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An illiquidity premium in stock returns?
- Evidence from the Stockholm Stock Exchange

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Master Thesis No 2005:14
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Abstract

Asset pricing models generally do not take into account differences across securities in trading costs or liquidity. Yet, in the recent past, numerous studies have found evidence of an illiquidity premium in stock returns on the US stock markets. It has also been tried to explain the small company effect with the help of differences in trading costs and liquidity. The purpose of this present study is, first, to describe the concept of liquidity, to discuss ways how to measure liquidity, and to review previous research with respect to illiquidity premiums in stock returns. Second, the purpose is also to investigate empirically whether the level of implicit trading costs and illiquidity contributes to the explanation of the cross-sectional variation in stock returns on the Stockholm Stock Exchange during the period from 1995 to 2004. This is done with the help of a portfolio analysis, cross-sectional regressions, and regressions that pool cross-sectional and time-series data. Only weak empirical evidence of an illiquidity premium in stock returns on the Stockholm Stock Exchange is found. No support of a small company effect that could have been explained with differences in trading costs is found.

Key-words: liquidity, illiquidity, implicit trading costs, bid-ask spread, asset pricing models, CAPM, beta, small company effect, cross-sectional regressions, pooling time-series and cross-sectional data

Acknowledgements

First of all I would like to thank my supervisor Professor Evert Carlsson for his insightful help and his suggestions for improving this present study.
I am also grateful to Professor Lennart Flood for his aid with my econometrical questions.
Moreover, I would like to take this opportunity to express thanks to all GBS staff and administration for all courses we followed during our master programme.
Furthermore, I would like to thank my class mates for any kind of supportive words throughout the process of thesis writing, especially for the useful criticism and comments that I obtained for the progress reports.
Finally, to the extent that there are pages without grammar mistakes in this thesis, this is the merit of Beate Gerwin.

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1 Introduction

The ease with which securities can be traded and the costs incurred for trading them are important features of securities. Yet, in general these attributes are not taken into account in asset pricing models which are based on assumptions such as absence of trading costs.

Nevertheless, when compared to the magnitude of asset returns, trading costs are of important size (see, *e.g.,* Keim and Madhavan, 1998). Therefore, and due to the fact that trading costs (at least the implicit costs related to illiquidity, *i.e.* the spread and the market impact of large trades) differ across stocks, it could be expected that investors take them into account in asset pricing decisions. Nevertheless, measures for trading costs and illiquidity have not at all been incorporated in asset pricing models until the work of Amihud and Mendelson (1986a). The empirical evidence following the work of Amihud and Mendelson (1986a) shows that it is not completely clear whether these factors are actually priced. Furthermore, it has also been tried to explain the "small company effect" with the aid of differences in trading costs, *i.e.* the phenomenon of abnormally high returns on small company stocks (Stoll and Whaley, 1983).

Therefore, more empirical evidence in this field of research is necessary. While most of the existing literature relating to this topic focuses on the US stock market, the presence of an illiquidity premium on the Stockholm Stock Exchange has not yet been investigated, at least not to the author's knowledge. Moreover, while in the existing literature the empirical findings appear to be sensitive to the choice of the liquidity measure, this study, instead of being limited to just one liquidity measure, examines the relationship between stock returns and a number of liquidity measures. The measures used are the quoted relative spread, the effective relative spread, SEK trading volume, share turnover rate, and a measure for market impact according to Amihud (2002).

More precisely, the research problem of this study is as follows: Does the level of implicit trading costs and illiquidity of a stock contribute to the explanation of the cross-sectional variation of stock returns on the Stockholm Stock Exchange? Can implicit trading costs and illiquidity explain any small company effect on the Stockholm Stock Exchange?

Thus the purpose of this study is, first, to describe the concept of liquidity, to discuss ways how to measure liquidity, and to analyse previous research with respect to illiquidity premiums in stock returns. Based on this, the second objective is to evaluate the impact of implicit trading costs and illiquidity in an asset pricing model based on data from the Swedish stock market and give insight into the question whether this can explain at least partially the small company effect, in case a small company effect is found.

The first method that is applied to obtain a first insight into these relationships for the case of the Stockholm Stock Exchange during the period from 1995 to 2004 is a portfolio analysis. Under this approach, average stock returns on portfolios consisting of stocks sorted on different criteria, such as market beta, size, and liquidity, are compared. The association between size and liquidity is further investigated with the help of a simple correlation analysis. Finally, the question whether the level of liquidity can contribute to the explanation of the cross-section variation of returns as well as the question whether there is a small company effect that could be explained with differences in liquidity is answered in a more formal way with the aid of cross-sectional regressions, as well as with the aid of a regression model that pools cross-sectional and time-series data.

To sum up the empirical results, it can be said that there is only weak evidence of an illiquidity premium in stock returns on the Stockholm Stock Exchange during the study period. In other words, the level of illiquidity and implicit trading costs rather does not contribute to the explanation of the cross-sectional variation of returns. Furthermore, the expected small company effect is not found.

The remainder of this study is organized as follows: The following section presents the theoretical framework which leads to the formulation of the hypotheses to be tested. This comprises an introduction to the notions of trading costs and liquidity, a discussion of the absence of trading costs in asset pricing models, the presentation of a theoretical model of the spread-return relation, and a review of some relating empirical evidence. Section 3 presents the data and the methodology applied in this study. It shows the general research steps that will be followed to tests the hypotheses; it discusses the choice of the liquidity measures; it describes the data on which this study is based, and finally, it presents the methods applied. Section 4 provides the empirical findings of this study, while section 5 discusses them. The final section concludes and offers suggestions for further research.

2 Theoretical framework and hypotheses development

2.1 Trading costs and (il)liquidity

This section defines trading costs, i.e. it differentiates between implicit and explicit trading costs. Moreover, it shows how implicit trading costs are related to the trading activity in the stock in question. However, it is also argued that it is rather the level of "liquidity" that counts, so that the notion of liquidity and the different dimensions of liquidity are discussed. Furthermore, reasons for the existence of the bid-ask spread are presented, and that mainly from a theoretical point of view. The entire section is based on a review of the relating literature.

2.1.1 Definition of trading costs

Trading costs (*i.e.* transactions costs for the trading of stocks) can be divided into implicit or indirect trading costs on the one hand, and explicit or direct trading costs on the other hand.[1] Explicit or direct trading costs include fees and commissions, such as brokerage commissions and clearing and settlement fees. Implicit or indirect trading costs are related to bid-ask spreads, as well as the extent to which an order makes the price move towards the seller or buyer. The latter phenomenon is called market impact[2] of a trade (see, *e.g.,* London Economics, 2002, pp. 17-18 and 50). In other words, market impact means the following: When a trader wants to sell a large amount, the price might fall compared to the quoted price, and increase compared to the quoted price in case of a large purchase.

As it is mainly the implicit trading costs that differ across stocks, and not the explicit trading costs, this study focuses on the former.

[1] If defining transactions costs more broadly, for example costs related to the production of the securities themselves or the cost of acquiring information about the general situation of the market would have to be included in the total costs, too (Demsetz, 1968, p. 35).

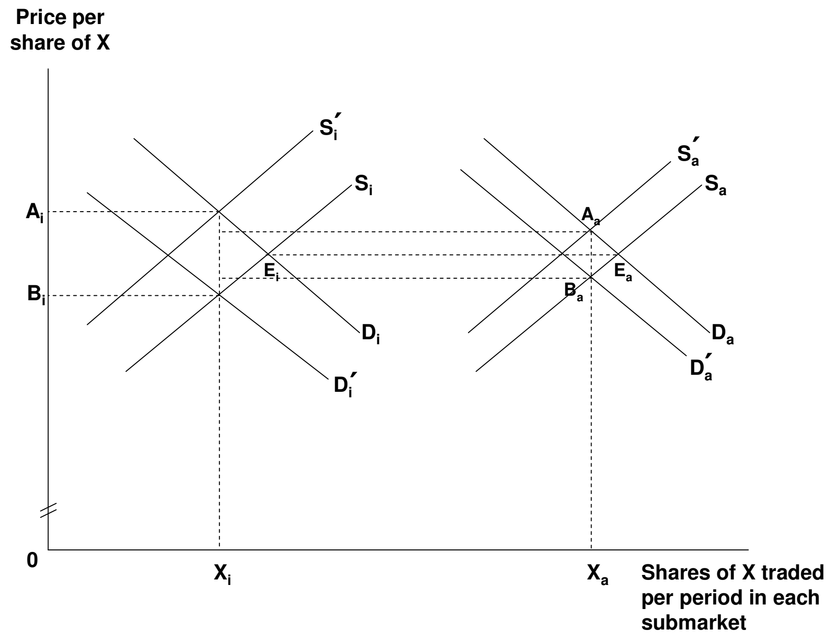
[2] Furthermore, it should be noted that there can be an additional cost, involving a trade-off: Market impact costs decrease when one waits and looks for a better possibility. But, then, opportunity costs arise, related to trades that were not undertaken. These opportunity costs increase when time passes. (see, *e.g.,* Goldman Sachs, 2003, p. 27)

According to Demsetz (1968, pp. 35-36) the bid-ask spread is "the markup that is paid for predictable immediacy". This is illustrated in figure 1 below (left panel). In a simple supply and demand model the equilibrium price would be E_i. However, a buyer who wants to buy X_i shares at price E_i cannot count on the immediate presence of respective sell orders. But, as shown by supply curve S_i', at a higher price there will be the possibility of immediate purchase. The price for a purchase by a trader who requires immediacy is therefore the ask-price, A_i. Respectively, the bid-price B_i is the price that a trader has to pay if he requires immediate sale. What is important, according to Demsetz (1968), the spread represents the "price of immediacy" (p. 37) or the "cost of making transactions *without delay*" (p. 39) paid by a trader not wanting to wait. And at the same time, it compensates the market maker, who waits and stands ready to buy and sell, for providing this immediacy (see Demsetz, 1968, pp. 35-39 for further details).

2.1.2 Relation of implicit trading costs to trading activity

Furthermore, Demsetz (1968, pp. 40-42) discusses the relationship between the magnitude of the bid-ask spread and the trading activity for a security. According to him, the greater the frequency of trading, the narrower the bid-ask spread, which he explains as follows: As far as limit orders[3] are concerned, those orders which are at the head of the trading queue will be executed first. They will be executed the sooner, the more frequently market orders arrive. Thus, waiting costs are lower, the more actively the security is traded. This means that, in order to get at the head of the trading queue, a trader is willing to submit limit orders with lower ask prices, or higher bid prices. This implies that the spread will be narrower for an actively traded security than for a less actively traded security. This relationship is illustrated in figure 1 where the spread for the actively traded security (subscript *a*) is smaller than the one for the inactively traded security (subscript *i*). Demsetz (1968) also finds empirical evidence for this relationship.

[3] A limit order is an order that is to be executed if the market price falls below a specified price for a purchase, or, for a sale, if the market price rises above a specified price. Contrarily, a market order is to be carried out immediately at any prevailing market price. (see, *e.g.,* Bodie et al., 1996, p. 88)



(Source: Demsetz, 1968, p. 36)

Figure 1: Spread size and trading activity

However, it will be seen later that the quoted spread does not correspond exactly to the actual implicit trading cost incurred.

With regard to implicit trading costs in the form of market impact of a trade, the following can be said: If a security disposes of high trading activity, it should be able to sustain a certain amount of trading. Thus, to some extent, it can be inferred that the trading cost related to market impact is determined by the degree of trading activity. Nevertheless, a low level of activity does not imply that a large trade would actually experience a strong market impact. It might also be possible that traders do not trade because they do not have any need, although the market would be able to accommodate large trades, if the latter were actually undertaken (Upper, 2001, p. 246). Thus, it might be possible that, although trading activity is low, trading cost related to market impact is low. It is rather the level of liquidity that determines the implicit trading costs, with liquidity, as it will be seen later, being defined as “the ease with which securities can be traded” (Upper, 2001, p. 245).

To summarize, both the spread and the market impact are related to the activity in trading. Yet, rather the level of liquidity seems to be what counts, in particular regarding the market impact. This can also be recognized in the fact that both the spread and the market impact can be referred to as “illiquidity costs” (London Economics, 2002, p. 50). However, the notion of liquidity deserves more attention. But, before this is tackled in section 2.1.4, the main theory explaining the *sources* of the spread is briefly presented.

2.1.3 Theoretical sources of the spread

Directly related to the problem of trading costs in a market is the question of how prices are set, especially how market makers[4], or others that provide liquidity, determine prices, and thus bid-ask spreads. From a theoretical point of view, this is dealt with in the market microstructure theory, which is the “study of the process and outcomes of exchanging assets under explicit trading rules” (O’Hara, 1995, p. 1).

The market microstructure theory knows two different frameworks of the price formation process, namely inventory-based models and information-based models.[5]

Inventory-based models deal mainly with optimization problems of market makers under uncertainty of order flow. More precisely, Garman (1976) models the price setting behaviour of monopolistic market makers, given the stochastic arrival of market orders. Thus, the spread mainly stems from the market power of the market maker. Stoll (1978) models the price setting of a, this time, risk adverse dealer who faces different kinds of costs due to his market making activities. These costs are inventory holding costs (including the related risk exposure and opportunity cost), order-processing costs, costs related to asymmetric information between better informed traders and the less well informed dealer.[6]

[4] Although most of the stocks traded on the Stockholm Stock Exchange do not dispose of a market maker, the sources of the spread as proposed by these models are insightful in any case.

[5] This presentation is mainly based on O’Hara (1995, pp. 12-91)

[6] It can be noted here that Huang and Stoll (1997) present an empirical estimation procedure of how the bid-ask-spread can be split up into these three cost components.

Cohen et al. (1981) develop a model without market maker, which is especially interesting for the case of the Stockholm Stock Exchange. Even without market makers, there are individual traders who provide immediacy by issuing limit orders or consume immediacy by issuing market orders. However, as the traders incur exogenous transactions costs when trading, there will always be a spread. Nonetheless, its size will be limited. The reason for this is the following: When the spread widens, more traders will issue limit orders and take the gains available for providing immediacy. This provision of limit orders will keep the spread small. But, if the spread narrows too much, fewer traders will issue limit orders because there is less gain available and they cannot cover the costs they incur when trading. This will prevent the spread from disappearing.

Furthermore, precisely the asymmetric information costs mentioned above are considered in information-based models. These models show that, due to asymmetric information alone, there would be a spread, even without any risk aversion, without any market power of the market maker, or without any inventory effect. Copeland and Galai (1983) demonstrate how market makers set bid and ask prices so that their losses from trades with informed traders are offset. Moreover, Glosten and Milgrom (1985) and Easley and O'Hara (1987) develop sequential trade models in which information is conveyed by the trades themselves. This means that the market makers learn from the order flow and take this into account when setting prices.

In addition to that, in order to be more complete, it should be mentioned that Kyle (1985) incorporates the strategic behaviour of one single informed trader into the trading model, this time a model where the trades take place all together at one price. However, this model does not include bid-ask spreads or individual transaction prices. [7]

Another, but less theoretical, factor that influences the level of the spread is the tick size.[8] This imposed price discreteness results in a lower bound for the spread. Niemeyer

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[7] For a more exhaustive overview of market microstructure theory, see O'Hara (1995) or O'Hara (2001).

[8] The tick size is the minimum difference between two adjacent prices. Trades can only submit orders at prespecified prices, the prices being separated by one tick. There are different tick sizes for different price ranges (see, *e.g.,* Niemeyer, 1994a, pp. 10-11, 24).

(1994a, pp. 24-25, and 1994b) finds evidence that, on the Stockholm Stock Exchange, the tick size has a strong impact on the size of the spread for at least some stocks, and especially for highly liquid stocks.

To summarize, the main sources of the spread are: market power of the market maker (in case there is any), inventory holding costs, order-processing costs, costs related to asymmetric information as well as the tick size.

2.1.4 Concept of liquidity

As it has been seen above, the spread and the market impact constitute the implicit trading costs, and it has already been mentioned that they are related to the "liquidity" of the security in question. However, the term "liquidity" still needs to be defined.
In the corresponding literature, liquidity refers to "the 'ease' with which securities can be traded" (Upper, 2001, p. 245) or, in other words, to "the cost and ease with which an asset can be converted into cash, that is, sold" (Bodie et al., 1996, p. 253). As far as the opposite, *i.e.* illiquidity is concerned, the level of "difficulty with which an asset is traded" can also be called trading friction (Stoll, 2000, p. 1479).
Keynes (1930, p. 59) defines liquidity as follows: If one investment is more liquid than another one, this means that it is "more certainly realisable at a short notice without loss". Based on this, Fernandez (1999, p. 9) sees liquidity as "the degree to which large size transactions can be carried out in a timely fashion with a minimal impact on prices". However, as the same author points out, terms like 'large', 'timely' and 'minimal' are not very precise.[9] Yet, they vary across securities or markets. Therefore, when liquidity is defined or measured, no absolute standard can be used. But liquidity can be defined or measured on a scale being based on elements of time, volume and transactions costs (Fernandez, 1999, p. 9). These elements can be found in the dimensions of liquidity that are presented in the next section. However, it has to be noted that, partly due to the fact

[9] Lipman and McCall (1986) focus on this time characteristic. They define and measure an asset's liquidity as the expected time it takes to sell the asset when the optimal policy based on a search environment model is followed.

that the concept of liquidity is based on a number of other elements, liquidity can be seen as a "slippery and elusive concept" (Kyle, 1985, p. 1316).

The corresponding literature refers the most often to three dimensions of liquidity: tightness, depth, resiliency (see, *e.g.*, Kyle, 1985, or Fernandez, 1999). Other authors (*e.g.* Upper, 2001) add immediacy as a fourth dimension. These dimensions can be defined as follows:

Tightness, also called breath, refers to the size of the bid-ask spread, or the distance between quote mid-point and actual price (Fernandez, 1999, p. 10). Thus it corresponds to the cost incurred when buying and selling a position within a short time (Kyle, 1985, p. 1316). The bid-ask spread as implicit trading cost has already been discussed above.

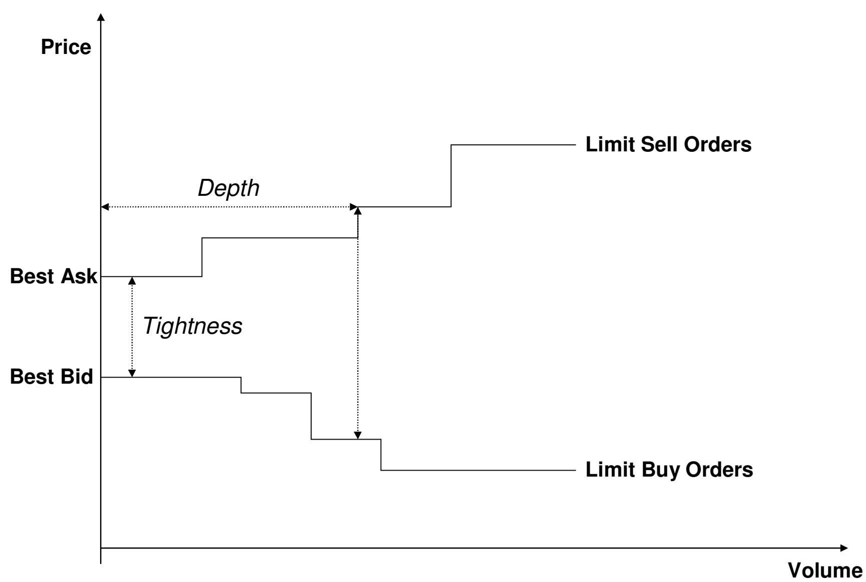
Depth, according to Fernandez (1999, p. 9) can be defined as: "(a) the availability of counteroffers; (b) the volume of trades possible without affecting prices, or (c) the amount of orders held by market makers or specialists, the size of the float or inventories maintained by market makers." Or according to Kyle (1985, p. 1316) depth is defined as "the size of an order flow innovation required to change prices a given amount". This is close to what has been discussed above in the context of the market impact of a trade.

As far as resiliency is concerned, Fernandez (1999, p. 10) describes it as "the speed with which price fluctuations resulting from trades dissipate or how quickly markets clear order imbalances", while for Kyle (1985, p. 1316) it is "the speed with which prices recover from a random, uninformative shock".

Immediacy refers to the time that is needed to execute a market order that has been placed, which can mainly be a problem during market crashes (Upper, 2001, pp. 245-246). However, it has been seen above, when presenting Demsetz (1968), that immediacy is normally available. But there is a price for this immediacy, which is the bid-ask spread. The size of the latter, however, is already included in the concept of tightness.

Black (1971a, p. 30) discusses under which conditions a market for a stock can be said to be liquid: For trades of small amounts of stocks, there are always bid and ask prices available (immediacy), the spread is always of small size (tightness), in absence of particular information the prices remain close to their current level (resiliency). But if a large amount of stocks is to be sold or bought immediately there will a discount or a premium depending on the size of the trade, because trading large amounts without much price impact is considered "simply unrealistic" by Black (1971a, p. 30). Thus, from this point of view, in order to be able to be considered liquid, a market does not have to be unlimitedly deep (see also Kyle, 1985, p. 1317). However, for this present study, it is not needed to decide which stocks are liquid and which are not. It is only necessary to distinguish cross-sectional differences. In section 3.2.2 it will be discussed how this can be accomplished.

