JEL Classification: G12, C21
Keywords: asset pricing, momentum, liquidity, bid-ask spread, trading volume, stock turnover, cross-sectional multifactor models, stock returns, Sweden

# Does Stock Liquidity Explain the Premium for Stock Price Momentum?*

Jiří NOVÁK—Institute of Economic Studies, Faculty of Social Sciences, Charles University in Prague (novakji@fsv.cuni.cz)

*Abstract*

*The empirically documented positive relationship between price momentum and subsequent stock returns constitutes a puzzle that evades a compelling theoretical explanation. This study analyzes one of the proposed explanations, namely that momentum is correlated with stock liquidity, which is the underlying factor affecting stock returns. We empirically test this proposition using the pre-crisis data from the Stockholm Stock Exchange covering the period between 1979 and 2005. The results from the Fama-MacBeth (1973) regressions provide some evidence that liquidity proxies are negatively correlated with average stock returns. However, contrary to the common prediction the inclusion of liquidity proxies does not significantly impact the explanatory power of momentum. This implies that stock liquidity is not a likely driver of short-term persistence in stock returns.*

## 1. Introduction

Measuring risk in the context of financial markets and analyzing its pricing implications is one of the biggest challenges of modern finance. Even though the determination of the cost of a company's equity hinges on the measurement of a stock's systematic risk, little consensus exists about the factors that are valid proxies for risk. The Capital Asset Pricing Model (CAPM) (Sharpe, 1964; Lintner, 1965; Mossin, 1966; Black, 1972) and its modifications constitute a solid theoretical argument for the importance of stock return sensitivity to market returns (beta). Nevertheless, it is well established by now that the ability of CAPM beta to predict future stock returns is weak and, conversely, other factors such as size and the ratio of book-to-market value of equity (BE/ME), for which the theoretical argument may be less compelling, feature a strong association with stock returns—e.g. Black et al., (1972), Basu (1977), Banz (1981), Stattman (1980) and Rosenberg et al. (1985). It is commonly argued that these factors may be correlated with the underlying risk factors, which would explain their ability to predict future returns. Understanding of the underlying drivers is crucial for our ability to judge the nature of the risk proxies that are often used in multi-factor models, e.g. the Fama and French (1993) three-factor model.

Of the empirical risk proxies that have been shown to be correlated with future stock returns, the stock price momentum is perhaps the most challenging to explain theoretically. Stock price momentum was first analyzed by Jegadeesh and Titman (1993), who found that stock returns feature short-term persistence, i.e. stocks that performed well in the recent past also perform well in the near future. The stock price momentum constitutes a particular challenge to rational risk-based explanation because it is quite difficult to see why a stock whose price has been

* The author gratefully acknowledges financial support from the Czech Science Foundation, grant number P403/12/2166.

recently rising turns more risky. In addition, two of the more established empirical risk factors are size (typically measured by the natural logarithm of the market value of equity) and the ratio of book-to-market value of equity. It is argued that stocks with low market valuation (i.e. size) and stocks with low market valuation relative to the accounting fundamental (i.e. market-to-book equity ratio) may be riskier, which justifies the higher subsequent stock returns. It is challenging to reconcile why stocks with low absolute or relative market valuation are riskier, while at the same time stocks that grow in size (i.e. have positive momentum) also become riskier, which would be necessary to support the risk-based explanation of momentum.

Analyzing a pool of potential risk proxies, Fama and French (1996) conclude that their three-factor model is able to explain most of the previous anomalous findings concerning the cross-sectional variation of stock returns with the exception of stock price momentum. Despite of the attempts to explain momentum by the variability in expected returns (Conrad and Kaul, 1998; Chordia and Shivakumar, 2002) momentum still evades a compelling explanation. For instance, Sadka (2006) suggests: "The momentum anomaly is recognized as one of the biggest challenges to asset pricing." (p. 310)

This study seeks a rational explanation of stock price momentum by linking it to stock liquidity. The importance of liquidity for explaining the cross section of stock returns has been considered in a number of studies. Amihud and Mendelson (1986) document a positive relationship between portfolio returns and liquidity measured as the bid-ask spread. Brennan et al. (1998) use trading volume as a proxy for liquidity and they show that illiquid stocks produce higher risk-adjusted returns on average. Subrahmanyam (2005) investigates the significance of stock turnover and concludes that the nature of the relationship depends on stocks' past performance. This indicates that momentum returns may be linked to liquidity. Also, Sadka (2006) proposes that the profitability of momentum strategies is highly dependent on transaction costs and therefore it is possible that momentum returns can be seen as a compensation for liquidity risk. This study builds on this idea by empirically testing how the inclusion of liquidity proxies impacts the capability of momentum to explain the cross section of stock returns.

Despite the intuitive appeal of the arguments linking momentum to liquidity, our results show that the inclusion of the liquidity proxies does not weaken the explanatory power of momentum. This implies that even after controlling for liquidity there is short-term persistence in stock returns that is driven by factors other than stock liquidity. We contribute to the ongoing discourse on the rational explanation of the momentum factor by providing empirical results that are inconsistent with one of the potential explanations. Thus, even though our findings do not allow us to indentify an economic factor that underlies momentum, they are important because they narrow down the scope of the search for an explanation of momentum. Our findings constitute an important input for researchers and practitioners that should help in deciding where the future effort to explain the "momentum puzzle" should be channeled.

The remainder of the paper is organized as follows: Section 2 reviews existing research and it states hypotheses tested in this study. Section 3 outlines the methodology and the data sample. In Section 4 we present and discuss the results of the empirical analysis, and Section 5 concludes the paper.

## 2. Prior Research

This section presents a review of existing research on stock price momentum and stock liquidity. First, we discuss the existing empirical findings on the relevance of momentum in predicting stock returns. Then we discuss stock liquidity and provide arguments why it may be expected to affect the risk-return relationship and why it may be the factor underlying the explanatory power of stock price momentum.

