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Liquidity and asset pricing on the Swedish Stock Market

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Abstract

Many different capital asset pricing models have been derived and tested the last couple of years as financial researchers' interest in liquidity has been increasing in a tremendous pace. In this study, I test two of these models along with the regular CAPM to see how illiquidity is priced in the Swedish stock exchange. In the paper, I try to find a model that is easy to use for Swedish investors but that proves to fit well according to statistical measures. Unfortunately, I do not find such a model, although I manage to find that liquidity, or illiquidity seems to be priced in the Swedish stock market and that there are good possibilities for future researchers to find a model that fit well.

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1. Introduction

Assets are priced after their riskiness. Risk itself can be seen as the possibility that an investor won't be able to sell his assets at their expected prices at a desired point in time. This implies that illiquidity must be risky.

Liquidity has been proved by several authors to come with a premium that investors often pay to be able to enter and exit securities smoothly. Logically, investors who choose to hold stocks that are illiquid will require a premium for doing so, leading to higher expected returns among illiquid stocks.

As the Capital Asset Pricing Model seems to underprice assets that are illiquid, it is intuitive to suspect that there is another dimension of risk than the mere covariance with market returns. Authors such as Pastor & Stambough(2002), Liu(2006) and Acharya & Pedersen (2005), have presented liquidity adjusted capital asset pricing models that help investors determine the levels at which liquidity is being priced throughout stocks. In the Acharya & Pedersen model for instance, three extra liquidity betas are used to adjust the beta of the regular CAPM. When the models were compared with data from the US market, the liquidity adjusted CAPM turned out to be significantly more accurate than the regular CAPM.

The liquidity adjusted CAPM requires that an investor chooses a way to measure illiquidity and that he computes several liquidity based betas which all depend on covariances of different variables. Here, Acharya & Pedersen use a measure of illiquidity that has been derived and tested by Amihud(2002) and that doesn't require much data, thus making it simpler to apply as there is no direct data on illiquidity. The model however, can still be difficult to understand and implement for an average investor who quickly wishes to study the effects of illiquidity in the Swedish stock market.

To simplify matters, this study aims to see whether there exists a liquidity premium in the Swedish stock market and to try and find a simple way for an investor to find it by using an appropriate model that doesn't require too much focus on finding data.

The study will be based on data from the Swedish stock market and will try to test and compare the fitness of a liquidity-adjusted CAPM with the original CAPM and then move on to test the simpler, Liu inspired illiquidity factor model using a Fama and MacBeth procerdure for testing linear factor models. The hope is that covariances explained in the complex liquidity adjusted CAPM are priced within the factors of the simplified version and that the model thus will fit as good for Swedish data as the liquidity adjusted CAPM.

Although I find that liquidity seems to affect asset prices in Sweden, this study does not provide us with a model that fits better than any other model. Instead we conclude that more studies on liquidity need to be conducted in the Swedish stock market before a good liquidity augmented capital asset pricing model can be used securely by Swedish investors.

2. Literature review

- **What is (il)liquidity?**

Basically, liquidity is how easily you are able to trade an asset without affecting its price. Another explanation is that liquidity is an investor's ability to quickly sell or buy an asset of his liking without having to pay a premium due to a low trading activity of the stock in the market at the point of time when the investor wishes to enter or exit the specific asset. The risks of holding an illiquid asset are higher than those of an asset that is liquid, since an investor will be able to exchange it for other assets whenever there's need for it.

- **Why and how does it affect asset pricing?**

According to Pastor and Stambaugh (2002), it appears logical that expected returns for assets with higher sensitivity to aggregate liquidity should be higher. They give an example of an investor using leverage facing a margin or solvency constraint to explain this. Basically, if the investor's wealth drops below a certain level he is required to liquidate some of his assets. If his assets have a high sensitivity to liquidity he will be more likely to lose wealth when the market is illiquid. Because liquidation is costlier when the market is illiquid the investors costs will be higher, further decreasing his wealth. Due to the way utility functions work, marginal utility is higher when wealth is lower, thus this further liquidation cost will be even more undesirable. So unless the investor is compensated for this he will choose securities that are less likely to require liquidation while market liquidity is low, even if the risk of requiring liquidation is the same seen over a longer period.

Amihud (2002) concludes that expected stock returns also include compensation for the expected market illiquidity. He also finds that higher (compared to expectations) realized illiquidity raises expected illiquidity, which results in raised expected returns and lower stock prices.

Not only liquidity risk affects asset prices, but also the cost of illiquidity (transfer prices etc as mentioned earlier). Theoretically, all future illiquidity costs should be discounted into a present value and lower the asset price by that amount (Amihud et al, 2005). If liquidity risk and cost affect the return required by investors, they also affect the cost of capital used within companies.

Sources of illiquidity

Liquidity problems can stem from several different sources according to Amihud et al (2005).

· *Exogenous transaction costs*

Different fees, costs and taxes to sell and buy a security can be examples of transaction costs that discourage trade. Investors will either prefer to hold their investments for large periods of time, making it difficult to buy or sell or, due to these transaction costs, they won’t want to buy securities at all, making them hard to sell.

- *Demand pressure* and *inventory risk*

Order sizes can greatly affect the price as it is very common that only a small amount of stocks are available when bid-ask spreads are low. As orders become larger, investors will have to go deeper into the bid-ask spread if they want to finish their transactions immediately, thus paying a liquidity premium for the stock that he is buying or selling.

-*Private information*

A sudden large scaled sales order might be perceived as if the seller has inside information that the buyer doesn't have. For this reason, a buyer will want to pay a lower price than he would if the seller wouldn't have had such a hurry in selling his stock. This can imply that an investor who is in great need of liquidating assets will be likely of facing a classic "lemon" problem.

Another problem with better informed investors is that they will only accept deals as soon as the offered price differs from the actual value of a security. A liquidity premium would hence be paid here by the less informed part when they place an order to buy or sell stocks at limited quantities.

- *Search frictions*

Trouble finding a counterparty that is willing to trade a large quantity of a security is obviously also a source of illiquidity , mostly relevant in over-the-counter markets.

Liquidity measures

Unfortunately, there's no exact formula for liquidity but it can however be calculated using different ratios of liquidity or illiquidity.

It's quite problematic to measure liquidity as it's not something that you can obtain direct data on. Instead, researchers have used many different liquidity measures such as the bid-ask spread or price response to order size measured with intra daily data. These methods are very fine measures of illiquidity but require big quantities of data that often can be difficult to get hold of.

Instead, Amihud created an illiquidity measure which he called ILLIQ and is stated below.

$$(1) \quad ILLIQ = 1/D_{iy} \sum_{t=1}^{D_{iy}} \frac{|R_{iyc}|}{VOL_{ivyc}}$$

Where

D_{iy} = number of days with data for stock i in year y.