To summarize, figure 2 illustrates the concepts of tightness, depth, and resiliency: Tightness is illustrated as the vertical distance between best (*i.e.* lowest) ask and best (*i.e.* highest) bid. Depth is illustrated by an order size (horizontal axis) and by the respective spread for that order size (vertical axis). As far as resiliency is concerned, this would be shown by how quickly the bid-ask schedule would return to its starting position after order execution (Upper, 2001, p. 245).



(Source: Upper, 2001, p. 245)

Figure 2: Dimensions of market liquidity

After this definition of trading costs and the discussion of the concept of liquidity, the following section deals with the second cornerstone of this study, namely asset pricing models.

2.2 Asset pricing models and illiquidity premiums

This section reminds the reader of the most well-known asset pricing models. It especially underlines the absence of trading costs in these models. Furthermore, it presents the theoretical model of the return-spread relation by Amihud and Mendelson (1986a) with which the research in this area began. Moreover, the most important empirical evidence on the question whether trading costs and liquidity determine stock returns is reviewed.

2.2.1 Short overview of asset pricing models

A number of asset pricing models exist in order to determine expected equilibrium returns on a security. The most prominent one is the CAPM, the Capital Asset Pricing Model, originally developed by Sharpe (1964) and Lintner (1965). (For an overview see, *e.g.*, Bodie et al., 1996, pp. 236-284.) The CAPM assumes, among other things, that all investors hold the market portfolio, which is the theoretical unique mean-variance efficient portfolio. The risk premium of an individual security over the risk-free rate will then depend on, first, the security's contribution to the risk of this portfolio, as measured by beta, and second, on the risk premium of the market portfolio over the risk-free rate. According to the CAPM, the expected return on a security *i* can be expressed as follows:

$$E(r_i) = r_f + \beta_i * \left[E(r_M) - r_f\right], \qquad \textbf{(1)}$$

where beta, or β_i, is the covariance of the security *i* with the market portfolio divided by the variance of the market portfolio, r_M us the return on the market portfolio, and r_f is the risk-free rate.

It has to be noted that the CAPM equation is expressed by (unobservable) *expected* excess returns and is based on a *theoretical* unique mean-variance efficient portfolio. However, in practice *realized* returns and a large *market index* are used instead.

A second well-known asset pricing model is the APT (Arbitrage Pricing Theory), developed by Ross in the 1970s (see, *e.g.,* Ross et al., 1999, pp. 271-288, for an overview). In the APT, stock returns are determined by a factor model consisting of several factors. It decomposes returns into an expected part, into a systematic risk part where return is based on the individual stock's sensitivity to deviation from the expected value of a number of risk factors affecting all firms, and into an unsystematic risk part that is unique to each security and can be diversified away. These systematic risk factors can be, for example: inflation, gross national product and interest rate.

Both the CAPM and the APT are based on theory, especially the CAPM. Furthermore, they are risk based models. This means that a security's risk is measured by its sensitivity to one or several factors affecting all firms. Then its expected excess return should be proportional to this sensitivity. However, there are models that are more empirically orientated. This means that it is searched for relations between certain stock attributes and returns, based on historic market data (see, *e.g.,* Ross et al., 1999, pp. 285-286).

One such finding for example is the "small company effect", or "size effect". Banz (1981) finds that stocks of small companies (size measured by market value of equity) offer significantly higher returns, compared to larger companies, after adjusting for risk. This size effect is strongest for the smallest firms.
Yet, it is not completely clear whether such findings mean that investments in small companies offer higher return because they are riskier or because size proxies for some other risk factor, or whether this is an anomaly contradicting the efficient market hypothesis (see, *e.g.,* Bodie et al., 1996, pp. 361-369). As it will be seen below, this small company effect is especially interesting in the context of liquidity and trading costs.

Another asset pricing model that has gained importance in the most recent past is the Fama-French-three-factor model (Fama and French, 1992 and 1993). In this model stock returns are explained by three factors, namely an overall market factor, a factor related to firm size, and a factor related to book-to-market equity. The authors argue that these are factors proxying for some risks.

However, an important feature of asset pricing models is that in general they do not take into account any trading costs. More precisely, especially the CAPM with its strong theoretical foundation is based on the assumption that trading is costless and thus the same for all stocks. Furthermore, investors are assumed to be price takers, as usually in economics (see, *e.g.*, Bodie et al., 1996, p. 237 for a discussion of the CAPM assumptions).

The absence of trading costs in asset pricing models is even more surprising if one takes into account that, first, trading costs are high in relation to stock returns (see, *e.g.,* Keim and Madhavan, 1998). And second, it has been known for long that there is a relation between illiquidity and return. Demsetz (1968, pp. 51-52) for example already points out that a company of which the shares of equity are relatively illiquid will experience economically significantly higher borrowing costs when issuing new shares. The company with less liquid shares will sell its shares at a lower price than a company with more liquid shares, all else being equal.

Also already Keynes (1930, p. 59), when discussing non-reserve bank assets, notes that more liquid investment classes are less profitable than less liquid investment classes. Still today this fact is an important concept in the liquidity risk management of banks (see, *e.g.,* Hempel and Simonson, 1999, p. 67). However, this refers to investment categories, and not to individual stocks, but the same idea will be applied to individual stocks in the next section.

2.2.2 Illiquidity premium in asset pricing

The Amihud-Mendelson-Model of the return-spread relation

Amihud and Mendelson (1986a) were the first to investigate the role of illiquidity in asset pricing[10]. In their theoretical model there are a number of investor types, who differ from each other by the expected holding period for their investment. Furthermore, there are a number of capital assets, which differ from each other by their relative spread, which reflects their trading cost. Each investor's objective is to maximize his expected discounted cash flow, which he receives over his holding period, net of trading costs.

The gross return on an asset has to be adjusted for trading costs, *i.e.* it has to be spread-adjusted. The expected trading costs (per unit time) depend on both the percentage spread and the liquidation probability, which is the inverse of the expected holding period. Prices being given, each investor will choose the assets that give the highest spread-adjusted return. For a given asset, the investor with a longer holding period will have a higher (or equal) spread-adjusted return. The gross return on an asset (*i.e.* the observed market returns on an asset) that an investor requires comprises both the required spread-adjusted return and the trading cost. As far as equilibrium gross returns are concerned, these will be determined for each asset by its highest-valued use. The highest-valued use is represented by the investor type that requires the minimal return.

Based on this, the authors formulate two propositions. According to proposition 1, assets with higher spreads are held by investors with the same or longer expected holding periods (clientele effect). According to proposition 2, in equilibrium, the observed gross market return is an increasing and concave function of the spread.

In other words, there is a positive relation between spread and observed market return, because investors require compensation for the incurred trading costs which differs across stocks. Yet, this positive relation is not linear. For, in equilibrium, higher spread assets are held by investors with a longer investment horizon. The latter require less

[10] This entire presentation is closely based on Amihud and Mendelson (1986a, pp. 223-229). See also Amihud and Mendelson (1986b), and Bodie et al. (1996, pp. 253-259) for a simplified version of the Amihud-Mendelson-model

compensation for a given increase in the spread, because the spread is amortized over a longer period. Thus, return increases in spread, but at a decreasing rate.

Empirical evidence for an illiquidity premium

Amihud and Mendelson (1986a) find strong empirical support for their theory presented above. They add the (relative) bid-ask spread into a CAPM model and find evidence that the effect that the spread has on stock returns on the New York Stock Exchange is highly significant. Moreover, the relationship is concave as suggested by their theory. Furthermore, no evidence of a small company effect is found, unless the spread variable is omitted from the model.
In addition to that, Amihud and Mendelson (1989) test an extended CAPM as proposed by Merton (1987). In the latter, expected asset returns are explained by systematic risk, residual risk, size, and the level of publicly available information. The authors show that the inclusion of the bid-ask spread makes the coefficients of the variables size and residual risk insignificant, while these latter two coefficients appear significant in a model without spread variable. They conclude that expected returns are an increasing function of systematic risk and the bid-ask spread.

Yet, some other authors cannot validate these finding by Amihud and Mendelson: Chen and Kan (1995) argue that the findings of Amihud and Mendelson (1986a) are only due to the regression method the latter use, because with different regression designs different results are obtained (see also section 3.4.4). Furthermore, Eleswarapu and Reinganum (1993) use a sample with modification compared to what Amihud and Mendelson (1986a) use. More precisely, they extend the length of the sample period and, most importantly, they differentiate between returns in the month of January and returns in non-January months. The result is that the positive relationship between spread and return that Amihud and Mendelson (1986a) find is only present in the month of January. Moreover, Eleswarapu and Reinganum (1993) apply less strict sample selection criteria than Amihud and Mendelson (1986a).[11] They also find evidence of a small firm effect, even after controlling for the liquidity premium, in contrast to Amihud and Mendelson (1986a).

Yet, other authors confirm the suggestion of Amihud and Mendelson (1986a) that illiquidity is priced: Eleswarapu (1997) finds evidence that the level of the spread determines stock returns on the Nasdaq. Datar et al. (1998) find support for this suggestion on the New York Stock Exchange, by using turnover rate as proxy variable for liquidity. Also Brennan et al. (1998) find that asset returns are strongly negatively related to trading volume.

Moreover, Amihud (2002) finds further confirmation that illiquidity[12] contributes to the explanation of the cross-section of expected returns. In addition to that, he shows that, over time, expected market illiquidity has positive impact on expected returns, while unexpected illiquidity has a negative impact on contemporaneous returns.

Chordia et al. (2001) examine the relation between stock returns and the level as well as the variability of trading activity (measured by trading volume and share turnover). The authors find a negative relationship between returns and the level of trading activity (as expected). But they also find a strong (unexpected) negative relationship between returns and the variability of trading activity.

Easley et al. (2002) examine the effect of trading costs related to asymmetric information. They show that the estimated probability of information based trading for an individual security is priced.

Some studies find differing results depending on the measure for liquidity and trading costs used in the asset pricing model: Brennan and Subrahmanyam (1996) find a positive and significant relationship between excess returns and both fixed cost of trading and variable costs of trading (*i.e.* cost depending on trade size) estimated from transaction

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[11] More precisely, they require only three years instead of ten years of return data previous to each test year, in the context of the portfolio formation process. This modification may diminish a possible survivorship bias, while according to Eleswarapu and Reinganum (1993, p. 385) the procedure by Amihud and Mendelson (1986a) tends to exclude smaller sized firms from the sample.

[12] The measure used is the ratio of daily absolute return to daily dollar trading volume, see below.

level data. Yet, the authors find a negative relationship between the relative spread (*i.e.* spread/price) and returns. Thus they argue that the reciprocal of price level is proxying for a risk not included in their model.

Furthermore, Chalmers and Kadlec (1998) find evidence that amortized (effective) spreads (*i.e.* spread cost over average holding period) are priced, but not that (effective) spreads are priced.

Several of the authors mentioned above include (among others) size and a measure for illiquidity as distinct explanatory variables in the model, representing different characteristics. (It can be noted that in most cases it is found that size and stock returns are inversely related, *e.g.* Datar et al., 1998, p. 210, or Brennan et al., 1998, p. 358.) Yet, it has also been suggested that illiquidity explains large parts of the small company effect, *i.e.* the phenomenon of abnormally high returns on small company stocks. Stoll and Whaley (1983) find evidence for a small company abnormality after adjusting for systematic risk. Yet, after considering returns net of transactions costs (relative spread plus commission rates) the authors find that the small company abnormality is reversed, so that large companies now tend to outperform small companies. However, the results also depend on the length of the holding period used in the calculations.

Yet, Schultz (1983) extends Stoll and Whaley's (1983) study to stocks traded on both the New York Stock Exchange (NYSE) and on the American Stock Exchange (AMEX), while Stoll and Whaley (1983) only consider NYSE stocks. The evidence found suggests that small firms still offer an abnormally high return, net of trading costs.

As already mentioned above, also Amihud and Mendelson (1986a and 1989) find that size has only a significant impact when the spread is not taken into account.

2.3 Hypotheses formulation

This section states the hypotheses that will be tested in the remainder of this study.

Based on the previous findings, differences in illiquidity across stocks can be expected to explain parts of the cross-section of stock returns. The reasons for this expectation can be summarized as follows: First, it is intuitive that investors require a higher return when they incur higher trading costs, because they should require compensation. Second, the theoretical model of Amihud and Mendelson (1986a) predicts such a relation. Third, although the empirical evidence, that has been presented above and that focuses on the US market, is less than clear, it tends to point in this direction, too. Thus, the following is expected for the Stockholm Stock Exchange:

Hypothesis 1: The cross-sectional variation of the illiquidity and implicit trading costs of the stocks traded on the Stockholm Stock Exchange contributes to the explanation of the cross-section of return.

Furthermore, it has been mentioned above that authors such as Stoll and Whaley (1983) argue that illiquidity can explain the 'small company effect'. As it is generally not clear yet whether size is actually proxying for some fundamental risk factor or whether the presence of a 'small company effect' is rather a market anomaly, it seems intuitively reasonable to follow Stoll and Whaley (1983) and to suggest the following, in case evidence for a small company effect is found:

Hypothesis 2: Differences in liquidity across stocks can explain at least parts of the small company effect.

3 Methodology and data

3.1 General research design

This section presents the steps that are followed in order to test the hypotheses and to answer the research questions. It does not offer methodological details which are presented later in this study.

In order to test hypothesis 1 the following steps will be followed:

(1a)	The CAPM must be found not to be sufficient to explain the cross-sectional variation in returns.

Otherwise, no additional factor explaining stock returns could be needed.[13] This, however, cannot be examined until results from the regressions are obtained.

(1b)	Differences in liquidity and/or implicit trading costs across stocks must be present.

This will easily be seen from the descriptive statistics in section 3.3.3.

(1c)	The level of liquidity and/or implicit trading costs must be found to determine stock returns.

As discussed in more detail in the methods section (section 3.4), the portfolio analysis will give a first informal insight into this question, while the cross-sectional regressions and the regression model that pools cross-sectional and time-series data aim at examining this in more detail. If a variable that measures illiquidity and implicit trading costs has a positive impact on stock returns, hypothesis 1 is not to be refused.

[13] It can be mentioned here that the risk adjustment is in many similar studies done with the Fama-French-risk factors, *i.e.* beta, size, and book-to-market value of equity. However, this risk adjustment does not seem less questionable than the risk adjustment with the CAPM only. Furthermore, using a size variable in the context of risk adjustment would be inconsistent with the second hypothesis.

Hypothesis 2 will be tested with the help of the following procedure:

(2a)	A small company effect must be found.

It is the portfolio analysis, the cross-sectional regressions as well as the pooled regression model that will investigate whether return decreases in size.

(2b)	Size and liquidity must be found to be positively related to each other.

This will be examined with the help of the portfolio analysis and with the help of an inspection of the bivariate correlations between size and the liquidity measures.

(2c)	Taking into account the level of liquidity and implicit trading costs must weaken the presence of the size effect.

It is the cross-sectional regressions and the pooled regression model that aim at testing this.

Before any empirical test can be made, it has to be discussed how liquidity can be measured, which is done in the next section.

3.2 Choice of variables

Firstly, this part briefly shows which variables are to be included in the regression models and to be considered in the portfolio analysis, without specifying the precise form of the variables, which will be done in section 3.3.1. Secondly, it discuses the choice of the measures of liquidity and implicit trading costs to be used. This choice is based on a review of the measures used in the corresponding literature. It is especially focused on measures that have been used in the asset pricing models of the studies already presented in section 2.2.2, but the needs and prerequisites of this study are taken into account, too.

3.2.1 Variables to be included in the study

The explanatory variables that are supposed to explain the dependent variable, excess stock return over the risk-free rate, are:

- Market beta from the CAPM, in order to take into account systematic risk
- Various measures for illiquidity and implicit trading costs, which are discussed in detail in the next section.
- Size, *i.e.* market capitalization, in order to be able to investigate the small company effect.

It has to be mentioned that it is not the purpose of this study to find a 'complete' asset pricing model that takes into account all possible risk factors. It is rather assumed that the risk adjustment with the CAPM is sufficient and that illiquidity and trading costs are not correlated to any other possible factors.[14] As it is simply not feasible to include all potential variables that have been found to determine stock returns anywhere in literature, this present study focuses on the variables that are necessary to answer the research questions of this study.

[14] It can be remembered here that, in general, if a relevant explanatory variable is omitted from a regression model and if the omitted variable is not correlated with the included variable, the estimator of the regression coefficient of the included variable will not be biased, only the estimator of the intercept will be biased. Yet, the estimator of the variance of the regression coefficient of the included variable will provide a too high variance, so that the testing of significance will be stricter than it should. However, if the omitted variable is correlated with the included variable, both the estimator of the intercept and the estimator of the regression coefficient of the included variable will be biased (see, *e.g.,* Kmenta, 1997, p. 445).

3.2.2 Measures of liquidity and implicit trading costs

It has been discussed above that liquidity is not a very precise concept. Therefore it is necessary to discuss in detail how illiquidity and implicit trading costs can be measured.

Quoted and effective spreads

One measure of liquidity is the quoted bid-ask spread, which actually measures the liquidity dimension of tightness (see, *e.g.,* Upper, 2001, p. 246).

However, first, it is possible that trades take place at a price which lies inside the quoted spread, so that the quoted spread may overstate the actual cost incurred.[15] Second, the quoted spread applies only to transactions being equal or below a specified (and varying) size. Thus a trade might as well take place outside the quoted spread. However, in order to take into account actual prices paid, the effective spread can be used (see, *e.g.,* Upper, 2001, p. 246). The quoted and the effective spread are calculated as follows, in the form of relative spreads:

Quoted relative spread $$QRS = (A - B) / (M) = (A - B) / [½ * (A + B)] \quad \textbf{(2)}$$

Effective relative spread[16] $$ERS = 2 * | P - M | / P , \quad \textbf{(3)}$$

where A is the ask price; B is the bid price; P is the actual trade price; M is the quote midpoint, *i.e.* the average of bid and ask, M = ½ * (A+B).

It should be noted that an entire spread refers to the cost of a buy and a sale at almost the same time, *i.e.* of two trades.

The following studies, which have already been mentioned above, are examples of the use of the spread in asset pricing models: Stoll and Whaley (1983, p. 59), Amihud and Mendelson (1986a, p. 232), Amihud and Mendelson (1989, p. 481), Eleswarapu and Reinganum (1993, p. 374), as well as Eleswarapu (1997, p. 2115).

[15] A trade can take place inside the quoted spread bracket for example when two market orders arrive simultaneously and are matched (see, *e.g.*, Eleswarapu, 1997, p. 2114).

[16] See, *e.g.,* London Economics, 2002, p. 26

When being compared to the quoted spread, the effective spread disposes of several advantages: First, it represents actually paid prices, not announced prices (Upper, 2001, p. 246). Thus, it reflects actual costs. Second, as London Economics (2002, p. 26) points out, the effective spread measures both the size of the spread and the market impact of a trade. Thus, it reflects what has been discussed above as the components of implicit trading costs. Or, according to Upper (2001, p. 246) the effective spread does not only measure the tightness of the market, but also its depth.

Thus, the effective spread seems to be theoretically appealing. Yet, it has to be taken into account that only closing data of each day will be used for this study. It should be reasonable to assume that there is not too much variation in quotes during the day.[17] Yet, the trade size of the last trade on each day, which will determine the effective spread, can be of any size. It would not be reasonable to assume that this trade size (which is unknown) can reflect the average market impact of all trades during the day. In addition to that, the last price of a day which is used to calculate the effective spread does not have to be paid at the same time of the day when the last quote is quoted.

Therefore both effective and quoted spread will be used in this study.

Market impact of trades

It has already been seen that the depth, and thus the trading costs related to market impact of a trade, can be caught in the effective spread. However, there are further measures. Kyle (1985, p. 1316) defines depth as "the size of an order flow innovation required to change prices a given amount". This author measures depth in a theoretical trade model as the sensitivity of the asset price to the deviation of the order flow (the aggregated traded amount) from its mean.

Many related studies (*e.g.* Brennan and Subrahmanyam, 1996) use intraday transaction data in order to estimate the market impact of a trade. But, this kind of data is not at the disposition of this present study.

[17] Actually, Niemeyer (1994a, p. 25) finds that the average intraday quoted spread of the OMX index stocks on the Stockholm Stock Exchange reaches a peak after the opening but is quite stable in the second half of the day.

A feasible measure based on Kyle (1985) is proposed and employed by Amihud (2002, pp. 32-34). More precisely it is the ratio of daily absolute return to daily dollar trading volume, averaged over some period. According to that author, this ratio is the price change per dollar traded, or the "daily price impact of the order flow". As the author himself points out, this measure is only a rough measure for the market impact, but it has the advantage that the required data is available from most stock exchanges, also over as long periods as required for asset pricing tests. Furthermore, this measure is close to the so called Amivest measure, which is widely used in practice to measure liquidity (ratio of the sum of the daily volume to the sum of the absolute return).

