An Impact of Illiquidity Risk for the Cross-Section of Nordic Markets.

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Abstract.

An illiquidity measure for four Nordic markets is estimated as monthly average of those days for which the events of zero return in local equity markets and of no change in $/local exchange rate occurred simultaneously. The advantages of estimating market-wide illiquidity this way are twofold, firstly in comparison with other commonly proposed measures of illiquidity in literature, it yields the maximum return spread between the most illiquid and liquid stocks. Secondly, it establishes the link between the cross-sections of return for different testing portfolios used in this paper with market-wide illiquidity risk, whereas similar connection does not exist when market model is used.

Keywords: Market-wide illiquidity, market model.

JEL Classifications: G310

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1. Introduction.

Numerous studies have documented the link between illiquidity effect and pricing of the assets. Recently though the systematic dimension of illiquidity in pondered more than the asset specific characteristics of it. One of the initial studies in this context is of Amihud (2002), in which it is shown that the expected illiquidity as well as unexpected changes in market illiquidity are the dimensions of illiquidity risk and both have significant bearing upon returns. This evidence is further culminated in other studies (see Pastor and Stambaugh (2003), Lesmond et al. (2004) and Sadka R., (2006) and others) which show that illiquidity risk based explanation is robust across many asset-pricing anomalies and not just confined to illiquidity effect. Much of this evidence is however, comprised of a single time-series and cross-section of stocks of the U.S market, which is supposedly also the most liquid market.

On the other hand illiquidity risk is expected to be priced for illiquid markets as suggested in Bekaert et al. (2007). There are recently some studies on emerging markets in nexus with illiquidity risk. Lesmond (2005) estimated different proxy measures of illiquidity and find that they are connected with actual trading costs when measured with high frequency data, which is not that easily available for such markets. Then developing on it Bekaert et al. (2007) tested Amihud (2002) hypothesis for 19 emerging markets. To estimate market illiquidity the monthly incidences of zero returns in equity markets across all the stocks are recorded and it is reported that local liquidity matters for returns in emerging markets. Griffin et al. (2010) also estimated the transaction cost for number of emerging markets which is higher in comparison to the developed markets. These studies establish that illiquidity risk matters for the markets which are more illiquid. However to perform asset pricing test for most of the illiquid markets the availability of longer time-series and larger cross-section of stocks is an issue. To, circumvent it, most of the studies relying on similar characteristics of these markets club together all the stocks listed in them. In this study therefore, an impact of illiquidity effect is studied on the four Nordic markets, namely Denmark, Finland, Norway and Sweden as a single cross-section of the stocks. Since these markets are comparatively illiquid and way too small in comparison to the U.S market, thus are appropriate candidates for illiquidity related studies.

In addition of examining illiquidity risk for asset prices, an influential strand of literature proposes new measures of illiquidity which can proxy for actual transaction cost of trading of the assets. Obviously so, because illiquidity is not an observed characteristics. Further in many markets high frequency data is not available such as longer series on the lines of Kayle (1985) can be estimated, or the spread measure at 5 minutes of trade data be accumulated for considerable number of years. Therefore, studies on illiquidity usually rely on proxy measures of it, which are usually estimated using daily data, so that longer series of an appropriate size for asset pricing test can be constructed. Recently Goyenko et al. (2009) analysis that generally proposed proxy measures of illiquidity do a good job, as they are linked with their counterpart measures when calculated using high frequency data for the U.S data.

Therefore in this paper we estimated most of the proxy measures of illiquidity which Goyenko et al. (2009) used. One of such is proposed by Amihud (2002) (Amihud onwards) and it has been extensively used in literature as it is akin to Kayle (1985) concept of illiquidity measure and it gauges an impact of traded volume upon returns. Secondly we estimate Roll (1984) (Roll spread onwards) which is proposed as related with effective spread. Similarly the most recently illiquidity measure is proposed by Corwin and Schultz (2011), (HL spread onwards) which proxy the bid-ask spread from daily low and high prices. Lastly we estimated the monthly incidences of zero returns as proposed by Lesmond et al. (1999) (ZERO-II onwards) and used by Bekaert et al. (2007). A rationale of zero return as an instance of illiquidity is that investor chooses not to trade while anticipating that transaction cost associated with trading is higher than the profits.

We estimated all these illiquidity measure with a perspective of international investor who sees returns in dollar denomination. Except for ZERO-II measure seeing the local illiquidity measures in dollar denomination do not make much difference. As for ZERO-II, this generally effect because when stock is not traded in equity market but dollar to local exchange-rate fluctuates then zero returns are non-zero. Thus estimating illiquidity in dollar denomination (ZERO-I onwards) is different than ZERO-II which is estimated by Bekaert et al. (2007). There is an additional advantage of estimating illiquidity this way, because it for zero returns in equity market adds another condition, which is implicit zero returns from trading in dollar or in local currencies of the countries included in the studies[1]. Obviously then no change in exchange rates of these provides implicit zero return for trading in them in forex market. However, we do not test this proposition in this paper that if investors hedge a risk of non-trading (zero returns) in equity market by taking positions in currencies. For the

[1] Provided that we assume that an international investor is only interested in dollar and local currency fluctuations for hedging purposes.

purpose of this paper this double criterion of zero return in equity market and implicit zero return in forex market is most likely to meet if the stock is not traded consecutively for longer time. Therefore, ZERO-I naturally accounts a length of non-trading interval while estimating illiquidity, which is also professed as higher instance of illiquidity in Bakaert et al. (2007). Never the less, all measures of illiquidity estimated for all four Nordic markets in dollar denomination are inversely related with the size of firms which is indirect hint that these measures are related with transaction cost (see Demsetz 1968, Copeland and Galai 1983, Stoll and Whaley 1983, Roll 1984). Further all of them are highly correlated with each other.

In most of the studies generally any individual measure of illiquidity is chosen to conduct asset pricing test. However, recently Korajczyk and Sadka (2008) by combining information of various measures of illiquidity constructed a new measure, and find that it has important implication for asset pricing than standalone measures. In this paper instead of extracting common component of illiquidity from the estimated measures we conduct a horse-race among them to find that which measure is the most relevant. Being relevant means that which measure yield the highest return spread between the most illiquid and liquid portfolios. For that the monthly returns on all stocks are partitioned into five quintiles by sorting on the previous month's respective measure of illiquidity. Such that, each quintile is increasing with respective measure of illiquidity used. Using ZERO-I we find that the return spread is the highest for all stocks combined in Nordic region and for each of its constituent markets. Except for that, only ZERO-II is second measure which performed somewhat consistently. This bestows an impression that non-overlapping information in ZERO-1 and ZERO-II account for the return spread in presence of high correlation among all estimated illiquidity measures. Therefore we used these measures for conducting asset pricing tests.

To proxy for market-wide illiquidity risk for four Nordic markets we average across all the stocks their respective monthly ZERO-I and ZERO-II measures for the time span of 1988:4 to 2012:4. Further we also fitted AR (2) model on market-wide illiquidity to collect residuals to portray the un-anticipated changes in it. The pricing implication of these level and shocks of illiquidity factor have been tested previously. For instant, Amihud (2002) for the U.S market analyzed that market level of illiquidity predicts returns positively and shocks to market illiquidity depresses the contemporaneous returns. Similarly Bekaert et al. (2007) tested these hypotheses for the emerging markets. Last but not the least Acharya and Pederson (2005) detailed the economic reasoning for the pricing of illiquidity risk. We investigate the relationship between illiquidity risk and the cross-section of stock returns for four Nordic markets. Our results support the conjecture that level of market illiquidity predicts the return positively. However this support comes only through ZERO-I measure. The shocks to market illiquidity are negatively priced as expected, but models using them generally have significant pricing errors. More importantly using ZERO-1 measure one can construct a factor-mimicking portfolio, yielding excess return by being long and short in illiquid and liquid portfolio with zero-investment strategy (in line with Fama and French (1993) factors), while controlling for the size factor. This illiquidity factor is also resilient in explaining the cross-section of stock returns. However, these illiquidity related characteristics explain the returns for those portfolios in better way which are constructed with illiquidity related characteristics, that is, size and price inverse ratio. For these portfolios illiquidity risk is enough and it requires no facilitation from market factor altogether. However when the cross-section of momentum related portfolios returns is used then illiquidity risk in its standalone capacity is not enough, but two factors model, comprising of illiquidity risk and market factor together drive the pricing errors insignificant. Never the less major contribution comes from illiquidity related factor.

The paper is organized such as that section 2, describes the construction of illiquidity measures and relatedness among them section 3, discuss the various characteristics of illiquidity measures section 4, elaborates upon the choice of illiquidity measure among all for the asset pricing test section 5, ponders upon the estimation methodology, and section 6 concludes.

2. Illiquidity Measures.

To construct illiquidity measures the data is downloaded from DATASTREAM for all four Nordic markets for the period of 1988:4 to 2012:4. As for this time period the data is available for the all markets namely, Denmark, Finland, Norway and Sweden. At the start of the period there are 91 firms listed in the four markets which by the end rose to 1065 firms, this shows a considerable increase in the size of these markets, overall for this span of period average number of listed firm are 526. For each firm the daily total return index, volume, prices, high and low price and size related information are retrieved for the requirement of estimating illiquidity measures. In addition the end of month total return index, size, and price related information for each stock are also retrieved. Using these stocks characteristics following measures are estimated.

1. Amihud.

This is probably the mostly used measure which takes into account the impact of trade order on returns. Intrinsically it caters the Kayle (1985) concept of illiquidity and is been proposed by Amihud (2002), and is used by Acharya and Pedersen (2005) among others. It is estimated as under

$$ILLIQ_{im} = 1/D_{im} \sum_{t=1}^{Dim} \left| R_{imd} \right| / VOLD_{imd} \qquad (1)$$

Where D_{im} is the number of days for which data is available for stock *i* in any month *m*. Moreover, the absolute return, $\left| R_{imd} \right|$, on stock *i* on day *d* of the month *m* is divided by its corresponding day traded volume in dollar, $VOLD_{imd}$, The daily traded volume is in dollars is the number of shares traded for stock *i* multiplied by the day end price for that stock. The ratio $\left| R_{imd} \right| / VOLD_{imd}$ gives absolute change in return per dollar traded, or daily price impact. Naturally, for the illiquid stock $ILLIQ_{im}$ is higher. To, construct market measure of illiquidity we average for all stocks their estimated Amihud measures using equation (1). Among other qualification criteria in Amihud (2002), one is that stocks should be traded at least for 15 days. This alone leaves Amihud measure to represent only 50% of the stocks listed in four markets, further the stocks it omits are mostly the illiquid stocks. Therefore, to accommodate the inclusion of illiquid stocks we estimated Amihud by waiving this restriction, however we also estimate it by imposing it and name this measure as Amihud-15.