R_{iyc} = return on stock i on day y measured in currency c (absolute measure).

VOL_{ivyc} = trading volume for stock i on day y in currency c.

This illiquidity measure is based on the ratio between stock return (absolute measure) to its trading volume in the local currency, averaged over a period of time. Basically, it can be interpreted as the price response to each unit of currency in trading volume, which is a rough estimate of price impact. It has been shown that this measure is positively and highly related to illiquidity estimates based on microstructure data (Amihud, 2002).

The big advantage with this measure is that the data used (stock price and volume) is more available than the data used in the more precise measures. These measures require data on microstructure that are unavailable for most markets for long periods of time.

PASTOR & STAMBAUGH's augmented Fama & French model

Pastor and Stambaugh presented in 2002, a similar model which one could say was an augmentation on the Fama and French three factor model. In their model, the authors have added a liquidity factor along with factors of book to market and long-short spreads. The authors also allow liquidity betas to vary across, time and use predictions of beta to sort their portfolios. They find that the liquidity sorted portfolios give expected returns that other factors cannot explain.

The liquidity measure that was used when testing this model was constructed by regressing individual stock returns on market premium and sign volumes. The sign premia, λ, in this equation would be used as a measure of illiquidity since it, according to their explanations, would act as a liquidity cost.

The model requires that an investor holds data on long-short term spreads, and data on order flows. For someone who intends to base his investments on easily obtainable data, this model can thus be quite inappropriate to use.

LIQUIDITY ADJUSTED CAPM

Acharya & Pedersen presented and tested a theoretical model to explain how liquidity risk affects asset prices. The model is basically the same as the original capital asset pricing model with three more covariances that act as betas. These betas are based on the covariance between the individual asset and the stock market and are measured and multiplied with the market premium. In addition to this, the following components are accounted for;

$\mathbf{Cov_t(c^{i}_{t+1}, c^{m}_{t+1})}$ *The relationship between the illiquidity of an individual stock and the market illiquidity.* As the illiquidity of most stocks has been found to co move with the market illiquidity, it is logical to believe that investors who seek to reduce their transaction costs due to illiquidity, will want to trade securities that are not positively correlated with market illiquidity and thus will not increase their costs of liquidating the stock as the rest of market becomes illiquid. This in turn leads to decreased prices for these kind of securities and thereby also increases their expected returns.

$Cov_t(r^i_{t+1},c^m_{t+1})$ *The relationship between the return of an individual stock and the market illiquidity.* When the market is illiquid, investors will value high returns more than when it is liquid. They will be willing to pay more for an asset whose return will be high in times when securities in general are hard to sell. This means that a positive relationship between stock returns and market illiquidity affects expected stock returns negatively.

$Cov_t(c^i_{t+1},r^m_{t+1})$ *The relationship between the illiquidity of an individual stock and the market return.* Here, the intuition and logic is quite similar to the previous one. When the market goes down, it is very important to be able to liquidate assets fast. The intuition is that investors mostly get poorer in a market downturn and thus will need to sell assets to receive working capital. An investor will most likely want to pay more for a stock that proves to become easier to sell as markets go bust or, in other words, a stock that has a positive co variation between its illiquidity and market return.

Once all the betas have been accounted for, they are combined into a net beta. The usage of a net beta is a key role in what differs this model from a factor model. Just as the regular CAPM, the liquidity adjusted CAPM only has one risk premium, λ, that is estimated with OLS regressions. Instead of adding factors to the standard CAPM, the market risk premium beta is merely adjusted for illiquidity.

Acharya & Pedersen report that two betas stand out as especially important, namely the one based on the covariance between market return and stock return, as well as the one based on the covariance between market return and stock illiquidity. Also, when letting their betas to have different risk premia, they find that there are severe problems of multi-collinearity. For this reason, they play with the possibility that not all their factors are relevant and that there thus is a window for improvement in their model.

A two factor liquidity augmented CAPM

In this section, I present and explain the thought behind a multi factor model that will be tested along with the illiquidity adjusted CAPM and the regular CAPM. If there is multicolliniarity between covariances that form the extra betas of the liquidity adjusted CAPM, there is a good possibility that all betas from the liquidity adjusted CAPM could be priced when using a simpler model that only considers the illiquidity of an individual stock's illiquidity.

$$(2) \quad E(r^i - r_f) = \beta_1 * RMRP + \beta_2 * ILLIQ_i$$

The model states that expected stock returns are explained by the market premium (RMRP) and an illiquidity premium ($ILLIQ_i$), where illiquidity is measured with Amihud's illiquidity measure.

The idea behind forming a model like this is that since two of the three liquidity betas in the liquidity adjusted CAPM have previously been reported to have very loq economic significance, it might seem more or less pointless for an investor to spend time measuring covariances for these and creating a net beta for them. Also, even though the model is quite similar to the augmented Fama & French model presented by Pastor & Stambaugh, in the sense that it uses an illiquidity factor to try and explain returns, it defers from it in the way and that this model does not require data of anything but stock returns, a risk free rate and trade volumes.

Liu (2006) constructs his model similarly to Fama and French but shows in his article that the size and book-to market factors have been proven to be insignificant when looking at data of over 20 years. He therefore concludes that the factors have limited explanatory value when it comes to excess returns.

As Liu(2006) argues, the factors of size and book to market in the Fama and French three factors model, should be priced in a liquidity or illiquidity factor. His main argument for this is that the Fama and French model describe their two extra factors as measures of market distress and that since market distress itself can be a source of illiquidity, it should correlate with and consequently be priced by the illiquidity premium.

I wish to build on the idea that the factors of an asset pricing model can be priced by an illiquidity factor. This should also be true for the betas of the liquidity adjusted CAPM, especially when having in mind that Acharya & Pedersen in their model show the effect of their liquidity net beta by separating it from the beta that corresponds to the market premium and giving it an own risk premium, λ.

If the different illiquidity risks are priced in the illiquidity premium stated in this model, or if the hypothesis that α is zero cannot be rejected, the model should prove to be useful for investors who lack the time or data to price assets according to the other two liquidity based capital asset pricing models that are explained in this thesis.

4. Data

Weekly data of closing prices, market cap and trading volume in stocks has been downloaded for 100-200 stocks from Datastream. Also, data on American treasury bills are used as a measure of risk free rate to compute a market premium. Unfortunately, it has proved difficult to randomize the samples as the ability of data hasn't been quite what I have expected. Also, due to the lack of data on index turnover, a value weighted market index has to be computed.