Hasbrouk (2005, pp. 20-21) examines the correlation between liquidity measures based on intraday data and proxies for them based on end of day-data. He finds that, although it is relatively difficult to find a proxy for price impact, the Amihud (2002) illiquidity measure does well.[18]

Therefore, the Amihud (2002) measure will also be used as illiquidity measure in this study, but with a modification: It does not seem to be reasonable to assume that each day the entire daily return is caused by the trading. There must be, of course, days where stock prices change because of new information. It is, however, impossible to distinguish between these two effects. But it can be assumed that the largest daily returns are rather due to new information and not due to trading. Therefore, the highest absolute daily returns are ignored, more precisely the highest returns for each stock over the whole study period, where the number of excluded daily returns corresponds to 5% of the number of trading days for the stock in question.

Trading activity

Liquidity in general, and depth in particular, can also be proxied for in a simple but not prefect way with the help of indicators of trading activity such as turnover, trading volume, number of trades or time between trades (Fernandez, 1999, pp. 9-10, or Upper, 2001, p. 246).

[18] The Amihud illiquidity measure has a Pearson correlation coefficient (usual correlation) of 0.537 and Spearman correlation coefficient (rank-order correlation) of 0.762 with the respective price impact measure from intraday data. (Hasbrouk, 2005, p. 37)

The following authors use measures based on trading activity in the context of asset pricing models: Brennan et al. (1998, pp. 348 and 352) employ dollar trading volume and share price; Datar et al. (1998, p. 205) take share turnover rate, *i.e.* the number of shares traded divided by the number of shares outstanding; Chordia et al. (2001, p. 9) use dollar trading volume and share turnover rate.

In the present study, the SEK trading volume as well as the share turnover rate will be used as explanatory variables, these measures being frequently used as measure for liquidity and the data being available. The role of the share turnover rate, however, will be further examined in the section discussing holding periods.

Note on explicit trading costs

The above discussion has focused on the measurement of liquidity and implicit trading costs and has not yet considered explicit trading costs. However, if explicit trading costs were supposed to explain the cross-sectional variation of returns, differences in explicit trading costs across stocks would have to be distinguished. Stoll and Whaley (1983, pp. 70-71) for example try to do this with the help of information on the average dollar transaction size across all stocks in each year, the price for each stock, and based on that, the average number of shares traded for each stock. The authors then apply the New York Stock Exchange minimum commission rate schedules in force in the respective years.

Yet, today commission rates have become negotiable. Furthermore, the direct trading costs that an investor has to carry also depend on whether he is a stock exchange member or whether he has to trade via his broker who is a member. And brokerage commissions vary from brokerage firm to brokerage firm (see, *e.g.,* Bodie et al., 1996, pp. 93-94). Therefore, it seems so impossible to make out differences in explicit trading costs across stocks that they will not be considered in this present study. Moreover, if a study is intended to focus on liquidity aspects, explicit trading costs can really be neglected.

Taking into account holding periods

Irrespective of which cost measure is used, the magnitude of the costs that actually incur also depends on the holding period of the asset in question.
The model by Amihud and Mendelson (1986a) presented in section 2.2.2 argues that differences in holding periods across investors have an impact on the form of the relationship between illiquidity (spread) and return, *i.e.* in their model the function is supposed to be concave.
Chalmers and Kadlec (1998, pp. 162-163) consider differences in holding periods in a different way, namely with the help of the amortized spread, *i.e.* the (effective) spread is amortized over the holding period. As the average holding period in years is equal to the ratio of number of shares outstanding and shares traded per year, the average holding period is the inverse of annual share turnover rate. In their study of the amortized spread, Chalmers and Kadlec (1998, p. 167) find evidence that is not consistent with Amihud and Mendelson's (1986a) clientele effect, because spread and average holding period appear to be negatively related.
As mentioned above, Datar et al. (1998, pp. 205-206) use the share turnover rate as proxy for liquidity. According to these authors, apart from being an intuitive measure for liquidity, this measure is also based on the model by Amihud and Mendelson (1986a). Since this model suggests that observed return should be an increasing function of the expected holding period (combination of proposition 1 and 2 in the model), this also implies that observed return should be a decreasing function of the turnover rate. (As mentioned above, these authors find the expected evidence).
This discussion shows some difficulties when one wants to take into account holding periods: On the one hand, a high turnover rate implies a high level of liquidity. Such an asset should offer a low observed return. On the other hand, a high turnover rate also means a short average holding period. This implies, on average and on an amortized basis, high incurred trading costs. Such an asset should offer a high observed return.
To conclude, as mentioned in the previous section, the share turnover rate will be included as liquidity measure in this study, but one has to be aware that the results

obtained have to be interpreted with caution, because of the holding period effect just discussed.

Conclusion

To summarize, the measures that will be used in this present study to proxy for implicit trading costs and illiquidity will be:

- The quoted relative spread
- The effective relative spread
- Share turnover rate (number of shares traded divided number of shares outstanding)
- The SEK trading volume
- A market impact measure based on Amihud (2002) but excluding the highest daily returns and called in the following “Amihud”

Finally, it should be said that two dimensions of liquidity (namely resiliency and immediacy) have not been mentioned yet. However, it can be noted that resiliency is very difficult to measure (Fernandez, 1999, p. 10). This would not be possible without transaction level data. As far as immediacy is concerned, it has already been mentioned that this is in general only a problem during crisis periods, while in normal periods the price paid for immediacy can be measured by the spread, at least for small trades.

The next section presents, among other things, the precise specification of the chosen variables.

3.3 Data

While the variables to be used have already been discussed above, this section presents the specification of these variables, the data sources and the sample.

The relation between monthly stock returns and systematic risk, size as well as various measures for implicit trading costs and liquidity on the Stockholm Stock Exchange is investigated over a 10-year study period from January 1995 to December 2004.

3.3.1 Data sources and calculation of variables

The main data source used for this study is the SIX Trust database accessible at the Ekonomiska biblioteket at the School of Business, Economics and Law Göteborg. The "raw" data obtained there consist of daily data for the following items for the sample stocks, with definitions from the SIX Trust database:

- Date
- Bid (*Köp*, *i.e.*, last quoted bid)
- Ask (*Sälj, i.e.* last quoted ask)
- Last price (*Senast betalt , i.e.* last paid price)
- Dividends (*Utdelning*)
- Number of traded shares (*Omsats Antal*. *i.e.* the number of shares traded during the opening hours on the Stockholm Stock Exchange[19])
- Number of shares outstanding (*Antal Aktier*, *i.e.* shares outstanding in the share class)
- Market value of equity (*Börsvärde*, *i.e.* the "bid" times the number of shares outstanding in that share class)

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[19] This is however only a part of the total trading, as discussed in more details in section 5.5. But, it reflects the liquidity that is immediately available for any kind of market participant.

Regarding the calculation of the monthly stock returns, the prices in the SIX Trust database are already adjusted for stock splits and stock dividends. The capital returns are calculated using quote mid-points. The cash dividends are added to the quote mid-point of the end of month where they occurred. As far as the choice between the use of simple returns or continuously compounded returns is concerned, according to Campbell et al. (1997, p. 12), when a cross-section of assets is studied, it is common to utilize simple returns. Thus, the return in month *t* for a given stock is calculated in the form of simple returns:

$$R_t = \frac{P_t + D_t}{P_{t-1}} - 1 \qquad \textbf{(4)}$$

In order to calculate the return on the market, it was intended to use the return on an equally weighted market index. The reason for this is that a market value weighted index such as Affärsvärldens Generalindex or SIX Return Index would be dominated by a few very large companies. However, the indices found either did not include dividend returns or did not offer a time-series long enough or were not equally weighted. Therefore, the return on the market in this study is calculated as the equally weighted total return on the stocks included in the sample.

The risk-free rate is the 1-month Swedish T-bill rate, prevailing at the beginning of each month, as obtained from the EcoWin database accessible at the Ekonomiska biblioteket.[20]

The market beta from the CAPM for each stock is calculated as the covariance between the monthly excess return on the stock in question and the monthly excess market return, divided by the variance of the monthly excess market return. The variance and the covariance are calculated over the 24 months preceding each month *t*.

The excess return on each stock in each month *t* is related to the level of liquidity of the stock during the preceding three months, *i.e. t-1, t-2, t-3*, as well as to the size (market value of equity) in the preceding three months, *t-1, t-2, t-3*. More precisely the "preceding

[20] EcoWin Financial → Sweden→ Money Market→ Treasury Bills, 1 month, Yield, Close, SEK

three months" means the preceding 63 trading days to make the periods equally long. However, the reasons why the variables are based on a period of three months and updated each month are: First, the explanatory variables are lagged and not contemporary because the information available at the beginning of each period should be considered, as the CAPM is originally formulated with expected returns. Second, only systematic variation in liquidity can be priced, while there would probably be some random fluctuation in the liquidity measures, if too short periods were considered. Therefore, these variables do not only refer to the immediate prior month.

More precisely, the liquidity measures (quoted and effective relative spread, share turnover rate, SEK trading volume, and the Amihud measure) as well as size (market value of equity) are calculated as follows:

The daily spreads (quoted and effective) are calculated as shown in equations 2 and 3 above, where the spread variable in each month *t* is the average over the existing values in the preceding three months. (Often, there is no last price and sometimes no complete quote.)

The daily SEK trading volume is the number of traded shares multiplied by quote mid-point[21] on a daily basis. The SEK trading volume variable for each month is the sum of the daily values in the preceding three months.

The share turnover rate for each month is the sum (over the preceding three months) of the daily ratios of number of shares traded and number of shares outstanding in that share class.

The Amihud measure for each month is calculated as the ratio of daily absolute return to daily SEK trading volume, averaged over the three preceding months, where the return is calculated based on quote mid-points. As already mentioned, the highest absolute daily returns are ignored, more precisely the highest returns for each stock over the whole study period, where the number of excluded returns corresponds to 5% of the number of trading days for the stock in question.[22] The monthly measure is multiplied by 1,000,000,000.

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[21] If there is no complete quote, the bid is used. When there is not bid on that date, the bid from the previous day is used.

[22] It is slightly inconsistent because in general returns in period *t* are to be explained with data available at the beginning of *t*. But in this case the elimination process of the highest daily returns is based on

Size corresponds to the average market value of equity over the preceding three months, where market value of equity is equal to the bid price multiplied by the number of shares outstanding in that share class.

As it can be seen in table 1 below, size and SEK trading volume are extremely positively skewed. Therefore they will be employed as their natural logarithm in the regressions. This transformation is not a problem because the values are always larger than 1.
Furthermore, size as well as the five liquidity variables for a given month will be used in the regressions as the deviation from their cross-sectional mean for that month[23], like in similar studies by Brennan et al. (1998, p. 352) and Chordia et al. (2001, p. 10). As these authors point out, this means that a stock with average size and average liquidity level will have a value of zero for these characteristics, so that its return will only be determined by its risk. Moreover, the level of general level of market trading activity has changed during the study period. As the coefficients in the regressions will be aggregated over time (see section 3.4.3 and 3.4.4), this procedure makes sure that the variables are comparable over time.

3.3.2 The sample

This study covers the common stocks, both foreign and Swedish ones, listed during the study period on the Stockholm Stock Exchange on the A-list or the O-list (or on the OTC-list which existed until 2000 when its listed shares were transferred to the O-list).
Theoretically, it is intended to include all companies that were listed during the study period on one of these lists. This means that not only the shares listed at the end of 2004

information on all daily returns over the study period. However, the exclusion of the highest returns for each time period across all companies would be an even worse approach because there are effects that affect all companies at some times, while in other times there are no news at all. And, the exclusion of the highest returns in each 3-month-period for each company would imply that the unexpected news should be very equally distributed.

[23] The variables are calculated as: (value for a stock in the given month – cross sectional mean for that month) / cross sectional mean for that month. They thus report how much larger or smaller a variable is compared to the mean.

on the Stockholm Stock Exchange are to be included, but also those that have been delisted during the study period, in order to minimize any possible "survivorship bias".

A detailed description of the actual inclusion and exclusion procedure is presented in appendix I. The most important points are that only one share class per company is included, namely the one with the smallest number of voting rights, and that the market beta for each stock has to be estimated with 24 months of return data before a stock can be included in the study.

This procedure results in a number of 374 different companies in the sample. On average there are 180 companies per month, with a minimum of 81 companies and a maximum of 253 companies. The total number of observations is 21,558.

3.3.3 Descriptive statistics

Table 1 shows basic descriptive statistics for the variables used in the study. It can easily be seen that there is a huge variation among the sample stocks with respect to their liquidity, which is a prerequisite of this study.

Table 1: Descriptive statistics

The statistics shown are based on the variables calculated as described in section 3.3.1, *i.e.* the liquidity measures are averages or sums over 3-month-periods. The statistics have been calculated for the sample in each of the 120 months. They are reported as their time-series mean over the 120 months. The variables are untransformed variables, *i.e.* no logarithms are taken.

	Quoted relative spread in %	Effective relative spread in %	Trading volume in million SEK	Share turnover rate in %	Amihud measure	Market value in million SEK	Beta	Excess return
Mean	2.43	2.05	2,303	16.60	179.86	8,127	0.95	0.010
Median	1.68	1.48	104	10.91	48.92	956	0.79	0.002
Variance	8.80	5.82	243,496,732	522.79	248,353.15	1,529,354,996	0.50	0.017
Skewness	3.64	3.49	9.43	4.50	4.19	8.07	0.97	1.12
Kurtosis	21.27	20.56	107.02	33.71	24.22	81.29	3.18	9.33
Minimum	0.20	0.19	0.62	0.41	0.02	18	-0.91	-0.349
Maximum	20.59	16.70	156,087	192.46	2,841.60	365,662	3.94	0.661

In order to illustrate how the level of liquidity has developed over time, appendix II shows the development over time of the means of the liquidity variables, as well as of size and of the number of sample stocks.

3.4 Methods

This section presents the methods that will be employed to find an answer to the research questions and to test the hypotheses. While the portfolio analysis intends to give only a first informal insight and the correlation analysis focuses on the relation between liquidity and size, the cross-sectional regressions and the pooled regression model aim at answering the two research questions in a more formal way. The methods themselves as well as the insights expected from them are presented in this section.

3.4.1 Portfolio analysis

First of all, average returns on portfolios of stocks ranked on different criteria will be compared. This shows in an informal way if there is any association between the variables of interest. An example of a study that applies such an analysis as a precursor of a regression analysis in a context similar to this present study is Chordia et al. (2001, pp. 12-13).

Procedure

In each month, stocks are ranked according to their market beta and are divided into five groups. Thus, the first sorting variable in each case is the stock's beta, where portfolio 1 consists of low beta stocks, and portfolio 5 consists of high beta stocks. Having assigned the stocks to one of the five beta portfolios, in a second step, each beta group is sub-divided into five sub-groups according to one of the liquidity measures or size. When each of the five beta portfolios is divided into five sub-portfolios, sub-portfolio 1 contains the stocks with the highest liquidity measures, or the lowest illiquidity measures, or the largest market capitalization, depending on the case. (Sub-portfolio 5 contains the stocks with the lowest liquidity measures, or the highest illiquidity measures, or the smallest market capitalization, depending on the case.) Thus, in total there are 25 different portfolios.[24]

This procedure of assigning stocks to a portfolio is repeated each month, *i.e.* the portfolios are rebalanced each month. Equally weighted average returns[25] for each portfolio and each month are calculated. Next, the average over the 120 months of the average return in each of the 25 portfolios is calculated. Tables 2 - 7 in section 4.1 report, for each of the 25 portfolios, across all months, the average return, the respective average (il)liquidity measure, and average size, where all averages are equally weighted.

Expected insights

This method is applied in order to obtain a first informal insight into the following questions:

- Is return increasing in beta?
  This should be expected according to the CAPM, but is of no important meaning to test the hypothesis of this study.
- Does return seem to increase in illiquidity / decrease in liquidity?
  (referring to step 1c of the general research design in section 3.1)
- Does return decrease in size?
  (referring to step 2a of the general research design)
- Are size and liquidity positively associated?
  (referring to step 2b of the general research design)

The ranking procedure implies that average portfolio returns are, according to hypothesis 1, expected to increase in the number of the liquidity group (tables 3-7). And in case of

[24] The number of five beta-portfolios, with five sub-portfolios for each, implies that there are in total 25 portfolios. The number of five is arbitrarily chosen, but takes into account that with a smaller number of portfolios there would be less variation in the variables. Yet, with six times six portfolios, there would be portfolios with just two stocks in it during the periods with a low number of sample stocks. Therefore the number of portfolios is five times five. In case the number of stocks in the period does not allow the portfolios to be of equal number of stocks, the “spare” stocks are first assigned to portfolio number 1, then to 5, then to 2, then to 4.

[25] Gross return, not excess return over the risk free rate

the presence of a small company effect, average portfolio returns are expected to increase in the number of the size group (table 2).

3.4.2 Correlation analysis

Although very simple, an investigation of the correlation between the liquidity measures and size can help examine hypothesis 2.

Procedure

Cross-sectional Pearson correlation coefficients between the liquidity measures and size are calculated each month. Table 8 shows their time-series mean over the 120 months. It also reports in how many out of the 120 months the correlation is significant at the 0.05 level (2-tailed).

Expected insights

Like the portfolio analysis, this approach shows whether size and liquidity are positively associated. Such an association is necessary if the level of liquidity explained any small company effect (referring to step 2b of the general research design). More precisely, size is expected to be positively correlated to liquidity and negatively to illiquidity.

3.4.3 Cross-sectional regressions

As it has been hypothesized that the cross-sectional variation of the illiquidity of the stocks contributes to the explanation of the cross-section of return, the most obvious method to investigate this in a formal way is a cross-sectional regression approach. The cross-sectional approach to test the CAPM has first been developed by Fama and MacBeth (1973). However, as Campbell et al. (1997, p. 216) point out, the Fama and MacBeth (1973) approach is particularly useful because it can easily include more explanatory variables than just the market beta from the CAPM. As it is seen below, the cross-sectional regressions from each period yield a time-series of estimates of the coefficients which have to be aggregated over time in order to obtain one overall coefficient. The classical Fama and MacBeth (1973) approach of averaging the coefficients over time can be further refined by the Litzenberger and Ramaswamy (1979) approach. However, both approaches have some inconveniences.

Procedure

Under the cross-sectional regression approach in this study, for each month as cross-sectional regression is run. The regressions coefficients obtained for each month are then averaged across time. The significance of the coefficients can be tested with the help of a standard t-test. (For details see Fama and MacBeth (1973), or, *e.g.*, Campbell et al. (1997, pp. 215-217).

The following regressions model is estimated using the Ordinary Least Squares method. For each month t, the regression model is run across the cross-section of i stocks, with j explanatory variables, depending on the case:

$$R_{it} = \gamma_{0t} + \sum_{j=1}^{J} \gamma_{jt} x_{it} + \varepsilon_{it} \ , \quad i = 1, 2, ..., N_t, \ t = 1, 2, ..., T, \qquad \textbf{(5)}$$

where R_{it} is the excess return on a stock i in month t, x_{it} are the values of j explanatory variables of stock i in month t, as defined in section 3.3.1. The number of stocks N_t varies from month to month, and ε_{it} is the error term. In appendix III it is examined whether the residuals show any violation of the assumptions for Ordinary Least Squares regressions. The regression model can be rewritten for the case $j = 3$ as:

$$\text{EXCESS RETURN}_{it} = \gamma_{0t} + \gamma_{1t}\,\text{BETA}_{it} + \gamma_{2t}\,\text{LIQUIDITY}_{it} + \gamma_{3t}\,\text{SIZE}_{it} + \varepsilon_{it} \qquad \textbf{(6)}$$

The model is estimated for each of the $t = 1,\ldots,120$ months. Thus a time-series of estimates for γ_{0t} , γ_{1t} , γ_{2t} , and γ_{3t} is obtained, with 120 estimates for each coefficient.

However, as already mentioned, these time-series of estimates have to be aggregated over time in order to obtain an overall estimate of the coefficient. There are different ways of how to deal with that.

Under the classical Fama and MacBeth (1973) approach, these T=120 estimates for each coefficient γ_j are averaged across time as follows[26]:

$$\hat{\gamma}_j = \frac{1}{T}\sum_{t=1}^{T}\hat{\gamma}_{jt} \qquad \textbf{(7)}$$

To test the hypothesis that $\gamma_j = 0$, the t-statistic of $\hat{\gamma}_j$ can be calculated as follows, being defined as $\omega(\hat{\gamma}_j)$:

$$\omega(\hat{\gamma}_j) = \frac{\hat{\gamma}_j}{\sigma_{\gamma_j}} \qquad \textbf{(8)}$$

$$\text{with} \quad \sigma^2_{\gamma_j} = \frac{1}{T(T-1)}\sum_{t=1}^{T}(\hat{\gamma}_{jt} - \hat{\gamma}_j)^2 \qquad \textbf{(9)}$$

The interpretation of the t-statistic can be based on a distribution of $\omega(\hat{\gamma}_j)$ that is Student t with (T-1) degrees of freedom.[27]

This classical cross-sectional Fama and MacBeth (1973) approach is widely used and has for example been employed by Fama and French (1992) in the context of the development of the Fama-French-three-factor model. In the context of illiquidity premiums in stock returns it has been used, for example, by Amihud (2002), Eleswarapu (1997), and Chalmers and Kadlec (1998).