2. Zero Measure

Lesmond et al. (1999) crystalized the idea of Rosett (1959) of friction in economics, that is, for small market yield the stock holdings for particular asset is not changed because of transaction cost. This no change in stock holding is manifested in zero returns. Higher the zero returns, the higher is anticipated transaction cost of that asset. The zero measure as an illiquidity measure has been used in recent studies[2]. The advantage of estimating the illiquidity measure through them is that it only requires the availability of return series to estimate it. Thus a more representative illiquidity measure is easily estimated. Whereas, the Amihud measure cannot be estimated for each stock in Nordic markets because for its

[2] Bekaert et al. (2007) then used this monthly zero returns measure for pricing implication of the illiquidity risk. Further Goyenko et at. (2009) showed that this zero measure is related with the finer measure of illiquidity when estimated at high frequency data.

construction it requires availability of daily volume as well, which is not that uniformly available.

We first measured zero return in dollar denomination to keep consistency in the analysis as each market has its own local currency. Therefore, our zero returns are those in which stock is not traded in equity market, as well as there is also no change in $/local exchange rate, or implicit zero returns are available by trading in them in forex market.

Zero-I= Total number of zero return in both markets /Total number of days to trade *(2)*

One additional benefit of estimating illiquidity measure this way is that it takes into account the length of non-trading intervals into its calculation[3]. It is because if currency fluctuation is random and stock is not traded consecutively then it is more probable to get zero returns matching in both markets[4]. In next section we also analyze that estimating illiquidity this way retains the trademark relationship with other measures of illiquidity and size. Secondly we also estimate the zero measure based upon zero returns in equity markets in local currency as is done in Bekaert et al. (2007).

Zero-II= Number of days with zero return /Total number of days to trade *(3)*

Similarly for all the stocks in four Nordic markets the average monthly illiquidity measure is estimated using both equation (2) and (3).

3. Roll-Spread.

Roll (1984) observed that first-order auto covariance of changes in prices actually proxy for the trading cost. This measure has been used in many studies as a standard measure of

[3] Bekaert et al.(2007) provide the analysis for 19 emerging markets that if number of zero returns are same for two stocks, but for the one they are consecutive then for that the instance of illiquidity is more pronounced.

[4] To illustrate this point we take a hypothetical example of two stocks which are not traded for 10 days in an equity market , with first one no trading days are randomly distributed and for second non-trading occur consecutively. We assume trading or non-trading in an equity market and change and no change in $/local exchange rate in forex market as equally likely and mutually exhaustive events. Then probability of zero returns in equity market is ½, and also of the incidence of no change in $/local exchange rate, with implicit zero return in forex market of trading in dollar or local currency. If both of these events are independent then probability of zero return in both markets is ¼, then simple expectation of 10 zero returns in both markets for the first stock will be ¼ x 10 = 2.5, as these zero returns are randomly distributed in the equity market Whereas for second stock the expectation of 10 zero returns in both markets will be simply ½ x 10 = 5, as we know that in equity market these zero returns occurred consecutively. Obviously these expected numbers of zero return comes in numerator of equation (2), which makes the second stock with longer length of non-trading more illiquid.

illiquidity[5]. Roll shows for the given market efficiency, the effective bid-ask spread can be estimated as under

$$S = 2\sqrt{-Cov(\Delta P_t, \Delta P_{t-1})} \tag{4}$$

However, as observed for many of the stocks the above measure is positive, resultantly it becomes undefined, we therefore used the equation (4) for estimating Roll-Spread for each firm only when above covariance turns out to be negative, that is, we allot zero to the positive covariance[6]. Then Roll spread at market level is simple average across all firms.

4. Turnover.

It is generally observed that illiquid stocks are traded less frequently as investor who specializes in such assets generally hold them for longer periods[7]. Investors holding periods can be inferred by the reciprocal of stock's turnover. Whereas, the turnover for any stock is estimated as a ratio of number of stocks traded (volume) for some day *j* in any month *i* over total number of stocks outstanding at the end of month *i*. This daily ratio is calculated for each firm as under and then it is summed up within each month for all stocks. Resultantly the

$$Turnover_{i,t} = \frac{\sum_{j=1}^{n} Vol_{i,j}}{SO_{i,t}} \tag{5}$$

total turnover for whole universe of stocks is simply the average of monthly turnovers across all the stocks.

5. HL Spread.

Corwin and Schultz (2011) estimated the bid-ask spread from daily high and low prices of the stocks. The basic idea is that a ratio between daily high and low price can be decomposed into stock's variance and bid-ask spread. Whereas, former depends upon the return interval

[5] Lesmond et al. (1999), Hasbrouck (2009), Corwin and Schultz (2011) proposed new measures of illiquidity and show the effectiveness of their constructed measure made comparison with proxy measure of effective spread proposed by Roll (1984).

[6] In literature many converted those positive covariance to negative, for example, Harris (1990) and Lesmond et al. (1999). Doing the same in our case gives some counter intuitive results.

[7] Amihud and Mendelson (1986) proposed that in equilibrium the long term investors specialize in illiquid assets.

and later remains constant. Therefore the spread can be estimated as a function of high-low ratios over one-day and two-day interval[8] as under

$$S = \frac{2(e^{\alpha} - 1)}{1 + e^{\alpha}} \qquad (6)$$

Where $\alpha = \frac{\sqrt{2\beta} - \sqrt{\beta}}{3 - 2\sqrt{2}} - \sqrt{\frac{\gamma}{3 - 2\sqrt{2}}}$, and β is $E\left\{\sum_{j=0}^{1}\left[\ln\left(\frac{H_{t+j}^{0}}{L_{t+j}^{0}}\right)\right]^{2}\right\}$, which is sum of expected squared ratio of high and low observed prices ratio for consecutive two days. And lastly γ is $\left[\ln\left(\frac{H_{t,t+1}^{0}}{L_{t,t+1}^{0}}\right)\right]^{2}$ a squared ratio of observed high and low prices over the range of two days. There are number of conditions spelled out in Corwin and Schultz (2011) to estimate above spread given in equation (6) which have been incorporated[9]. To get the monthly spread for each firm in our sample we average the spread estimated from the all overlapping two-day periods within the month. Similarly the average spread for all of the stocks available in four markets is calculated by the taking the average of equation (6) across all firms.

In the following sections we analyze the performance of these measures. Especially how these measures are correlated across the countries to provide a rationale of studying the illiquidity related studies for four different markets. Above all, as we have estimated these measures in dollar denomination for keeping the consistency of the analysis across the countries, therefore it is of substance to check that these measures pass the indirect tests of being credible candidate of illiquidity suggested in the literature. Last but not the least, we also analyze which illiquidity measure among all estimated one is the best in terms of attainting the highest return spread between the most illiquid and liquid stocks.

3. Characteristics of illiquidity measures.

One requisite for clubbing all the stocks in four Nordic markets is the evidence, that illiquidity across these markets is similar. That is, we find among these countries greater

[8] The formal derivation of extracting the spread estimator from one-day to two-day ratios of high to low price ratio is discussed at length in Corwin and Schultz (2011).

[9] These conditions are discussed in Corwin and Schultz (2011) under the sections of *A. Adjustment for the Overnight Price Changes. B. True High and Low Prices are not Observed for Infrequently Traded Stocks. C. High-Low Spread Estimates May be Negative.*

commonality in liquidity[10]. In table 1, we have shown across the country correlation pattern for each measure of illiquidity for the sample from 1988:4 to 2012:4. Generally, the each measure is positively correlated and in particular the ZERO-I and ZERO-II are correlated the most. This correlation between the zero returns among the markets alludes that each country is having quite common trading patterns and associated trading cost. Table 1, also hints that those illiquidity measures which proxy for benchmark spread measures[11] at high frequency data, that is zero measure, Roll spread and HL spread are more correlated whereas, Amihud which proxy for price impact measure is not that correlated.

Table 1 Cross-sectional correlation among the illiquidity measures for the four Nordic markets.

In each month across all available stocks for some particular country six different measures of illiquidity are estimated. Then the cross-sectional correlation among all countries are calculated for the monthly time series of the period of 1988:4 to 2014:4 for each illiquidity measure e.g. under Amihud, the cross-sectional correlation among four countries are estimated for each country's respective measure of Amihud and similarly correlations are calculated for other measures of illiquidity as well. Amihud measure gauges on average monthly impact of one dollar traded volume upon absolute returns. In Amihud-15 we adopted qualification criteria and estimated the illiquidity of only those stocks which are traded for at least 15 days in any month. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in $/local exchange rate, over the total days to trade in a month. ZERO-II is ratio of incidences zero return in local currency to the total number of trading days available in any month. Roll spread is an autocorrelation between daily changes in prices for any firm within each month and it is estimated as $S = 2\sqrt{-Cov(\Delta P_t, \Delta P_{t-1})}$. Turnover is a monthly sum of daily ratio of equity value traded and number of shares outstanding for each firm. Lastly the HL spread is average of the high-low spread estimator across all overlapping two-day periods within the month. All the estimated measures are equally weighted.