### 2.1 Momentum

Short-term persistence in stock returns—stock price momentum—constitutes a rather puzzling empirical finding. Momentum was first empirically documented in studies by De Bondt and Thaler (1985, 1987) who show that past winners (stocks with high returns over the past five years) outperform past losers over a short investment horizon (ranging over several months). However, the authors do not concentrate on this finding as they analyze the results for long investment horizons (five years) where the pattern reverses. The first empirical study with an explicit focus on momentum was performed by Jegadeesh and Titman (1993), who show that using a strategy of buying past winners, i.e. stocks that performed well in the past three to 12 months, and selling past losers yields an excess return of approximately 1% per month. Later they show that positive excess returns on momentum strategies persisted also in the 1990s (Jegadeesh and Titman, 2001). Rouwenhorst (1998) provides international evidence showing momentum returns for 12 non-US markets.

Unless these findings can be attributed to some risk characteristics, systematically higher returns on stocks with positive momentum would violate the weak form of stock market efficiency as defined by Fama (1970). Grundy and Martin (2001) as well as Brennan et al. (1998) show that momentum returns cannot be fully captured by either CAPM or the three-factor model. Hence, it has been suggested that momentum proxies for some risk dimension and thus it is sometimes used as the fourth factor in the empirical pricing models. When examining the relative importance of individual factors, Subrahmanyam (2005) shows that the ratio of the book-to-market value of equity and stock price momentum are the most robust factors explaining the cross-section of stock returns.

Even though momentum is sometimes used in asset pricing models, rational explanations justifying momentum as a risk factor are still tenuous. Several theoretical models have been proposed but there is little consensus about the plausibility of these models. Conrad and Kaul (1998) argue that momentum arises because of cross-sectional variability in expected returns. Stocks with high past realized returns are likely to have high expected returns, which generates momentum driven by variation in a firm's systematic risk. Chordia and Shivakumar (2002) suggest that the cross-sectional variation in expected returns is driven by a set of standard macroeconomic variables. Berk et al. (1999) developed a model where the changes in a firm's systematic risk (and hence in expected returns) are based on adoption of investment opportunities, which changes the mix of company assets and growth opportunities. They show that simulations based on this model produce momentum in stock prices.

These models, however, are rather problematic. Jegadeesh and Titman (2001) argue that the reversals in the post-holding period cast doubt on the variation in expected returns as an explanation of momentum returns. Hong et al. (2000) state that momentum strategies work better for stocks with lower analyst coverage, which is consistent with a slow diffusion of information among investors. Hence, some argue that momentum is driven by investor irrationality, namely by the under-reaction to news that gets incorporated only slowly into stock prices. This behavioral argument is similar to the one supporting post-earnings announcement drift (Bernard and Thomas, 1990), which seems to be one of the most intriguing stock market anomalies (Kothari, 2001). In fact, Daniel et al. (1998) and Barberis et al. (1998) developed models that attribute the existence of momentum to cognitive biases rather than to risk. In this paper we develop an alternative explanation based on the proposed association between momentum and liquidity. The first hypothesis aims at confirming the ability of momentum to predict stock returns in the Swedish market.

*H1: There is a positive association between momentum and excess stock returns.*

## 2.2 Liquidity

Several studies suggest that a stock's liquidity may have an influence on its expected return (Amihud and Mendelson, 1986; Amihud, 2002; Brennan, et al., 1998; Subrahmanyam, 2005). Intuitively, stocks are liquid if they can be readily converted into cash without inferring large discounts, which means that liquid stocks incur comparatively low costs of immediate execution of trading (Amihud and Mendelson, 1986). The concept of liquidity can be operationalized in a number of ways. One can use a relative bid-ask spread (scaled by stock price) that should proxy for the size of the discount/premium applicable when selling/buying the stock. It is also possible to address the issue indirectly and measure the total trading volume (measured in currency units) or stock turnover (i.e. trading volume value normalized by the market value of equity), which indicate how much the stock is traded and hence how likely it is to find a counterparty when an investor intends to sell the stock. Amihud (2002) presents an alternative concept of *illiquidity* which is defined as the ratio of a stock's return to the trading volume of the stock. Furthermore, it is possible to measure the impact of single transactions on the market or use the probability of information-based trading Sadka (2006). However, the use of these latter measures requires extensive microstructure data, which are difficult to obtain in many capital markets over a sufficiently long time period.

One of the earliest studies on liquidity was performed by Amihud and Mendelson (1986). They find a positive relationship between portfolio returns and the bid-ask spread as well as a clientele effect whereby investors with longer investment horizons select assets with larger spreads. Similarly, Eleswarapu (1997) documents a positive relationship between the quoted bid-ask spread and risk-adjusted stock returns. Brennan et al. (1998) find a strong negative relationship between liquidity expressed in terms of trading volume and returns adjusted for risk on an individual stock basis either by means of the three-factor model (Fama and French, 1993) or by the principal components approach of Connor and Korajczyk (1988). Amihud (2002) shows a significant positive relationship between illiquidity (defined as the ratio of a stock's return to the trading volume of the stock) and ex-ante stock excess returns, and he shows that illiquidity more significantly affects returns of small stocks. Subrahmanyam (2005) documents the significance of stock turnover and suggests that the nature of the relationship depends on stocks' past performance. Stocks with good performance in the recent past have been found to have a positive turnover-return relationship, while the turnover-return relationship is negative for stocks with weak past performance. This indicates that the significance of liquidity may be conditional on momentum. We use this finding to motivate our main empirical analysis, which assesses the predictive power of momentum in the presence of liquidity proxies. Overall, investors seem to require a premium for holding illiquid stocks, which motivates the following hypothesis:

*H2: There is a negative association between liquidity and stock returns.*

The discussion above suggests that the justification for momentum as a risk proxy remains elusive. Liew and Vassalou (2000) conclude that there is little evidence that excess returns associated with momentum strategies are related to an additional risk factor. Also Clubb and Naffi (2007) are skeptical about the relationship between momentum and risk as they point out: "It should be noted that empirical findings of share price momentum are particularly open to a stock mispricing rather than risk factor interpretation." (p. 6)

This paper proposes that momentum may be associated with stock returns because it is related to liquidity. We argue that the empirically documented positive association between momentum and the expected return is not because momentum is a risk factor per se, but rather because positive price momentum is associated with reduced expected liquidity. The higher expected return may thus be compensation for the reduced liquidity. Thus we propose the following hypothesis.

