Chapter 5
Systematic Liquidity Risk and Asset Pricing: UK Evidence

5.1. Introduction

Liquidity has been studied as one of the most important phenomena in financial markets. It is generally defined as the ability to buy/sell large amounts of the security quickly at a low cost and with a minimum price change. Liquidity is a multi-dimensional phenomenon that reflects many aspects, including transaction cost, depth, trading volume, price impact and resiliency. Early studies concentrate on the effect of a stock's liquidity on its return (see, for example, Amihud and Mendelson, 1986; Eleswarapu, 1997; Chalmers and Kadlec, 1998; Datar et al., 1998). Most of these studies find that investors require a liquidity risk premium. Therefore, illiquid stocks earn higher returns than liquid stocks. However, the well documented evidence of the co-movement of stock liquidity with market liquidity[1] (the so-called commonality in liquidity phenomenon) has switched the focus of recent research. Recent studies concentrate on examining whether aggregate market liquidity risk represents a source of a systematic (undiversifiable) risk for asset pricing. Pastor and Stambaugh (2003) are the first to examine this issue. They provide evidence that the covariance between stock return and aggregate market liquidity, measured as an average of all the individual stock measures of liquidity in the market, represents a state variable priced in US financial markets. Pastor and Stambaugh's (2003) study was followed by many others examining the same issue.

[1] Examples of papers examining the commonality in liquidity phenomenon are Chordia et al. (2000), Hasbrouck and Seppi (2001), Huberman and Halka (2001) and Brockman and Chung (2002).

Most of these studies have concentrated on the US markets (see, for example, Amihud, 2002; Liu, 2006). Yet, no single study has examined other important markets such as LSE, one of the major capital markets in the world. This chapter contributes to the literature in four important ways. First, we examine whether market liquidity risk is priced in LSE. The answer to this question enables us to check whether the US evidence is country-specific or a worldwide phenomenon. Second, if liquidity is, at all, priced, we are interested in knowing which aspect of liquidity is most important in the asset pricing. Third, we provide the best model that can fully explain the variations of stock returns in LSE. Finally, besides the OLS, we use GARCH models to account for volatility clustering, leptokurtosis and leverage effects in returns[1]. The GARCH models are also used to adjust for the heteroskedastic nature of the error term generated from the OLS estimation. Conditional heteroskedasticity adjustment is recommended by many researchers, including Corhay and Rad (1996), Batchelor and Orakcioglu (2003), Gregoriou et al. (2004) and Hahn and Reyes (2004).

Our sample consists of 642 companies representing the constituents of FTSEALL share index according to the list of February 2008 in the DataStream. Our analysis covers the period 1st July 1987 to 29th June 2007. We use three liquidity measures reflecting three different aspects of liquidity. These measures are the proportional quoted bid-ask spread, the Amihud's (2002) illiquidity ratio and the turnover rate. The proportional quoted bid-ask spread is a proxy of the transaction cost, the illiquidity ratio measures the price impact of order flow and the turnover rate

[1] Volatility clustering is the tendency of asset return volatility to come in bunches. Leptokurtosis is the tendency of asset returns to have distributions with fat tails and excess peakedness at the mean. Leverage effect is the asymmetric behaviour of volatility, thus increasing more following a large price fall than following a large price rise.

represents a proxy for the trading activity. The methodology of the study is based on the time series regressions of Black et al. (1972)[1]. We conduct the analysis on the individual stock basis as well as on a portfolio basis. We follow Liu (2006) in constructing our aggregate market liquidity proxy. Specifically, the aggregate liquidity factor represents a mimicking liquidity factor that is defined as the payoff from taking a long position in most liquid portfolio and short position in least liquid portfolio.

The main findings of this chapter can be summarised as follows. The individual stock-based analysis shows strong evidence that liquidity risk is a priced state variable in LSE. This is consistent with the US evidence of Pastor and Stambaugh (2003). Approximately 50% to 90% of the FTSEALL stocks have significant liquidity coefficients. The three dimensions of liquidity, the transaction cost, the quantity traded and the price impact play important roles in the asset pricing. Liquidity factor outperforms the momentum factor in explaining the stocks returns. The evidence is robust to different estimation methods and distributions of the error term in our regressions. We show that the returns of most FTSEALL share index stocks are best described by a model that consists of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking liquidity factor (regardless of which liquidity proxy is used). However, the portfolio-based analysis shows clear evidence that liquidity risk is priced exclusively when liquidity is measured by the Amihud's (2002) illiquidity ratio. This evidence is in line with the Spanish evidence of Martinez et al. (2005) who have reached to the same conclusion. The results of the portfolio approach are perhaps