Cross-correlation								
	Amihud				**Amihud-15**			
	Denmark	Finland	Norway	Sweden	Denmark	Finland	Norway	Sweden
Denmark	1.000	0.164	0.232	0.185	1.000	0.169	0.614	0.602
Finland	0.164	1.000	0.101	0.276	0.169	1.000	0.205	0.149
Norway	0.232	0.101	1.000	0.201	0.614	0.205	1.000	0.693
Sweden	0.185	0.276	0.201	1.000	0.602	0.149	0.693	1.000
	ZERO-I				**ZERO-II**			
	Denmark	Finland	Norway	Sweden	Denmark	Finland	Norway	Sweden
Denmark	1.000	0.675	0.686	0.573	1.000	0.824	0.838	0.555
Finland	0.675	1.000	0.639	0.508	0.824	1.000	0.782	0.745
Norway	0.686	0.639	1.000	0.511	0.838	0.782	1.000	0.581
Sweden	0.573	0.508	0.511	1.000	0.555	0.745	0.581	1.000
	Roll Spread				**HL Spread**			
	Denmark	Finland	Norway	Sweden	Denmark	Finland	Norway	Sweden
Denmark	1.000	0.374	0.705	0.737	1.000	0.483	0.545	0.636
Finland	0.374	1.000	0.325	0.345	0.483	1.000	0.598	0.515
Norway	0.705	0.325	1.000	0.648	0.545	0.598	1.000	0.736
Sweden	0.737	0.345	0.648	1.000	0.636	0.515	0.736	1.000

[10] Evidence of commonality in liquidity is first provided by Chordia et al. (2000) for the stocks within the U.S market, across country evidence is provided by Karolyi et al. (2007) and others.
[11] Goyenko et al. (2009) analyzed proxy measures of illiquidity using low frequency data and tested which ones are more correlated with their benchmark measures of spread and price impact measure when estimated using high-frequency data.

In Fig.1, we plot simple graphs for each measure of illiquidity estimated across all stocks for four markets in Nordic region. A representation that these markets have become liquid over time can be seen through ZERO-II, which is a monthly incidence of zero returns in all four

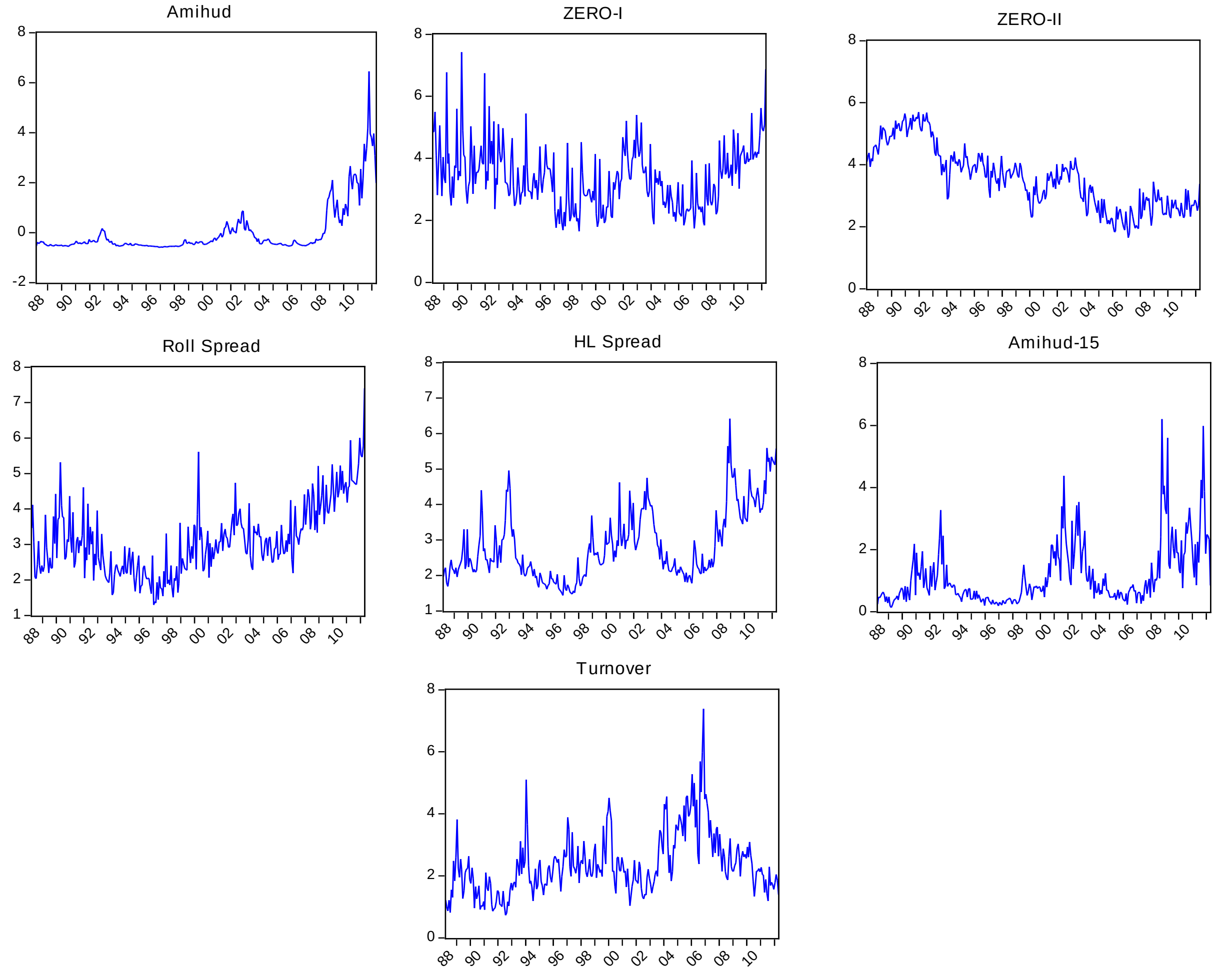

Figure 1. Evolution of different il-liquidity measure for the stocks listed in four Nordic markets: Amihud measure gauges on average monthly impact of one dollar traded volume upon absolute returns. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in $/local exchange rate, over the total days to trade in a month. ZERO-II is ratio of incidences of zero return in local currency to the total number of trading days available in any month. Roll spread is an autocorrelation between daily changes in prices for any firm within each month and it is estimated as $S = 2\sqrt{-Cov(\Delta P_t, \Delta P_{t-1})}$. The HL spread is average of the high-low spread estimator across all overlapping two-day periods within the month. In Amihud-15 we adopted qualification criteria and estimated the illiquidity of only those stocks which are traded for at least 15 days in any month. Lastly Turnover is a monthly sum of daily ratio of equity value traded and number of shares outstanding for each firm. All the estimated measures are equally weighted. The above plots are drawn for the sample of 1988:4 to 2012:4. The y-labels are almost similar for different measures for the reason that these measures have been standardized.

markets. There is an obvious trend of decrease in zero returns, which indicate that trading activity across all these markets has increased over time. As already hinted at Table 1, that ZERO-II measure is the most highly correlated among all four markets, thus it is plausible to assume that tradability has increased for all four markets over the time, possibility due to decrease in trading cost. There are some common movements among some illiquidity measures for instant, HL spread and Amihud-15 have quite adjacent ebbs and flows[12]. Further, Amihud (unrestricted), ZERO-I, Roll spread and turnover behave quite similarly by the end of 2006 till end of the sample, a period acquainted with financial crises. The first three measures of illiquidity are increasing whereas, turnover which measures liquidity is decreasing after sudden increase by the end of 2006[13]. Generally, Fig.1 gives the impression that the different measures of il-liquidity have much in common[14] even though these have been estimated using different methodologies.

Table 2 Correlation among il-liquidity measures

Each measure of il-liquidity is measured as an average across the all stocks listed in four Nordic markets from 1988:4 to 2012:4. Then we estimated the correlation among these measures for the total sample. As each market has its own currency, therefore to keep consistency we used dollar dominated series. Amihud measure gauges on average monthly impact of one dollar traded volume upon absolute returns. In Amihud-15 we adopted qualification criteria and estimated the illiquidity of only those stocks which are traded for at least 15 days in any month. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in $/local exchange rate, over the total days to trade in a month. ZERO-II is ratio of incidences of zero return in local currency to the total number of trading days available in any month. Roll spread is an autocorrelation between daily changes in prices for any firm within each month and it is estimated as $S = 2\sqrt{-Cov(\Delta P_t, \Delta P_{t-1})}$. Turnover is a monthly sum of daily ratio of equity value traded and number of shares outstanding for each firm. Lastly the HL spread is average of the high-low spread estimator across all overlapping two-day periods within the month. All the estimated measures are equally weighted.

	Amihud	Amihud-15	ZERO-I	ZERO-II	Roll Spread	Turnover	HL Spread
Amihud	1.000	0.711	0.361	-0.304	0.666	-0.188	0.769
Amihud-15	0.711	1.000	0.181	-0.187	0.466	-0.231	0.777
ZERO-1	0.361	0.181	1.000	0.393	0.606	-0.456	0.420
ZERO-II	-0.304	-0.187	0.393	1.000	-0.225	-0.668	-0.163
Roll Spread	0.666	0.466	0.606	-0.225	1.000	-0.141	0.726
Turnover	-0.188	-0.231	-0.456	-0.668	-0.141	1.000	-0.235
HL Spread	0.769	0.777	0.420	-0.163	0.726	-0.235	1.000

This can be further exemplified in Table 2, in which correlation pattern among il-liquidities measures is shown. Amihud measure the unrestricted one and Amihud-15 both have similar patterns and mostly positively related with other measures of illiquidity and negatively related with turnover as expected. Especially these measures are highly correlated with HL spread .ZERO-II measure which is incidences of zero returns in local currency have some counterintuitive correlation pattern with most of other measures, it is only positively related with ZERO-I and negatively related with turnover as should be the case. To, summarize the whole correlation structure presented in Table 2, all measures of il-liquidity are related with

[12] Corwin and Schultz (2011), using Amihud (2002) proposed measure of illiquidity concludes that HL spread and Amihud measure both have same asset pricing implication for the U.S market

[13] This is one of the reported drawbacks of turnover as a measure of liquidity, as it generally increases when market becomes suddenly illiquid and investors liquidate their positions.

[14] As pointed out in Korajczyk and Sadka (2008) that different measure of liquidities actually capture different facets of the same concept of illiquidity, and thus are correlated.

each other whereas, ZERO-I measure and average turnover have the most appropriate signs throughout.