*H3: The inclusion of liquidity proxies reduces the power of momentum to explain the cross section of expected returns.*

## 3. Research Design

### 3.1 Data Sample

We gather data on all companies listed on the Stockholm Stock Exchange (SSE) between 1979 and 2005 from the Six Trust Database. We do not consider data from after 2006 as the financial markets may have become less efficient during the financial crisis and so the standard association between return and the underlying risk factors may have become weaker. We follow a standard procedure (e.g. Fama and French, 1992) and exclude all financial and insurance companies because their specific asset and liability structure typically produces high financial leverage, which hinders the comparability of their BE/ME ratios with non-financial firms. A stock's share price in month $t$ is defined as the closing purchase price on the last trading day in a given month. In total the sample comprises 609 stocks and 59,400 firm-month observations.

SSE is of interest for several reasons. First, most of the empirical risk factors (size, BE/ME, momentum) have been discovered and analyzed on several large, typically Anglo-American markets. Stock return performances on these markets are highly correlated (Engsted and Tanggaard, 2004). The Scandinavian corporate governance system is usually described as distinct from both the Anglo-American and Germanic corporate governance systems (La Porta and Lopez-de-Silanes, 1999). Swedish data thus provide out-of-sample evidence that can be used to verify the significance of the factors in an environment with different characteristics and to draw conclusions about their generality. This seems to be particularly important given the empirical (rather than theoretical) basis of most of the commonly used risk-factors (Conrad, et al., 2003). Second, SSE is a reasonably large stock exchange with a quite heterogonous composition of stocks, which makes it possible to draw sensible inferences from the 59,400 firm-month observations available. Third, to the best of our knowledge, stock liquidity has not been previously studied in the Scandinavian setting and so this study pioneers that area.

Our analysis aims at assessing the power of several previously proposed variables to explain stock returns. Realized monthly excess returns (defined as raw stock return minus risk-free return) are used as a proxy for expected returns. Market expectations (or at least analysts' expectations) are not observable on a monthly basis, which necessitates the use of realized returns as proxies. This involves an implicit assumption that the market expectations are on average "right" and hence the realized monthly returns are representative of their expectations at the beginning of the period. Furthermore, monthly returns on three-month Swedish Government Bonds are used as a proxy for the risk-free asset. This is because the data on one-month Swedish Government Bonds prior to 1993 are not available. We do not expect the choice of the risk-free proxy to have any significant impact on the results since the correlation between the two series over the period between November 1993 and May 2005 is 0.972 and the average difference between the two return series is a mere 0.002%.

We analyze the explanatory power of momentum and liquidity incremental to the already established risk factors—the CAPM beta, size and the book-to-market equity ratio. We acknowledge that CAPM betas may change over the sample period (27 years) and hence for every stock CAPM beta is re-estimated at the beginning of each month by means of longitudinal rolling window regressions of individual stock excess returns on market excess returns over the past 60 months.[1] A standard Swedish stock market index (AFGX) is used as a proxy for market return. This follows the recommendation of Bartholdy and Peare (2001, 2005), who conclude that the use of five years of monthly data and an equal-weighted market index provide the most efficient beta estimates.

As a proxy for size ln(ME), we use the natural logarithm of market value of equity computed as the stock price at the beginning of the month times the total number of stocks. To construct the book-to-market equity ratio (BE/ME), we use common shareholders' equity from the accounting period ending at least three months before the beginning of the month and the market value of equity from the beginning of the month. The minimum three-month lag follows a standard procedure that ensures that the accounting information is known to the market at that time. Momentum ($R^{-7,\,-1}$) is defined as the dividend-adjusted ex-post raw return on the stock over a six-month period ending at the beginning of the month of the regression.

Several proxies are used for stock liquidity. First, the study uses a relative bid-ask spread (Bid-ask) that reflects the direct marginal cost of trading. A relative bid-ask spread is defined as the percentage difference between the offered selling and

[1] There is a minimum requirement of at least 48 pairs of observations to be available.

**Table 1 Descriptive Statistics**

Number of monthly observations (*N*), *mean*, standard deviations (*sd*), minimum (*min*), first quartile (*p25*), median (*p50*), third quartile (*p75*) and maximum (*max*) for the dependent variable of excess stock returns (*exret*), as well as all the regressors, including CAPM beta estimates based on the preceding 60 months (*beta*), size proxied by the natural logarithm of the market value of equity (*ln(ME)*), the ratio of the book-to-market value of equity (*BE/ME*), *momentum* defined as the preceding six-month dividend-adjusted stock return, the relative bid-ask spread (*bid-ask*) defined as the six-month average difference between the selling price and purchase price scaled by the purchase price, stock turnover defined as the six-month average ratio of the trading volume and the market value of equity (*turnover*) and trading volume defined as the six-month average of the value of trades in the stock (*volume*). Panel A is based on the full data sample while Panel B gives descriptives for the sample Winsorized at three standard deviations for each of the variables.

| | Exret | Beta | ln(ME) | BE/ME | Momentum | Bid-ask | Turnover | Volume |
|---|---|---|---|---|---|---|---|---|
| *Panel A—Full Sample* | | | | | | | | |
| *N* | 59 248 | 39 594 | 57 740 | 54 881 | 58 320 | 61 180 | 46 339 | 51 122 |
| mean | 0.008 | 0.917 | 6.575 | 8.2 | 0.106 | -0.032 | 0.634 | 401.4 |
| sd | 0.165 | 0.521 | 1.901 | 229.3 | 0.479 | 0.063 | 19.762 | 3 624.8 |
| min | -1.013 | -0.482 | -2.469 | 0.0 | -0.998 | -0.834 | 0.000 | 0.0 |
| p25 | -0.061 | 0.567 | 5.267 | 0.3 | -0.124 | -0.038 | 0.007 | 2.8 |
| p50 | -0.003 | 0.854 | 6.373 | 0.5 | 0.059 | -0.021 | 0.019 | 12.5 |
| p75 | 0.065 | 1.167 | 7.791 | 0.8 | 0.264 | -0.012 | 0.043 | 62.8 |
| max | 5.026 | 4.370 | 14.680 | 12 844.8 | 19.000 | 7.518 | 1 701.080 | 141 285.0 |
| *Panel B—Winsorized Sample* | | | | | | | | |
| *N* | 59 248 | 39 594 | 57 740 | 54 881 | 58 320 | 61 180 | 46 339 | 51 122 |
| mean | 0.005 | 0.910 | 6.577 | 1.7 | 0.093 | -0.032 | 0.152 | 270.4 |
| sd | 0.135 | 0.493 | 1.873 | 26.8 | 0.375 | 0.035 | 2.575 | 1 176.2 |
| min | -0.487 | -0.482 | 0.870 | 0.0 | -0.998 | -0.221 | 0.000 | 0.0 |
| p25 | -0.061 | 0.567 | 5.267 | 0.3 | -0.124 | -0.038 | 0.007 | 2.8 |
| p50 | -0.003 | 0.854 | 6.373 | 0.5 | 0.059 | -0.021 | 0.019 | 12.5 |
| p75 | 0.065 | 1.167 | 7.791 | 0.8 | 0.264 | -0.012 | 0.043 | 62.8 |
| max | 0.503 | 2.480 | 12.279 | 696.2 | 1.542 | 0.157 | 59.920 | 11 275.8 |