Trade volume

Even though the trade volume in Amihud's liquidity measure is in US dollars, local currencies obviously have to be used, resulting in the fact that the currency of Swedish crowns will be used in this case.

$$(3)\quad Trade\ volume\ in\ SEK = Stock\ turnover * \frac{price_t + price_{t-1}}{2}$$

However, problems still have aroused as the data on trade volume that has been obtained in the Swedish market has been of traded amount stocks and unfortunately not absolute local currency. To solve this problem, the closing price of week w has been added with the closing price of the previous week w-$_1$. Afterwards, the closing price has been divided by two to compute an average price that has been multiplied by the trading volume for week w.

5. Methodology

Once trade volumes in absolute currency have been computed, the illiquidity (ILLIQ) can be computed for each individual stock. First, the relationship between illiquidity and stock returns will be tested briefly by plotting average returns and average stock illiquidity. The same will be done with the different relationships explained in the literature review. The idea is to create a visual feeling of these relationships before we start testing them in the different models.

Being the simplest model to compute and to test, the CAPM will be tested first. The market premium is generated and a series of OLS regressions will be run to test the model with two-step procedure that will be described later.

Afterwards, the four covariances that have been described earlier are computed for each portfolio so that cross sectional regressions can be run on the betas and the market premium to test the liquidity adjusted CAPM.

Finally, the Two factor liquidity augmented CAPM will be tested using the same method as when testing the CAPM.

RETURNS

This study requires two measures of returns; absolute returns in local currency and relative returns in percentage. Absolute returns are necessary for the illiquidity measure and are computed weekly by subtracting each week's stock price with that of the week before. Stock prices are also used when computing the relative returns, only these are computed monthly since they aren't used until the data has been normalized into monthly data.

The illiquidity measure

Amihud's illiquidity measure is computed just as it is explained earlier. This means that once absolute returns and trade volumes in absolute, local currency have been produced, each stock's individual weekly return is divided by its trade volume. Monthly illiquidity per stock is finally obtained by calculating the mean illiquidity each month.

Market portfolio

According to the theory and just as in the regular CAPM, movements in the market portfolio still play the central role in predicting returns. This is true both in terms of market liquidity as well as market returns. For this, a value weighted market portfolio is formed by calculating the weights of each stock's total value as a ratio of the total market value of all stocks. Total market returns are then obtained by multiplying each individual stock's market weight with its return and finally summing up the weighted returns.

The same method is used to generate the illiquidity of the market portfolio.

ILLIQUIDITY PORTFOLIOS

To reduce noise in the data and make it more presentable, the stocks are divided into ten illiquidity portfolios where portfolio number one is the most illiquid and portfolio ten the most liquid. This is done by ranking stocks according to their mean yearly illiquidity and dropping those that have less than 25 weekly observations per year. This implies that all observations from year 2013 have to be dropped as there simply weren't enough observations during that year when the data was tested. Afterwards, securities are sorted into deciles that are rebalanced yearly according to mean illiquidity of securities to correct for any changes in illiquidity over time.

The three models that are tested in this study will be tested when stocks are sorted into these liquidity portfolios. Afterwards, all models will be tested without sorting stocks into portfolios to see and compare an eventual difference in results. One reason why differences might occur is that stocks will not be weighted in the same way.

Value weighted portfolios

The market portfolio and the illiquidity portfolios both are all formed by value weighted returns and illiquidity. Some might argue that equally weighted returns would be better for this kind of tests, as the illiquid stocks, being small in value, would affect results better. However, value weighted returns are chosen for this study because they give a fairer picture.

Value weighted portfolio returns cannot be computed without establishing the weight that each stock will represent. Total market value is obtained as the sum of each individual stock's total market capitalization. These market values are then divided by the total market value and thus generating the individual stock weights.

$$(4) \quad w_i = mv_i \sum mv_i$$

Monthly stock weights are computed to generate monthly returns and illiquidity values for each portfolio that is formed while yearly stock weights in the illiquidity portfolios are obtained so that stocks can change portfolio yearly in case their illiquidity would change from year to year.

Adjusting for inflation

A problem with the illiquidity measure that is implemented in this study is that it is not adjusted for inflation as it is measured as a nominal trading cost. To correct this problem the following ratio is created for each observation.

$$(5) \quad P^m = \frac{mv_{t=1}}{mv_t}$$

Basically, it divides the total value of market capitalization at the first point in time of the observations with the market value at the observation date. The ratio can then be multiplied with the illiquidity measure to obtain a fair value of illiquidity.

$$(6) \quad ILLIQ_m^P = MarketIlliq * P^m$$

LIQUIDITY ADJUSTED CAPM

INNOVATIONS IN ILLIQUIDITY

As illiqiudity has been reported by Acharya and Pedersen to be persistent over time, which hasis presented visually in figure (6), their model focuses on innovations in illiquidity. These innovations are seen as the difference in actual illiquidity and predicted illiquidity.

$$(7) \quad C_t^M - E(C_{t-1}^M)$$

To predict market illiquidity from period to period, the assumption that illiquidity is persistent over time is utilized and illiquidity each month is thus expected to be the same as it was the month before.

$$(8) \quad E(C_t^M) = E(C_{t-1}^M)$$

This brings us to the simple conclusion that monthly innovations in illiquidity are chosen to be calculated as the observed illiquidity from month t subtracted with the observed illiquidity from the previous month t_{-1}. Mean monthly illiquidity measures are used for these calculations.

As for the innovations in market returns, the same principles are applied.

LIQUIDITY BETAS

Average betas for the whole time period are calculated using the following set of equations.

$$(9) \quad \beta^{1,i} = \frac{cov(r_t^i, r_t^m - E_{t-1}(r_t^m))}{var(r_t^m - E_{t-1}(r_t^m) - \left(C_t^m - E_{t-1}(C_t^m)\right))}$$

$$(10) \quad \beta^{2,i} = \frac{cov(c_t^i, -E_{t-1}(C_t^i), c_t^m, -E_{t-1}(C_t^m))}{var(r_t^m - E_{t-1}(r_t^m) - \left(C_t^m - E_{t-1}(C_t^m)\right))}$$

$$(11) \quad \beta^{3,i} = \frac{cov(r_t^i, c_t^m - E_{t-1}(C_t^m))}{var(r_t^m - E_{t-1}(r_t^m) - \left(C_t^m - E_{t-1}(C_t^m)\right))}$$

$$(12) \quad \beta^{4,i} = \frac{cov(c_t^i, -E_{t-1}(c_t^i), r_t^m - E_{t-1}(r_t^m))}{var(r_t^m - E_{t-1}(r_t^m) - \left(C_t^m - E_{t-1}(C_t^m)\right))}$$

Where $c_t^i, -E_{t-1}(C_t^i)$ is the innovation in illiquidity and $r_t^m - E_{t-1}(r_t^m)$ is the innovation in market returns.

