the full model, and the remaining model risk premium is associated with illiquidity-related risks. The proportional illiquidity effect is not as substantial as reported in the full period; yet it accounts for approximately 60 percent of the model-predicted risk premium.

Never the less the evidence highlights the time variation in illiquidity premia. However, illiquidity-related risks are more important than market risk, regardless of the market conditions, and constitute a major part of the model-projected risk premium. Arguably, if the sample includes the illiquidity period, then compensation for illiquidity risks is sufficient to cover the total model risk premium (approximately).

*4.6. Asset prices from illiquid markets*

Given the multi-collinearity issue confronted with the empirical testing of the Acharya and Pedersen model (Lee, 2011), we replicate the regressions for all Nordic equity markets to report percentage liquidity risk premium and percentage market risk premium in the total model premium using two factor model of Liu (2006). We use a new measure[25] of illiquidity, as a monthly frequency of those days, when the incidences of zero return and of no change in $/local exchange rate occur simultaneously. Using this new measure of illiquidity for each Nordic country we construct mimicking liquidity portfolio (MLP onwards), which is a zero investment strategy by being long in the most illiquid portfolios and short in liquid portfolio. In each country MLP yields excess return, Liu (2006) uses this mimicking factor as a candidate for market-wide illiquidity risk. For the noted constraints of limited availability of stocks in Nordic markets, five portfolios are constructed using size information and other five portfolios are constructed using reciprocal of stock prices. Returns on these portfolios and on market return (MR) and MLP are in dollar denomination so that consistency in analysis is maintained across markets: each country has its own local currency. [26]

The results for each country are reported in Table 8. It is quite obvious that in almost all Nordic markets, a model 2 using liquidity factor has higher $R^2$ in comparison to model 1 using market risk. Especially for Norway and Sweden, as well as for Denmark, only in case Finland that $R^2$ is just marginally higher. This hints at the relative superior pricing capacity of liquidity factor over market factor. Nevertheless, a true comparison between these two pricing factors is presented at model 3 for each country that is, Liu's model. We first take up the example of size portfolios. A relative annual return dispersion between the smallest firms (1st quintile) and for the largest firms (5th quintile) for Denmark, Finland, Norway and Sweden is 9.12%, 13.32%, 13.20% and 15.48% respectively. Using estimated price of risk for the model 3 for each country given in Table 8, and respective factor loadings[27] these return dispersion differences are quite accurately estimated. Such that, for Denmark, Finland, Norway and Sweden the Liu model predicted return differentials are 9.44%, 12.67%, 13.69% and 13.00% for each market respectively, these predicted return differentials are quite near to their actual differentials. Finally in Table 8, we show the relative contribution of illiquidity risk and market risk of the total explanation of Liu's model for each country.

Of the total return dispersion explained for the size based extreme portfolios, more than 90% explanation for Denmark and Sweden is reserved for illiquidity risk. Even for Norway this explanation is more than 100%, this is owed to failure of market risk to capture an inherent risk in small sized firms, and therefore it predicted negative return dispersion between small and large sized portfolios. The minimum contribution of illiquidity risk is for Finland market and that too is 73.43%, pretty much in line to the reported numbers in section 4.4 and 4.5. Similarly for the price inverse portfolios, a sizeable risk premium is attributed to illiquidity risk. As far as performance of Liu model is concerned to predict return dispersion for PI portfolios, the numbers are approximately similar to that of size based portfolios. Although the return dispersion between the extreme portfolios, for the former portfolios, is significantly higher than later portfolios.

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[25] As noted, Butt (2013) finds in the context of Nordic markets, the illiquidity measure estimated this way gives the highest spread between the most illiquid and liquid portfolios. Such that this return spread is into double digits of yearly basis across all these four markets, namely, Denmark, Finland, Norway and Sweden. On the other hand the commonly proposed measures of Amihud (2002), Lesmond et al. (1999) and others are not that consistent across these markets giving prominent return spreads across portfolios.

[26] Rate of risk free returns are taken from Kenneth's website for the all the markets for the tests in this section.

[27] To converse space the factor loading for each estimated model shown in Table 8 are not presented and such can be provided upon request.