However, there are some problems with respect to the aggregation of the estimates over time. The Fama and MacBeth (1973) approach assumes that each of the estimates of the coefficient is drawn from a stationary distribution (see, *e.g.*, Litzenberger and

[26] The following equations are based upon Fama and MacBeth (1973, p. 619), and Campbell et al. (1997, eqs. 5.8.2- 5.8.4)

[27] For a discussion why the use of t-statistics is appropriate even if stock returns are not normally distributed (as it is assumed when interpreting t-statistics) please refer to Fama and MacBeth (1973, pp. 619-624).

Ramaswamy, 1979, p. 175). This means that the true coefficient should have a constant mean and constant variance over time. Under the Fama and MacBeth (1973) approach, the variance of the estimate (which is needed to obtain the t-statistics) is solely based on the variance of the time-series of estimates of the coefficient. The variance of the time-series estimates should therefore not include any other sources of variance. In addition to that, the mean of the true coefficient should be constant. This is especially a problem for the coefficient for the beta variable. The reason for this is that the coefficient should theoretically be equal to the market premium for each period (see below). And this market premium is of course positive in some periods and negative in other periods.

As far as the explanatory variables size and liquidity are concerned, the general market level of market capitalization and liquidity may vary over time. But, as described in section 3.3.1, the explanatory variables size and liquidity are employed as deviation from their cross-sectional mean for each month. This intends to make sure that the variables are comparable over time. Therefore, it can be considered reasonable to aggregate the coefficients of the size and the liquidity variables over time.

Moreover, under the Fama and MacBeth (1973) approach, equal weight is placed on all estimates in the time-series of estimates. The standard error with which these estimates are obtained is not taken into account. Therefore, Litzenberger and Ramaswamy (1979) propose a refinement of this classical approach. They put more weight on the estimates that are obtained with more precision and less weight on the estimates that are obtained with less precision (see, *e.g.*, Datar et al. (1998) who use this method in the context of illiquidity premiums in stock returns). In other words, the estimator of the overall coefficient, $\hat{\gamma}_j$, is the weighted mean of the monthly estimates, with the weights being inversely proportional to the variances of these estimates (Litzenberger and Ramaswamy (1979, eqs. 27-29):

$$\hat{\gamma}_j = \sum_{t=1}^{T} Z_{jt} \hat{\gamma}_{jt} \ , \quad \textbf{(10)}$$

$$\text{var}(\hat{\gamma}_j) = \sum_{t=1}^{T} Z_{jt}^2 \, \text{var}(\hat{\gamma}_{jt}) \ , \quad \textbf{(11)}$$

$$Z_{jt} = \left[\text{var}(\hat{\gamma}_{jt})\right]^{-1} \Big/ \sum_{t} \left[\text{var}(\hat{\gamma}_{jt})\right]^{-1} . \quad \textbf{(12)}$$

Nevertheless, the Litzenberger and Ramaswamy (1979) method has an inconvenience, too. It has the objective to give more precise estimates of the coefficients, with less variance. However, incorrect conclusions might be drawn when relying too much on estimated coefficients that are, to some extent, forced to appear significant, due to the reduction in estimated variance.

The problems inherent to both approaches are tackled in the following way. The time-series of the coefficients will be aggregated over time in order to obtain an overall estimate of the coefficient, as well as an estimate of its variance. This will be done both with the equal-weighting approach of Fama and MacBeth (1973) and with the refined approach of Litzenberger and Ramaswamy (1979). The significance of the obtained coefficients will be tested with the help of a t-test. However, in order not to rely too much on the estimates from the Litzenberger and Ramaswamy (1979) approach with reduced variance, it is also reported in how many of the 120 months of this study the monthly coefficients are significant. This simple "counting" does not allow any formal hypothesis testing, but is intended to check the plausibility of the estimates obtained with the Litzenberger and Ramaswamy (1979) approach.
As far as the coefficient of the beta variable is concerned, as mentioned the above, the coefficient cannot be assumed to be constant over time. Therefore, additionally, it is tested for each individual month whether the estimated coefficient can be equal to the market premium in that month, as suggested by theory. This is reported in appendix IV.

An additional word of caution is due because there might be an "errors-in-variables" problem in the regressions. In the above regression, a stock's beta (its relative risk) is one of the explanatory variables, which according to the CAPM should be positively related to returns. This beta has to be estimated because true betas are of course not observable. Thus the beta has to be estimated, while the other variable used are only sums or averages of numbers that can be read from the data source. This "measurement error" can lead to a complication in the regression because generally it is assumed that explanatory variables are measured without error. This problem is discussed in more details in appendix V. It is however assumed in this study that the betas estimated as described in section 3.3.1 are of sufficient quality.

Expected insights

The cross-sectional regressions intend to make sure that the CAPM is not sufficient to explain the cross-section of returns, as expressed by step 1a of the general research design. The CAPM would imply that the overall estimate of the coefficient of the beta variable (*i.e.* the time-series average of the monthly estimates) is positive, *i.e.* $\gamma_1 > 0$, *i.e.* that there is a positive market risk premium, which should correspond to the average excess market return during the study period (1.007 % on a monthly basis). In addition to that, the CAPM would imply that $\gamma_0 = 0$, *i.e.* that there is no intercept and a security's return is solely determined by its risk (see, *e.g.,* Campbell et al., 1997, p. 215, or Black et al., 1972, p. 91). Thus, in this present study it is especially expected that the estimate of $\gamma_0 \neq 0$.

As discussed in detail above, it is difficult to obtain an average of the monthly estimates of the coefficient for the beta variable (γ_{1t}). However, on a monthly basis, if the CAPM is does not function in the predicted way, the estimates of γ_{1t} will not be equal to the market premium in that month.

Furthermore it is expected that the regressions with market beta only have a rather low R^2.

Moreover, with the cross-sectional regressions, hypothesis 1 will be tested formally, namely, whether the level of liquidity has explanatory power for the cross-section of returns (step 1c of the general research design). If hypothesis 1 is not to be rejected, then the estimate of coefficient γ_2 has to be positive in case the liquidity variable measures illiquidity (quoted relative spread, effective relative spread, Amihud), and negative in case the liquidity variable measures liquidity (SEK trading volume, and with limitations discussed in section 3.2.2, also share turnover rate). The relationship between (il)liquidity and return should be robust throughout the different measures used.

In addition to that, the cross-sectional regression can test more formally whether there is a small company effect and whether hypothesis 2 can at all be examined, which corresponds to step 2a of the general research design. Thus, the estimate of γ_3 should be negative in absence of any liquidity related variable.
Finally, in case illiquidity can explain parts of the small company effect (hypothesis 2 and step 2c of the general research design) the inclusion of a liquidity variable should decrease the magnitude of the estimate of γ_3 or even make it statistically insignificant.

However, due to difficulties in aggregating over time the coefficients obtained for each period, there is motivation to use, in addition to the cross-sectional regressions, a regression model that pools cross-sectional and time-series data in one model, as described in the following section.

3.4.4 Pooling of the cross-sectional and time-series data

Procedure

Under this approach all the observations in the data set will be employed in the same model. This means the time-series of data that exist on a cross-section of stocks will be "pooled" into the same model.
The most important advantage of such a procedure is that the increased number of observations leads to more reliable estimates of the regression coefficients when compared to a pure cross-sectional or pure time-series approach (Balestra, 1996a, p. 26). Furthermore, the problem described in the previous section, namely the question of how to average across time the coefficients obtained from the monthly cross-sectional regressions, is avoided.

The model chosen to pool the data of this study is the so called fixed effects model[28] or dummy variables model. The response parameters are assumed to be constant for all companies and for all periods. This is important to note. But the intercept may vary from company to company and/or from period to period. More precisely, an intercept that is allowed to vary from period to period would take into account time specific effects. An intercept that is allowed to vary from company to company would take into account company specific effects (see for more details Balestra, 1996b, pp. 34-43, or, Hill et al., 2001, pp. 357-359).

In the cross-sectional approach in the previous section there has been an intercept in each month. For this reason, in the pooled model of this study the intercept will be allowed to vary from month to month, too. This should ensure that the results obtained under both methods are comparable. There will not be any intercepts that take into account company specific effects. This would make it impossible to compare the results from the two regression methods. And, in addition to that, asset pricing models generally assume that there are no such effects. (And the computational efforts would increase when additional 374 intercepts are needed.)

The model looks very similar to the model of the cross-sectional regressions. The differences are that there is just one overall response parameter per explanatory variable (γ_j), and one overall intercept (γ_0), and in addition to that, an intercept[29] that varies from month to month (α_t). Thus, the model that is estimated with Ordinary Least Squares[30] regressions is the following:

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[28] This is opposed to a random effects model or error component model, which would be appropriate if the sample companies were chosen randomly from a larger population and were representative of the latter (Hill et al., 2001, p. 359). This is not the case for this present study because the sample comprises as many companies as possible.

[29] The actual model with which the regressions are run has a dummy variable for each month, which creates an intercept for each month. This is the reason why the model can be called dummy variables model.

[30] For the pooled model, it has not been tested whether the residuals show any violation of the assumptions necessary for Ordinary Least Squares. It is rather assumed that the conclusions drawn for the residuals in the cross-sectional model (appendix III) regarding linearity, normality, constant variance and absence of multicollinearity are valid for the pooled model, too. However, as far as multicollinearity is concerned, it has to be noted that the SPSS programme automatically deletes one of the 120 dummy variables in order to avoid a multicollinearity problem. Nevertheless, it must be noted that there is probably a problem with auto-correlation. The size and liquidity variables for each month have been calculated over the 3-month-period preceding each month. This implies that they must be correlated over time.

$$R_{it} = \gamma_0 + \alpha_t + \sum_{j=1}^{J} \gamma_j x_{it} + \varepsilon_{it} \ , \quad i = 1, 2, ..., N_t \, , \, t = 1, 2, ..., T, \tag{13}$$

where R_{it} is the excess return on a stock i in month t, x_{it} are the values of j explanatory variables of stock i in month t. The number of stocks N_t varies from month to month, and ε_{it} is the error term.

Amihud and Mendelson (1986a) and Amihud and Mendelson (1989) for instance use such a pooled time-series and cross-section methodology. Yet, Chen and Kan (1995) mention concern that the positive association that Amihud and Mendelson find between the relative spread and return might be a spurious effect.

The reasoning of Chen and Kan (1995) is based on Miller and Scholes (1982) who find evidence that there is a positive association between return and the inverse of the stock price. Miller and Scholes (1982, p. 1133) argue that the inverse of the price (from the end of the previous period) "may contain additional and more recent information about the firm's risk and prospects" than an estimated beta. As Chen and Kan (1995) do not obtain the same results as Amihud and Mendelson (1986a) (with the same data but with different methods), the former present three explanations why the findings of the latter might be spurious:

First of all, like in Fama and MacBeth (1973) type cross-sectional regressions, the betas are estimated with imprecision. In addition to that, according to Chen and Kan (1995), a variable that is a function of the stock price may lead to spurious results especially in a regression model that pools time-series and cross-sectional data. Chen and Kan (1995) show that, over time, the market return is positively related to the relative spread averaged across all stocks in the preceding period. Therefore, the spread variable may proxy for changes in the market premium, which in a pooled model is forced to be constant over time.[31] In this study, this problem is tried to be attenuated in the way described below, which, however, might not be a perfect solution. Furthermore, Chen and Kan (1995) find evidence that the relative spread may also proxy for changes in the beta

[31] In the model by Amihud and Mendelson (1986a), the estimate of beta is used as explanatory variable and the estimate of its coefficient should correspond to the market premium, like in the cross-sectional regressions of this study.

of a stock over time. This is problem is not solved in this present study, but taken into account when the results are analyzed.
Although Chen and Kan (1995) refer mainly to relative spreads (and also size), the same thinking can be applied to the variable SEK trading volume and the Amihud measure.

However, the problem that there is just one constant coefficient per explanatory variable, which is especially a problem for the coefficient for the beta variable, is tackled in the following way: The beta variable will not be used in the form of the estimated beta for each company and each month (*i.e.* BETA_{it}) like in the cross-sectional regressions, but in the form of estimated beta for each company and each month times the market premium for the given month, *i.e.* [BETA_{it}* (market return $_t$ – risk free rate $_t$)]. This procedure intends to take into account that the market premium is not constant over time.

For the case $j = 3$, the regression model can be written as:

$$\text{EXCESS RETURN}_{it} = \gamma_0 + \alpha_t + \gamma_1 \text{ BETA}_{it}{*}(\text{Rm}_t - \text{Rf}_t) + \gamma_2 \text{ LIQUIDITY}_{it} + \gamma_3 \text{ SIZE}_{it} + \varepsilon_{it} \qquad \textbf{(14)}$$

where BETA_{it} is the estimate of the beta of stock i in month t, Rm_t is the market return in month t, and Rf_t is the risk free rate in month t.

Expected insights

The expectations with respect to the signs of the regression coefficients for size and liquidity are the same as for the overall coefficients from cross-sectional regressions and will not be repeated here. The coefficient for the variable $\text{BETA}_{it}{*}(\text{Rm}_t - \text{Rf}_t)$ should be 1 if the CAPM works. It is therefore expected that it is different from 1.

4 Presentation and analysis of empirical results

Firstly, this section presents the results from the portfolio analysis, in order to give a first insight into the relationships among the investigated variables. Secondly, it examines the association between the liquidity measures and size, and that will be done with the help of a simple examination of the correlation coefficients. Thirdly, this section presents and analyzes the more formal results from the cross-sectional regressions, obtained with the classical Fama and MacBeth (1973) approach, as well as those obtained with the refined approach of Litzenberger and Ramaswamy (1979). Fourthly, it reports the results from the pooled regression model. Based on this, it is analyzed whether the hypotheses of this study can be found to be validated. Finally, in order to investigate the quality with which the results are obtained, reliability and validity of the study are discussed.

4.1 Portfolio analysis

Tables 2 - 7 report the average returns on portfolios consisting of stocks sorted on beta and liquidity measures or size, according to the procedure described in detail in section 3.4.1.[32]

4.1.1 Beta and size

Table 2 examines the relationship between beta and return as well as size and return. It can be seen that average return decreases in average beta, which is the opposite of what the CAPM suggests.

As far as the size effect in concerned, within the 25 beta-size portfolios the pattern is not very clear. But, if the average across the five size groups only is considered (the last

[32] The variables are of the specification described in section 3.3.1. Thus, the return in a given period t is related to the beta estimated with the returns of the preceding 24 months (t-1 to t-24) and the size and the liquidity variables calculated over the preceding 3 months (t-1, t-2, t-3), like in the cross-sectional regressions. The means in the table (column on the right and line at the bottom) are the mean across the other fields in the table. This implies that the numbers for the means across beta groups are not equal among all tables because, because, depending on the sub-group a stock is assigned to, the stock gets a different weight because of unequal portfolio sizes.

column on the right in table 2), return seems to decrease in size, except for the group with the largest companies.

Furthermore, size and beta do not seem to be strongly related as the five beta groups consist of stocks with, on average, similar size.

Table 2: Average return on portfolios sorted on beta and size

In each month, the sample stocks are ranked according to their estimated beta and divided into five groups. Then, each group is divided into five sub-groups according to market value. The table shows equally weighted average gross returns for each portfolio, as well as the equally weighted average beta and average market value of each of the 25 portfolios. The column and the row entitled "Mean" shows the equally weighted means of the variables across the five size groups or across the five beta groups, respectively. Market value is reported in million SEK.

				beta					
				low systematic risk			high systematic risk		
				1	2	3	4	5	**Mean**
size	large size	1	portfolio no.	11	21	31	41	51	
			monthly return	**1.68%**	**1.35%**	**1.49%**	**1.14%**	**0.39%**	**1.21%**
			beta	0.24	0.56	0.81	1.14	1.85	**0.92**
			market value	26,658	30,513	31,783	34,688	45,574	**33,843**
		2	portfolio no.	12	22	32	42	52	
			monthly return	**1.73%**	**1.25%**	**1.45%**	**1.12%**	**0.36%**	**1.18%**
			beta	0.28	0.55	0.79	1.19	1.96	**0.95**
			market value	3,518	3,797	4,926	3,472	1,505	**3,444**
		3	portfolio no.	13	23	33	43	53	
			monthly return	**1.54%**	**1.42%**	**1.55%**	**0.11%**	**1.65%**	**1.25%**
			beta	0.23	0.55	0.80	1.18	1.98	**0.95**
			market value	1,290	1,291	1,687	1,164	615	**1,209**
		4	portfolio no.	14	24	34	44	54	
			monthly return	**2.16%**	**1.79%**	**1.62%**	**1.04%**	**0.47%**	**1.42%**
			beta	0.23	0.55	0.81	1.17	2.10	**0.97**
			market value	486	468	615	515	291	**475**
	small size	5	portfolio no.	15	25	35	45	55	
			monthly return	**2.63%**	**1.74%**	**0.93%**	**1.25%**	**1.22%**	**1.55%**
			beta	0.14	0.55	0.81	1.18	2.15	**0.97**
			market value	127	147	172	185	125	**151**
	Mean		monthly return	**1.95%**	**1.51%**	**1.41%**	**0.93%**	**0.82%**	
			beta	**0.22**	**0.55**	**0.80**	**1.17**	**2.01**	
			market value	**6,416**	**7,243**	**7,837**	**8,005**	**9,622**	

4.1.2 Quoted relative spread and effective relative spread

Table 3 and 4 illustrate the relationships between return, beta, and quoted relative spread, and between return, beta, and effective relative spread, respectively. When examining the averages across the five spread groups (the last column on the right in each table), it can be seen that the spread group with the highest spread has the highest return, and the group with the lowest spread has the lowest return. More precisely, the difference in monthly returns between 1.28% and 1.44% for the quoted relative spread, and between 1.25% and 1.38% for the effective relative spread corresponds, on an annual basis, to a return difference of 1.92 and 1.56 percentage points, respectively.

However, for the spread groups 2, 3, and 4 no pattern can be seen. Nevertheless, it can be stated that there seems to be a strong negative association between size and spread. This is evident even within each beta group (each column).