As the liquidity adjusted CAPM model that is presented by Acharya & Pedersen assumes that the iliquidity premium (lλ) is the same for each beta, their model allows us to combine the betas into a net beta.

$$(13) \quad \beta^{net,i} = \beta_1 + \beta_2 - \beta_3 - \beta_4$$

Two factor liquidity augmented model

This model doesn’t need much explanation as most of the steps taken to form and test it are explained above. The main differences from the liquidity adjusted CAPM is that this model will not focus on innovations in illiquidity or innovations in market returns but will instead use the actual illiquidity for each period of time.

Once illiquidity and returns of each portfolio at each point of time have been computed monthly, all we need is the market premium which also has been obtained by this stage. Just as in the liquidity adjusted CAPM, the market return and market illiquidity are value weighted.

Testing MODELS

The Fama-MacBeth procedure is used throughout the study to test the linear models. It is a two-step procedure of running different sets of OLS regressions. First, the following set of time series regressions are run to find the betas that belong to each individual security and factor that is included in the model.

$$(14) \quad E(r^i - r_f) = \alpha + \beta^1 F_1 + \beta^2 F_2 + \cdots + \beta^i F_i$$

Secondly, a set of cross sectional regressions is run for all assets at each point of time that there's observations for. This is to find the risk premium associated to each factor and its beta.

$$(15)\quad E(r^i - r_f) = \alpha + \beta^1\lambda^1 + \beta^2\lambda^2 + \cdots + \beta^i\lambda^i$$

To see whether the risk premia are significant, (Λ) and (alpha) are estimated as the average over time. Hypothesis tests are then run with the following hypothesis:

TEST 1	TEST 2
H0: $\lambda_i \neq 0$	H0: $\alpha = 0$
H1: $\lambda_i = 0$	H1: $\alpha \neq 0$

The hope is to see that the risk premium is significant by failing to reject the hypothesis that the premium is zero and at the same time failing to reject that alpha is significantly different from zero. If both criteria are met, the model and its factors can be accepted for the data that they are tested on. If all alphas are jointly zero in one model but not in the other, results are truly interesting as they would imply that one model fits better than the other.

For the testing of the illiquidity adjusted CAPM, betas are as explained earlier, computed with the equations 9-12 and there is no need for running time series regressions to obtain these betas. Hence, the net beta is used directly for the second stage in the FamaMacbeth procedure, namely by running cross sectional regressions for each stock at each point of time that there are observations for to obtain the risk premium. Practically, this means that stocks that have observations in the same month are tested with each other. Also, as the model contains expected illiquidity and since we are interested in obtaining α and λ for our test, the regression that must be run is:

$$(16)\quad E(r^i - r_f) - E(C_t^i) = \alpha + \lambda * \beta^{net,i}$$

This way, alpha is assumed to be the constant given from running the cross sectional regressions and λ is simply the coefficient of the OLS regression. Note that even though the dependent variable in the regression is $E(r^i - r_f) - E(C_t^i)$, results will be presented as predicted excess returns $E(r^i - r_f)$ in purpose to make them more comparable.

The three illiquidity betas will also be allowed to have individual risk premia, λ, to see whether there is a problem with multicollinearity in the model when applied to Swedish data. That is, the following version of the liquidity adjusted CAPM is tested.

$$(17) \quad E(r^i - r_f) = \alpha + E(C_t^i) \; + \; \lambda^1\beta_1\lambda^2\beta_2\lambda^3\beta_3\lambda^4\beta_4$$

6. Results

Securities were successfully sorted into portfolios after their average illiquidity which was revealed when plotting mean ililiquidity of portfolios (figure 1). However, as shown by table (1), standard deviations in mean illiquidity of these protfolios are reported. The four liquidity betas of the liquidity adjusted CAPM were successfully computed according to their equations but they do not seem to follow any specific pattern that can be reported as they seem to vary widely over liquidity portfolios.

As shown in figures (3-4), there is a positive trend between individual stock illiquidity and stock returns as well as a positive trend between market returns and stock returns. Further, when investigating different relationships by plotting different factors with each other, it appears that there are relationships between most factors and aspects of illiquidity that are discussed in this thesis.

However, when testing the models as the hypothesis that the intercept, α, is zero could not be rejected for any of the models, be it when testing the models with stocks sorted into value weighted illiquidity portfolios or directly on the set of stocks. For the risk premia however, there were some tests that showed significantly positive λ. Results vary both inter and intra models. Failure to reject the hypothesis that some factors' risk premia are significantly different from zero are sometimes reported when stocks are divided into portfolios and at the same time turn out to be significantly positive when in the scenario where models were tested without dividing them into portfolios. These differences are specifically apparent in the market premium as it can vary from being insignificant when testing the CAPM with illiquidity portfolios, to being significantly different from zero when stocks were not balanced into portfolios.

When allowing betas in the liquidity adjusted CAPM to have their own separate risk premia,λ, a collinearity problem aroused that led to the omitting of two liquidity betas. This was true when liquidity portfolios were used for testing the model. Also, when testing the same version of the model without sorting stocks into portfolios, the same two risk premia turned out to be significantly distinct from zero. The fourth liquidity beta, namely the one based on the relationship between market returns and stock illiquidity proves to be significant in all cases.

7. Analysis and discussion

High standard deviations in illiquidity throughout the illiquidity portfolios indicate that either something is wrong in the way the illiquidity measure is treated in this study, or that there have been errors when rebalancing the portfolios. Even though it might not be strange that a different data set from the one that was used by previous authors provide highly different results, it seems strange to me to find illogical such as the fact that my tables show that the market premium should not affect portfolio returns significantly. On the other hand, as Liu(2006) explains, sometimes liquidity seems to affect stock prices more than market premium, a finding that could be concluded when analyzing the results from this study as well, given the fact that the isolated illiquidity premium seems to be significantly different from several times throughout the testing of different models. This could be amplified when stocks are divided into portfolios after their illiquidity as they have been in this case.

Surprisingly, illiquidity portfolios do not obtain the same illiquidity betas as the original study by Acharya & Pedersen. For example, the fourth beta, namely the beta that is based on the covariance between market returns and individual stock illiquidity, increases with portfolio illiquidity. Logically, this implies that there is a positive correlation between a stock that becomes illiquid when the market goes bust and that the more illiquid a portfolio is, the stronger is this positive covariance.

As the fourth beta is negative when creating the net beta, the final prediction of the model becomes logical since it tells us that stock returns go down for stocks that become illiquid when market returns are low. Anyhow, it is interesting to point out that even though results were not always as previous empirics have proved, they were not always too different from what is logical. This fourth liquidity beta for instance, which was found to be the most important one in previous studies, also seems to be the most important one among the liquidity betas when testing the model in Sweden as well.