purchase price averaged over the past six months. The bid-ask spread is used as a liquidity proxy by, for example, Amihud and Mendelson (1986). Second, we use trading volume (TV), which captures how much of the stock changes hands in a month and thus gives an indication of how easy it is for investors to find a counterparty for trading and how likely the investor is to depress the price in the case that he/she decides to sell a substantial amount of the stock. The use of trading volume is motivated by Glosten and Harris (1988) and Brennan and Subrahmanyam (1995), who show that it is a major determinant of liquidity. Finally, we use stock turnover (TV/ME), which captures the percentage of market capitalization that is traded on average over a month in the past six months. Turnover is used as a liquidity proxy by, for example, Amihud and Mendelson (1986) and Sadka 2006.

*Table 1* provides descriptive statistics based on monthly observations of all the variables used. Panel A uses the full data sample as obtained from the Trust database, whereas in Panel B the data are based on a sample that has been treated for outliers by Winsorizing the data at three standard deviations. The importance of this procedure can be seen, for example, by observing its effect on excess returns (exret). Winsorizing reduces the range of excess stock returns from –101.3% to 502.6% in the original sample to –48.7% to 50.3% in the adjusted sample. Concentrating on the Winsorized sample, we can observe that the medians of all variables take values that are broadly consistent with the intuitive expectations. The median excess return is close to zero (–0.3%), median beta is close to one (0.854), BE/ME is 0.5, which implies the market-to-book equity ratio (i.e. inverse of BE/ME) of 2, and the median momentum is 5.9%, which implies the annual stock return of approximately 12%.

*Table 2* shows the pairwise correlations between variables together with the corresponding *p*-values. Again, Panel A uses the full data sample, whereas Panel B is based on the sample Winsorized at three standard deviations. *Table 2* gives some initial indications concerning the relationships between the studied variables. It can be observed that the correlation between beta and excess returns is indeed very weak (in fact, somewhat negative for the Winsorized sample). The correlations with excess returns for both the size and BE/ME have the expected sign (negative for size and positive for BE/ME), but only the correlation of size to excess returns in the full sample is statistically significant. The correlation of excess returns with momentum, on the other hand, is positive and significant in both samples, suggesting that momentum is likely to be an important factor for explaining the cross section of stock returns. As is consistent with the predictions, the correlation between excess returns and Bid-ask is negative and significant, but only in the full sample. The correlations for the indirect liquidity measures (turnover and volume) are all insignificant.

### 3.2 Methodology

For each set of explanatory variables we run a series of monthly cross-sectional Fama-MacBeth (1973) regressions of dividend-adjusted excess returns on the set of proposed risk factors. This methodology is commonly used in asset pricing to assess the significance of stock return determinants. In order to maintain consistency with prior research and to allow for good comparability of results across various papers, we also follow this methodology.

The Fama-MacBeth (1973) methodology involves two stages. First, CAPM betas are estimated by time-series regression using historical monthly asset excess returns and market excess returns. For each firm, when estimating beta, we use five years of monthly excess return data (i.e. 60 observations) and we require at least 36 observations (i.e. three years) to exist. This procedure gives us a CAPM beta estimate for each firm-month. Second, each month we run a cross-sectional regression of realized excess returns on the CAPM beta and the other proposed risk factors as measured at the beginning of the month. Each of the 254 monthly cross-sectional regressions generates the estimate coefficient of each of the risk factors. The mean values for each explanatory variable are reported in the tables as the estimated slope coefficient.[2]

[2] Weighting the monthly slope coefficients by the number of firm observations on which they are based does not materially affect the results.

**Table 2 Correlation Matrix**

Correlation coefficients and corresponding *p*-values (reported below each coefficient) for the dependent variable of excess stock returns (*exret*) as well as all regressors, including CAPM beta estimate based on the preceding 60 months (*beta*), size proxied by the natural logarithm of the market value of equity (*ln(ME)*), the ratio of the book-to-market value of equity (*BE/ME*), *momentum* defined as the past six-month dividend-adjusted stock return, the relative bid-ask spread (*bid-ask*) defined as the six-month average difference between the selling price and purchase price scaled by the purchase price, stock turnover defined as the six-month average ratio of the trading volume and the market value of equity (*turnover*), and trading volume defined as the six-month average of the value of trades in the stock (*volume*). Panel A is based on the full data sample while Panel B gives descriptives for the sample Winsorized at three standard deviations for each of the variables.