**Table 8**

**Pricing of Illiquidity risk for Nordic markets**

This table reports the estimates for the illiquidity related betas and market beta using cross-sectional regression analysis for each of the four Nordic countries for the period of 1994-2009. For each market 10 equally weighted portfolios are used, of which 5 are based on market capitalization and other 5 are based on the price inverse ratio. To estimate coefficients, different variants of following relation between excess returns and explanatory factors are used:

$$E(R_i) = \alpha_0 + \lambda_m \beta_m + \lambda_l \beta_l$$

$R_i$ is the excess return on some test portfolio, $\beta_m$ and $\beta_l$ corresponding vector of factor loadings on market and illiquidity factor respectively. Market factor is excess return on the market portfolio and liquidity factor is difference in the monthly excess return on the most illiquid and liquid portfolio across the size factor. Whereas, illiquidity of any stock is measured as the ratio of zero-return days (where zero-return refers to the combined incidence of zero returns in equity markets and of no change in the $/local exchange rate) to the total number of trading days in a month. Below each estimate in parentheses is its statistical significance, which is corrected in line with Shanken (1992). $R^2$ is obtained for each of the estimated model and adjusted $R^2$ is reported in parentheses.

| Markets | Constant | $\lambda_m$ | $\lambda_l$ | $R^2$ | Size Portfolios | | PI-Portfolios | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Market Premium % | Illiquidity Premium % | Market Premium % | Illiquidity Premium% |
| Denmark | | | | | | | | |
| 1 | -0.028<br>(-2.29) | 0.0392<br>(3.04) | | 72.460<br>(69.018) | | | | |
| 2 | 0.0059<br>(1.61) | | 0.0162<br>(3.37) | 82.192<br>(79.965) | | | | |
| 3 | -0.0017<br>(-0.016) | 0.013<br>(1.08) | 0.0148<br>(2.63) | 82.853<br>(77.954) | 0.58% | 99.47% | 22.27% | 77.73% |
| Finland | | | | | | | | |
| 1 | -0.0198<br>(-1.51) | 0.0311<br>(2.23) | | 80.709<br>(78.297) | | | | |
| 2 | 0.0105<br>(2.25) | | 0.0115<br>(2.14) | 81.633<br>(79.337) | | | | |
| 3 | -0.0041<br>(-0.43) | 0.0153<br>(1.40) | 0.0071<br>(1.24) | 84.186<br>(79.667) | 26.67% | 73.43% | 42.72% | 57.29% |
| Norway | | | | | | | | |
| 1 | -0.0216<br>(-2.71) | 0.0328<br>(3.22) | | 49.820<br>(43.548) | | | | |
| 2 | 0.0031<br>(0.64) | | 0.0172<br>(3.50) | 85.190<br>(83.339) | | | | |
| 3 | 0.0067<br>(0.86) | 0.0046<br>(0.47) | 0.0178<br>(3.25) | 85.487<br>(81.341) | -10.67% | 110.67% | 7.03% | 92.97% |
| Sweden | | | | | | | | |
| 1 | -0.0171<br>(-1.07) | 0.0301<br>(1.66) | | 27.425<br>(18.353) | | | | |
| 2 | 0.0218<br>(3.46) | | 0.0234<br>(3.77) | 91.298<br>(90.209) | | | | |
| 3 | 0.0118<br>(0.84) | 0.0012<br>(0.07) | 0.0204<br>(4.32) | 93.574<br>(91.738) | 5.59% | 94.41% | 1.26% | 98.74% |

*4.7. Robustness tests*

Asparouhova et al. (2010) report the premium with liquidity risks is biased upwards by microstructure based measurement errors in prices, such as the bid-ask bounce or temporary price pressures due to order imbalances and suggest a correction based on weighted least square (WLS) method.[28] Since, we use Black, Scholes and Jensen (1970) as the main workhorse for estimating cross-sectional regressions, the suggested WLS correction does not scale down the premium related with liquidity risks for the Nordic markets (results available upon request). First, this may imply the biases in price measurement are not to the level to change the size of liquidity premium. Second, the noted biases are more important for frequency lower than one month to categorize discernible upward liquidity premium biases, see foot note 18 Asprouhova et al. Third, to give the correction an improved chance we run Fama and MacBeth (1976) regressions that if there are microstructure biases which may scale down liquidity premium when estimated through month by month regressions.

**Table 9**

**WLS regressions: Asparouhova et al. (2010) microstructure bias correction**

This table reports the results of monthly Fama and MacBeth (1973) regressions using the conventional methodology (OLS) and the one suggested by Asparouhova et al. based on WLS estimation. They suggest weighting current months returns (gross) by the previous months returns (gross) corrects for microstructure bias in estimated liquidity premiums. The cross-sectional regressions take full sample constant time-series betas, for each time t temporal regression (following Lettau and Ludvigson, 2001), in the second stage Fama and MacBeth conventional and WLS price of risk estimations. The t-values for the model coefficients are reported in () using standard error estimated from the variance of month by month regression estimates from OLS and WLS respectively.