This of course is expected when studying the results of Acharya & Pedersen as well as the results of betas in this study that all show that the two lower covariances named here are very low when presented as betas while the two stronger ones (relationship between market return and stock return and the relationship between market returns and market illiquidity) are stronger in terms of betas as well as in explaining stock returns.

8. Conclusion & Future research

Illiquidity definitely seems to affect asset pricing. The fact that two of the three liquidity betas were omitted due to collinearity when seeking their individual risk premia, λ, points out that the liquidity adjusted CAPM really can't be seen as a factor model. More work needs to be done with liquidity adjusted capital asset pricing models, whether it's by adjusting a net beta or adjusting different factors.

The high standard deviations of illiquidity must be solved somehow. The way of handling some problems throughout this study, problems such as the lack of trade volume in absolute Swedish Crowns have surely led to incorrect trade volume and consequently an error in the computation of the illiquidity measure. Beyond that, a normalization of the illiquidity measure could most likely have reduced noise in illiquidity. It is my belief that future research should focus on the understanding and the importance of an illiquidity measure that makes sense as it really is the main building block for all liquidity adjusted pricing models.

Another way in which my testing method differ from other people who have tested the liquidity adjusted CAPM, is the way innovations in illiquidity and in market return were treated. Instead of predicting market returns and market illiquidity to be persistent over time and using their values at each point of time as predictors for the next time period, I would like to see this study repeated with predictions based tests on autocorrelation of the market illiquidity and market returns.

One can also question whether it's enough to test the models by using only the Fama-MacBeth method. Ideally, I would also like to have run GMM regressions as well and compared results as this would have given stronger conclusions. GMM regressions were run by the creators of the liquidity adjusted CAPM and it could be interesting to see a study like this one with the same kind of testing method.

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Amihud Långa

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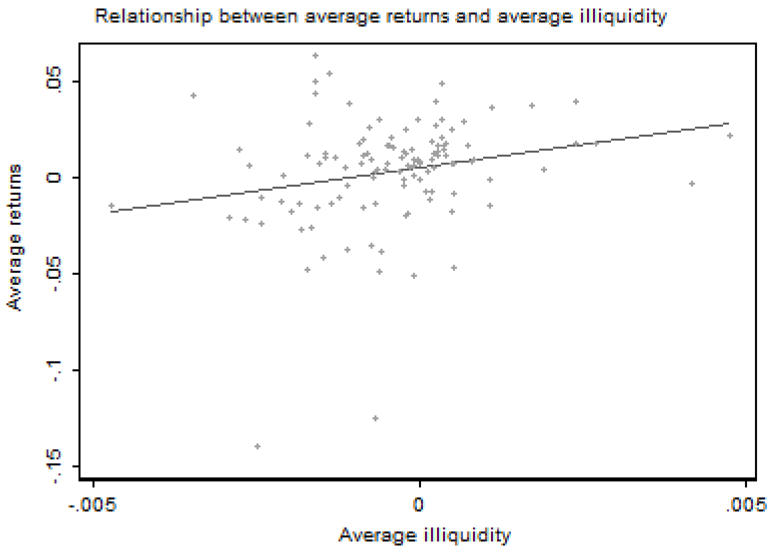
Appendix

Figure (1)



The graph shows the relationship between a stock's average return and its average illiquidity.

Figure (2)

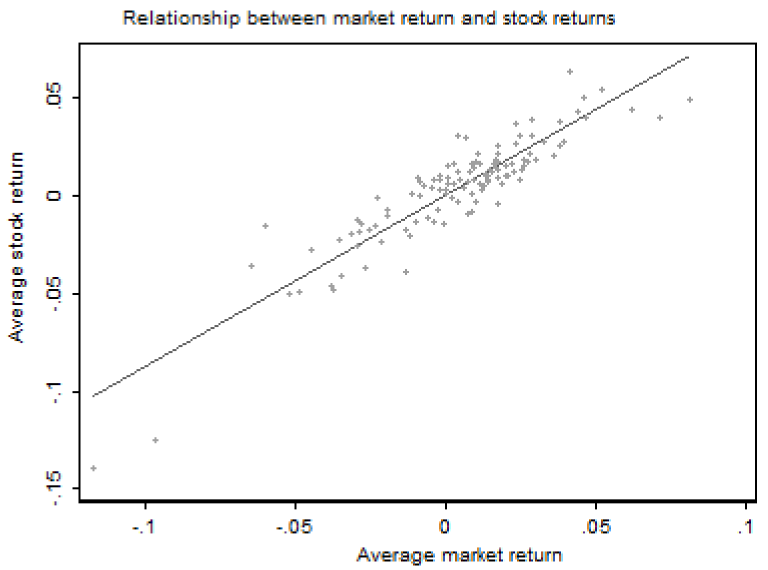


Figure (3)

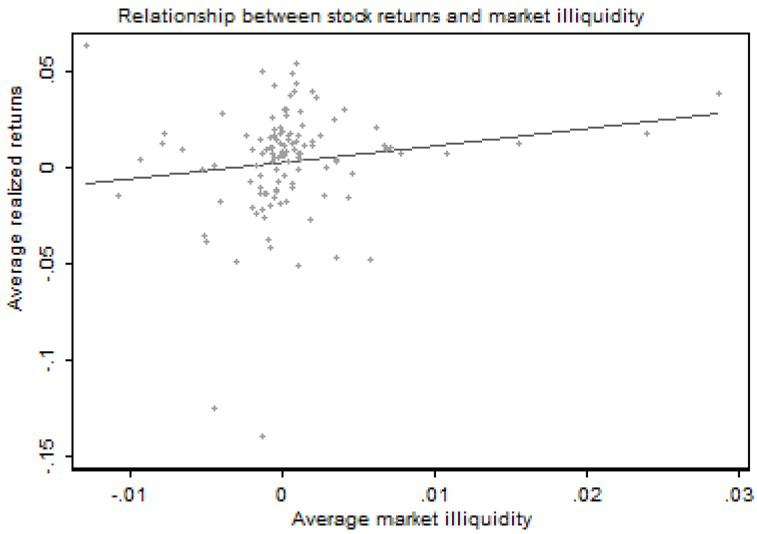


Figure (4)