| | Exret | Beta | ln(ME) | BE/ME | Moment | Bid-ask | Turnover | Volume |
|---|---|---|---|---|---|---|---|---|
| | | | | *Panel A—Full Sample* | | | | |
| **Exret** | 1.000 | | | | | | | |
| **Beta** | 0.001 | 1.000 | | | | | | |
| | (0.846) | | | | | | | |
| **ln(ME)** | -0.023 | 0.044 | 1.000 | | | | | |
| | (0.000) | (0.000) | | | | | | |
| **BE/ME** | 0.004 | 0.006 | -0.147 | 1.000 | | | | |
| | (0.319) | (0.288) | (0.000) | | | | | |
| **Moment** | 0.048 | 0.035 | 0.106 | -0.009 | 1.000 | | | |
| | (0.000) | (0.000) | (0.000) | (0.047) | | | | |
| **Bid-ask** | -0.060 | 0.065 | 0.458 | 0.013 | 0.102 | 1.000 | | |
| | (0.000) | (0.000) | (0.000) | (0.004) | (0.000) | | | |
| **Turnover** | 0.009 | 0.014 | -0.131 | 0.645 | 0.004 | 0.016 | 1.000 | |
| | (0.071) | (0.016) | (0.000) | (0.000) | (0.432) | (0.001) | | |
| **Volume** | -0.006 | 0.104 | 0.276 | -0.003 | 0.005 | 0.042 | -0.002 | 1.000 |
| | (0.170) | (0.000) | (0.000) | (0.486) | (0.229) | (0.000) | (0.734) | |
| | | | | *Panel B—Winsorized Sample* | | | | |
| **Exret** | 1.000 | | | | | | | |
| **Beta** | -0.009 | 1.000 | | | | | | |
| | (0.092) | | | | | | | |
| **ln(ME)** | -0.002 | 0.051 | 1.000 | | | | | |
| | (0.591) | (0.000) | | | | | | |
| **BE/ME** | 0.002 | 0.011 | -0.129 | 1.000 | | | | |
| | (0.581) | (0.036) | (0.000) | | | | | |
| **Moment** | 0.079 | 0.004 | 0.139 | -0.017 | 1.000 | | | |
| | (0.000) | (0.456) | (0.000) | (0.000) | | | | |
| **Bid-ask** | 0.005 | 0.103 | 0.514 | 0.009 | 0.193 | 1.000 | | |
| | (0.216) | (0.000) | (0.000) | (0.037) | (0.000) | | | |
| **Turnover** | 0.003 | 0.016 | -0.139 | 0.989 | -0.009 | 0.027 | 1.000 | |
| | (0.567) | (0.006) | (0.000) | (0.000) | (0.064) | (0.000) | | |
| **Volume** | 0.001 | 0.060 | 0.483 | -0.009 | 0.018 | 0.167 | -0.002 | 1.000 |
| | (0.865) | (0.000) | (0.000) | (0.061) | (0.000) | (0.000) | (0.687) | |

Relative to pure cross-sectional regression of time-series averages, the Fama-MacBeth (1973) methodology allows the individual risk factors to vary over time. The advantage of this approach relative to standard pooled regression is that it automatically corrects the standard errors for the cross-sectional correlation in the panel data. It does not correct for the possible time-series autocorrelation. However, the latter is typically considered to have a minor effect when the sampling frequency is sufficiency short. That is why monthly return sampling frequency is used. Using even shorter intervals would not be desirable because of the increase in the noise in the high frequency returns. Factors other than risk may temporarily affect short-term returns. In longer-term returns the risk factors should prevail. Hence, the monthly sampling frequency represents a commonly used compromise between the two considerations.

To assess the significance of the estimated slope coefficients, we use *t*-statistic computed as the ratio of the mean estimated monthly coefficient divided by the product of their standard deviation and the square root of the number on monthly regressions. The individual monthly coefficients thus constitute estimates obtained from repeated sampling from the underlying return distribution. Their variance is used to assess the standard error and to compute the resulting *t*-statistic. The standard errors based on the cross-sectional estimates will thus approach normal distribution even though the underlying return distribution may not be normal.

To control for the effect of outliers in our main test, we Winsorize all variables at three standard deviations, i.e. all values that are further than three standard deviations away from the mean are replaced by the value equal to the mean plus or minus three standard deviations. This ensures that the reported results are not driven by a limited number of extreme observations that may be unusual or that may result from an error in the database we use. Nevertheless, the impact of the risk factors on stock returns may not be linear and a low probability of a large gain (loss) may compensate for an overall lower (higher) return in the middle of the sample. Winsorizing eliminates these unusual return observations which may potentially bias the results. Hence, it is important to also investigate the entire sample including both the common and unusual observations. To that end we also report the results for the non-Winsorized sample.

## 4. Results

In the empirical analysis we first analyze the association between excess stock returns on one hand and momentum or the three liquidity measures on the other. Afterwards we add the momentum and liquidity measures to the three-factor model to see their incremental effect after having controlled for the already established risk factors (CAPM beta, size, BE/ME). Finally, we test the prediction that the inclusion of various liquidity proxies reduces the explanatory power of momentum.

### 4.1 Price Momentum

*Tables 3* and *4* show that there is a positive association between the stock price momentum and the realized stock returns (model 1 in *Tables 3* and *4*). Nevertheless, the positive association is significant only for the Winsorized sample reported in *Table 4* (*t*-statistic of 2.642). Model 5 in *Tables 3* and *4* shows the association after controlling for the risk measures included in the three-factor model

**Table 3 Full Sample Results**

Mean slope coefficients (*mean*) and corresponding *t*-statistics (*t-stat*) from monthly cross-sectional regressions of stock excess return on its CAPM beta, size, BE/ME, momentum, relative bid-ask spread, trading volume and stock turnover based on the complete sample. *T* gives the number of monthly regressions performed for each specification. *Cons* gives the intercept term. CAPM beta (*beta*) is estimated ex post, i.e. from rolling window regressions of stock excess returns on market excess returns based on the 60 preceding months. Size (*ln(ME)*) is measured as the natural logarithm of the market value of equity at the beginning of the month. *BE/ME* is the ratio of book value of equity from the accounting period ending at least three months before the beginning of the month to market value of equity at the beginning of the month. Momentum (*moment*) is the dividend-adjusted stock return over the preceding six months. *Bid-ask* is the relative bid-ask spread averaged over the preceding six months. *Turnover* is the trading volume divided by the market value of the equity at the beginning of the month averaged over the preceding six months. *Volume* is the six-month average of the value of trades in the stock.