Table 3: Average return on portfolios sorted on beta and quoted relative spread

In each month, the sample stocks are ranked according to their estimated beta and divided into five groups. Then, each group is divided into five sub-groups according to quoted relative spread. The table shows equally weighted average gross returns for each portfolio, as well as the equally weighted average beta, average quoted relative spread, and average market value of each of the 25 portfolios. The column and the row entitled "Mean" shows the equally weighted means of the variables across the five spread groups or across the five beta groups, respectively.
Market value is reported in million SEK, the quoted relative spread (QRS) in %.

liquidity			beta: low systematic risk 1	2	3	4	high systematic risk 5	Mean
high liquidity	1	portfolio no.	11	21	31	41	51	
		monthly return	**1.94%**	**1.50%**	**1.57%**	**1.28%**	**0.13%**	**1.28%**
		beta	0.25	0.56	0.80	1.15	1.96	**0.94**
		QRS	0.64	0.55	0.51	0.58	0.70	**0.60**
		market value	24,266	28,823	28,480	33,394	44,798	**31,952**
	2	portfolio no.	12	22	32	42	52	
		monthly return	**1.62%**	**1.39%**	**1.56%**	**0.85%**	**1.21%**	**1.33%**
		beta	0.25	0.55	0.80	1.18	1.98	**0.95**
		QRS	1.26	1.10	0.89	1.20	1.28	**1.14**
		market value	4,465	4,394	6,964	3,840	1,725	**4,278**
	3	portfolio no.	13	23	33	43	53	
		monthly return	**1.85%**	**1.30%**	**1.24%**	**0.80%**	**1.41%**	**1.32%**
		beta	0.23	0.55	0.80	1.18	2.01	**0.95**
		QRS	1.94	1.66	1.36	1.80	1.90	**1.73**
		market value	2,102	1,865	2,581	1,555	895	**1,800**
	4	portfolio no.	14	24	34	44	54	
		monthly return	**1.81%**	**1.63%**	**1.40%**	**1.19%**	**0.38%**	**1.28%**
		beta	0.26	0.55	0.81	1.18	2.04	**0.97**
		QRS	3.00	2.65	2.20	2.78	2.83	**2.69**
		market value	1,085	963	1,003	896	502	**890**
low liquidity	5	portfolio no.	15	25	35	45	55	
		monthly return	**2.55%**	**1.77%**	**1.28%**	**0.56%**	**1.06%**	**1.44%**
		beta	0.14	0.55	0.80	1.17	2.06	**0.94**
		QRS	7.32	5.82	5.20	5.96	5.46	**5.95**
		market value	323	333	368	442	238	**341**
Mean		monthly return	**1.96%**	**1.52%**	**1.41%**	**0.94%**	**0.84%**	
		beta	**0.22**	**0.55**	**0.80**	**1.17**	**2.01**	
		QRS	**2.83**	**2.35**	**2.03**	**2.46**	**2.43**	
		market value	**6,448**	**7,276**	**7,879**	**8,026**	**9,632**	

Table 4: Average return on portfolios sorted on beta and effective relative spread

In each month, the sample stocks are ranked according to their estimated beta and divided into five groups. Then, each group is divided into five sub-groups according to effective relative spread. The table shows equally weighted average gross returns for each portfolio, as well as the equally weighted average beta, average effective relative spread, and average market value of each of the 25 portfolios. The column and the row entitled “Mean” shows the equally weighted means of the variables across the five spread groups or across the five beta groups, respectively.
Market value is reported in million SEK, the effective relative spread (ERS) in %.

			beta					
			low systematic risk			high systematic risk		
			1	2	3	4	5	**Mean**
liquidity (high liquidity)	1	portfolio no.	11	21	31	41	51	
		monthly return	**1.87%**	**1.39%**	**1.55%**	**1.24%**	**0.21%**	**1.25%**
		beta	0.25	0.56	0.80	1.14	1.96	**0.94**
		ERS	0.59	0.52	0.48	0.55	0.66	**0.56**
		market value	23,236	28,147	28,125	33,257	44,789	**31,511**
	2	portfolio no.	12	22	32	42	52	
		monthly return	**1.53%**	**1.39%**	**1.63%**	**0.94%**	**1.20%**	**1.34%**
		beta	0.24	0.55	0.81	1.17	1.97	**0.95**
		ERS	1.12	0.99	0.82	1.09	1.18	**1.04**
		market value	5,654	4,996	7,073	3,932	1,752	**4,681**
	3	portfolio no.	13	23	33	43	53	
		monthly return	**1.94%**	**1.34%**	**1.53%**	**0.57%**	**1.32%**	**1.34%**
		beta	0.24	0.55	0.80	1.19	1.99	**0.95**
		ERS	1.67	1.45	1.21	1.58	1.70	**1.52**
		market value	2,147	2,008	2,899	1,624	884	**1,913**
	4	portfolio no.	14	24	34	44	54	
		monthly return	**1.87%**	**1.71%**	**1.37%**	**1.54%**	**0.21%**	**1.34%**
		beta	0.25	0.55	0.81	1.17	2.04	**0.96**
		ERS	2.50	2.24	1.93	2.34	2.46	**2.29**
		market value	1,011	920	976	923	497	**865**
(low liquidity)	5	portfolio no.	15	25	35	45	55	
		monthly return	**2.56%**	**1.77%**	**0.94%**	**0.42%**	**1.22%**	**1.38%**
		beta	0.14	0.55	0.80	1.17	2.08	**0.95**
		ERS	5.62	4.57	4.24	4.92	4.54	**4.78**
		market value	324	335	402	430	236	**345**
	Mean	monthly return	**1.96%**	**1.52%**	**1.40%**	**0.94%**	**0.83%**	
		beta	**0.22**	**0.55**	**0.80**	**1.17**	**2.01**	
		ERS	**2.30**	**1.96**	**1.74**	**2.09**	**2.11**	
		market value	**6,474**	**7,281**	**7,895**	**8,033**	**9,632**	

4.1.3 SEK trading volume

Table 5 (see last column on the right in the table) shows that the liquidity group with the highest liquidity has a lower return than the liquidity group with the lowest liquidity. However, in between there does not seem to be any pattern.

Furthermore, the row at the bottom of the table indicates that low beta stocks tend to have a low SEK turnover, whereas high beta stocks tend to have a high SEK turnover. While the relationship between beta and return does not have the "correct" sign, the row at the bottom of the table gives the impression that return seems to decrease in trading volume, after systematic risk is controlled for.

Moreover, SEK trading volume and size are strongly and positively related, even in all beta groups.

4.1.4 Share turnover rate

Table 6 shows that the expected relationship between share turnover rate and return is only present in the turnover groups 1 to 3 (see last column on the right in the table). Then, in groups 4 and 5, it is reversing. But, as mentioned previously, it is difficult to have any clear expectation concerning the impact of share turnover rate.

Moreover, beta and turnover rate seem to be positively associated. A look at the bottom line of the table shows that return seems to decrease in turnover rate, which is the same as what has been seen above with regards to SEK trading volume.

As it has already been seen for the other liquidity measures, size and liquidity seem to be positively related to each other.

Table 5: Average return on portfolios sorted on beta and SEK trading volume

In each month, the sample stocks are ranked according to their estimated beta and divided into five groups. Then, each group is divided into five sub-groups according to SEK trading volume. The table shows equally weighted average gross returns for each portfolio, as well as the equally weighted average beta, average SEK trading volume, and average market value of each of the 25 portfolios. The column and the row entitled "Mean" shows the equally weighted means of the variables across the five trading volume groups or across the five beta groups, respectively.
Market value is reported in million SEK. SEK volume is the total SEK trading volume over 3-month periods and reported in million SEK.

			beta					
			low systematic risk			high systematic risk		
			1	2	3	4	5	**Mean**
liquidity	high liquidity	1	portfolio no.	11	21	31	41	51	
			monthly return	**1.54%**	**1.47%**	**1.52%**	**1.02%**	**0.53%**	**1.21%**
			beta	0.25	0.56	0.81	1.14	1.93	**0.94**
			SEK volume	4,967	6,543	9,256	11,687	19,669	**10,424**
			market value	25,333	29,790	31,133	34,288	45,145	**33,138**
		2	portfolio no.	12	22	32	42	52	
			monthly return	**1.76%**	**1.33%**	**1.76%**	**0.99%**	**-0.20%**	**1.13%**
			beta	0.25	0.55	0.80	1.20	2.05	**0.97**
			SEK volume	344	367	748	526	337	**464**
			market value	3,921	3,880	5,011	3,432	1,591	**3,567**
		3	portfolio no.	13	23	33	43	53	
			monthly return	**1.99%**	**1.54%**	**1.00%**	**0.85%**	**1.77%**	**1.43%**
			beta	0.22	0.55	0.80	1.18	2.04	**0.96**
			SEK volume	94	100	165	155	130	**129**
			market value	1,711	1,557	2,015	1,408	819	**1,502**
		4	portfolio no.	14	24	34	44	54	
			monthly return	**2.61%**	**1.77%**	**1.05%**	**0.81%**	**0.49%**	**1.34%**
			beta	0.23	0.55	0.81	1.18	2.02	**0.96**
			SEK volume	25	31	50	57	56	**44**
			market value	935	774	762	632	392	**699**
	low liquidity	5	portfolio no.	15	25	35	45	55	
			monthly return	**1.92%**	**1.55%**	**1.64%**	**1.04%**	**1.55%**	**1.54%**
			beta	0.16	0.55	0.80	1.16	2.00	**0.93**
			SEK volume	5	8	13	16	19	**12**
			market value	275	263	313	303	202	**271**
	Mean		monthly return	**1.96%**	**1.53%**	**1.39%**	**0.94%**	**0.83%**	
			beta	**0.22**	**0.55**	**0.80**	**1.17**	**2.01**	
			SEK volume	**1,087**	**1,410**	**2,046**	**2,488**	**4,042**	
			market value	**6,435**	**7,253**	**7,847**	**8,012**	**9,630**	

Table 6: Average return on portfolios sorted on beta and share turnover rate

In each month, the sample stocks are ranked according to their estimated beta and divided into five groups. Then, each group is divided into five sub-groups according to share turnover rate. The table shows equally weighted average gross returns for each portfolio, as well as the equally weighted average beta, average share turnover rate, and average market value of each of the 25 portfolios. The column and the row entitled "Mean" shows the equally weighted means of the variables across the five turnover groups or across the five beta groups, respectively.
Market value is reported in million SEK. Turnover rate is the total share turnover rate over 3-month periods and reported in %.

			beta					
			low systematic risk			high systematic risk		
			1	2	3	4	5	**Mean**
liquidity	high liquidity	1	portfolio no.	11	21	31	41	51	
			monthly return	**2.21%**	**1.46%**	**1.21%**	**1.24%**	**0.12%**	**1.25%**
			beta	0.20	0.56	0.82	1.17	2.24	**1.00**
			turnover rate	31	28	38	44	64	**41**
			market value	14,161	18,872	17,168	20,224	22,190	**18,523**
		2	portfolio no.	12	22	32	42	52	
			monthly return	**2.24%**	**0.72%**	**1.39%**	**1.22%**	**0.92%**	**1.30%**
			beta	0.22	0.55	0.80	1.18	2.09	**0.97**
			turnover rate	12	13	17	19	29	**18**
			market value	10,156	9,701	12,165	10,085	14,405	**11,302**
		3	portfolio no.	13	23	33	43	53	
			monthly return	**2.66%**	**1.88%**	**1.43%**	**0.79%**	**1.07%**	**1.57%**
			beta	0.22	0.55	0.80	1.19	1.93	**0.94**
			turnover rate	7	8	11	13	19	**12**
			market value	4,129	4,176	6,155	4,840	7,151	**5,290**
		4	portfolio no.	14	24	34	44	54	
			monthly return	**1.34%**	**2.15%**	**1.80%**	**0.58%**	**0.70%**	**1.31%**
			beta	0.25	0.56	0.80	1.17	1.90	**0.94**
			turnover rate	4	5	7	9	13	**7**
			market value	2,208	2,248	2,793	3,496	3,784	**2,906**
	low liquidity	5	portfolio no.	15	25	35	45	55	
			monthly return	**1.53%**	**1.55%**	**1.19%**	**0.86%**	**1.21%**	**1.27%**
			beta	0.23	0.54	0.79	1.16	1.85	**0.92**
			turnover rate	1	2	3	4	6	**3**
			market value	2,199	1,889	1,858	2,277	1,412	**1,927**
	Mean		monthly return	**1.99%**	**1.55%**	**1.40%**	**0.94%**	**0.81%**	
			beta	**0.22**	**0.55**	**0.80**	**1.17**	**2.01**	
			turnover rate	**11**	**11**	**15**	**18**	**26**	
			market value	**6,571**	**7,377**	**8,028**	**8,184**	**9,788**	

4.1.5 Amihud measure

Table 7 (see last column on the right in the table) shows that the liquidity group with the highest liquidity has a lower return than the liquidity group with lowest liquidity. However, in between no visible pattern exists. Moreover, the Amihud measure, which measures illiquidity, and size are strongly and negatively related to each other, even in all beta groups.

Table 7: Average return on portfolios sorted on beta and Amihud measure

In each month, the sample stocks are ranked according to their estimated beta and divided into five groups. Then, each group is divided into five sub-groups according to the stocks' Amihud measure. The table shows equally weighted average gross returns for each portfolio, as well as the equally weighted average beta, average Amihud measure, and average market value of each of the 25 portfolios. The column and the row entitled "Mean" shows the equally weighted means of the variables across the five Amihud measure groups or across the five beta groups, respectively. Market value is reported in million SEK.

				beta					
				low systematic risk			high systematic risk		
				1	2	3	4	5	Mean
liquidity	high liquidity	1	portfolio no.	11	21	31	41	51	
			monthly return	**1.83%**	**1.56%**	**1.50%**	**1.07%**	**0.55%**	**1.30%**
			beta	0.25	0.56	0.81	1.14	1.93	**0.94**
			Amihud	2.74	1.12	0.66	1.63	3.62	**1.95**
			market value	25,173	29,815	31,135	34,222	45,112	**33,091**
		2	portfolio no.	12	22	32	42	52	
			monthly return	**1.54%**	**1.12%**	**1.49%**	**1.07%**	**0.46%**	**1.14%**
			beta	0.24	0.55	0.80	1.19	2.03	**0.96**
			Amihud	23.29	12.49	5.10	22.24	20.35	**16.69**
			market value	3,870	3,629	4,958	3,330	1,551	**3,467**
		3	portfolio no.	13	23	33	43	53	
			monthly return	**2.19%**	**1.27%**	**1.60%**	**0.82%**	**1.23%**	**1.42%**
			beta	0.23	0.55	0.80	1.18	2.06	**0.96**
			Amihud	68.03	49.38	27.82	70.24	69.56	**57.01**
			market value	2,105	1,768	1,958	1,336	824	**1,598**
		4	portfolio no.	14	24	34	44	54	
			monthly return	**1.73%**	**2.06%**	**1.00%**	**0.99%**	**0.77%**	**1.31%**
			beta	0.25	0.55	0.80	1.18	1.98	**0.95**
			Amihud	174.87	150.91	114.40	190.81	201.26	**166.45**
			market value	812	805	847	825	465	**751**
	low liquidity	5	portfolio no.	15	25	35	45	55	
			monthly return	**2.50%**	**1.56%**	**1.41%**	**0.79%**	**1.08%**	**1.47%**
			beta	0.15	0.55	0.80	1.17	2.04	**0.94**
			Amihud	627.89	591.06	509.34	754.25	758.25	**648.16**
			market value	257	274	337	338	205	**282**
	Mean		monthly return	**1.96%**	**1.51%**	**1.40%**	**0.95%**	**0.82%**	
			beta	**0.22**	**0.55**	**0.80**	**1.17**	**2.01**	
			Amihud	**179.37**	**160.99**	**131.46**	**207.83**	**210.61**	
			market value	**6,443**	**7,258**	**7,847**	**8,010**	**9,631**	

4.1.6 Conclusions from portfolio analysis

It has been seen that return does not seem to increase in beta, which contrasts with what is suggested by the CAPM. Referring to step 1a of the general research design, it might be concluded that more variables than the beta from the CAPM might be needed to explain the cross-sectional variation of returns. In fact, return seems to decrease in beta which is rather surprising.

As it has already been seen in the descriptive statistics in table 1, the portfolio analysis has shown again that there is considerable variation in the liquidity variables, as there are large differences between the magnitudes of the liquidity measures in the different liquidity groups (referring to step 1b of the general research design).

Furthermore, and most important, it has been seen that there are some indications that return increases in illiquidity (step 1c of the general research design), but this relationship is not too clear. However, although this relationship is not very clear, it cannot be said with certainty that it is not present. This allows to proceed with the study, as a more formal proof is required.

Concerning the second hypothesis, some evidence that return decreases in size has been found, yet, with some limitation (referring to step 2a of the general research design). But, at least, the portfolio analysis offers a strong indication that size and liquidity are positively associated (which corresponds to step 2b of the general research design). This association between size and liquidity is further investigated in the next section.

4.2 Correlation analysis

The table 8 below shows the correlation coefficients between the variables that will be used as explanatory variables in the regressions. As it is requested by step 2b of the general research design, it especially examines the association between size and the liquidity measure. It can be seen that size is, as expected, strongly negatively related to illiquidity measures (quoted and effective relative spread and the Amihud measure) and very strongly positively related to the liquidity measure SEK trading volume. The positive association with share turnover rate is rather weak. This shows that, in case a small company effect is present, one explanation for this might really be the level of liquidity and implicit trading costs.

Table 8: Correlations

Bivariate Pearson correlation coefficients among the liquidity measures, size, and beta have been calculated each month. SEK trading volume and size have been transformed to their natural logarithm, like in the regressions. The table reports the mean of the time-series of the 120 correlation coefficients obtained for each pair of variables. In brackets, it is reported in how many out of the 120 months the correlation is significant at the 0.05 level (2-tailed).

	Quoted relative spread	Effective relative spread	Amihud measure	Log SEK trading volume	Share turnover rate	Log market value	beta
Quoted relative spread		0.96 [120]	0.79 [120]	-0.69 [120]	-0.25 [113]	-0.63 [120]	-0.07 [45]
Effective relative spread	0.96 [120]		0.77 [120]	-0.70 [120]	-0.25 [112]	-0.64 [120]	-0.05 [40]
Amihud measure	0.79 [120]	0.77 [120]		-0.60 [120]	-0.21 [103]	-0.55 [120]	-0.06 [63]
Log SEK trading volume	-0.69 [120]	-0.70 [120]	-0.60 [120]		0.47 [120]	0.90 [120]	0.07 [39]
Share turnover rate	-0.25 [113]	-0.25 [112]	-0.21 [103]	0.47 [120]		0.16 [55]	0.26 [92]
Log market value	-0.63 [120]	-0.64 [120]	-0.55 [120]	0.90 [120]	0.16 [55]		-0.11 [44]
beta	-0.07 [45]	-0.05 [40]	-0.06 [63]	0.07 [39]	0.26 [92]	-0.11 [44]	

Furthermore, it should be noted here that the liquidity measures are strongly correlated among each other, all with the expected sign, depending on whether they measure liquidity or illiquidity. Only the correlations between share turnover rate and the other (il)liquidity measures are rather weak.

4.3 Cross-sectional regressions

The tables 9 and 10 show the estimates of the regression coefficients, when only one explanatory variable is included in the model (either beta, or size, or one liquidity measure), when two explanatory variables are included (beta and size, or beta and one liquidity measure), as well as when three explanatory variables are included (beta, size, and one liquidity measure). With five different liquidity measures, this yields 18 different regression models for each of the two approaches of weighting the monthly estimates. The variables used in the regressions are those described in section 3.3.1. It should be remembered that SEK trading volume and market value (size) have been transformed to their natural logarithm, due to the extreme skewness they show. Furthermore, the liquidity variables and size are employed as deviation from their cross-sectional mean for each month, as already discussed.

4.3.1 Classical approach and equal weighting of monthly coefficients

Table 9 shows the regression coefficients obtained under the Fama and MacBeth (1973) approach of weighting the monthly estimates of the coefficients. It can be seen that all response parameters are statistically insignificant. Only the intercept is significant in most of the cases. (The critical value for the t-statistic is, with 119 degrees of freedom, 1.98, for a 5% significance level). This finding would mean that neither beta, nor size, nor any of the liquidity measures contribute to the explanation of the cross-sectional variation of returns.

Table 9 also shows the R^2, averaged across the 120 months. They are all extremely low. Nevertheless, they increase when more variables are added to the model.

However, in section 3.4.3 it has been discussed that the weighting procedure can be refined with the Litzenberger and Ramaswamy (1979) approach. The results of this are presented in the next section.

Table 9: Estimated regression coefficients under Fama and MacBeth (1973) approach

The table shows: the estimate of the coefficient, (its standard error), [its t-value].
The model that is estimated is shown in equations 5 and 6 above. The estimate of the coefficients is obtained as shown in equation 7, and their t-values as shown in equations 8 and 9 above. The critical value for the t-statistic is 1.98.

Model	Constant γ_0	Beta γ_1	(Il)liquidity measures γ_2					Size γ_3	R square
			Quoted spread	Effective spread	Amihud measure	SEK trading volume	Share turn-over rate		
1	0.012 (0.004) [3.143]	-0.003 (0.004) [-0.715]							5.81%
2	0.010 (0.005) [1.789]							-0.008 (0.019) [-0.413]	2.10%
3	0.012 (0.004) [3.244]	-0.003 (0.004) [-0.816]						-0.017 (0.018) [-0.938]	7.65%
4	0.012 (0.004) [3.049]	-0.003 (0.004) [-0.599]	0.001 (0.002) [0.592]						8.21%
5	0.012 (0.004) [3.028]	-0.002 (0.004) [-0.565]		0.001 (0.002) [0.452]					8.22%
6	0.012 (0.004) [3.110]	-0.003 (0.004) [-0.674]			0.001 (0.001) [0.607]				7.88%
7	0.012 (0.004) [3.131]	-0.003 (0.004) [-0.681]				-0.011 (0.011) [-0.960]			7.47%
8	0.012 (0.004) [3.017]	-0.003 (0.004) [-0.713]					-0.001 (0.001) [-0.663]		7.45%
9	0.012 (0.004) [3.116]	-0.003 (0.004) [-0.710]	-0.0002 (0.002) [-0.129]					-0.019 (0.020) [-0.966]	9.65%
10	0.012 (0.004) [3.107]	-0.003 (0.004) [-0.680]		-0.0005 (0.002) [-0.259]				-0.021 (0.019) [-1.118]	9.54%
11	0.012 (0.004) [3.149]	-0.003 (0.004) [-0.758]			0.0001 (0.001) [0.128]			-0.014 (0.019) [-0.758]	9.44%
12	0.013 (0.004) [3.058]	-0.004 (0.004) [-1.088]				0.011 (0.032) [0.329]		-0.038 (0.052) [-0.721]	8.99%
13	0.013 (0.004) [3.122]	-0.003 (0.004) [-0.899]					-0.001 (0.001) [-0.429]	-0.021 (0.020) [-1.086]	9.21%
14	0.010 (0.005) [1.789]		0.001 (0.002) [0.454]						2.45%
15	0.010 (0.005) [1.789]			0.001 (0.002) [0.282]					2.47%
16	0.010 (0.005) [1.789]				0.0002 (0.001) [0.276]				2.18%
17	0.010 (0.005) [1.789]					-0.010 (0.011) [-0.929]			1.69%
18	0.010 (0.005) [1.789]						-0.002 (0.002) [-1.136]		2.56%

4.3.2 Refinement of weighting procedure

Table 10 shows the cross-sectional regression results under the Litzenberger and Ramaswamy (1979) approach of weighting the monthly regression estimates. It can be seen that, when beta is the only explanatory variable, its coefficient is highly significant. However, being negative, it has the "wrong sign" according to the CAPM. Nevertheless, this finding is consistent with the results from the portfolio analysis in section 4.1. Furthermore, there is a statistically significant intercept. This indicates that the CAPM is not sufficient to explain the cross-section of returns. In addition to that, in appendix IV it is tested whether the monthly coefficient of the beta variable can equal the market premium in each month. It is seen there that the hypothesis that they are equal can be refused in more than half of the months. This is an additional confirmation that the CAPM is not sufficient to explain the cross-section of returns.