Lastly it is of some interest to see if these estimated measures intrinsically estimate the transaction cost of trading stocks. Unfortunately, the direct test is not possible which require detailed trade level data at high frequency. However, literature has proposed some indirect test, that is, size is proxy measure for transaction cost[15]. As the small stocks have higher transaction cost and vice versa. This can also be tested, for that we apportion all the stocks in each month for all four markets into five quintiles. Each quintile is increasing in size hence, we expect the illiquidity (liquidity) measures to decrease (increase) as size increases. Table 3, establishes this as all illiquidity measures are uniformly decreasing as size of the firms increases, though turnover measuring liquidity does not take expected direction.

Table 3 Size factor and transaction cost.

The results are based upon monthly il-liquidity measures estimated for the stocks belonging to a particular size quintile for four Nordic markets for the period of 1988:4 to 2012:4. Each size quintile increases in order, with each succeeding one having 20% of firms with higher capitalization than preceding one, making first quintile comprised of the lowest 20% capitalized firms and fifth quintile as composed of top 20% capitalized firms . Amihud measure gauges on average monthly impact of one dollar traded volume upon absolute returns. In Amihud-15 we adopted qualification criteria and estimated the illiquidity of only those stocks which are traded for at least 15 days in any month. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in \$/local exchange rate, over the total days to trade in a month. ZERO-II is ratio of incidences of zero return in local currency to the total number of trading days available in any month. Roll spread is an autocorrelation between daily changes in prices for any firm within each month and it is estimated as $S = 2\sqrt{-Cov(\Delta P_t, \Delta P_{t-1})}$. Turnover is a monthly sum of daily ratio of equity value traded and number of shares outstanding for each firm. Lastly the HL spread is average of the high-low spread estimator across all overlapping two-day periods within the month. All the estimated measures are equally weighted.

	Amihud	Amihud-15	ZERO-I	ZERO-II	Roll Spread	Turnover	HL Spread
S-1	3.08%	1.54%	26.73%	67.04%	15.73%	4.12%	5.42%
S-2	0.63%	0.38%	15.68%	53.11%	7.46%	3.70%	2.81%
S-3	0.24%	0.15%	12.09%	41.32%	6.06%	3.73%	2.03%
S-4	0.11%	0.09%	8.77%	30.24%	6.35%	3.69%	1.56%
S-5	0.02%	0.02%	5.90%	17.42%	6.20%	5.51%	1.20%

This section concludes number of stylized facts for the four Nordic markets. Firstly, these markets have similar illiquidity related attributes and thus studying a role of illiquidity for a cross-section of combined stocks is reasonable choice. Secondly a newly proposed proxy measure of illiquidity ZERO-I is correlated with other more commonly used measures of illiquidity in literature and also is inversely related with the market capitalization of the

[15] This evidence is based on the studies of Demsetz (1968), Roll (1984), Lesmond et al. (1999) and many others.

stocks. Both of these attributes establish that ZERO-I in an appropriate candidate of transaction cost for the stocks used in this study.

In next sections we construct a measure of market-wide illiquidity risk using ZERO-I and ZERO-II and analyze its pricing implication for the returns of portfolios used in this paper.

4. Illiquidity Risk.

In most of the studies a single measure of il-liquidity is used to establish the link between returns and illiquidity risk. Though generally there is commonality among all illiquidity measures, but it may be the case that some illiquidity measures are better proxy for transaction cost in comparison to others. Unfortunately, there is no direct guide-line available to which one is to use. Therefore, Korajczyk and Sadka (2008) motivated a use of global liquidity factor which is extracted from a group of illiquidity measures proposed in literature by using factor decomposition technique. We instead of finding that common factor among all estimated measures use a conjecture that, the best illiquidity measure is, which creates the maximum return spread between the most illiquid and liquid portfolios. That is, the theoretical proposition that illiquid (liquid) stock should give the higher (lower) returns is actually met the best by which one the candidate proxy measures.

In Table 4, we calculated the return spread between the most illiquid and liquid portfolios for each market individually, and then for whole stocks taken together as they are traded in one single market. As a procedure we estimate the next month return of the stock on the basis of its previous month respective measure of illiquidity and in total all stock returns are apportioned into five quintile portfolios. Such that each succeeding quintile (portfolio) is increasing in its respective measure of illiquidity. Finally the yearly return differential between the most illiquid and liquid quintiles associated with some measure of illiquidity for each country and for all markets in shown in Table 4.

With Amihud, unrestricted measure there is generally positive return spread associated with each market and overall, but these differential are considerably small. However, its performance compared to Amihud-15 is better, which includes only those stocks which are at least traded for 15 days. The negative return differentials associated with Amihud-15 is may be due to non-inclusion of illiquid stocks. The most recently proposed measure, the HL spread has also dismal performance and much akin to Amihud-15, indeed these two measures are highly correlated as per table 2. The Roll spread has only positive return spread for

Norway among all countries. The positive return spread for all markets is may be due the reason that in 5th quintile, the most of illiquid stocks from Norway are hoarded. There are some better results from ZERO-II, that is, considerable return differential for Finland and Sweden. However by far the best results are achieved with ZERO-I measure, as for all of the markets there is two digits return differential between the stocks with least and the most zero returns .Above all this return spread for each market individually and for all markets taken together is quite uniform. Thus ZERO-I is a quite representative measure of illiquidity for all of these markets. This confirms that the newly estimated measure of illiquidity is an improvement upon other measure of illiquidity. The second best measure of illiquidity is ZERO-II, whereas, the main difference with ZERO-I is that later measure take into account the length of non-trading intervals.

Table 4 Return dispersion between extreme portfolios.

This table reports the yearly returns dispersion between the 20% of the most illiquid and liquid stocks. Firstly this dispersion in returns is shown for each country separately and then for all stocks taken together. Further the respective illiquidity measure used for estimating such dispersion in returns is also shown. As a procedure the returns in each month for all stocks listed in the respective equity market and for all market taken together are predicted on the basis of previous month's illiquidity and sorted into five portfolios. Such that each succeeding portfolio is increasing in illiquidity and hoarding 20% of more illiquid stocks. Then the difference between the average monthly return on the most illiquid portfolio and liquid is calculated and annualized. The Sample spans from 1988:4 to 2012:4, and returns shown are equally weighted. Amihud measure gauges on average monthly impact of one dollar traded volume upon absolute returns. In Amihud-15 we adopted qualification criteria and estimated the illiquidity of only those stocks which are traded for at least 15 days in any month. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in $/local exchange rate, over the total days to trade in a month. ZERO-II is ratio of incidences of zero return in local currency to the total number of trading days available in any month. Roll spread is an autocorrelation between daily changes in prices for any firm within each month and it is estimated as $S = 2\sqrt{-Cov(\Delta P_t, \Delta P_{t-1})}$. Lastly the HL spread is average of the high-low spread estimator across all overlapping two-day periods within the month.

	Denmark	Finland	Norway	Sweden	All Markets
Amihud	2.49%	3.16%	4.22%	2.08%	0.80%
Amihud-15	-10.75%	-16.44%	-3.68%	-7.29%	-10.13%
ZERO-I	14.71%	18.88%	12.56%	20.89%	18.59%
ZERO-II	3.60%	8.99%	0.91%	8.80%	2.97%
Roll Spread	-0.28%	-5.43%	10.67%	-1.48%	8.67%
HL Spread	-0.74%	-1.50%	1.70%	-1.34%	0.51%

4.1 Illiquidity factor.

To study the implication of illiquidity risk for asset pricing in the context of four Nordic markets we use ZERO-I and II as our main illiquidity measures. Therefore we use equation (2) and (3) to estimate the both measures, for each stock and then average the available stocks illiquidities within each month to construct a market-wide illiquidity measure. We tested as spelled out in Amihud (2002)[16], that the level of market illiquidity predicts higher positive returns and shocks to market illiquidity depresses the contemporary returns, and both of these effects are stronger for illiquid stocks. To accumulate the series of unexpected illiquidity shocks we estimated the following ARMA model.

$$L_t^i = c + \sum_{i=1}^{p} \Phi_i L_{t-i}^i + \sum_{i=1}^{q} \Theta_i \varepsilon_{t-i}^i + \varepsilon_t^i \qquad (7)$$

We fit AR (2) model on both of market-illiquidity series constructed with ZERO-I and II, as with it we find the highest R^2 value for the model and it leaves the shocks unpredictable. Many studies[17] exemplify the rationale of using series of innovation than predicable series for asset pricing tests. We used both, the level of market illiquidity at previous lag and unexpected shocks to market-wide illiquidity as the separate illiquidity risk factors.

In addition to above we also construct illiquidity factor which is similar to *SML* and *HML* factors of Fama and French (1993) and momentum factor of Carhart (1997). This way we can break an intricate relationship between size and illiquidity. For that in each month we partition the whole universe of stocks into two equal halves, one containing small firms (S) and other big firms (B). Then on the basis of ZERO-I measure we partitioned the whole stocks in three portfolios increasing in their illiquidity, first one containing 30% of stocks L (liquid),second one containing the 40% of the stocks M(medium liquid), and the last one containing the 30% of the most illiquid stocks IL(illiquid). Further like FF (1993), an intersection of all small firms across all three illiquidity related portfolios is taken and three portfolios SL, SM and SIL are constructed. Similarly the same procedure is repeated for the big firms and three portfolios BL, BM, and BIL are constructed. This mechanism keeps size constant and allows analyzing if returns are increasing in line with increasing illiquidity, and if returns do increase, then it provides credence that illiquidity effect is independent of size factor. This is indeed the case, the yearly returns for SL, SM and SIL within small firms are 5.75%, 12.33% and 26.79%. Whereas for the big firms these yearly returns for BL, BM, and

[16] Generally known as Amihud (2002) illiquidity related hypotheses which have been tested for 19 emerging markets by Bekaert et al. (2007). Somewhat similar hypothesis are also tested in Acharya and Pedersen (2005) with more economic intuition of pricing of illiquidity effect.