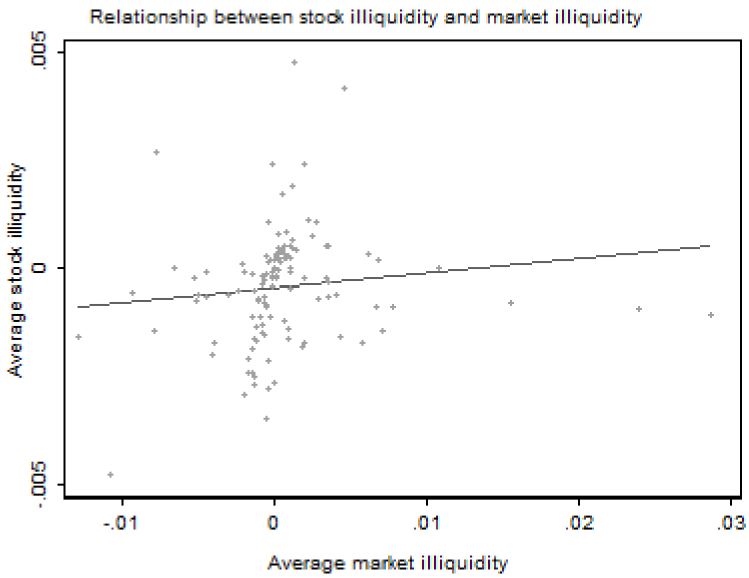
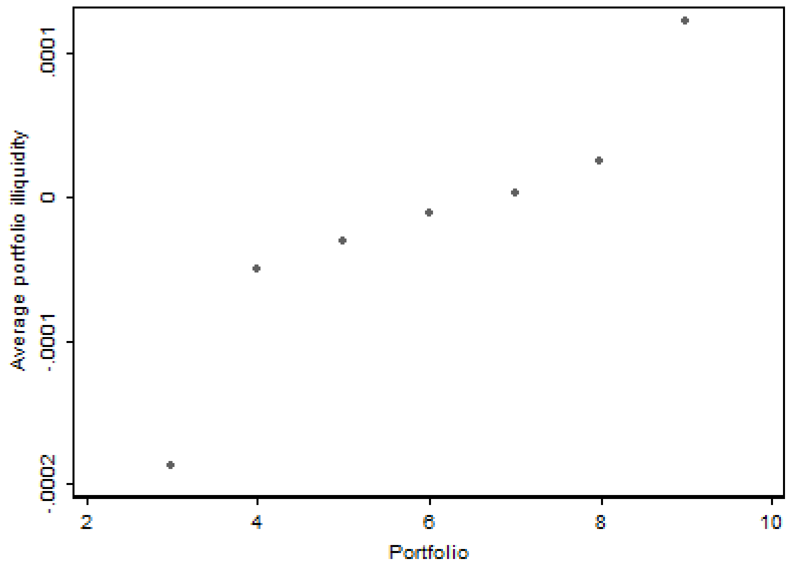


FIGURE (5)



The graph plots average portfolio illiquidity and portfolio id. It shows how portfolios have successfully been constructed such that average illiquidity gradually increases with portfolio id. Portfolio number one and portfolio number ten have been excluded from the graph due to the fact that they were both outliers. However, they both follow the trend and would have been placed where they intuitively belong.

Table (1)

Average illiquidity per illiquidity portfolio

Portfolio	Mean illiquidity	Standard deviation
1	-0,00968	0,01533
2	-0,00056	0,00167
3	-0,00019	0,00050
4	-0,00006	0,00537
5	-0,00003	0,00012
6	-0,00001	0,00007
7	0,00000	0,00005
8	0,00003	0,00010
9	0,00012	0,00057
10	0,00313	0,00841

The table shows descriptive statistics of means and standard deviations of portfolio illiquidity. They point out large standard deviations in illiquidity per portfolio and that the illiquidity measure thus is nosiy.

Table (2)

Portfolio	β1	β2	β3	β4
1	0,15184	0,00199	0,00152	0,01991
2	-0,01596	0,00046	-0,00160	0,00461
3	-0,01563	0,00008	-0,00156	0,00080
4	-0,00436	0,00068	-0,00044	0,00681
5	-0,00163	0,00004	-0,00016	0,00040
6	-0,01877	0,00002	-0,00188	0,00020
7	0,00036	0,00000	0,00004	0,00001
8	0,00219	0,00000	0,00022	0,00001
9	0,00534	-0,00007	0,00053	-0,00068
10	0,00095	0,00210	0,00010	0,02097

Above are the betas that have been computed in order to compute the net beta that is used in the liquidity adjusted CAPM.

Table (3)

Testing λ & α in CAPM

H0:α = 0 H1:α≠0

H0:λ = 0 H1:λ>0

Observations	sample mean	sd.	[95% Conf. Interval]		sample mean=μ	Conclusion
α	-0,01060	0,02622	[-0.01217	-0.00903]	t = -13.2854	**Reject null hypothesis**
λ	0,01287	0,09312	[0.0073	0.01843]	t = 4.5406	**Reject null hypothesis**

Table (4)

Testing λ & α in Liquidity adjusted CAPM

H0:α = 0 H1:α≠0

H0:λ = 0 H1:λ>0

Observations	sample mean	sd.	[95% Conf. Interval]		sample mean=μ	Conclusion
α	-0,00806	0,00979	[-0.00865	-0.00748]	t = -27.0595	**Reject null hypothesis**
λ1	-0,25091	0,83297	[-0.30064	-0.20118]	t = -9.8992	**Fail to reject**

Table (5)

Testing λ & α in Liquidity adjusted CAPM (with seperate risk premia, λ)

	H0:α = 0			H0:λ = 0	
	H1:α≠0			H1:λ>0	
Observations	**sample mean**	**sd.**	**[95% Conf. Interval]**	**sample mean=μ**	**Conclusion**
α	-.0010503	.0088355	[-0.00158 -0.00052]	t = -3.9066	**Reject null hypothesis**
λ1	-0,01226	1,88891	[-0.12504 0.10052]	t = -0.2133	**Fail to reject**
λ2	0,00000	0,00000	[0 0]		**Omitted (collinearity)**
λ3	0,00000	0,00000	[0 0]		**Omitted (collinearity)**
λ4	0,42718	1,24336	[0.35294 0.50141]	t = 11.2908	**Reject null hypothesis**

Table (6)

Testing λ & α in the Two factor illiquidity augmented CAPM

	H0:α = 0		H0:λ = 0		
	H1:α≠0		H1:λ>0		
Observations	**sample mean**	**sd.**	**[95% Conf. Interval]**	**sample mean=μ**	**Conclusion**
α	-0,00979	0,02923	[-0.01154 -0.00805]	t = -11.0107	**Reject null hypothesis**
λ1	0,01321	0,09611	[0.00748 0.01895]	t = 4.5184	**Reject null hypothesis**
λ2	-0,00026	0,00108	[-0.00032 -0.00020]	t = -7.8816	**Fail to reject**

Table (7)

Testing λ & α in CAPM (only stocks)

	H0:α = 0			H0:λ = 0	
	H1:α≠0			H1:λ>0	
Observations	**sample mean**	**sd.**	**[95% Conf. Interval]**	**sample mean=μ**	**Conclusion**
α	-0,00521	0,02252	[-0.005479 -0.00493]	t = -37.2259	**Reject null hypothesis**
λ1	0,00375	0,04213	[0.00324 0.00427]	t = 14.3501	**Reject null hypothesis**