Moreover, the second and the third regression model in table 10 provide evidence that size does contribute to the explanation of the cross-sectional variation of returns. The coefficient is statistically significant, both when excess return is regressed against size alone and when excess return is regressed against beta and size. But, the coefficient is positive and not negative as the "size effect" suggests. Nevertheless, when the number of individual months where size has a significant impact is examined, it can be seen that this number is rather low (about 30% of the months only), and its sign is not much more frequently positive than it is negative. Thus, the fact that there is no clear evidence of any significantly higher return on small companies means that an examination of hypothesis 2 becomes superfluous or rather impossible.

With regard to the examination of the question whether the level of liquidity determines stock returns, the following can be said: In the regression models with beta and one liquidity measure at a time, the coefficients of the quoted relative spread (model 4), the Amihud measure (model 6), and SEK trading volume (model 7) are insignificant. The coefficient of the effective relative spread is significant (model 5), but its sign is opposite to what has been hypothesized. In fact, it indicates that excess return decreases in illiquidity. However, the number of individual months where the effective relative spread has a significant impact is rather low (38 of 120 months, and only 22 months with significantly negative impact).

Only the share turnover rate (model 8) appears to have a significant coefficient with the expected sign, with the negative sign indicating that return decreases in liquidity. However, it has been seen above that it is difficult to build up expectations concerning the impact of share turnover rate, due to its relation to holding periods. Therefore, it is surprising that it is just the share turnover rate that offers the only confirmation of the expectation. Furthermore, the fact that one out of five liquidity measures shows the expected impact does not mean that it can be concluded that liquidity determines stock returns, because this finding should be robust throughout the other measures. When taking a closer look at the number of individual months where the impact of share turnover rate is significant, it can be seen that it has been positive in as many months as it has been negative. Therefore, the evidence that the share turnover rate offers is rather weak.

In addition to that, as the (estimated) beta might not be a perfect measure of systematic risk, excess return is also regressed against each liquidity measure alone (models 14-18). The findings are, however, very similar to those from the regression against liquidity and beta. The coefficients of SEK trading volume and Amihud measure are found to be insignificant. Yet, both the quoted and the effective spread have a statistically significant impact, but both of them with the wrong sign. They seem to indicate that return decreases in illiquidity. As discussed above, only share turnover rate fulfils the expectation in a statistically significant way.

For the purpose of completeness, table 10 also shows the results from multivariate regression including beta, size, as well as one of the liquidity measures. This is, however, not really necessary because there is no small company effect whose presence might be weakened when liquidity is taken into account. But nevertheless, there is one interesting finding. Both share turnover rate and SEK trading volume have a significant coefficient in these regression models, even with the “right” sign. While the inclusion of a liquidity measure was originally intended to weaken the presence of a small company effect, the inverse of the small company effect that has been found appears to become even stronger when these two liquidity measures are included.

Table 10: Estimated regression coefficients under Litzenberger and Ramaswamy (1979) approach

The model that is estimated is shown in equation 5. The estimates of the coefficients and their variances are obtained as in equations 10-12. It is shown: The estimate of the coefficient, (its standard error), [its t-value], number of months where coefficient is significant and positive, number of months where coefficient is significant and negative.

Model	Constant γ_0	Beta γ_1	(Il)liquidity measures γ_2					Size γ_3
			Quoted spread	Effective spread	Amihud measure	SEK trading volume	Share turn-over rate	
1	0.009 (0.001) [7.356] 36 + ; 14 -	-0.017 (0.001) [-17.456] 26 + ; 40 -						
2	0.001 (0.001) [1.121] 56 + ; 36 -							0.035 (0.008) [4.415] 20 + ; 15 -
3	0.009 (0.001) [7.468] 38 + ; 12 -	-0.017 (0.001) [-17.003] 23 + ; 40 -						0.017 (0.008) [2.156] 19 + ; 18 -
4	0.009 (0.001) [7.657] 37 + ; 14 -	-0.017 (0.001) [-17.604] 26 + ; 41 -	-0.001 (0.001) [-1.555] 18 + ; 18 -					
5	0.009 (0.001) [7.608] 37 + ; 14 -	-0.017 (0.001) [-17.570] 26 + ; 40 -		-0.001 (0.001) [-2.131] 16 + ; 22 -				
6	0.010 (0.001) [7.847] 38 + ; 14 -	-0.018 (0.001) [-17.862] 25 + ; 39 -			-0.0002 (0.0003) [-0.671] 14 + ; 16 -			
7	0.009 (0.001) [7.543] 36 + ; 14 -	-0.018 (0.001) [-17.564] 26 + ; 40 -				0.003 (0.006) [0.464] 13 + ; 18 -		
8	0.008 (0.001) [6.070] 36 + ; 14 -	-0.016 (0.001) [-15.039] 22 + ; 36 -					-0.001 (0.001) [-2.051] 16 + ; 16 -	
9	0.009 (0.001) [7.442] 37 + ; 14 -	-0.017 (0.001) [-17.079] 22 + ; 40 -	-0.0002 (0.001) [-0.270] 11 + ; 16 -					0.014 (0.010) [1.384] 15 + ; 12 -
10	0.009 (0.001) [7.489] 37 + ; 13 -	-0.017 (0.001) [-17.181] 22 + ; 40 -		-0.001 (0.001) [-1.258] 13 + ; 16 -				0.009 (0.010) [0.909] 14 + ; 11 -
11	0.009 (0.001) [7.493] 39 + ; 13 -	-0.018 (0.001) [-17.387] 21 + ; 41 -			0.0003 (0.0004) [0.672] 12 + ; 12 -			0.016 (0.009) [1.721] 16 + ; 14 -
12	0.007 (0.001) [5.082] 37 + ; 17 -	-0.014 (0.001) [-12.802] 20 + ; 35 -				-0.049 (0.014) [-3.511] 13 + ; 18 -		0.079 (0.019) [4.092] 17 + ; 12 -
13	0.007 (0.001) [5.819] 34 + ; 17 -	-0.015 (0.001) [-13.736] 19 + ; 33 -					-0.001 (0.001) [-2.506] 13 + ; 14 -	0.020 (0.008) [2.407] 20 + ; 16 -
14	0.001 (0.001) [1.356] 56 + ; 36 -		-0.001 (0.001) [-2.124] 17 + ; 23 -					
15	0.001 (0.001) [1.363] 56 + ; 36 -			-0.002 (0.001) [-2.703] 17 + ; 20 -				
16	0.001 (0.001) [1.043] 56 + ; 36 -				-0.0005 (0.0003) [-1.357] 17 + ; 13 -			
17	0.001 (0.001) [1.077] 56 + ; 36 -					0.002 (0.006) [0.307] 13 + ; 18 -		
18	0.001 (0.001) [0.775] 57 + ; 37 -						-0.003 (0.001) [-5.970] 18 + ; 27 -	

4.3.3 Conclusions from cross-sectional regressions

Although the CAPM is found not to be sufficient to explain the cross-section of returns (step 1a of the general research design), it can be concluded that, under the cross-sectional regression method, the expected evidence of an illiquidity premium in stock returns is not found. The employed liquidity measures do not seem to contribute to the explanation of the cross-sectional variation of stock returns on the Stockholm Stock Exchange during the study period (step 1c of the general research design). The evidence found under the Litzenberger and Ramaswamy (1979) approach with respect to share turnover rate is not enough to draw a different conclusion. The same can be said with respect to the effective spread whose coefficient, however, has the "wrong" sign. Apart from these two exceptions, the finding of the non-existing illiquidity premium in stock returns is robust throughout the two approaches of weighting the coefficients. Finally, it should be remembered that the Litzenberger and Ramaswamy (1979) approach is intended to make the estimates of the coefficients more precise, with lower variance. And even under this approach no consistent illiquidity premium in stocks return could be identified. Therefore, the cross-sectional approach seems to indicate that hypothesis 1 cannot be validated and has to be refused.

Furthermore, with the cross-sectional regressions no evidence of a small company effect has been found (step 2a of the general research design). The informal indication of an existence of a small company effect from portfolio analysis is not confirmed. But there is weak evidence of an inverse small company effect. Consequently, hypothesis 2 could not be fully investigated, and therefore it could not be validated either.

However, due to difficulties in aggregating the monthly regression coefficient over time, a pooled model is applied in the next section.

4.4 Pooling of cross-sectional and time-series data

The regression results from the pooled cross-sectional and time-series regressions are reported in table 11.

Table 11: Estimated regression coefficients when pooling time-series and cross-sectional data

The model that is estimated is shown in equations 13 and 14. It is shown: The estimate of the coefficient, (its standard error), [its t-value]. The estimates of the overall intercept γ_0 and of the intercepts for each time period α_t are not reported. The critical value for the t-statistic is 1.96.

Model	Beta γ_1	(Il)liquidity measures γ_2					Size γ_3	F-value	R square
		Quoted spread	Effective spread	Amihud measure	SEK trading volume	Share turn-over rate			
1	0.557 (0.017) [32.625]							49.088	21.6%
2							-0.014 (0.010) [-1.439]	38.337	17.7%
3	0.557 (0.017) [32.617]						-0.013 (0.010) [-1.296]	48.698	21.6%
4	0.557 (0.017) [32.641]	0.001 (0.001) [1.076]						48.692	21.6%
5	0.557 (0.017) [32.627]		0.0004 (0.001) [0.464]					48.682	21.6%
6	0.559 (0.017) [32.704]			0.001 (0.0004) [2.684]				48.756	21.6%
7	0.558 (0.017) [32.684]				-0.019 (0.007) [-2.741]			48.759	21.6%
8	0.559 (0.017) [32.746]					-0.002 (0.001) [-3.450]		48.806	21.6%
9	0.557 (0.017) [32.608]	0.0004 (0.001) [0.356]					-0.010 (0.012) [-0.804]	48.298	21.6%
10	0.557 (0.017) [32.591]		-0.0004 (0.001) [-0.389]				-0.015 (0.012) [-1.270]	48.298	21.6%
11	0.559 (0.017) [32.695]			0.001 (0.001) [2.357]			0.002 (0.011) [0.174]	48.355	21.6%
12	0.561 (0.017) [32.789]				-0.056 (0.015) [-3.591]		0.059 (0.022) [2.657]	48.431	21.6%
13	0.559 (0.017) [32.734]					-0.002 (0.001) [-3.263]	-0.006 (0.010) [-0.652]	48.408	21.6%
14		0.0002 (0.001) [0.244]						38.317	17.7%
15			-0.0002 (0.001) [-0.201]					38.316	17.7%
16				0.001 (0.0005) [1.483]				38.338	17.7%
17					-0.013 (0.007) [-1.935]			38.354	17.7%
18						-0.001 (0.001) [-2.066]		38.359	17.7%

In model 1, with [BETA $_{it}$* (market return $_t$ – risk free rate $_t$)] as the only explanatory variable, the estimate of the coefficient of the latter is 0.557. This coefficient is statistically significant. (The critical t-value now is 1.96.) This means that this coefficient is not 0 at the 5 % significance level. However, according to the CAPM, the coefficient should be around 1. At the 5% significance level it is not equal to 1 either.[33] This means that excess return is not fully explained by a CAPM based variable. This is consistent with the findings from other methods.[34]

Next, it has to be noted that the pooled models show much higher R^2 values than the cross-sectional regressions. Yet, the dummy variables in the model with which the regressions were run are considered to be explanatory variables in the calculation of R^2. And, values between 17.7% and 21.6% are still not particularly high.

With regard to the question whether there is a size effect, the following can be noted. In models 2 and 3 in table 11 the coefficient of the size variable is insignificant. This means that the results from the pooled model do not show any evidence of a size effect, neither a positive nor a negative one. This finding is inconsistent with the Litzenberger and Ramaswamy (1979) approach of cross-sectional regressions.

When each of the five liquidity variables is added to the model with the market beta variable (models 4-8), the coefficient of three out of five liquidity variables appears to be significant. More precisely, the Amihud measure, which measures illiquidity, seems to have a positive impact on excess stock return; SEK trading volume and share turnover rate, which measure liquidity, seem to have a negative impact on excess stock return. These three findings seem to confirm hypothesis 1. It might be concluded that there is evidence of an illiquidity premium in stock returns on the Stockholm Stock Exchange during the study period. Yet, the following has to be taken into account, too:

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[33] t-test of hypothesis that $\gamma_1 = 1$: $t = \frac{\hat{\gamma}_1 - 1}{se(\hat{\gamma}_1)} = \frac{0.557 - 1}{0.017} = -26.059$.

This exceeds the critical value of 1.96 (significance level = 5%, degrees of freedom = 21556). The hypothesis that $\gamma_1 = 1$ is refused.

[34] To make sure that the differences between the results of the cross-sectional regressions and the results of the pooled regressions do not only stem from the difference in the market beta variable, the cross-sectional regressions have been repeated with [BETA $_{it}$* (market return $_t$ – risk free rate $_t$)] as market beta variable, like in the pooled regressions. The results concerning size and liquidity are basically the same as in the cross-sectional regressions with BETA $_{it}$ as market beta variable. These results are not reported here.

- This is the only method applied in the study that presents such a clear finding. If one remembers that the total number of regression models run is relatively high, there is the possibility that these results are obtained by chance.
- The coefficients of the quoted relative spread and the effective relative spread are insignificant.
- It has to be remembered that the pooled method may lead to spurious regression results, due to the problems presented by Chen and Kan (1995) discussed above.
- Furthermore, as mentioned above, the variables in the data set are probably autocorrelated which would violate the assumptions of OLS regressions.
- In the regressions with a liquidity measure as the only explanatory variable (models 14-18), the coefficients of SEK trading volume and the Amihud measure become insignificant. Only share turnover rate still seems to have a statistically significant impact on excess stock return. On the one hand, the omission of a relevant explanatory variable (*i.e.* the omission of the market beta variable) may lead to an upward bias in the variance of the explanatory variable included in the model (*i.e.* the liquidity measure). This might be the reason why at least the coefficient of the Amihud measure has become insignificant; it has a higher standard error in model 16 than in model 6. On the other hand, the imprecision of the market beta variable discussed in appendix V may lead to spurious regression results, too.
- The pooled model has also been run with $BETA_{it}$ instead of [$BETA_{it}$* (market return $_t$ – risk free rate $_t$)] as beta related variable. (The results are not reported here). According to Chen and Kan (1995) such a model should tend to provide spurious regression results. Yet, in this study the coefficients of all liquidity variables turned out to be insignificant.

Table 11 also states the results of the multivariate regressions with the market beta variable, size, and liquidity. Although there is no size effect, it is interesting to note that the inclusion of SEK trading volume (model 12) makes the coefficient of size become positive and significant. In the models without liquidity measure (model 2 and 3) the coefficient of size is insignificant (and negative, as far as an insignificant coefficient can be negative).

However, it is not completely clear why the results from the cross-sectional regression are not the same as the results from the pooled model. A very simple but possible explanation might be that the number of stocks in each month is not equal.

The conclusions that can be drawn are as follows: The pooled model shows some evidence that seems to confirm hypothesis 1. But this evidence is rather weak. As far as hypothesis 2 is concerned, the pooled model does not find evidence of a size effect, neither a positive nor a negative one.

Before the reliability and validity of the results are discussed in section 4.6, the empirical findings from all methods are summarized in the next section.

4.5 Summary of empirical results

With reference to step 1a of the general research design, *i.e.* the question whether the CAPM is sufficient to explain the cross-sectional variation of returns, the following can be noted: The portfolio analysis and the cross-sectional regressions approach of Litzenberger and Ramaswamy (1979) show that there is a strong relation between market beta (*i.e.* $BETA_{it}$) and stock return. In contrast to the prediction of the CAPM, this relationship is negative. In the cross-sectional regressions approach of Fama and MacBeth (1973) the impact of beta (*i.e.* $BETA_{it}$) is insignificant. Furthermore, in all cross-sectional regressions an intercept remains. In the pooled regression model, the estimate of the coefficient of the market beta variable [*i.e.* $BETA_{it}$* (market $return_t$ – risk free $rate_t$)] is statistically different from 1. These findings all indicate that the CAPM is not sufficient to explain the cross-sectional variation in returns.
As far as step 1b of the general research design is concerned, the portfolio analysis as well as the basic descriptive statistics show that there is large cross-sectional variation in the level of liquidity and implicit trading costs.
With respect to step 1c of the general research design, namely the question whether there is evidence that the level of liquidity determines stock returns, the findings can be

summarized as follows: In the informal investigation of the relationship between liquidity and return that has been made with the help of a portfolio analysis, it is doubtful whether such a relationship exists. In the cross-sectional regressions approach of Fama and MacBeth (1973) no evidence of such a relationship was found. In the cross-sectional regressions approach of Litzenberger and Ramaswamy (1979) there is some very weak evidence that (il)liquidity determines stock returns (The coefficient of the effective spread variable has the "wrong" sign, the coefficient of the share turnover rate variable has the "correct" sign, while the coefficient of the other three liquidity measures are found to be insignificant). This evidence seems to show that hypothesis 1 needs to be rejected. This would mean that no evidence of an illiquidity premium in stock returns on the Stockholm Stock Exchange has been found. Yet, under the approach of pooling time-series and cross-sectional data there is some evidence that confirms hypothesis 1.
However, it has been discussed in detail what problems are inherent to each approach. This exactly has been the motivation to apply several methods, in order not to have to rely on the findings from one single method that might not be a perfect one.
Therefore, it can be concluded that there is only weak evidence of an illiquidity premium in stock returns on the Stockholm Stock Exchange during the study period. In other words, the level of illiquidity and implicit trading costs rather does not contribute to the explanation of the cross-sectional variation of returns. Hypothesis 1 cannot be refused completely, but it has to be emphasized that the evidence in favour of it is weak and not robust throughout the methods applied in this study.

As far as hypothesis 2 is concerned, step 2a of the general research design consisted in the question whether there is a small company effect. The portfolio analysis shows some indication of a small company effect (*i.e.* return decreases in size), but only with limitations. Under the cross-sectional regressions approach of Fama and MacBeth (1973) no impact of size is evident. The same can be said for the pooled model. Yet, the cross-sectional regressions approach of Litzenberger and Ramaswamy (1979) suggests that there is an inverse small company effect (*i.e.* return increases in size). It can be concluded that the expected small company effect has not been found. This makes the examination of hypotheses 2 superfluous and impossible. Nevertheless, the portfolio analysis and the correlation analysis suggest that size and liquidity are strongly positively correlated. This finding indicates that returns net of trading costs might be higher for stocks of firms with large market capitalization than for stocks of firms with small market capitalization.

4.6 Reliability and validity of study

4.6.1 Reliability

As for the reliability of the data used in this study, it can be said that the SIX Trust database is a reliable source whose accuracy of data is assumed to be sufficient, as it widely used in the professional and in the academic world.

Furthermore, a lot of care was taken over the collection of raw data from the database and over subsequent data treatment and transformation, as well as over the calculations for the analysis.

In addition to that, the information provided in this study regarding constitution of the sample, data collection, and calculation of variables is relatively detailed. This might help students who want to perform similar studies compare the results in a more thorough way. With respect to reliability this means that it can be found out more easily where potential differences in data stem from, because it is important that it can be seen what exactly is intended to be measured in a reliable way.

4.6.2 Validity

First of all, the validity of the methods applied has to be discussed. It has been mentioned in detail that each of the methods applied has its pitfalls, while there is also motivation to employ each of them. Thus, it is difficult to find one single regression method that can be expected to provide valid and trustworthy results. For this reason several methods have been applied, in order to check the robustness of the results obtained with the help of the other methods. Although the results obtained with the different methods are not completely consistent, this is better than relying on findings from one single approach if there are any doubts with respect to the quality of the results obtained. The overall conclusion drawn in this study, namely that there is only weak evidence of an illiquidity premium in stock returns on the Stockholm Stock Exchange, takes this into account.

Next, it has to be discussed whether the variables used in this study measure what they are supposed to measure.

As it has been discussed in detail in section 3.2.2, any liquidity measure can only be a proxy for liquidity because liquidity is a rather imprecise concept and has several dimensions. However, the choice has been based on a detailed discussion of potential measures. Furthermore, one measure alone would certainly not be able to capture all dimensions of liquidity; and no chosen measure could be a perfect one. Therefore several measures are employed in this present study. Moreover, it has been mentioned that finer measures exists. But their calculation needs intraday data. This does not appear feasible for periods as long as those needed for asset pricing tests.

As far as the "size" variable is concerned, market capitalization surely does not measure the size of a company, especially not when it only refers to one share class. It does not take into account differences in debt-equity ratios or stocks listed on other exchanges. And not even the entire capital of a company would be a good proxy for "size". But this is not a problem, because the "size effect" in the corresponding literature always refers to market value of equity. Thus the "size" variable measures what it is supposed to measure.