| | | *T* | Cons | Beta | ln(ME) | BE/ME | Moment | Bid-ask | Turnover | Volume |
|---|---|---|---|---|---|---|---|---|---|---|
| | predicted | | | (+) | (–) | (+) | (+) | (–) | (–) | (–) |
| 1 | mean | 254 | 0.005 | | | | 0.006 | | | |
| | *t*-stat | | (1.149) | | | | (0.910) | | | |
| 2 | mean | 254 | 0.001 | | | | | -0.157 | | |
| | *t*-stat | | (0.154) | | | | | (-3.250) | | |
| 3 | mean | 251 | 0.003 | | | | | | 0.013 | |
| | *t*-stat | | (0.783) | | | | | | (0.105) | |
| 4 | mean | 251 | 0.006 | | | | | | | 0.0 |
| | *t*-stat | | (0.926) | | | | | | | (-0.777) |
| 5 | mean | 254 | 0.011 | -0.005 | 0.0 | 0.002 | 0.005 | | | |
| | *t*-stat | | (1.905) | (-1.352) | (-0.449) | (0.641) | (1.002) | | | |
| 6 | mean | 254 | -0.003 | -0.003 | 0.001 | 0.001 | | -0.188 | | |
| | *t*-stat | | (-0.366) | (-0.690) | (1.346) | (0.457) | | (-3.901) | | |
| 7 | mean | 249 | 0.008 | -0.002 | 0.0 | 0.002 | | | -0.019 | |
| | *t*-stat | | (1.198) | (-0.554) | (-0.014) | (0.615) | | | (-0.223) | |
| 8 | mean | 249 | 0.011 | -0.003 | -0.001 | 0.001 | | | | 0.0 |
| | *t*-stat | | (1.668) | (-0.681) | (-0.764) | (0.387) | | | | (1.003) |
| 9 | mean | 254 | -0.003 | -0.004 | 0.001 | 0.002 | 0.007 | -0.186 | | |
| | *t*-stat | | (-0.464) | (-1.047) | (1.246) | (0.657) | (1.349) | (-3.900) | | |
| 10 | mean | 249 | 0.007 | -0.003 | 0.0 | 0.003 | 0.006 | | -0.046 | |
| | *t*-stat | | (1.025) | (-0.851) | (0.042) | (0.993) | (1.058) | | (-0.523) | |
| 11 | mean | 249 | 0.010 | -0.004 | -0.001 | 0.002 | 0.005 | | | 0.0 |
| | *t*-stat | | (1.580) | (-1.071) | (-0.771) | (0.571) | (0.868) | | | (0.964) |
| 12 | mean | 249 | 0.003 | -0.003 | 0.0 | 0.002 | 0.007 | -0.119 | -0.07 | 0.0 |
| | *t*-stat | | (0.401) | (-0.644) | (-0.145) | 0.660 | (1.171) | (-2.264) | (-0.759) | (1.125) |

(CAPM beta, size, BE/ME). It can be observed that in both the full and Winsorized samples there is a positive association between the momentum and the excess returns, but none of the two results is statistically significant (*t*-statistic of 1.002 for the full sample and 1.357 for the Winsorized sample). Thus, we find some support for Hypothesis 1, which suggests that stock returns exhibit short-term persistence;

**Table 4 Winsorized Sample Results**

Mean slope coefficients (*mean*) and corresponding *t*-statistics (*t-stat*) from monthly cross-sectional regressions of stock excess return on its CAPM beta, size, BE/ME, momentum, relative bid-ask spread, trading volume and stock turnover based on the sample Winsorized at three standard deviations for each variable. *T* gives the number of monthly regressions performed for each specification. *Cons* gives the intercept term. CAPM beta (*beta*) is estimated ex post, i.e. from rolling window regressions of stock excess returns on market excess returns based on the 60 preceding months. Size (*ln(ME)*) is measured as the natural logarithm of the market value of equity at the beginning of the month. *BE/ME* is the ratio of book value of equity from the accounting period ending at least three months before the beginning of the month to market value of equity at the beginning of the month. Momentum (*moment*) is the dividend-adjusted stock return over the preceding six months. *Bid-ask* is the relative bid-ask spread averaged over the preceding six months. *Turnover* is the trading volume divided by the market value of the equity at the beginning of the month averaged over the preceding six months. *Volume* is the six-month average of the value of trades in the stock.

| | | ***T*** | **Cons** | **Beta** | **ln(ME)** | **BE/ME** | **Moment** | **Bid-ask** | **Turnover** | **Volume** |
|---|---|---|---|---|---|---|---|---|---|---|
| | predicted | | | (+) | (–) | (+) | (+) | (–) | (–) | (–) |
| 1 | mean | 254 | 0.002 | | | | 0.014 | | | |
| | *t*-stat | | (0.636) | | | | (2.642) | | | |
| 2 | mean | 254 | 0.003 | | | | | -0.039 | | |
| | *t*-stat | | (0.757) | | | | | (-1.040) | | |
| 3 | mean | 251 | 0.002 | | | | | | -0.048 | |
| | *t*-stat | | (0.448) | | | | | | (-0.634) | |
| 4 | mean | 251 | 0.001 | | | | | | | 0 |
| | *t*-stat | | (0.191) | | | | | | | (-0.042) |
| 5 | mean | 254 | 0.008 | -0.005 | 0 | 0.001 | 0.006 | | | |
| | *t*-stat | | (1.406) | (-1.614) | (0.310) | (0.484) | 1.357) | | | |
| 6 | mean | 254 | -0.001 | -0.004 | 0.001 | 0.001 | | -0.141 | | |
| | *t*-stat | | (-0.145) | (-1.142) | (1.613) | (0.278) | | (-3.119) | | |
| 7 | mean | 249 | 0.002 | -0.003 | 0.001 | 0.003 | | | -0.022 | |
| | *t*-stat | | (0.302) | (-0.788) | (1.140) | (1.111) | | | (-0.305) | |
| 8 | mean | 249 | 0.006 | -0.004 | 0 | 0.001 | | | | 0 |
| | *t*-stat | | (0.936) | (-0.977) | (0.148) | (0.468) | | | | (0.983) |
| 9 | mean | 254 | -0.002 | -0.005 | 0.001 | 0.001 | 0.007 | -0.142 | | |
| | *t*-stat | | (-0.336) | (-1.407) | (1.487) | (0.554) | (1.693) | (-3.159) | | |
| 10 | mean | 249 | 0.001 | -0.004 | 0.001 | 0.004 | 0.008 | | -0.043 | |
| | *t*-stat | | (0.134) | (-1.102) | (1.093) | (1.543) | (1.596) | | (-0.590) | |
| 11 | mean | 249 | 0.005 | -0.005 | 0 | 0.002 | 0.006 | | | 0 |
| | *t*-stat | | (0.864) | (-1.355) | (0.072) | (0.694) | (1.261) | | | (0.942) |
| 12 | mean | 249 | 0 | -0.003 | 0 | 0.003 | 0.008 | -0.081 | -0.087 | 0 |
| | *t*-stat | | (0.047) | (-0.821) | (0.335) | (1.224) | (1.673) | (-1.623) | (-1.102) | (1.098) |

the expected positive association is documented for the Winsorized sample, but it seems that part of the effect is absorbed by the established risk factors.