[1] Time series regressions approach of Black et al. (1972) adopted by Fama and French (1993, 2004), Pastor and Stambaugh (2003) and Liu (2006), among others.

more accurate than those of the individual stock approach. Thus, using portfolios and specifically diversification may clear a lot of noise that the individual stocks may have. Our results vary over time. Specifically, we repeat the analysis of the portfolios that are sorted on the basis of their historical liquidity betas over three sub-periods. Each sub-period reflects a different trading system of FTSEALL share index stocks[1]. The results indicate no evidence that liquidity risk is priced when liquidity is measured by the proportional bid-ask spread and the turnover rate over the three sub-periods. The evidence that the Amihud's (2002) illiquidity ratio is priced exists in the earliest sub-period, but disappears in the two following sub-periods. This may be explained by the introduction of new trading systems, on the FTSEALL share index stocks, which may have improved the aggregate liquidity of the market and reduces investors concerns with the liquidity risk.

The remainder of this chapter is organised as follows. The next section describes our data. Section 5.3 explains the research design. Section 5.4 reports the empirical findings of the study. Finally, section 5.5 is a conclusion of the main findings.

5.2. Data

Our study is based on the constituents of FTSEALL share index included in the February 2008 list. We sample FTSEALL share index stocks rather than the complete universe of UK stocks because: if the liquidity risk premium is apparent

[1] First sub-period extends from 1st July 1992 to 17th October 1997. Second sub-period starts from 20th October 1997 to 3rd November 2003. Third sub-period is from 4th November 2003 to 29th June 2007. In the first period, trading was through SEAQ (stock exchange automated quotation system), that is, a dealership market. The second period reflects an order-driven market where SETS (Stock Exchange Trading System) has been introduced to the market. The third sub-period represents a hybrid market where new trading system has been introduced: SETSmm (Stock Exchange Trading System with Market Makers).

when examining the FTSEALL share index companies, it will most definitely be significant in both economic and statistical terms when tested to the lowest percentile of the LSE listings. Each year, we include only the companies with complete sets of trading data on the DataStream. The final sample includes 642 companies. The data set for each company consists of the daily observations of the closing price, the ask price, the bid price, the quantity trading volume, the dollar trading volume, the price to book value ratio, the market capitalisation and the number of outstanding shares. The analysis covers a 20-year period starting from 1st July 1987 to 29th June 2007. There are 5218 trading days within this period. Table 5.1 summarises the number of available and missing observations of each variable in the first and last year of the study. Thus, the number of available observations was increasing between 1987 and 2007.

Table 5.1

Sample stocks

This table summarises the number of available, missing and percentage of observations for each variable in the study in year 1987 and 2007.

	Year 1987			Year 2007		
Variable	**Available**	**Missing**	**Percentage**	**Available**	**Missing**	**Percentage**
Ask price	139	503	21.65%	638	4	99.38%
Bid price	139	503	21.65%	641	1	99.84%
Capitalization	264	378	41.12%	634	8	98.75%
Closing price	264	378	41.12%	642	0	100.00%
# of common shares	265	377	41.28%	642	0	100.00%
Price/book	226	416	35.20%	634	8	98.75%
Trading volume	33	609	5.14%	640	2	99.69%

Our limited ability to have the real lists of the constituents of FTSEALL share index throughout the full period of the study has caused a problem of survivorship bias in our sample. The survivorship bias is the tendency for unsuccessful companies to be barred from performance studies because they no longer exist. It often causes the results of studies to skew higher because only companies which were successful enough to survive until the end of the period are involved. Kothari et al. (1995) are the first proponents of the survivor-bias story but Chan et al. (1995) submit direct evidence against their claim. However, this sort of bias is most likely to have serious effects on the analysis that is executed on long run horizons. In our case, the analysis in this chapter includes an annual rebalancing of portfolios and is mainly focused on a 10-day window in chapters 6 and 7. Therefore, we expect that the survivorship bias has minimum and most likely insignificant effects on our results.