Nevertheless, a more serious problem can be seen with respect to the estimation of market beta from CAPM. Beta has to be estimated while the liquidity measures are only calculated (this means that beta, like any regression coefficient, is only an estimate). This errors-in-variable problem is in detail discussed in appendix V. Furthermore, section 2.2.1 has already mentioned that the CAPM is formulated in terms of expected returns, while it can only be tested in terms of realized return, and that the CAPM is based on a theoretical mean-variance efficient portfolio, while it can only be tested with the help of the return on a market index which must be chosen in some way. Thus, one has to be aware of the fact that results from this study with respect to the beta variable that intends to measure systematic risk might be limited. Due to these difficulties, the results obtained from regressions that do include a beta related variable have been compared to results from regressions where the beta related variable is omitted, although the model is not complete in the latter case.

Furthermore, although the impact of the beta variable is almost "strange" as it is contrary to what is suggested by the CAPM and although the expected small company effect is not found, it can be mentioned here that these findings are consistent with similar studies on the Stockholm Stock Exchange (see section 5.1). This confirms the validity of this present study.

Additionally, it has to be mentioned that the study period is relatively short for an asset pricing test, which means that the results cannot be generalized beyond the study period. A longer study period would however not be of great interest as the level of liquidity and trading costs in the market has probably changed over time, and the present is much more interesting than the past.

Finally, two common dangers in empirical research will be discussed, namely data mining and sample selection bias.[35]

In order to avoid any sample selection bias, it has been tried to include into the sample all companies that have been listed any time during the study period and that fulfil the sample selection criteria. A potential survivorship bias forms a special danger when studying the size effect, because the small companies that might be included in the sample might be the ones that are especially profitable, while the unprofitable ones might be delisted soon and therefore might not be included in the sample. Efforts have been made to identify the companies delisted during the study period. Nevertheless, not all of them could be identified, and a few companies that should be included in the sample did

[35] *Sample selection bias* may be present when, due to data availability, stocks with certain characteristics tend to be excluded. When data requirements make stocks of firms that fail tend to be excluded from a study, there may be a *survivorship bias* (see, *e.g.,* Campbell et al., 1997, p. 212). *Data mining* means searching for a relation between variables until a relation is found, although the found relation is purely accidental (see, *e.g.,* Ross et al, 1999, p. 286)

not have complete data sets in the SIX Trust database. Especially for the early years of the study period, some difficulties have been encountered.
Although the hypotheses of this study could not be completely validated, it has to be underlined that, on purpose, it has not been tried to find more significant results by means of different ways of calculating the variables (*e.g.* calculate the size and liquidity variables over 1 or 6 or 12 month periods). Otherwise, an accusation of data-mining would be due (especially when remembering that the total number of regression models run is already high). Instead, variables have been constructed in the way that seemed most reasonable.

To sum it up, the reliability and validity of this study should be found to be sufficient to draw the conclusion that the level of liquidity and implicit trading costs rather do not contribute to the explanation of the cross-sectional variation of returns during the study period on the Stockholm Stock Exchange.

5 Discussion of findings

This section compares the empirical findings of this study (concerning the impact of market beta and of size) to the findings of similar studies performed with data from the Stockholm Stock Exchange. In addition to that, it aims at finding some possible explanation why it seems that the level of liquidity rather does not seem to contribute to the explanation of the cross-sectional return, in contrast to the hypotheses developed in the beginning of the study.

5.1 Consistency with similar studies

The findings concerning the amazing impact of market beta and the non-existing size effect are consistent with similar studies on the Stockholm Stock Exchange: In a portfolio analysis performed by Bilinski and Lyssimachou (2004) evidence is found that return decreases in market beta, like in this study, the data set being similar but not identical. As far as the size effect is concerned, the same authors find out in their portfolio analysis that return seems to decrease in size, except for the portfolio with the largest stocks, like in this study. Furthermore, when testing the Fama-French-three factor with the help of mimicking portfolio analysis, Bilinski and Lyssimachou (2004) come to the result that small companies tend to have a lower return, if their entire study period is considered (1982-2002). This is consistent with the findings of the cross-sectional regressions of this present study. However, Bilinski and Lyssimachou (2004) argue that a positive small company premium is present in non-recession years (*i.e.* return decreases in size).

Another study dealing with the existence of a size effect of the Stockholm Stock Exchange is performed by Abrahamsson and Sigte (2005). These authors find indications of a small company effect, but not of a statistically significant one.

5.2 Lack of market efficiency

Based on the empirical results presented in this study with regards to the CAPM itself, the following can be said: This study might be one more example that shows either that the CAPM does not seem to work in the predicted way, although it is so widely used in practice, or that it is simply impossible to test the CAPM, due to difficulties already described.[36] In case it is assumed that the CAPM can be tested properly and that it should work in the predicted way, it can however be said that the finding of this study (market beta from CAPM does not have a positive impact on returns) does not let the Stockholm Stock Exchange appear to be an efficient market[37] where the prices reflect all information.

Regarding the finding that trading costs rather do not seem to determine stock returns, it could be said that this finding is in favour of the CAPM, as the CAPM does not suggest such a relationship. However, the CAPM is based on the assumption that trading is costless, which in reality does not seem to be the case. Therefore, in order to find support that the market is efficient, one should find indications that returns reflect the level of trading costs, because then prices would reflect more of the available information. Furthermore, it can be inferred that on average investors do not make a good deal when investing in less liquid stocks, compared to more liquid stocks, if there is not any compensation in the form of an illiquidity premium. In addition to that, if investors do not demand an illiquidity premium, it might be inferred that companies issuing shares do not need to make any effort to increase the liquidity of their shares, *e.g.* engage a market maker for their stocks.[38]

The absence of any really clear size effect points into the direction of an efficient market. But the following has to be taken into account, too: One finding of this study is as

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[36] See, *e.g.,* MacQueen (1986) for an illustrative discussion of difficulties in testing the CAPM.

[37] It has to be taken into account that one cannot draw the conclusion that a market is actually inefficient. It can only be said that if the market was efficient, the results of this study should have been different. Furthermore, market efficiency is of course quite a complex concept. See Cleasson (1987) for an examination of the efficiency of the Stockholm Stock Exchange.

[38] In contrast to the findings of this present study and thus based on the idea that there is an illiquidity premium in stock returns and that more liquid stocks are higher priced, Amihud and Mendelson (1988) discuss costs and benefits of increasing the liquidity of a company's shares as well as possible liquidity increasing measures.

expected and very clear, namely the strong correlation between size and liquidity. Therefore, if any other study finds a small company effect, one should check whether abnormally high returns still exist after trading costs have been taken into account. For, the correlation between size and liquidity appears to be really strong. Furthermore, taking into account the (weak) evidence of inverse small company effect, as shown by the cross-sectional regressions, the following can be stated: If large companies really provide higher return, this return should even be higher on a net of costs basis, compared to smaller companies. This would not correspond to an efficient market either.

Apart from this, there might be other reasons why no evidence has been found that illiquidity and implicit trading costs determine stock returns.

5.3 Differences in market structure compared to US market

It must be noted that the corresponding literature on which the formulation of the hypotheses has been based mainly stems from the US market (New York Stock Exchange or Nasdaq). There are considerable differences in market structure between the US and the Swedish market. On the New York Stock Exchange, it is the "specialist" for each stock who operates the order book and works as market maker for the stock. Also on the Nasdaq all trades have to take place through a "dealer".[39] On the Stockholm Stock Exchange, listed companies can, if they wish, engage a so called "liquidity provider"[40] for their stocks to promote the liquidity of their stocks. This is rather a new procedure, however, and only applies to less liquid stocks. The Stockholm Stock Exchange works as a centralized computer based trading system (called SAX), with a consolidated open limit order book. This is very similar to for example the Paris Stock Exchange, but not to the US exchanges (for an overview of the trading structure on the Stockholm Stock Exchange, see Niemeyer, 1994a). Markets with automated trading systems are also called order driven markets, while markets that are centred around a market maker are also called quote driven markets.

[39] See, *e.g.*, Bodie et al. (1996, pp. 88-96) for an overview

[40] see http://www.omxgroup.com/stockholmsborsen/en/index.aspx?lank=70 (downloaded July 13, 2005)

In a study by Marshall and Young (2003) the relationship between liquidity and stock return is investigated on the Australian stock market, which is a pure order driven market with a fully automated trading system, and thus very similar to the Swedish market. Based on the idea that order driven markets tend to be more liquid markets than quote driven markets, these authors expected a "smaller, or less consistent" (p. 186) illiquidity premium in stock returns on the pure order driven Australian market compared to US stock markets. Yet, these authors find a negative relationship between return and turnover rate, which does not correspond to their expectation. However, they also find a negative relationship between spread and return (which they interpret as the result of imprecise beta estimates), and no relationship between amortized spread and return.

Nevertheless, trading costs occur under any trading system. And the level of liquidity of a market does not only depend on its structure. There are bid-ask spreads on the Stockholm Stock Exchange, their magnitude being discussed in the next section. And of course large orders will make the price of a stock move. But most importantly, there are large differences in liquidity and implicit trading costs across stocks. Therefore there is no rationale to believe that the reason why no clear evidence of an illiquidity premium on the Stockholm Stock Exchange is found is the difference in trading structure compared to markets where this evidence has been found in many studies.

5.4 Magnitude of costs

Another possible explanation why the impact of illiquidity and implicit trading costs is not clearer might be the possibility that implicit trading costs are so low on the Stockholm Stock Exchange that they cannot have any impact. It has only been mentioned so far that there is lot of variation among the stocks with respect to their level of liquidity, but not whether the related costs can be of any economic importance. It can be seen in table 1 (descriptive statistics) that the average across time of the cross-sectional mean of the quoted relative spread is 2.43%. (And the average across time of the cross-sectional median is 1.68%). This shows that the cost related to one purchase and one sale of an average stock is not inconsiderable when compared to the usual magnitude of returns.

The average over time of the maximum quoted relative spread in each month is even more striking with 20.59%. Although the effective spreads are somewhat lower, their magnitude cannot be ignored either. If one compares the magnitude of the average spread on the Swedish market with the US market, it cannot be found that the spread on the Swedish market is small. In the study on the New York Stock Exchange by Stoll and Whaley (1983, p. 73) already referred to several times, for example, the average quoted relative spread for the largest 10% of companies is on average 0.69%, while it is 2.93% for the smallest 10% of companies. Although the size of the spreads cannot be compared directly because it is not known which amount can be traded at this spread, it does not seem that the spreads on the Stockholm Stock Exchange are smaller than on the New York Stock Exchange.

Another possible explication might be that the holding periods are so long that the costs incurred for trading are small when amortized over such a long period. The average share turnover rate for three month periods is 16.6 % (table 1). If per year, on average 66.4% (4x16.6 %) of all outstanding shares are traded, the average holding period is approximately 1.5 years (1/0.664).[41] This does not let the magnitude of the spread appear much lower.

5.5 Ignoring of differences in illiquidity

Another explanation can be thought of when differentiating between small, inexperienced investors and large, institutional investors. Small, inexperienced investors might not have the competences or resources to take into account differences in trading costs when choosing among investments in different stocks. They might not be aware of differences between gross returns and returns net of costs, and they might not be aware of differences across stocks.

[41] The actual average holding period must however be even much shorter. The reason for this is that the actual share turnover rate is higher because this study only refers to data for trades taken place during the opening hours on the exchange.

As far as large institutional investors wanting to trade in Swedish stocks are concerned, these investors maybe do not depend much on the liquidity provided on the Stockholm Stock Exchange. Trades may also be executed outside the automated trading system of the exchange. First, trades may be accomplished after the closing of the exchange. Second, even during the opening of the exchange, they may also be executed directly between the two parties involved, under certain conditions, especially in case of large block trades. Third, a broker may also clear two corresponding customers' orders in-house. Fourth, a large part of the trading in Swedish stocks takes place outside Sweden, mainly on the London Stock Exchange (Niemeyer, 1994a, pp. 12-15).[42]

Therefore, at least as far as trading costs concerning the market impact of a trade are concerned, it might be possible that they are not really a problem because the possibility to look for liquidity elsewhere exists, *i.e.* outside the Stockholm Stock Exchange. Consequently, large institutional investors maybe do not have to take into account differences in liquidity when they take asset pricing decisions. At least, it might be concluded that they are not too much concerned by the differences in liquidity across stocks that the trading in the automated trading system on the Stockholm Stock Exchange presents. However, as argued above, this is the liquidity that is the most immediately available for Swedish investors.

5.6 Irrationality of investors

Finally, there is another possible reason why empirical evidence found does not correspond to what asset pricing models predict. More precisely, it is not impossible that investors are less rational than economic theory suggests. In this case, explanations why traditional asset pricing models do not work in the way they should are to be searched for in the area of Behavioural Finance.

[42] Although not being a recent source, Niemeyer (1994a, p. 15) reports that the amount traded in the automated trading system is only as large as the total amount of trading after opening hours and direct trading between the two parties involved during opening hours. But, in terms of number of trades, this relation is 88% to 12%. In addition to that, only about half of the trading in Swedish stocks takes place in Sweden.

6 Concluding remarks

This final part presents the conclusions to be drawn from this study and offers a few suggestions for further research.

Following the theoretical model of the spread-return relationship by Amihud and Mendelson (1986a), a number of empirical studies have found evidence of an illiquidity premium in stock returns, with these studies mainly focussing on the US market. Apart from this empirical support it is also intuitive to suggest that investors require compensation for higher trading costs in the form of higher returns. The presence of an illiquidity premium on the Swedish stock market has not yet been investigated, at least not to the author's knowledge. Therefore, this study has aimed at investigating whether the level of implicit trading costs and illiquidity of a stock contributes to the explanation of the cross-sectional variation of stock returns on the Stockholm Stock Exchange. After the concept of liquidity and potential liquidity measure had been discussed, the choice of the liquidity measures to be used was made in favour of the quoted relative spread, the effective relative spread, SEK trading volume, share turnover rate, and a measure for market impact according to Amihud (2002).

The relationship between return and (il)liquidity has been examined in an informal way with the help of a portfolio analysis, and in a more formal way with the help of cross-sectional regressions as well as a regression model that pools cross-sectional and time-series data. The results from the portfolio analysis are not clear. Under the approach of pooling time-series and cross-sectional data there is some evidence of an illiquidity premium, but this finding could not be confirmed in the cross-sectional regressions. Consequently, it has been concluded that there is only weak evidence that the level of illiquidity and implicit trading costs of a stock contributes to the explanation of the cross-sectional variation of stock returns on the Stockholm Stock Exchange during the study period. The evidence in favour of an illiquidity premium is too weak and not robust enough to draw a different conclusion.

As some authors (especially Stoll and Whaley, 1983) have even tried to explain the small company effect with differences in trading costs, it has been intended to try to do the same, in case a small company effect was found. However, no support of a small company effect has been found.

The results of this study are not in line with the findings in the corresponding literature that focuses mainly on the US market.

Differences in market structure or differences in the magnitude of implicit trading costs have been excluded as potential explanations for this discrepancy.

A possible explanation why investors do not seem to require illiquidity premiums might be that small investors cannot or do not want to take into account such differences across stocks, while large investors can easily bypass the Stockholm Stock Exchange in case they encounter liquidity constraints.

However, given the finding that there is not any illiquidity premium in stock returns, the return on less liquid stocks must, on average and on an after cost basis, be lower than the return on more liquid stocks. However, the result that the after-cost return on a less liquid stock tends to be lower than the after-cost return on a more liquid stock appears to be obvious at first sight, but contrasts with the theory of illiquidity premiums. It has been discussed that this finding can be seen as an indication of an inefficient market where prices do not reflect all information.

Furthermore, it has been seen that, if investors do not demand an illiquidity premium, it might be inferred that companies issuing shares do not need to make any effort to increase the liquidity of their shares. This seems to be a surprising conclusion. Yet, if investors were willing to pay a higher price for a more liquid stock (which is a very common idea), there should be evidence of an illiquidity premium in stock returns.

Finally, taking into account that the empirical evidence found does not correspond to the expectations, it has been mentioned that one should not forget that it is not impossible that investors are less rational than economic theory suggests.

Although the reliability and validity of this study have been found to be sufficient to draw the conclusions that have been drawn, it has also been seen that each of the methods applied in this study has its drawbacks. A reconsideration of the choice of the regression methods and especially an improvement of the way in which the beta estimates have been obtained might be an opportunity for future research and could test the robustness of the results obtained in this study.

Furthermore, another interesting direction of future work might be to try to obtain transaction-level data over a period long enough for an asset pricing test. This would then allow to decompose trading costs into their different cost components (i.e. inventory costs, order processing costs, and asymmetric information costs) so that it could be tested if the different costs components have an impact on the cross-section of returns.[43]

Moreover, while this study focuses on illiquidity as a trading *cost*, other authors have included in asset pricing models a liquidity *risk* factor that is based on the sensitivity of the return of a stock to changes in market wide liquidity (Pástor and Stambaugh, 2003). Such an investigation on the Stockholm Stock Exchange or any other market where such a study has not yet been performed might be promising, too.

In addition to that, another interesting question might be thought of when companies whose stocks are listed on more than one exchange are considered. It might be appealing to test whether differences in trading costs across exchanges have any impact on gross returns and thus on the cost of capital.

[43] The reader interested in this is invited to study *e.g.* Huang and Stoll (1997), Madhavan et al. (1997), or Stoll (2000).

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Appendices

Appendix I: Sample selection procedure

This present study covers the common stocks listed during the study period on the Stockholm Stock Exchange on A-list or O-list (or on the OTC-list shares which existed until 2000 when its shares were transferred to the O-list).[45]

Theoretically, it is intended to include all companies that were listed during the study period on one of these lists. This means that all shares listed at the end of 2004 on the SSE are to be included, as well as those that have been delisted during the study period. The information on listings and delistings has been obtained from the Stockholm Stock Exchange website[46]:

- Listed companies in 2004: Data file entitled Basic Data Shares for 2004 (downloaded July 13, 2005). It includes both the shares listed at the end of 2004 and those delisted during 2004.
- Delisted companies in years 2000 - 2003: Data files entitled Delisted companies for the respective year (downloaded on September 13, 2005)
- Delisted companies in 1999: Fact Book 1999 (referring to 1999), p. 40 (downloaded July 13, 2005)
- Delisted companies in 1998: Fact Book 1999 (referring to 1998), tables 23, 27, 31 (downloaded July 13, 2005)
- Delisted companies in 1997: Fact Book 1998 (referring to 1997), tables 23, 27, 31 (available at Ekonomiska biblioteket)
- Delisted companies in 1996: Fact Book 1997 (referring to 1996), tables 23, 27, 31 (downloaded July 13, 2005)
- Delisted companies in 1995: Fact Book 1996 (referring to 1995), tables 23, 27, 31 (available at Ekonomiska biblioteket)

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[45] At the beginning of the study period, the stocks traded on the Stockholm Stock Exchange have been separated into three different lists: A-list (larger companies), OTC-list (smaller and mid-size companies), and O-list (other companies). [For the differences in listing requirement see, *e.g.,* Stockholm Stock Exchange Fact Book 1999 (referring to 1999), pp. 26-27] In addition, since 1998 there has been a New Market list. In 2000, the stocks listed on the OTC-list were transferred to the O-list. Since 2003, there has also been an X-ternal list. The New Market is excluded from the study, as well as the single company listed on the X-ternal list. This single company (with the ticker PFE) would have been excluded from the study in any case, due to its short listing period.

[46] http://www.omxgroup.com/stockholmsborsen/index.aspx - Statistics - Annual Statistics

However, the following has to be noted with respect to the inclusion and exclusion of companies:

Only one share class per company is included. The choice takes into account that Swedish companies often issue A-shares and B-shares, with A-shares differing from B-shares by the large number of votes attached to them (in general, A-share: one vote; B-share: one tenth of a vote). Thus, if both A-shares and B-shares are listed, the A-shares are excluded from this study. The reason for this is, firstly, they are often not very actively traded. Although this might be particularly interesting for this study, it is possible that they are not at all efficiently priced due to the low trading activity. Secondly, in most cases the number of A-shares is much lower than the number of B-shares and therefore can be neglected. Thirdly, it might be possible that the return on A-shares is influenced by the fact that they have superior voting rights. This in combination with the often low trading activity would disturb the results.

However, it has to be noted that in a very limited number of cases the number of A-shares is higher than the number of B-shares, with higher trading activity for the A-shares. Nevertheless, the selection procedure is applied consistently.[47]

Furthermore, if there is only one share class of a given company (either A or B), the company is included, which means that there can be shares of class A in the sample.

Moreover, for a limited number of companies the choice to be made was not between A and B-shares but between A and C or between A and R. The share class with the least voting rights is included in the sample.[48]

Foreign companies are not excluded, but shares with trading in EUR are excluded, because it is assumed that shares with trading in EUR do not have a comparable investor base so that the pricing may differ. The shares of companies that can be traded in EUR can, however, also be traded in SEK and are then included in the sample. Their number is

[47] More precisely, in 2004 the companies whose B-shares are included although the A-shares are considerably higher in number and more actively traded are: ATCO-B, GAMB-B, INVE-B, SSAB-B, SHB-B (in ticker symbols).