[17] Sadka (2005) used innovation in constructed series of market illiquidity for the U.S market (see also Chen, Roll, and Ross (1986))

BIL are 10.70%, 16.74% and 17.90%[18]. The zero investment based monthly strategy of being long in the most illiquid portfolios (SIL and BIL, equally weighted) with same amount, and being short in the most liquid portfolios (SL and BL, equally weighted), also with same amount yields economically considerable returns, which are equivalent to 14.11%[19] on average at annual basis with a *t-statistics* of 6.71. The liquidity factor (LFAC onwards) thus constructed has almost same return as of market portfolio. Another study that specifically used mimicking liquidity factor on lines of FF (1993) and Carhart (1997) is Liu (2006). In that study[20] for the U.S market yearly return differentials of zero based investment strategy between the most illiquid and liquid equally weighted portfolio is 8.99% with *t-statistics* of 4.56.

As a whole we constructed the illiquidity risk in three ways to gauge its impact over returns. Firstly we test that if the level of market illiquidity predicts future returns[21], secondly how unexpected shocks to market illiquidity affects the returns[22] and lastly if LFAC[23] as a return on zero investment strategy is priced market-wide liquidity risk.

4.2 Portfolio construction.

In total three sets of ten portfolios constructed each using the entire sample of available stocks from 1998:4 to 2012:4. The first two sets are based on size and price inverse ratio related information[24]. The whole stocks related data for this exercise has been downloaded from DATASTREAM. The data in each month m – 1 for the size (market capitalization) of the firm is recorded and on the basis of it the return in the month m is predicted and allotted to ten portfolios, each increasing in the size, that is each succeeding decile is having 10% of higher sized firms. To, keep the consistency among four markets with different currencies, excess returns are dominated in $ dollar. Then to estimate the expected monthly illiquidity of these sized based portfolios the monthly incidences of zero returns as qualified through

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[18] By reversing the pattern and seeing if return increases as size increases, while keeping the illiquidity constant, we find no such monotonicity in returns.

[19] While using Zero-II measure there was no zero based investment strategy return spread.

[20] The mimicking liquidity factor in Liu (2006) does not separate the size effect from the liquidity.

[21] Amihud (2002) and Bakerat et al. (2007) tested the effect of market level of illiquidity upon return for the U.S and emerging markets respectively.

[22] Considerable studies tested the link between unexpected shocks to market-wide illiquidity with returns (see Amihud (2002), Acharya and Pedersen (2005), Bakerat et al. (2007) , Pastor and Stambauch (2003), Korajczyk and Sadka (2008), Sadka (2005) and others).

[23] Liu (2006) use the mimicking liquidity factor for the U.S market

[24] Both of this stock related information has been used extensively in literature for illiquidity related studies. (see Amihud (2002), Acharya and Pedersen (2005), and others).

ZERO-I measure is estimated. Both the monthly excess returns and expected illiquidity (ZERO-I) is shown in Table 5. In addition to Size factor, the monthly excess returns of the stocks in month m are also sorted on the basis of at the end of month m - 1 value of the reciprocal of their respective prices. These excess returns are partitioned into ten portfolios with each higher portfolio increasing in price inverse ratio. Similarly, the monthly series for excess return and expected illiquidity (ZERO-I) for price inverse based portfolios are also accumulated and shown in Table 5. Last set of ten portfolios are based on momentum factor[25], the momentum is calculated for the previous 12 months cumulative returns (excluding the last month return) and on the basis of the previous year performance the next month return on

Table 5 Portfolios returns and illiquidity related characteristic

This table provides the monthly excess returns on the size, price inverse and momentum related ten portfolios constituted from the stocks enlisted in four Nordic countries Denmark, Finland, Norway and Sweden along with monthly estimates of illiquidity captured by ZERO-I for the period of 1988:4 to 2012:4. To construct size related portfolios, the size is taken as the end of month market capitalization of any stock, and on the basis of it the next month's return of each stock is predicted and allotted to 10 portfolios each increasing in the size. Same procedure is repeated for price inverse related portfolios and returns are partitioned into 10 portfolios each increasing in its respective price-inverse ratio. Lastly Momentum is calculated for the previous 12 months cumulative returns (excluding the last month return) and on the basis of previous year performance the next month return on the stocks are predicted and allotted to 10 portfolios, varying monotonically on previous year performance. For all portfolios the returns are excess of risk free rate and are equally weighted. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in $/local exchange rate, over the total days to trade in a month. Excess returns and ZERO-I both are equally weighted.

Portfolio Ranking	Size		Price Inverse		Momentum	
	Excess return	ZERO-I	Excess return	ZERO-I	Excess return	ZERO-I
1	2.46 %	32.01 %	0.07 %	2.56 %	1.43 %	14.60 %
2	0.74 %	21.87 %	0.41 %	3.16 %	0.68 %	12.72 %
3	0.71 %	16.05 %	0.44 %	4.18 %	0.61 %	12.35 %
4	0.60 %	15.31 %	0.58 %	5.40 %	0.55 %	11.89 %
5	0.58 %	12.95 %	0.78 %	6.72 %	0.53 %	11.99 %
6	0.76 %	11.22 %	0.94 %	8.83 %	0.75 %	11.69 %
7	0.88 %	9.68 %	0.89 %	11.73 %	0.84 %	12.37 %
8	0.93 %	7.86 %	0.96 %	17.10 %	0.93 %	13.17 %
9	0.82 %	5.72 %	1.59 %	27.16 %	1.05 %	15.10 %
10	0.94 %	6.07 %	2.83 %	52.87 %	1.73 %	21.10 %

the stocks are predicted and allotted to 10 portfolios, which are varying monotonically on previous year performance. For momentum portfolios as well, their monthly expected illiquidity (ZERO-I) is also gathered and results are shown in Table 5.

[25] Many studies have spelled out a rational of using non illiquidity based characteristic to construct portfolios to test that if illiquidity is market-wide characteristics then it matter for the returns related with characteristics other than illiquidity. There are studies which supported this conjecture (Korajczyk and Sadka (2008), Lesmond et al. (2004), Sadka (2005), and others)

In Table 5, the expected illiquidity measured by ZERO-I is monotonically increasing for size and price inverse portfolios which alludes that these portfolios are related with illiquidity. On the contrary, the momentum portfolios do not show such pattern and no monotonicity is observed in ZERO-I measure. Secondly we expect that excess returns on the extreme portfolios should be different to pose a challenge for an asset pricing model to explain this differential. This is very much the case with illiquidity related portfolios, for example, the return differential between the first decile of size portfolio (small stocks) and tenth decile (large stocks) is 18.14% annually with the illiquidity is quite higher for the former portfolio. Similarly for the price inverse portfolios this return differential is 33.14%, with illiquidity is even higher for the highest price inverse portfolio in comparison to the most capitalized portfolio. For momentum portfolios neither return differential nor difference in illiquidity measure between the loser and winner are economically significant.

5. Illiquidity and Asset Pricing.

In this section we study how illiquidity risk affects the expected returns on the testing portfolios constructed in the previous section. For that, we use cross-sectional regression in line with the methodology proposed by the Black, Jensen and Scholes[26] (1972) and estimated a following asset pricing model.

$$E(R_i) = \alpha_0 + \lambda\beta_i \tag{8}$$

The left hand side of above equation $E(R_i)$ is expected excess return on our testing portfolios. We include α_0 to see how big are the pricing errors for all model tested, we expect it to be near zero (since excess returns are used in this analysis) such as only pricing factor used is an appropriate measure of risk. The β_i is a vector of factor loadings[27] depending upon model. Importantly λ is vector of risk premium, for a pricing factor to be priced it should be significantly different than zero. In equation (8) a measure of risk β_i is not an observed characteristic and therefore has to be pre-estimated as under.

$$R_i = \beta_{0,i} + \beta_i f_t + \varepsilon_{i,t} \tag{9}$$

[26] Our results are maintained with the methodology proposed by Fama and MacBeth (1973) and point estimates associated with different illiquidity risk even give better fits, but estimated imprecisely, if the whole system is estimated using GMM framework.

[27] Factor loading is simply a covariance between asset returns and a pricing factor overtime scaled by the variance of the factor itself.

This method is also commonly adhered as two-pass methodology. The equation (9) is the first pass in which time series analyses are conducted using the whole sample, and β_i on some factor is estimated. And then in the second pass a cross-sectional regression as given in equation (8) is estimated assuming that these time series betas are true measure of the risk. However, estimated betas differ from their true betas by estimation error. Higher is this estimation error worse is error-in-variable problem[28]. One remedy that existing literature propose is to use portfolios instead of individual stocks and second is proposed by Shanken (1992). To, incorporate both, we therefore use portfolios in this study and in addition also correct the standard errors of estimated risk premia to reasonably evaluate the statistical significance. Then to evaluate the performance of each model tested we report its adjusted R^2 using equation (8) by implying factor loadings estimated through equation (9). This generally tells how much of return dynamics are statistically explained, naturally when regression errors are the least the model R^2 tends to be higher. However, this high value alone without meaningful intercept can be misleading.

5.1 Time series properties of factor loadings.

In Table 6, the properties of some interesting factor loadings of the tested models are shown for size and price inverse ratio based portfolios. In panel A, for the size portfolios, the MKT is loadings on market factor, which are statistically significant for each portfolio. However, these loadings are almost same for the 1st and 10th extremely different capitalized portfolios, for which there is an obvious return differential as shown in Table 5. Similarly in panel B, for price inverse portfolios, these market factor loadings do not have much dispersion as can be seen for excess returns for extreme portfolios. This hints that CAPM predict either illiquid portfolio less riskier or liquid portfolio generally more risky. On the other hand we anticipate using illiquidity risk as a factor may bring out the higher risk inherent in illiquid stocks when compared to liquid stocks.

In the Table 6, panel A, second column the LFAC, is the factor loadings on the illiquidity factor. The highest factor loading both economically and statistically is for the smallest size portfolios. Afterwards, these factor loadings start to decrease till the most capitalized portfolio, and for it the loading is statistically insignificant as well. In panel B, for the price inverse portfolios, the same trend can be traced. At least for five first price inverse portfolios,

[28] See Fama (1976), chap.9, for a detailed discussion of error in variable problem and for general issues relating to cross-section regression analysis.

which are generally liquid and have high prices, the factor loading are not that statistically significant. This also bestows upon an impression that liquid portfolios, which are either highly capitalized stocks, or the stocks with high prices are generally hedged well against illiquidity related risk.