| | | OLS | WLS | Diff. | Size Portfolios | PI Portfolios |
|---|---|---|---|---|---|---|
| Markets | | Mean (t-stat.) | Mean (t-stat.) | Mean (t-stat.) | % age Mod. Prem. | % age Mod. Prem. |
| Denmark | | | | | | |
| | $\lambda_m$ | 0.0120 | 0.0118 | 0.0002 | 0.21% | 20.89% |
| | *t-stat.* | (1.0779) | (1.0666) | (0.3852) | | |
| | $\lambda_l$ | 0.0149 | 0.0147 | 0.0000 | 99.79% | 79.11% |
| | *t-stat.* | (2.8246) | (2.7905) | (0.0974) | | |
| Finland | | | | | | |
| | $\lambda_m$ | 0.0143 | 0.0144 | -0.0001 | 28.06% | 44.49% |
| | *t-stat.* | (1.3632) | (1.3681) | (-0.2133) | | |
| | $\lambda_l$ | 0.0072 | 0.0063 | 0.0001 | 71.94% | 55.51% |
| | *t-stat.* | (1.2766) | (1.1322) | (0.3874) | | |
| Norway | | | | | | |
| | $\lambda_m$ | 0.0044 | 0.0039 | 0.0002 | -8.44% | 5.82% |
| | *t-stat.* | (0.4791) | (0.4203) | (0.5274) | | |
| | $\lambda_l$ | 0.0180 | 0.0184 | -0.0001 | 108.44% | 94.18% |
| | *t-stat.* | (3.4740) | (3.5376) | (-0.7615) | | |
| Sweden | | | | | | |
| | $\lambda_m$ | 0.0012 | 0.0010 | -0.0013 | 4.87% | 1.10% |
| | *t-stat.* | (0.0808) | (0.0688) | (-1.7547) | | |
| | $\lambda_l$ | 0.0204 | 0.0203 | 0.0007 | 95.13% | 98.90% |
| | *t-stat.* | (4.5187) | (4.5009) | (2.5856) | | |

The results from the conventional Fama and MacBeth method regressions and Aspurhova et al. WLS corrected regressions are reported in Table 9. The reported results show that the differences in the estimated premiums with the WLS method and the conventional are very small and insignificant,

[28] We thank an anonymous referee for suggesting this correction.

with an exception for Sweden. The difference, for Swedish stocks, between the conventional and WLS market premium is sizeable and significant at 10 percent critical t-values, though the difference for liquidity risk premium of Liu (2006) model is small but highly significant. This check furthers our observation that the Nordic markets are illiquid to provide large liquidity risk compensation and these high illiquidity premiums are not an outcome of microstructure based biases in measuring prices. The percentage components of market premium and liquidity premium, as part of total market prediction, also are in close neighborhood of the percentages provided in Table 8. Such that across all the Nordic markets liquidity risk compensation dominates the market risk compensation as part of total model prediction, consistent with our main findings in the constrained specifications of equilibrium model in section 2.

## 5. Conclusions

In this paper, we simplify the liquidity-adjusted model developed by Acharya and Pedersen (2005) to determine asset prices and account for the total cost of trade in a single period equilibrium model. The liquidity-adjusted model is tested across four Nordic stock markets but the main evidence is reported for the Finnish market test case. Through the analysis, we emphasize the greater relevance of illiquidity-related theories and models to comparably more illiquid stock markets, rather than the standard practice of analyzing the most liquid market, the U.S. The liquidity adjustment in the model is incorporated through two different measures to proxy for transaction costs. The selection of two separate illiquidity measures is employed to analyze whether illiquidity's effect on asset pricing is captured any differently via a particular measure. We show that the proxy measures capture asset illiquidity while considering the key illiquidity characteristics of firm size, turnover, and PI ratio following Demsetz (1968), Datar et al. (1998), and Brennan and Subrahmanyam (1996), among others.

The central finding of the paper is the substantial risk premium related to illiquidity risks for Finnish stocks (92 percent in full periods and 60 percent in calm periods) in the total model risk premium. The illiquidity premium is far larger than the reported illiquidity premium (17 percent) in the U.S. market as inferred from a comparable study (Acharya and Pederson, 2005). The remaining empirical evidence can be divided into three parts. First, the estimations using the illiquidity measures show that different model (illiquidity) risks are important in explaining variations in expected returns and reducing model mispricing across samples. Therefore, we argue that the empirical significance of depressed wealth effect in Acharya and Pederson (2005) is more of a dimensional effect of the proxy measure used than the systematic effect of the risk, given the unavailability of exacting illiquidity proxies that cover all aspects of stock liquidity. Nonetheless, the varying ability of illiquidity risks across specifications, in explaining cross-sectional return differences, does not undermine the overall performance of the illiquidity measures in capturing liquidity effect. Second, time variation in the illiquidity premium is documented across the samples, which include and exclude illiquid periods. Third, a liquidity-adjusted CAPM performs remarkably better than simple CAPM specifications across the samples, including and excluding illiquidity periods. We suggest that the illiquidity premium across stock markets (both developed and emerging) should be quantified to make further generalizations.

The liquidity premium for the Nordic markets, when estimated using a variant zero measure (Butt, 2013) with Liu (2006) model, makes even larger component of model risk premium than market risk premium, consistent with our main findings in the constrained specifications of adjusted Acharya and Pedersen (2005) one period model.

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