### 4.2 Liquidity

We further investigate the role of the three liquidity proxies—the bid-ask spread (Bid-ask), the trading volume (TV) and the stock turnover (TV/ME). The bid-ask spread captures how much of the offered selling price paid by the new investor must be sacrificed the in case that he/she decides to sell the stock immediately after purchase. It is expressed as a negative percentage of the purchase price. Stocks with very negative Bid-ask are the most illiquid ones, for which investors are expected to require a premium; hence we expect a negative slope coefficient at Bid-ask. Negative slope coefficients are also expected for TV (the value of monthly trades in the stock) as well as for TV/ME (percentage of stocks that change hands over a month averaged over the past six months) because the higher trading volume or stock turnover, the better the stock liquidity and hence the lower the liquidity premium should be.

Models 2, 3 and 4 in *Tables 3* and *4* provide some support for the prediction. By using the Winsorized sample, the slope coefficients of all three liquidity measures are negative, but none of them is statistically significant (*t*-statistics of –1.04 for the bid-ask spread, –0.634 for the stock turnover, and –0.042 for the trading volume). Considering the non-Winsorized sample the coefficient for the bid-ask spread is negative and statistically significant (*t*-statistics of –3.25).

When analyzing the three liquidity proxies in combination with the three established risk factors (Models 6, 7 and 8), the bid-ask spread features a negative association with the realized returns that is significant both for the Winsorized and non-Winsorized sample (*t*-statistic of –3.901 for the full sample and –3.119 for the Winsorized sample). The association between the stock turnover and realized returns is negative as predicted, but it is insignificant for both the Winsorized and non-Winsorized sample (*t*-statistic of –0.223 for the full sample and –0.305 for the Winsorized sample). Finally, trading volume is positive and insignificant.

Taken together, we find some support for Hypothesis 2, which predicts a negative association between the liquidity proxies and the realized returns. The bid-ask spread seems to be the most powerful liquidity proxy that features a fairly consistent negative association both on a stand-alone basis and in combination with the three-factor model. Conversely, the trading volume does not seem to capture liquidity in a robust way and its association with the subsequent stock returns is not consistent. The stock turnover performs somewhat better, but the negative associations documented in the Winsorized sample are not statistically significant.

### 4.3 Liquidity and Momentum

Finally, we include the three liquidity proxies in the four-factor model in order to see how their inclusion conditions the significance of momentum. We expect that momentum is positively associated with stock returns because of its negative relation with liquidity. Hence, we expect that inclusion of the liquidity proxies absorbs some of the momentum effect and thus weakens the association between momentum and realized returns.

First, we augment the four-factor model with one of the liquidity proxies at a time. Interestingly, we find that the inclusion of the bid-ask spread and the stock turnover does not weaken the association between momentum and realized stock returns. On the contrary, it seems that the association gets stronger after the inclusion of the liquidity proxies while at the same time the slope coefficients at the liquidity proxies turn more negative. Focusing first on the Winsorized sample reported in *Table 4,* the *t*-statistic at the momentum slope coefficient increases from 1.357 to 1.693 after including the bid-ask spread, and to 1.596 after including stock turnover. A similar pattern can be observed for the non-Winsorized sample reported in *Table 3*. The *t*-statistic at the momentum slope coefficient increases from 1.002 to 1.349 after including the bid-ask spread, and to 1.058 after including stock turnover. The increase in the level of significance is stronger for the inclusion of the bid-ask spread, which was found to be a better liquidity measure in the previous section, and it does not occur at all after the inclusion of the trading volume, which we found to be a poor proxy of stock liquidity. While the inclusion of the bid-ask spread increases the significance of momentum, the significance of the liquidity measures themselves is not impaired; it is virtually unchanged for the bid-ask spread and it increases (in absolute value) for the stock turnover (*t*-statistic changes from –0.305 to –0.590 for the Winsorized sample and from –0.223 to –0.523 for the non-Winsorized sample). This implies that momentum and liquidity seem to capture two different dimensions and the ability of momentum to predict future stock returns cannot be explained by the argument that momentum proxies for liquidity as is sometimes suggested.

Finally, we include momentum together with all three liquidity proxies in a single regression (Models 12 in *Tables 3* and *4*). This does not affect the inferences drawn above. The slope coefficient at momentum remains positive (marginally significant for the Winsorized sample with a corresponding *t*-statistic of 1.673) while both the bid-ask spread and the stock turnover retain a insignificant negative association to the realized stock returns (*t*-statistic of –1.623 and –1.102 for the Winsorized sample and –2.264 and –0.759 for the non-Winsorized sample). Thus, we do not find empirical support for Hypothesis 3, which suggests that the inclusion of liquidity proxies decreases the explanatory power of momentum.

## 5. Summary and Conclusion

We investigate whether stock liquidity is the underlying driver of the ability of stock price momentum to predict future stock returns. To empirically test this proposition, we run Fama-MacBeth (1973) regressions using the Fama and French (1993) three-factor model augmented for stock price momentum and liquidity proxies. We examine whether inclusion of the liquidity proxies reduces the explanatory power of momentum. First, we find some evidence on the positive relationship between past and future stock returns, though its significance depends on the treatment of outliers. Second, we also provide evidence that liquidity is relevant for realized stock returns, but this inference depends on the way liquidity is measured. Of the three liquidity measures considered, only the direct measure—the relative bid-ask spread—is found to be associated with realized stock returns. Conversely, the trading volume does not seem to capture liquidity well. Third, we show that the inclusion of liquidity proxies does not weaken the explanatory power of momentum. If anything, the association between momentum and realized stock returns gets slightly stronger after the inclusion of the bid-ask spread and stock turnover.

We conclude that liquidity does not seem to be the underlying driver for stock price persistence (i.e. momentum). The underlying assumption of the empirical asset pricing models is risk is multidimensional and therefore several factors are needed to capture the various risk dimensions. It is typically proposed that low absolute market valuation, i.e. size measured as the natural logarithm of the market value of the equity, and low relative market valuation, i.e. the inverse of the book-to-market equity ratio, imply potential financial difficulties for a company. Size and BE/ME should thus capture the relative risk of financial distress that should be priced over and above the systematic risk measured by CAPM beta. It is also suggested that momentum captures a latent risk variable. The identification of the underlying driver of this risk dimension is challenging since a consistent argument would have to explain why companies with a low stock price are riskier while at the same time companies with a rising stock price are also riskier. This study concludes that while both momentum and liquidity are related to realized stock returns in the predicted dimension, using them jointly only strengthens their explanatory power and hence stock liquidity does not seem to be the underlying driver of the momentum puzzle.