Table 6 Market and illiquidity related loading for size and price inverse portfolios.

This table reports the loadings of size and price inverse portfolios with equally weighted returns on the market and other illiquidity related traded and non-traded factors. The loading are estimated for the period comprising of 1988:4 to 2012:4 and *t*-statistics are reported in parentheses. In panel A, ten size portfolios are shown, each succeeding portfolio comprises of 10% higher capitalized stocks, whereas, in panel B, ten price inverse portfolios are shown, and each succeeding portfolio has stocks with 10% higher price inverse ratio. Both of these portfolios are constructed using the stocks available in four markets namely, Denmark, Finland, Norway and Sweden. MKT and LFAC are the excess return on market and illiquidity related portfolios. Excess return on later portfolio is independent of size factor. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in $/local exchange rate, over the total days to trade in a month. SZERO-II is monthly shocks of the AR (2) model for the series of zero returns over total days available to trade within any month across the four equity markets in Nordic region, when returns are seem in local currency.

Panel A: Size Portfolios					Panel B: Price Inverse Portfolios				
Portfolios	MKT	LFAC	ZERO-I	SZERO-II	Portfolios	MKT	LFAC	ZERO-I	SZERO-II
S-1	1.080 (17.844)	1.055 (6.643)	0.503 (4.105)	-0.391 (-3.201)	P-1	0.824 (29.717)	-0.127 (-1.173)	0.208 (2.628)	0.003 (0.039)
S-2	0.879 (30.731)	0.4653 (4.170)	0.219 (2.603)	-0.160 (-1.925)	P-2	0.849 (35.962)	-0.464 (-0.432)	0.189 (2.413)	0.027 (0.349)
S-3	0.9456 (39.273)	0.350 (3.013)	0.201 (2.319)	-0.139 (-1.614)	P-3	0.887 (40.401)	0.049 (0.451)	0.152 (1.884)	-0.019 (-0.238)
S-4	0.962 (45.272)	0.423 (3.676)	0.203 (2.356)	-0.101 (-1.176)	P-4	0.931 (45.974)	0.131 (1.159)	0.109 (1.304)	0.066 (0.797)
S-5	0.953 (48.666)	0.308 (2.700)	0.162 (1.908)	-0.070 (-0.832)	P-5	1.012 (42.983)	0.150 (1.208)	0.175 (1.922)	0.039 (0.434)
S-6	1.030 (53.737)	0.328 (2.680)	0.224 (2.470)	-0.043 (-0.472)	P-6	0.996 (43.999)	0.356 (2.953)	0.173 (1.938)	-0.021 (-0.229)
S-7	1.051 (51.353)	0.277 (2.120)	0.176 (1.883)	-0.0154 (-0.165)	P-7	1.039 (49.369)	0.446 (3.619)	0.189 (2.055)	-0.033 (-0.363)
S-8	1.068 (45.360)	0.310 (2.401)	0.207 (2.162)	0.037 (0.384)	P-8	1.091 (42.493)	0.644 (4.989)	0.257 (2.626)	-0.147 (-1.495)
S-9	1.026 (38.151)	0.238 (1.862)	0.188 (1.988)	0.118 (1.257)	P-9	1.159 (38.909)	0.802 (5.861)	0.279 (2.653)	-0.136 (-1.286)
S-10	1.000 (32.519)	0.063 (0.485)	0.094 (0.988)	0.169 (1.796)	P-10	1.214 (22.543)	1.456 (9.627)	0.442 (3.521)	-0.395 (-3.152)

We also trace this illiquidity risk through ZERO-I measure which is also a main driver behind LFAC. For both portfolios the factor loadings are almost the same as with LFAC, however for price inverse portfolios, the factor loading for the 10th portfolio is not that high. In addition of these factors we also use SZERO-II, which is the series of monthly shocks, to ZERO-II accumulated using equation (7). An ample literature suggests that these illiquidity shocks which suddenly increase market-wide illiquidity, depress contemporaneously returns significantly for the illiquid stocks. In Table 6, it is obvious that most of the illiquid portfolios, for instant S-1 and P-10, have their returns negatively related with suddenly changing market illiquidity, opposite pattern to this can be seen for S-10 and P-1 which are liquid portfolios.

5.2 Cross-sectional analysis.

The asset pricing tests are conducted using equation (8) with market risk and different illiquidity related risks, which are estimated using equation (9). For these models to be successful it requires that all factor loadings on the right side of equation explain the returns on the left hand side. In Table 7, the performance of different models has been tested for the illiquidity related portfolios. In panel A, for the size based portfolios the first line is for CAPM model. Here we have economically and statistically significant intercept which indicates the failure of model, as we have used excess returns for our testing portfolios hence we expect pricing errors around zero. In the second line the LFAC is used. The model is accepted as it has insignificant pricing errors and high R^2, in the presence of positively significant risk premium. We expect positive risk premium associated with LFAC as investors need to be compensated for bearing an excess exposure of market-wide liquidity risk upon the return structure of their assets. In line three of Table 6, we have tested the impact of illiquidity risk associated with ZERO-I measure, it differs with LFAC slightly as in later measure we have controlled for size factor. This model is so, far the best among all single factor model tested for the size related portfolios. It has the minimum intercept which is virtually zero and high R^2, this hints that market illiquidity at time t – 1 predicts the returns at time t positively. Alternatively it can be said that when at t - 1, there are high zero returns market-wide, then at time t the returns increases and vice-versa, further this effect is more pronounced for illiquid portfolios.

To, establish link between returns and illiquidity risk contemporaneously at time t the shocks to expected illiquidity are used. Therefore, we use SZERO-I, a series of shocks to ZERO-I, we expect that when at time t the market-wide zero returns suddenly increases then the returns are depressed and vice-versa, such that negative relationship between unexpected illiquidity and asset returns exist . This effect is also expected to be stronger for the illiquid stocks. In line four we do see negative risk premium[29] associated with SZERO-I. However, neither the pricing errors are insignificant nor we have high R^2. As, a robustness check we also estimate in line five the model in which illiquidity risk is gauged by market-wide zero returns measured by ZERO-II. This way the illiquidity risk is not significantly linked with future returns as against ZERO-I measure which has adequately captured the return patterns.

[29] This negative premium is because as explained in Acharya and Pedersen (2005), that investors forego some return for those stocks whose return increases when market illiquidity suddenly increases, that is, for stocks which are better hedges for rising market illiquidity.

Table 7 Pricing illiquidity risk for illiquidity related test portfolios

This table provides the estimates related with market and different illiquidity related betas using cross-sectional regression for the period of 1988:4 to 2012:4. The cross-section of stocks is constituted of four Nordic countries Denmark, Finland, Norway and Sweden. The portfolios returns are equally weighted and they are rebalanced on monthly basis using end of the month's average market capitalization and inverse of price for each stock as sorting criteria. To estimate coefficients the different variants of following relation between excess returns and explanatory factors is used.

$$E(R_i) = \alpha_0 + \lambda\beta_i$$

Where R_i is excess return on some testing portfolio, and β_i is corresponding vector of factor loadings. These loadings are estimated using excess return of market portfolio (MKT), and different illiquidity related factors such as, LFAC, ZERO-I, SZERO-II, ZERO-II and SZERO-II. The LFAC is monthly excess return difference between the most illiquid and liquid portfolio across the size factor. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in $/local exchange rate, over the total days to trade in a month. SZERO-I is monthly shocks when accumulated by fitting AR (2) model on ZERO-I. Similarly ZERO-II and SZERO-II are counterparts of ZERO-I and SZERO-I when estimated in local currency. In panel A we estimate coefficients for 10 size related test portfolios and in panel B the same coefficients are estimated for price inverse portfolios. Whereas, size is taken as the end of month market capitalization of any stock, and on the basis of it the next month's return of each stock is predicted and price inverse simply the inverse of end of month price of any stock, and on the basis of it next month's returns are predicted for all the available stocks. .The size/price inverse ratio portfolios are increasing in their respective size /price inverse ratio. The *t*-statistics are reported in parenthesis below the estimate and these are corrected as per Shanken (1994). R^2 is shown in the last column of following table, and below it the adjusted R^2 is shown in parenthesis.

Panel A:Size Portfolios							
Intercept	MKT	LFAC	ZERO-I	SZERO-I	ZERO-II	SZERO-II	R^2
-0.0387	0.0482						0.3152
(-3.8034)	(4.4849)						(0.2297)
0.0028		0.0173					0.6802
(0.7273)		(2.8729)					(0.6402)
-0.0008			0.0472				0.7719
(-0.1848)			(2.9337)				(0.7433)
0.0123				-0,0207			0.2340
(3.3987)				(-1.8922)			(0.1383)
0.0153					0.2126		0.2949
(3.7412)					(0.7003)		(0.2068)
0.0081						-0.0212	0.3763
(2.3164)						(-2.3130)	(0.2983)
-0.0230	0.0325		0.0442				0.8360
(-2.0478)	(1.8552)		(2.2088)				(0.7891)

Panel B:Price Inverse Portfolios							
Intercept	MKT	LFAC	ZERO-I	SZERO-I	ZERO-II	SZERO-II	R^2
-0.0445	0.0540						0.8131
(-5.9158)	(4.9901)						(0.7898)
0.0034		0.0158					0.9480
(1.0626)		(4.1291)					(0.9415)
-0.0065			0.0737				0.7692
(-1.7812)			(3.7446)				(0.7404)
0.0180				-0.0615			0.5871
(4.4247)				(-3.6816)			(0.5355)
0.0185					0.3286		0.4698
(4.4359)					(0.9984)		(0.4035)
0.0062						-0.0524	0.8293
(1.8658)						(-4.5403)	(0.8080)
0.0109	-0.0014	0.0171					0.9502
(0.7269)	(-0.0792)	(3.8980)					(0.9359)

Table 8 Pricing illiquidity risk for momentum portfolios

This table provides the estimates related with market and different illiquidity related betas using cross-sectional regression for the period of 1988:4 to 2012:4. The cross-section of stocks is constituted of four Nordic countries Denmark, Finland, Norway and Sweden. Momentum is calculated for the previous 12 months cumulative returns (excluding the last month return) and on the basis of previous year performance the next month return on the stocks are predicted and allotted to 10 portfolios, varying monotonically on previous year performance, whereas the portfolios returns are equally weighted and rebalanced on monthly basis. To estimate coefficients the different variants of following relation between excess returns and explanatory factors is used.

$$E(R_i) = \alpha_0 + \lambda\beta_i$$

Where R_i is excess return on some testing portfolio, and β_i is corresponding vector of factor loadings. These loadings are estimated using excess return of market portfolio (MKT), and different Illiquidity related factors such as, LFAC, ZERO-I, SZERO-II, ZERO-II and SZERO-II. The LFAC is monthly excess return difference between the most illiquid and liquid portfolio across the size factor. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in $/local exchange rate, over the total days to trade in a month. SZERO-I is monthly shocks when accumulated by fitting AR (2) model on ZERO-I. Similarly ZERO-II and SZERO-II are counterparts of ZERO-I and SZERO-I when estimated in local currency. We estimate coefficients for 10 momentum related test portfolios. The *t*-statistics are reported in parenthesis below the estimate and these are corrected as per Shanken (1994). R^2 is shown in the last column of following table, and below it the adjusted R^2 is shown in parenthesis.