Table (8)

Testing λ & α in Liquidity adjusted CAPM (only stocks)

	H0:α = 0 H1:α≠0			H0:λ = 0 H1:λ>0	
Observations	**sample mean**	**sd.**	**[95% Conf. Interval]**	**sample mean=μ**	**Conclusion:**
α	-0,00152	0,03352	[-0.00192 -0.00111]	t = -7.2864	**Reject null hypothesis**
λ1	0,01268	1,62506	[-0.00710 0.03246]	t = 1.2569	**Fail to reject**

Table (9)

Testing λ & α in Liquidity adjusted CAPM (with seperate λ & only stocks)

	H0:α = 0 H1:α≠0			H0:λ = 0 H1:λ>0	
Observations	**sample mean**	**sd.**	**[95% Conf. Interval]**	**sample mean=μ**	**Conclusion:**
α	-0,00222	0,03347	[-.0026266 -.0018119]	t = -10.6779	**Reject null hypothesis**
λ1	2,02360	18,78809	[1.79493 2.25226]	t = 17.3457	**Reject null hypothesis**
λ2	-1271	15707	[-1462.206 -1079.869]	t = -13.0320	**Fail to reject**
λ3	-476	4586	[-532.1445 -420.5127]	t = -16.7270	**Fail to reject**
λ4	5,84493	67,58936	[5.022321 6.667546]	t = 13.9268	**Reject null hypothesis**

Table (10)

Testing λ & α in Two factor illiquidity augmented CAPM (only stocks)

	H0:α = 0 H1:α≠0			H0:λ = 0 H1:λ>0	
Observations	**sample mean**	**sd.**	**[95% Conf. Interval]**	**sample mean=μ**	**Conclusion**
α	-0,00501	0,02195	[-0.00528 -0.00474]	t = -36.7421	**Reject null hypothesis**
λ1	0,00374	0,04282	[0.00321 0.00426]	t = 14.0476	**Reject null hypothesis**
λ2	0,00000	0,00000	[9.45e-09 2.77e-08]	t = 3.9918	**Reject null hypothesis**

Figure (6)

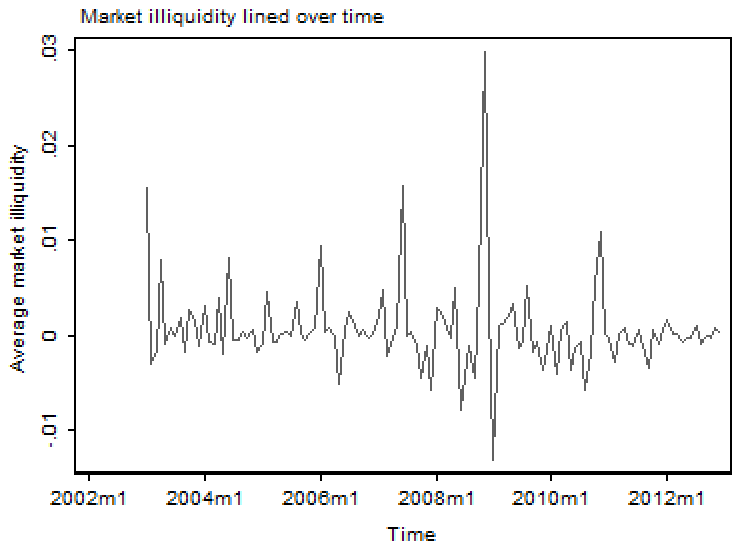
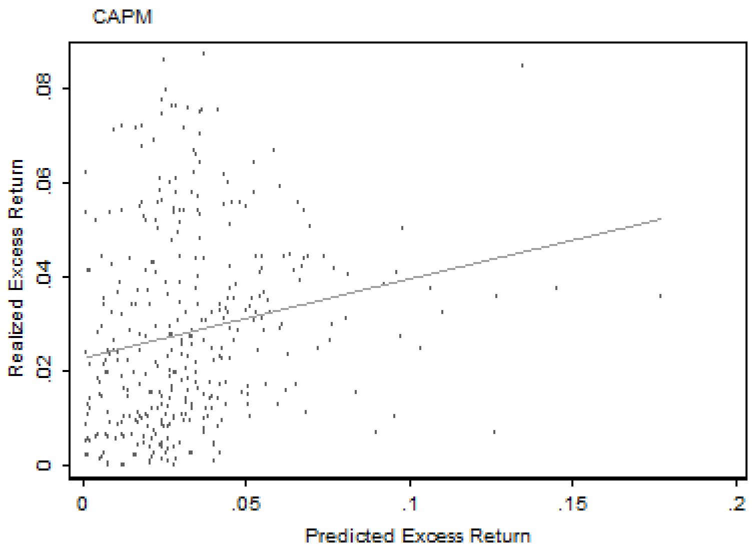


Figure (7)



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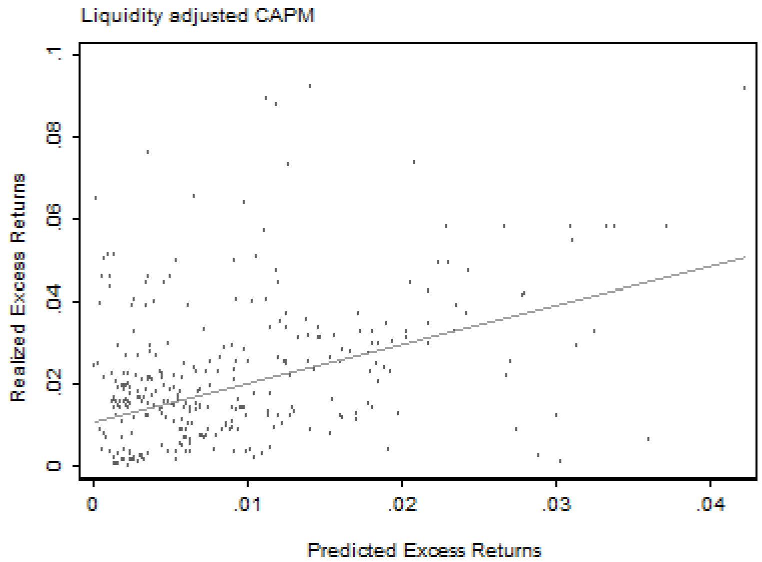

Figure (9)