REFERENCES

Amihud Y (2002): Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets*, 31.

Amihud Y, Mendelson H (1986): Asset Pricing and the Bid-Ask Spread. *Journal of Financial Economics*, 17:223.

Banz RW (1981): The Relationship between Return and Market Value of Common Stocks. *Journal of Financial Economics*, 9:3.

Barberis N, Shleifer A, Vishny R (1998): A model of investor sentiment. *Journal of Financial Economics*, 49:307.

Bartholdy J, Peare P (2001): The Relative Efficiency of Beta Estimates. *Aarhus School of Business Working Paper*. Available at SSRN:
http://ssrn.com/abstract=263745 or http://dx.doi.org/10.2139/ssrn.263745

Bartholdy J, Peare P (2005): Estimation of expected return: CAPM vs. Fama and French. *International Review of Financial Analysis*, 14:407.

Basu S (1977): Investment Performance of Common Stocks in Relation to Their Price-Earnings Ratios: A Test of the Efficient Market Hypothesis. *Journal of Finance*, 32:663.

Berk J, Green RC, Naik V (1999): Optimal investment, growth options, and security returns. *Journal of Finance*, 54:1553.

Bernard VL, Thomas JK (1990): Evidence that Stock Prices Do Not Fully Reflect the Implications of Current Earnings for Future Earnings. *Journal of Accounting & Economics*, 13:305.

Black F, Jensen M, Scholes M (1972): The capital asset pricing model: some empirical tests. In: Jensen M (Ed.): *Studies in the Theory of Capital Markets*. Praeger Publishers, New York.

Black F (1972): Capital Market Equilibrium with Restricted Borrowing. *Journal of Business*, 45:444.

Bondt WFM de, Thaler R (1985): Does the Stock Market Overreact? *Journal of Finance*, 40:793.

Bondt WFM de, Thaler RH (1987): Further Evidence on Investor Overreaction and Stock Market Seasonality. *Journal of Finance*, 42:557.

Brennan MJ, Chordia T, Subrahmanyam A (1998): Alternative factor specifications, security characteristics, and the cross-section of expected stock returns, *Journal of Financial Economics*, 49:345.

Brennan MJ, Subrahmanyam A (1995): Investment analysis and price formation in securities markets. *Journal of Financial Economics*, 38:361.

Clubb C, Naffi M (2007): The Usefulness of Book-to-Market and ROE Expectations for Explaining UK Stock Returns. *Journal of Business Finance & Accounting*, 34:1.

Connor G, Korajczyk RA (1988): Risk and Return in an Equilibrium APT: Application of a New Test Methodology. *Journal of Financial Economics*, 21:255.

Conrad J, Cooper M, Kaul G (2003): Value versus Glamour. *Journal of Finance*, 58:1969.

Conrad J, Kaul G (1998): An Anatomy of Trading Strategies. *Review of Financial Studies*, 11:489.

Daniel K, Hirshleifer D, Subrahmanyam A (1998): Investor psychology and security market under- and overreactions. *Journal of Finance*, 53:1839.

Eleswarapu VR (1997): Cost of Transacting and Expected Returns in the Nasdaq Market. *Journal of Finance*, 52:2113.

Engsted T, Tanggaard C (2004): The Comovement of US and UK Stock Markets. *European Financial Management*, 10:593.

Fama EF (1970): Efficient Capital Markets: A Review of Theory and Empirical Work. *Journal of Finance*, 25:383.

Fama EF, French KR (1992): The Cross-Section of Expected Stock Returns. *Journal of Finance*, 47:427.

Fama EF, French KR (1993): Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, 33:3.

Fama EF, French KR (1996): Multifactor Explanations of Asset Pricing Anomalies. *Journal of Finance*, 51:55.

Fama EF, MacBeth JD (1973): Risk, Return, and Equilibrium: Empirical Tests. *Journal of Political Economy*, 81:607.

Glosten LR, Harris LE (1988): Estimating the Components of the Bid/Ask Spread. *Journal of Financial Economics*, 21:123.

Grundy BD, Martin JS (2001): Understanding the nature of the risks and the source of the rewards to momentum investing. *Review of Financial Studies*, 14(1).

Hong H, Lim T, Stein JC (2000): Bad news travels slowly: Size, analyst coverage, and the profitability of momentum strategies. *Journal of Finance*, 55:265.

Chordia T, Shivakumar L (2002): Momentum, Business Cycle, and Time-varying Expected Returns. *Journal of Finance*, 57:985.

Jegadeesh N, Titman S (1993): Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *Journal of Finance*, 48:65.

Jegadeesh N, Titman S (2001): Profitability of Momentum Strategies: An Evaluation of Alternative Explanations. *Journal of Finance*, 56(2).

Kothari SP (2001): Capital markets research in accounting. *Journal of Accounting & Economics*, 31:105.

La Porta R, Lopez-de-Silanes F (1999): Corporate ownership around the world. *Journal of Finance*, 54:471.

Liew J, Vassalou M (2000): Can book-to-market, size and momentum be risk factors that predict economic growth? *Journal of Financial Economics*, 57:221.

Lintner J (1965): The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *Review of Economics & Statistics*, 47:13.

Mossin (1966): Equlibrium in a Capital Asset Market. *Econometrica*, 34:768.

Rosenberg B, Reid K, Lanstein R (1985): Persuasive evidence of market inefficiency. *Journal of Portfolio Management*, 11:9.

Rouwenhorst KG (1998): International momentum strategies. *Journal of Finance*, 53:267.

Sadka R (2006): Momentum and post-earnings-announcement drift anomalies: The role of liquidity risk. *Journal of Financial Economics*, 80:309.

Sharpe WF (1964): Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. *Journal of Finance*, 19:425.

Stattman D (1980): Book values and stock returns. The *Chicago MBA: A Journal of Selected Papers*, 4:25

Subrahmanyam A (2005): On the Stability of the Cross-Section of Expected Stock Returns in the Cross-Section: Understanding the Curious Role of Share Turnover. *European Financial Management*, 11:661.