Momentum Portfolios							
Intercept	MKT	LFAC	ZERO-I	SZERO-I	ZERO-II	SZERO-II	R^2
-0.0069	0.0163						0.3361
(-0.7915)	(1.7049)						(0.2531)
0.0069		0.0052					0.1310
(2.0058)		(0.8764)					(0.0239)
0.0059			0.0141				0.1780
(1.5989)			(1.1441)				(0.0752)
0.0166				-0.0491			0.7834
(3.8905)				(-3.1904)			(0.7564)
0.0116					0.0853		0.2681
(1.5369)					(0.9173)		(0.1766)
0.0074						-0.0324	0.6375
(2.2528)						(-2.4332)	(0.5921)
0.0093	0.0003			-0.0431			0.8269
(0.7884)	(0.0138)			(-1.7330)			(0.7774)

Lastly, we use shocks to ZERO-II measure as illiquidity risk. Even though SZERO-II does not perform better than other illiquidity related models but it still have better pricing ability in comparison to CAPM, as economically lower pricing errors and slightly higher R^2 is observed. In the last line we tested two-factor model much in line with Liu (2006), the choice of illiquidity risk along with market factor is arbitrary, and we choose that model which performs the best. Even doing so, the explanatory power of two factor model is not better than alone factor ZERO-I.

In Panel B, the same models are tested for the price inverse related portfolios. In line one the CAPM still have economically high and statistically significant pricing errors. Even though this time R^2 is quite high, however in presence of significant pricing errors it should be interpreted cautiously[30]. In line two the LFAC still has positively significant risk premium,

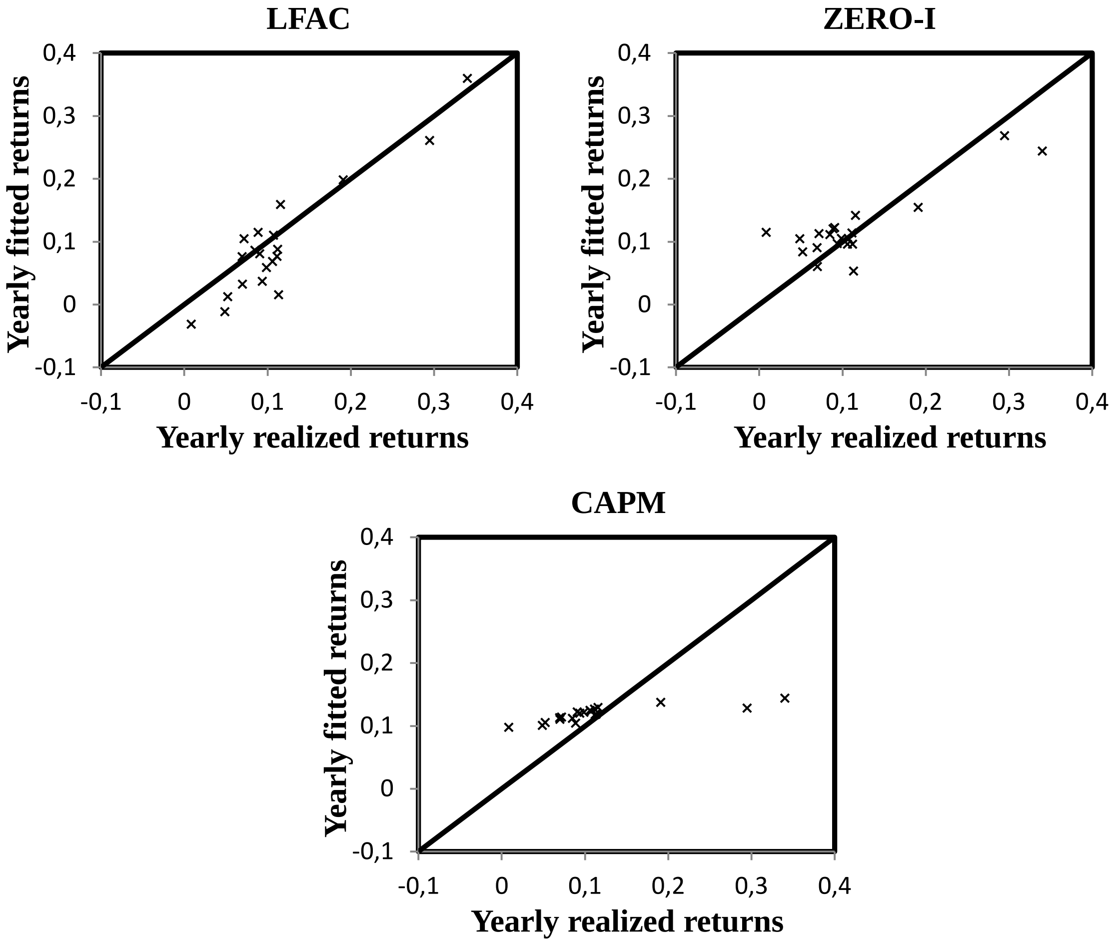

Figure 2. Illiquidity related portfolios and illiquidity risk: a cross-section of equally weighted returns for 20 size and price inverse based portfolios each is constructed for the stocks listed in four Nordic markets namely, Denmark, Finland, Norway and Sweden for the period of 1998:4 to 2012:4. The size is taken as the end of month market capitalization of any stock, and on the basis of it the next month's return of each stock is predicted. The price inverse measure is simply the inverse of end of month price of any stock, and on the basis of it next month's returns are predicted for all the available stocks. The size/price inverse ratio portfolios are increasing in their respective size /price inverse ratio. The illiquidity risk is measured as LFAC, which is monthly difference of excess return between the most illiquid and liquid portfolio across the size factor. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in $/local exchange rate, over the total days to trade in a month. Lastly the market factor is monthly average excess return across the all listed stocks. The above graph is between yearly predicted returns from each model versus the actual realized yearly returns.

and the highest R^2 along with the economically smallest pricing errors which are statistically insignificant, by far it performs the best among all models. ZERO-I also have positive and significant risk premium, however this time intercept is partially significant but still quite lower than market model. The more persistent performance of illiquidity factor LFAC in comparison to ZERO-I across the both portfolios is may be because the former factor is

[30] Lewellen et al.(2010), at length discuss that model R^2 is not only criteria for success of the model in the presence of unreasonable estimates zero-beta rates.

independent of the size factor. Therefore ZERO-I performed relatively better for the size based portfolios than for price inverse portfolios.

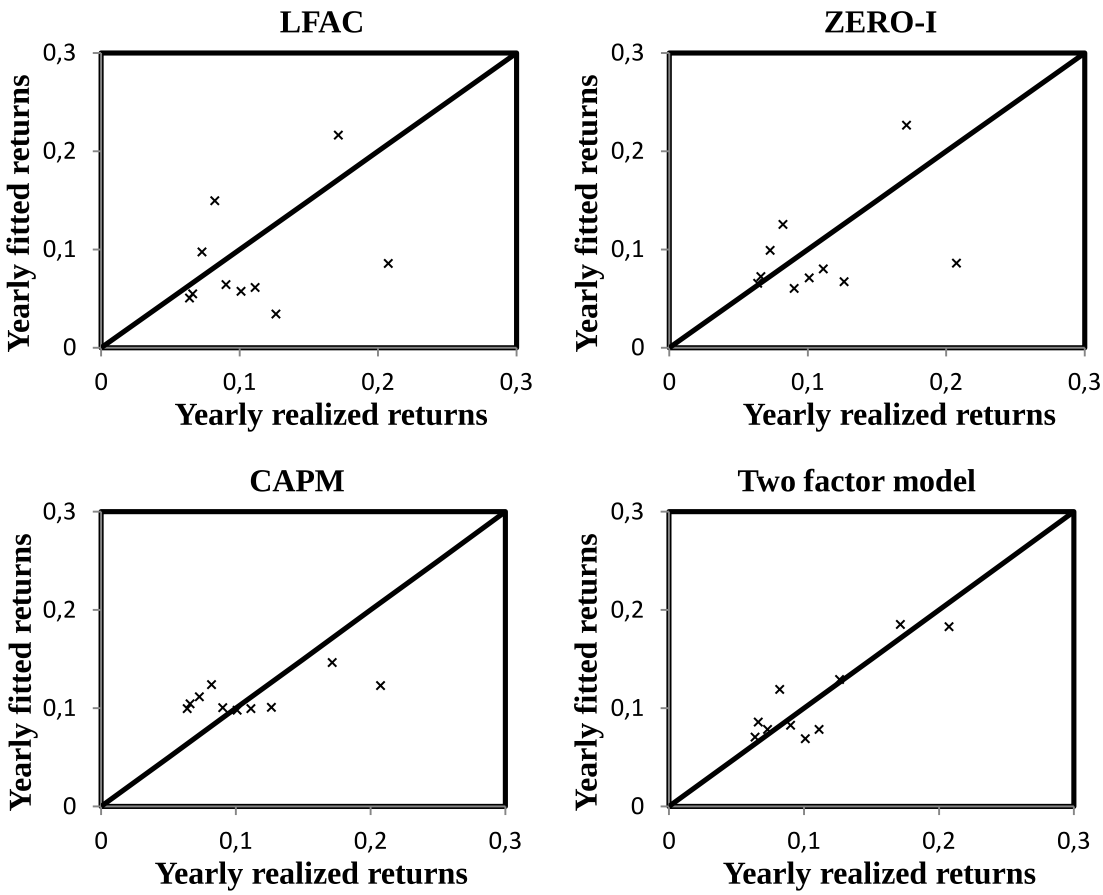

Figure 3. Momentum portfolios and illiquidity risk: a cross-section of return of 10 Momentum portfolios is constructed for the stocks listed in four Nordic markets namely, Denmark, Finland, Norway and Sweden for the period of 1998:4 to 2012:4. Momentum is calculated for the previous 12 months cumulative returns (excluding the last month return) and on the basis of previous year performance the next month return on the stocks are predicted and allotted to 10 portfolios, varying monotonically on previous year performance, whereas the portfolios returns are equally weighted and rebalanced on monthly basis. The illiquidity risk is measured as LFAC, which is monthly difference of excess return between the most illiquid and liquid portfolio across the size factor. ZERO-I is a ratio of days with combined incidence of zero returns in equity market and of no change in $/local exchange rate, over the total days to trade in a month. Lastly the market factor is monthly average excess return across the all listed stocks. The above graph is between yearly predicted returns from each model versus the actual realized yearly returns.