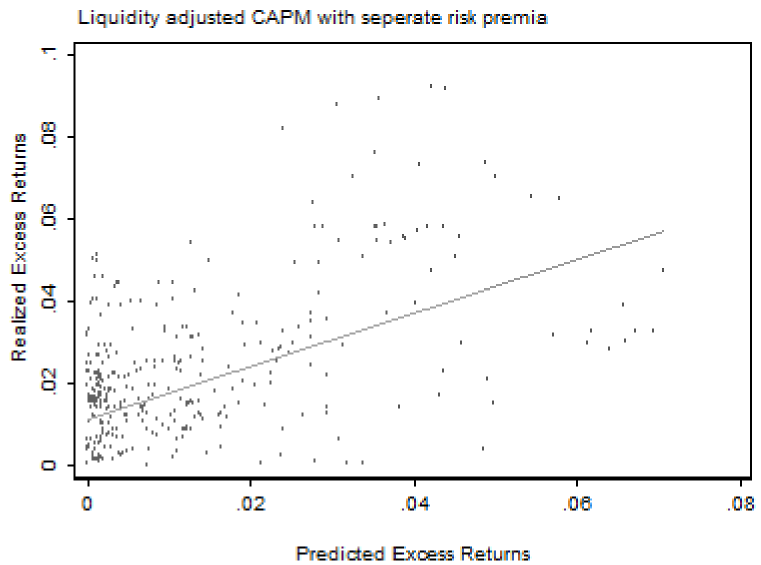

Figure (10)

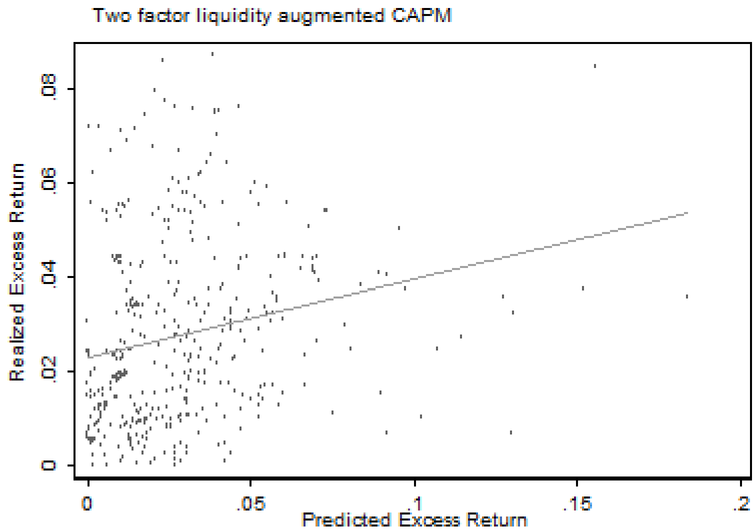
Two factor liquidity augmented CAPM
Realized Excess Return
0
.02
.04
.06
.08
0
.05
.1
.15
.2
Predicted Excess Return

Figure (11)

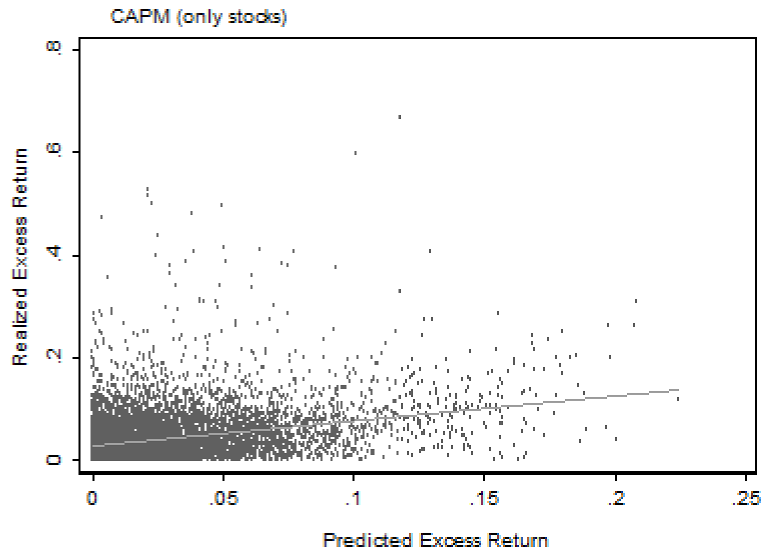

Figure (12)

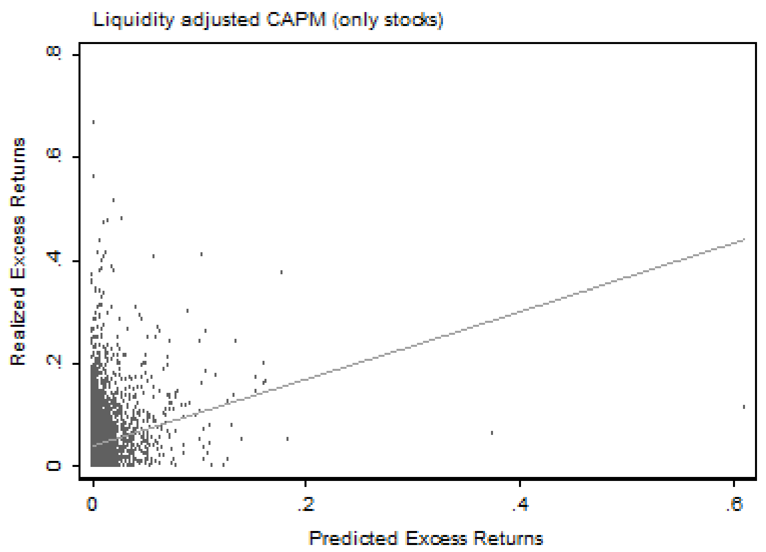

Figure (13)

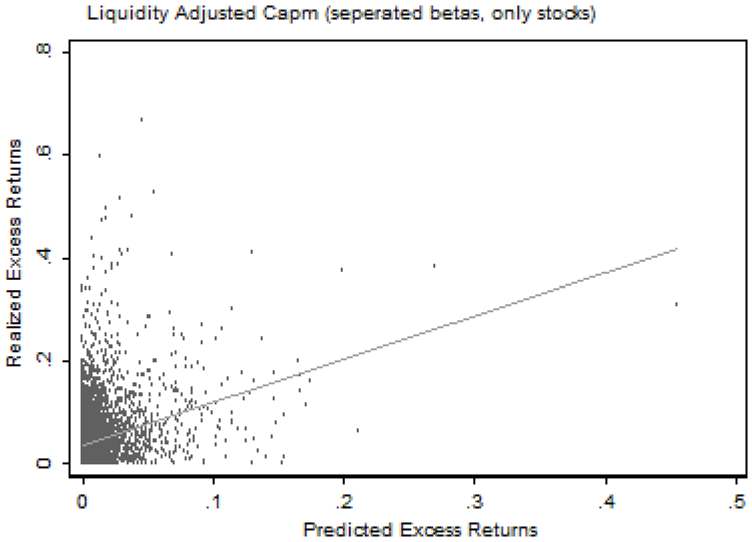

Figure (14)