[48] This means that, in year 2004, the following shares are included in the sample (with the excluded ones in brackets): HUFV-A (HUFV-C), INDU-C (INDU-A), STE-R (STE-A). Exception: Although SEB-C has less voting rights compared to SEB-A it is not included because its market capitalization can be ignored when compared to SEB-A. Thus SEB-A is included.

anyhow very limited. Furthermore, listed "depåbevis", (with ticker symbols ending with -SDB) are not excluded from the sample because in practice they are considered to be substitutes of foreign shares.[49]

A certain number of stocks are completely missing in the SIX Trust database or cannot be identified with the company name only. For few other stocks the available data is not complete.

40 months of listing data is needed for each stock: First, 25 months of price data is necessary to calculate the market beta over 24 months. In addition to that, the first 12 months of listing are ignored (*i.e.* the start of the beta calculation and thus the inclusion into the sample is delayed by another 12 months). The purpose of this is to make sure that there is a regular trading that should make an efficient pricing possible. The estimated betas appeared to be volatile anyhow, but they seem to be very instable in the beginning of the listing of a stock. Furthermore, it is required that a stock contributes at least three months of data to the study; otherwise it is excluded from the study.

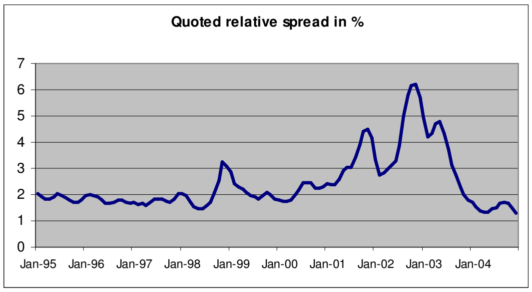
As far as mergers, acquisitions and name changes of companies are concerned, there is the question whether to consider companies experiencing such events as one or as two companies. This study tried to follow the delisting information provided by the Stockholm Stock Exchange. Thus, an acquired company or a company with a name change is treated as two distinct companies when it is considered to be a delisted company by the exchange. When a company changes its name or buys another company without having its time-series of data interrupted, then it is considered one single company in the study.

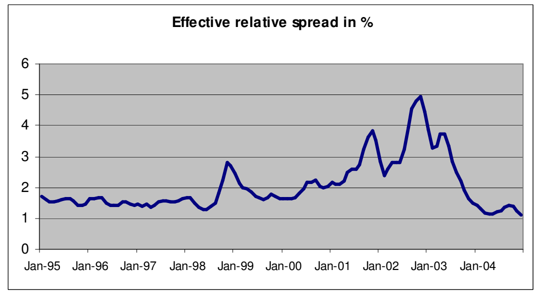
This procedure results in a number of 374 different companies in the sample. On average there are 180 companies per month, with a minimum of 81 companies and a maximum of 253 companies. The total number of observations is 21,558.

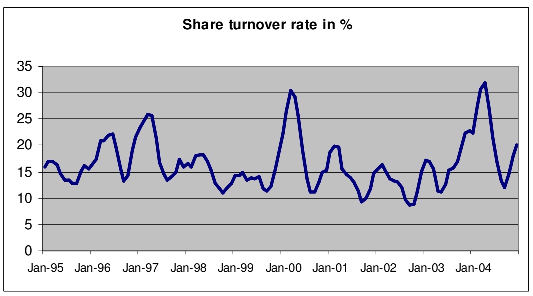
[49] http://www.fondhandlarna.se/remisser/nyin0308.doc (October 5, 2005)

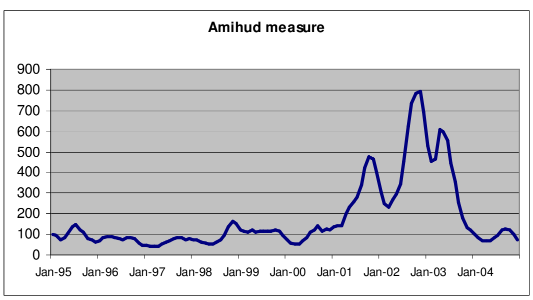
Appendix II: Development of average liquidity over time

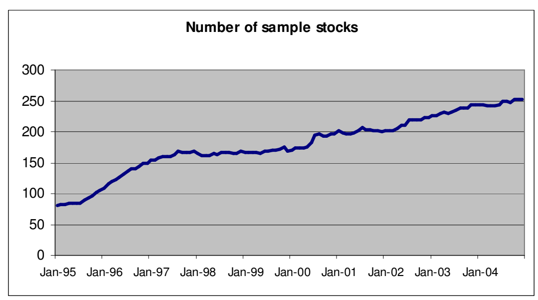
The graphs show the development over time of the cross-sectional sample mean of the liquidity measures and of market value as well as of the number of sample stocks. Please note that SEK trading volume and share turnover rate are sums over three-month periods.

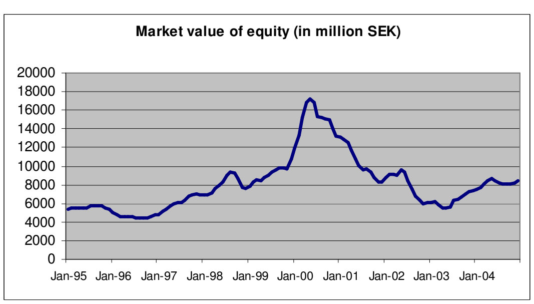












Appendix III: Check for violations of OLS regression assumptions

It has to be tested whether the assumptions that are necessary for hypothesis testing in the Ordinary Least Square regression model are met.[50] More precisely, this appendix does this for the monthly cross-sectional regressions. It is checked whether the residuals show any serious violation of the assumptions[51] of linearity, normality, constant variance and, in case of more than two explanatory variables, absence of multicollinearity. (The assumption of independence, *i.e.* absence of auto-correlation, is not considered here because this is rather a problem in time-series regressions.)

In case the relationship between dependant and explanatory variables is not linear there would be a pattern in the residuals when the residuals are plotted against the predicted values. When plotting residuals against predicted values, the variance of the residuals should be the same for all predicted values. This means that there should not be more variance for high predicated values than for low predicted values or vice versa. In order to check whether the distribution of the residuals is normal, histograms of residuals are compared to normal curves. The absence of multicollinearity is checked with the help of the tolerance values[52].

For each of the 120 months and each of the 18 model specification of the cross-sectional regressions, the standardized residuals have been plotted against the standardized predicted values, and the histogram of the residuals has been compared to a normal curve. In addition to that, in the multiple regression models, it has been checked if any of the tolerance values are below 0.1. This procedure is rather subjective, but it aims at identifying violations of the basic assumptions that are strong and evident.

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[50] The procedure is based on Norušis (2000, pp. 431-448, 467-468, and 490-502).

[51] For more details on the basic regression assumptions see, *e.g.*, Hill et al. (2001, pp.149-150)

[52] The tolerance value measure the proportion of variability in an explanatory variable that is not explained by any linear relationship between this explanatory variable and the other explanatory variables. If the tolerance value is smaller than 0.1 there may be a multicollinearity problem.

The results are not reported in detail, but can be summarized as follows: There is no evident indication of any violation of the assumption of linearity. The assumption of constant variance seems to be met in most of the periods. The residuals show slight deviation from the assumption of normal distribution, but it can be found that the violation of this assumption is not too strong. There is clearly no multicollinearity problem, except for the model with beta, size, and SEK trading volume as explanatory variables. In addition to that, also the correlation coefficients in table 8 have shown that SEK trading volume and size are the only variables that are very strongly correlated.

Appendix IV: Test if γ_{1t} equals market premium

It is tested whether the estimated coefficient of the beta variable obtained from cross-sectional regressions for each month can be equal to market premium in that month. This test is done for the cross-sectional regression model that includes beta as the only explanatory variable (Model 1 in tables 9 and 10), thus:

$$\text{EXCESS RETURN}_{it} = \gamma_{0t} + \gamma_{1t}\,\text{BETA}_{it}$$

It is tested whether the estimate of γ_{1t} can equal the market premium in that month (Market premium $_t$ = market return $_t$ – risk free rate $_t$). The t-statistic for each month is calculated as:

$$t = \frac{\hat{\gamma}_1 - c}{se(\hat{\gamma}_1)},$$

where c is the market premium for the month. The hypothesis that the coefficient of the beta variable equals the market premium is refused when $|t| >$ t critical. The level of significance of the test is 5% (2-tailed). It can be seen from the table below that this hypothesis is refused in 64 months out of the 120 months.

Month	Estimate γ_{1t}	Std. Error	Market premium	t-statistic	Number of observations	Degrees of freedom	t critical (right tail)	Reject hypothesis?
Jan-95	-0.002	0.017	0.043	-2.63	81	79	1.99	yes
Feb-95	-0.003	0.015	-0.005	0.13	82	80	1.99	no
Mar-95	-0.030	0.011	-0.089	5.34	83	81	1.99	yes
Apr-95	-0.046	0.013	0.038	-6.22	84	82	1.99	yes
May-95	0.005	0.021	-0.001	0.27	84	82	1.99	no
Jun-95	-0.071	0.014	0.014	-6.01	85	83	1.99	yes
Jul-95	0.002	0.012	0.027	-2.05	85	83	1.99	yes
Aug-95	-0.062	0.016	-0.005	-3.47	89	87	1.99	yes
Sep-95	0.055	0.018	0.066	-0.59	93	91	1.99	no
Oct-95	0.041	0.017	-0.050	5.47	97	95	1.99	yes
Nov-95	0.017	0.015	-0.010	1.89	101	99	1.98	no
Dec-95	-0.009	0.020	-0.005	-0.21	106	104	1.98	no
Jan-96	0.002	0.018	0.005	-0.15	109	107	1.98	no
Feb-96	0.024	0.026	0.019	0.22	115	113	1.98	no
Mar-96	0.005	0.015	0.022	-1.13	120	118	1.98	no
Apr-96	0.007	0.016	0.045	-2.47	122	120	1.98	yes
May-96	0.037	0.019	0.051	-0.75	127	125	1.96	no
Jun-96	0.040	0.016	0.015	1.60	132	130	1.96	no
Jul-96	0.003	0.011	-0.025	2.56	137	135	1.96	yes
Aug-96	0.014	0.014	0.042	-2.07	140	138	1.96	yes
Sep-96	-0.023	0.012	0.023	-3.81	141	139	1.96	yes
Oct-96	0.003	0.015	0.039	-2.34	143	141	1.96	yes
Nov-96	0.001	0.021	0.101	-4.72	150	148	1.96	yes
Dec-96	-0.028	0.015	0.052	-5.36	149	147	1.96	yes
Jan-97	-0.011	0.019	0.066	-4.11	154	152	1.96	yes
Feb-97	0.011	0.020	0.054	-2.15	154	152	1.96	yes
Mar-97	0.011	0.019	0.002	0.50	158	156	1.96	no
Apr-97	-0.009	0.009	-0.029	2.26	159	157	1.96	yes
May-97	0.021	0.011	0.030	-0.79	160	158	1.96	no
Jun-97	0.000	0.011	-0.007	0.75	160	158	1.96	no
Jul-97	0.014	0.010	0.029	-1.48	163	161	1.96	no
Aug-97	0.014	0.012	0.021	-0.56	168	166	1.96	no
Sep-97	-0.010	0.012	0.075	-7.05	166	164	1.96	yes
Oct-97	0.002	0.012	-0.073	6.39	166	164	1.96	yes
Nov-97	-0.002	0.015	0.026	-1.86	166	164	1.96	no
Dec-97	-0.012	0.017	0.019	-1.83	168	166	1.96	no
Jan-98	0.013	0.013	-0.001	1.07	165	163	1.96	no
Feb-98	0.040	0.011	0.051	-0.99	161	159	1.96	no
Mar-98	-0.013	0.013	0.067	-6.18	162	160	1.96	yes
Apr-98	-0.017	0.014	-0.002	-1.09	162	160	1.96	no
May-98	0.054	0.016	0.045	0.56	165	163	1.96	no
Jun-98	-0.052	0.013	-0.019	-2.51	164	162	1.96	yes
Jul-98	-0.036	0.013	-0.004	-2.41	167	165	1.96	yes
Aug-98	-0.037	0.013	-0.149	8.42	166	164	1.96	yes
Sep-98	-0.013	0.020	-0.094	4.01	166	164	1.96	yes
Oct-98	0.013	0.020	-0.034	2.38	165	163	1.96	yes
Nov-98	0.123	0.026	0.097	1.01	165	163	1.96	no
Dec-98	-0.019	0.017	-0.015	-0.20	168	166	1.96	no
Jan-99	-0.014	0.015	-0.010	-0.21	167	165	1.96	no
Feb-99	-0.047	0.015	0.018	-4.25	166	164	1.96	yes
Mar-99	-0.016	0.015	-0.009	-0.48	166	164	1.96	no
Apr-99	0.009	0.017	0.054	-2.59	166	164	1.96	yes
May-99	-0.015	0.019	0.036	-2.77	165	163	1.96	yes
Jun-99	-0.010	0.013	-0.013	0.24	168	166	1.96	no
Jul-99	-0.013	0.011	-0.013	-0.02	169	167	1.96	no
Aug-99	0.002	0.017	0.034	-1.90	171	169	1.96	no
Sep-99	0.050	0.023	0.025	1.10	171	169	1.96	no
Oct-99	0.035	0.014	0.000	2.41	172	170	1.96	yes
Nov-99	0.069	0.023	0.176	-4.55	175	173	1.96	yes
Dec-99	0.117	0.027	0.181	-2.36	168	166	1.96	yes

Month	Estimate γ_{1t}	Std. Error	Market premium	t-statistic	Number of observations	Degrees of freedom	t critical (right tail)	Reject hypothesis?
Jan-00	0.071	0.035	0.082	-0.33	170	168	1.96	no
Feb-00	0.088	0.029	0.129	-1.42	173	171	1.96	no
Mar-00	-0.066	0.016	-0.003	-3.93	174	172	1.96	yes
Apr-00	-0.030	0.015	-0.040	0.72	173	171	1.96	no
May-00	-0.050	0.013	-0.040	-0.79	176	174	1.96	no
Jun-00	-0.054	0.014	-0.077	1.66	183	181	1.96	no
Jul-00	0.001	0.009	0.000	0.14	195	193	1.96	no
Aug-00	0.040	0.015	0.048	-0.55	197	195	1.96	no
Sep-00	-0.026	0.011	-0.014	-1.14	193	191	1.96	no
Oct-00	-0.080	0.011	-0.077	-0.23	193	191	1.96	no
Nov-00	-0.070	0.010	-0.069	-0.10	196	194	1.96	no
Dec-00	-0.046	0.010	-0.031	-1.49	196	194	1.96	no
Jan-01	0.090	0.016	0.092	-0.12	201	199	1.96	no
Feb-01	-0.097	0.009	-0.086	-1.27	198	196	1.96	no
Mar-01	-0.047	0.008	-0.080	4.17	197	195	1.96	yes
Apr-01	-0.008	0.010	0.051	-5.86	197	195	1.96	yes
May-01	-0.029	0.009	0.038	-7.61	198	196	1.96	yes
Jun-01	-0.074	0.008	-0.089	1.84	202	200	1.96	no
Jul-01	-0.040	0.007	-0.060	2.85	207	205	1.96	yes
Aug-01	-0.056	0.008	-0.091	4.31	204	202	1.96	yes
Sep-01	-0.038	0.008	-0.137	12.82	203	201	1.96	yes
Oct-01	0.079	0.022	0.103	-1.12	201	199	1.96	no
Nov-01	0.095	0.019	0.161	-3.48	201	199	1.96	yes
Dec-01	-0.056	0.008	-0.002	-7.19	200	198	1.96	yes
Jan-02	-0.010	0.008	-0.006	-0.57	202	200	1.96	no
Feb-02	-0.049	0.012	0.005	-4.53	202	200	1.96	yes
Mar-02	-0.023	0.010	0.026	-4.76	202	200	1.96	yes
Apr-02	-0.093	0.011	-0.063	-2.81	205	203	1.96	yes
May-02	-0.053	0.011	-0.036	-1.57	211	209	1.96	no
Jun-02	-0.036	0.008	-0.086	5.91	211	209	1.96	yes
Jul-02	-0.001	0.009	-0.080	8.96	219	217	1.96	yes
Aug-02	-0.042	0.010	-0.063	2.14	220	218	1.96	yes
Sep-02	-0.089	0.013	-0.168	5.82	220	218	1.96	yes
Oct-02	0.150	0.019	0.142	0.43	220	218	1.96	no
Nov-02	0.094	0.031	0.176	-2.60	222	220	1.96	yes
Dec-02	-0.116	0.008	-0.124	0.97	223	221	1.96	no
Jan-03	0.003	0.012	-0.035	3.11	227	225	1.96	yes
Feb-03	-0.016	0.010	-0.030	1.35	227	225	1.96	no
Mar-03	-0.026	0.009	-0.038	1.30	229	227	1.96	no
Apr-03	0.002	0.011	0.079	-6.82	231	229	1.96	yes
May-03	0.052	0.013	0.056	-0.31	230	228	1.96	no
Jun-03	0.028	0.014	0.075	-3.40	231	229	1.96	yes
Jul-03	0.032	0.011	0.066	-3.14	235	233	1.96	yes
Aug-03	0.019	0.013	0.065	-3.57	238	236	1.96	yes
Sep-03	0.036	0.012	0.034	0.16	239	237	1.96	no
Oct-03	0.031	0.012	0.076	-3.70	239	237	1.96	yes
Nov-03	0.015	0.009	0.035	-2.21	243	241	1.96	yes
Dec-03	-0.021	0.007	0.015	-5.02	244	242	1.96	yes
Jan-04	0.077	0.016	0.142	-3.96	244	242	1.96	yes
Feb-04	-0.007	0.008	0.031	-4.60	243	241	1.96	yes
Mar-04	-0.027	0.006	-0.027	0.11	242	240	1.96	no
Apr-04	-0.036	0.007	0.003	-5.28	242	240	1.96	yes
May-04	-0.029	0.006	-0.026	-0.52	242	240	1.96	no
Jun-04	-0.006	0.005	0.012	-3.66	244	242	1.96	yes
Jul-04	-0.032	0.005	-0.042	1.93	250	248	1.96	no
Aug-04	-0.017	0.006	-0.027	1.80	249	247	1.96	no
Sep-04	0.019	0.008	0.060	-4.98	248	246	1.96	yes
Oct-04	-0.022	0.007	-0.001	-2.92	253	251	1.96	yes
Nov-04	0.001	0.006	0.072	-12.26	253	251	1.96	yes
Dec-04	-0.007	0.008	0.036	-5.31	253	251	1.96	yes

Appendix V: Beta estimation – An "errors-in-variables" problem

In the cross-sectional regressions (equation 5 or 6), a stock's beta (its relative risk) is one of the explanatory variables, which according to the CAPM should be positively related to returns. Yet, this beta has to be estimated because true betas are, of course, not known. This "measurement error" can lead to a complication in the regression because generally it is assumed that explanatory variables are measured without error.

Black et al. (1972, pp. 84-86) as well as Fama and MacBeth (1973, pp. 614-615) present the following procedure to reduce this measurement error: In a first step they estimate the beta for each individual stock. Then the stocks are ranked according to their estimated beta. A number of portfolios of stocks are formed, where, in order not to lose the variation in beta, the assignment of a stock to a portfolio is based on the estimated beta. In a second step, the beta for the portfolio is estimated, but with data for subsequent time periods. The reason why data from subsequent time periods has to be used is that, otherwise, the stocks in the high beta portfolio will tend to suffer from an over-estimation of their true beta, while the stocks in the low beta portfolio will suffer from an under-estimation of their true beta. The beta that is estimated for the portfolio is then used in the regressions. This beta for a portfolio is intended to be a more exact estimate of the true beta of a security than the beta estimated for individual securities.
Many of the studies investigating an illiquidity premiums in stock return and having been analysed for this present study solve the "errors-in-variables" problem by the procedure just described. It has been tried to do the same for this study. Yet, in some periods, the procedure has yielded high portfolio beta for portfolios that were supposed to have a low beta and vice versa. And in some other cases the variation in beta has been lost. Therefore, the "errors-in variables" problem in the beta estimates is simply ignored and betas estimated for each individual stock, as described in section 3.3.1, are used in the regressions.

Furthermore, it should be mentioned that for a number of companies the beta estimates obtained appeared to be highly volatile. This does not correspond to what is generally expected from a beta. One reason is probably that the period over which beta is estimated is rather short with 24 months (*i.e.* monthly return data from 24 months). But this length is not unusual. Moreover, one should surely not force the beta estimates to be more stable by extending the estimation period, if the values obtained with the chosen estimation period are not too stable. Moreover, the 24 month period length makes sure that the beta estimate reflects the current level of risk as the level of risk might actually change.

However, one has to be aware of potential problems, but it also has to be remembered that the purpose of this study is to investigate the presence of an illiquidity premium and not to test the CAPM. However, caution is due with respect to the results concerning the impact of the estimated beta.