The performance of others models are almost the same except for SZERO-II. However, the pricing errors are still partially significant but they are economically small with quite high R^2. Again in the last line two factors model is tested and this time as well the inclusion of market factor adds no explanatory power to the model with LFAC factor only.

In Table 8, the same asset pricing models which have been tested for the illiquidity related portfolios are also tested for momentum based portfolios. There is evidence for the U.S market that returns on momentum portfolios have some exposure to illiquidity risk[31]. However in the context of this study the models tested with MKT, LFAC, ZERO-I and ZERO-II have not approved the joint criteria of insignificant pricing errors and high R^2 , further risk premiums are also not significant. Only with the unexpected illiquidity as estimated by SZERO-I and SZERO-II the high square R^2 and significant risk premiums are found, however pricing errors are still significant. For momentum portfolios the two factor model in line with Liu (2006) is so, far the best model, which is shown in the last line of Table 8. Here using the shocks to the series of ZERO-I[32] along with market factor we find the insignificant pricing errors and the highest R^2 among all models tested, however risk premium associated with SZERO-I is only significant (though partially).

Table 9 Return pattern of size based portfolios in good and bad times.

This table reports the yearly return on ten size based portfolios. Ten portfolios are constructed on the basis of previous month's size information. Each succeeding portfolio contains 10% higher capitalized stocks, such that S-1 is a portfolio with contains first decile of the smallest capitalized stocks, and S-10 have the firms belonging to the highest decile of size factor. Good times suggest when market-wide zero return suddenly decreases and vice-versa for bad time. The sudden increases/ decreases in zero return is measured as a shock to ZERO-II illiquidity measure ,these shocks are estimated by AR (2) model.

Good Times				Bad Times			
S-1	46.07%	S-6	13.48%	S-1	10.03%	S-6	3.87%
S-2	16.50%	S-7	13.48%	S-2	-0.96%	S-7	6.47%
S-3	16.92%	S-8	14.08%	S-3	-1.32%	S-8	7.37%
S-4	13.97%	S-9	10.22%	S-4	-0.49%	S-9	9.15%
S-5	12.69%	S-10	8.65%	S-5	0.56%	S-10	13.92%

5.3 Discussion and analysis.

The results show that illiquidity is priced characteristic for the set of portfolios tested in this paper in the context of Nordic markets. However, it is priced differently for the different portfolios. In the case of illiquidity related portfolios the LFAC and ZERO-I are sufficient pricing factors and addition of other factor, that is, market factor does not increase the model adequacy. For expositional purposes we estimate the cross-section of twenty portfolios[33] by imposing the condition that intercept is zero as guided by the theory. In fig 2, a scatter diagram between realized and model fitted returns is shown. It is clear that illiquidity risk captures the most of the varying return patterns for the portfolios differing in their illiquidity whereas, CAPM is quite flat. A particular incapacity of CAPM is that it assigns higher factor loadings to liquid portfolios and lower to the illiquid portfolios, in comparisons to their realized returns. Whereas, illiquidity related factors assign the appropriate loadings, keeping

[31] Studies which documented a link between returns of momentum portfolios and illiquidity risk for the U.S markets are Pastor and Stambaugh (2003), Korajczyk and Sadka (2008), Lesmond et al. (2004), Liu (2006), Sadka (2005), and other.

[32] Using the shocks to ZERO-II has almost given the comparable results.
[33] Whereas ten portfolios are size based and other 10 are price inverse ratio based portfolios.

into account that former portfolios are hedged well against illiquidity risk and later are exposed to it, thus their lower and higher returns are basically compensation to investors for hedging/bearing marker-wide illiquidity risk. This can be further illustrated by analyzing how well the returns differential is explained between the most illiquid and liquid portfolios, by taking the differential between factor loading on extreme portfolios associated with some factor and multiplying it by respective risk premium. For the price inverse portfolios yearly realized return difference is 33.14%, and LFAC predicts this difference to be 39.11% and CAPM predicts only 4.6% of it. Whereas, for size based portfolios the realized returns differential is 18.14% and ZERO-I predict 17.27% but CAPM hardly explains 0.94% of it.

For momentum based return structure the successful models for illiquidity related models are not that important. However, the shocks to both the ZERO-1 and II have performed much better and generally two factor model comprising market factor and SZERO-I is the most successful. It is also obvious from fig 3, in which we draw a scatter diagram between the realized and model fitted returns. It may be so, that for illiquidity related portfolios the only illiquidity risk alone is sufficient, however for momentum based portfolios it is important but not the sole pricing factor. Another thing to notice is that the most of studies that find the link between illiquidity risk and returns on momentum based portfolios used unexpected rise and fall in market-illiquidity. Similarly in the context for this paper this is corroborating evidence.

To analyze the importance of unexpected market illiquidity, we use the series of shocks of SZERO-II and partitioned the returns structure of size portfolios into two regimes. First in which value of SZERO-II is negative (zero returns are dropped suddenly market-wide), this indicates that market's liquidity suddenly increases, second when market liquidity suddenly decreases, that is, when SZERO-II is positive (zero returns are increased suddenly market-wide). The Table 9, elaborates these return patterns of the portfolios within these two regimes, where $S \in \{1,2,3,4,5\}$, are illiquid portfolios (smaller capitalized) and $S \in \{6,7,8,9,10\}$ are liquid (highly capitalized). In good times when market becomes unexpectedly liquid than there is obvious monotonicity in the realized returns and average yearly returns on five illiquid portfolios are 21.33% and for liquid one it is 12.00%. A somewhat reserve pattern is there in bad times when market becomes suddenly illiquid for instant, now yearly return on illiquid portfolios are 1.56% and for liquid it is 8.25%. Obviously the drop for illiquid portfolios is more phenomenal.

For pricing of such kind of patterns in stock returns, Acharya and Pedersen (2005) elaborate that, covariance between illiquidity and stocks returns is negatively priced. Indeed the shocks to market illiquidity are persistently been negatively priced across all testing portfolios in table 7 and 8. As assets which give higher returns when market illiquidity increases as is S-10, for that the investor forego some returns when market is liquid. Therefore, the lower returns of liquid stocks in good times are compensated with higher returns in bad times and vice versa for illiquid stocks. However, for model success purposes the estimated factor loading associated with SZERO-II in Table 6, do not line up that well with the realized returns. There may be some possible reason for that, the choice of sample or survivorship bias etc. Never the less some sort of effect does exist as is seen in Table 9. This effect is present for other portfolios as well and for market returns as a whole, as the total yearly return on market portfolio is 16.79% in good times and 4.87% in bad times. This indicates that there is an overall impact of changing market-wide illiquidity across the universe of the stocks.

6. Conclusion.

This paper finds that the illiquidity risk matters for the combined stocks of four similar illiquid markets in the Nordic region .To bring out this relationship a choice of illiquidity measure to proxy for market-wide risk is crucial. As most of the commonly proposed measures do not yield return dispersion for the stocks differing in their respective liquidities. Thus they do not constitute the interesting characteristics for conducting asset pricing tests. However a different version of Bekaert et al. (2007) proposed measure used in this paper, provides the most interesting results. A possible reason for its better performance in comparison to others, including Bekaert et al. (2007) itself, is that it assigns higher value of illiquidity to the stocks which have low speed of trading / relatively longer intervals of no-trade. Alternatively said, it gives more weightage to the stocks which are not traded for consecutive days as they involve higher transaction cost and investor needs higher market returns to rationalize trade for such assets. Another conjecture is that the stocks which more frequently encounter a situation of zero returns in equity market and of no change in $/local exchange rate, face an acute liquidity shortage, as it leaves an investor with no possibility to hedge a risk of non-trading in equity market in more liquid forex market by taking some position in dollar or local currency. This proposition can be tested but is beyond the scope of this paper.

In this study we also estimate illiquidity risk as a factor-mimicking portfolio (LFAC), which yields an excess return on high-low illiquid portfolios with zero-investment strategy. This liquidity factor is independent of capitalization of stocks so, that size and illiquidity nexus is disentangled in this study. In nutshell both of these market-wide illiquidity risks, that is, ZERO-I and LFAC in standalone capacity price the size and price inverse related portfolio very well. However, for non-illiquidity related characteristic, for instant, the momentum related portfolios these factors do not constitute the successful models. Therefore, in addition to these factors we also constructed the systematic risk of illiquidity as a monthly accumulation of shocks to expected illiquidity which is practice in vogue for illiquidity related studies. We find that the returns structure for momentum portfolios is captured well by shocks to ZARO-I in conjunction with market factor .Even though in this two factor model the illiquidity related factor is stronger and significant in comparison to the market factor. Overall the models using shocks to market illiquidity as systematic risk are not that successful, but some indirect analysis conducted do suggest that stock returns in general sway along with the un-anticipated changes in market illiquidity.

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