5.3. Research design

Most of the studies that have investigated whether the level of *individual* stock liquidity affects its return use the Fama and MacBeth (1973) methodology or a modified version of it (see, for example, Amihud and Mendelson, 1986; Eleswarapu, 1997; Brennan et al., 1998; Chalmers and Kadlec, 1998; Datar et al., 1998). Fama and MacBeth (1973) use a pooled cross-sectional regression for all the stocks in the sample or for portfolios sorted according to the variable of interest. The dependent variable for each stock (or portfolio) in the pool is its return while the independent variables are the levels of stock characteristics known to affect stock return such as the market capitalisation, book-to-market value ratio, earning-to-price ratio and dividends' yield. Liquidity is added as one of these explanatory variables. However, when the purpose is to detect whether a certain factor represent a *common systematic risk* factor that affects stock returns, a different methodology is used. Fama and French (1993) use the time series regressions of Black, et al. (1972) to show that market return, size and book-to-market value ratio represent sources of systematic (undiversifiable) risk that affect stock returns. Consequently, the papers intending to investigate whether aggregate market liquidity rather than individual stock liquidity represents a systematic priced risk follow the same approach as Fama and French (1993)(e.g. Pastor and Stambaugh, 2003; Liu, 2006). Given that our purpose is the same as that of both Pastor and Stambaugh (2003) and Liu (2006), we use the time series regressions of Black et al. (1972). The dependent variable in these regressions is the excess return, which is calculated as the return minus the risk free return on the 3-month UK treasury bills, while the explanatory variables are excess returns and the returns on zero investment portfolios constructed according to the variable of interest. In such regressions a significant slope and a high adjusted R-squared indicate evidence that the independent variable is a systematic risk factor that captures the common variations in stocks returns. Moreover, the model that fully explains the variations in stock returns should have an intercept that is not significantly different from zero. The average risk premium in such regressions is simply the average value of the independent variable for all stocks in the market.

The liquidity measures used in this analysis are the proportional quoted bid-ask spread, the illiquidity ratio of Amihud (2002) and the turnover rate. The choice of these measures comes deliberately to reflect different aspects of liquidity. The proportional quoted bid-ask spread is a proxy for the transaction cost of trading. The illiquidity ratio is a price impact measure. The turnover rate measures the trading activity or alternatively the quantity traded. Table 5.2 summarises the definitions of the three liquidity measures.

Panel A of Table 5.3 provides the descriptive statistics of the main variables used in this study. On average, each of the FTSEALL index shares earns a daily rate of return of 0.3% over the entire study period. The daily mean transaction cost measured by the proportional bid-ask spread is .023. The mean of the Amihud's (2002) illiquidity ratio approaches zero indicating high level of liquidity with negligible price impact on order flow. The daily average of the stock turnover rate is .005. All these averages exceed the median values, indicating the presence of skeweness in the distributions of our variables.

Our research design consists of both individual stock approach and a portfolio approach. The portfolio approach is also adopted in other studies such as Pastor and Stambaugh (2003) and Liu (2006).

Table 5.2

Liquidity measures

This table defines the liquidity proxies used in the study. P is quoted price. Superscripts A, B, i and t denote ask, bid, stock i and day t respectively. R, VOL, DVOL and NO indicate return, trading volume, dollar volume and number of outstanding shares, correspondingly.

Liquidity Measure	Acronym	Definition	Units
Proportional Quoted Spread	PSPR	$PSPR_{i,t} = \frac{(P_{i,t}{}^{A} - P_{i,t}{}^{B})}{(P_{i,t}{}^{A} + P_{i,t}{}^{B})/2}$	None
Turn Over Rate	TO	$TO_{i,t} = \frac{VOL_{i,t}}{NO_{i,t}}$	Times
Amihud's Illiquidity Ratio	AM	$AM_{i,t} = \frac{\lvert R_{i,t} \rvert}{DVOL_{i,t}}$	None

Table 5.3

Descriptive statistics

This table reports descriptive statistics of daily observations of main individual stock variables of the study. Sample consists of 642 stocks of FTSEALL share index. For each stock, return is calculated as natural logarithm of product of dividing closing price on day t by closing price on day t-1. Market capitalisation is expressed in millions of pounds. PSPR denotes proportional quoted bid-ask spread, AM is Amihud's (2002) illiquidity ratio and TO is turnover rate. Panel A presents results for full period of study, 1st July 1987 to 29th June 2007. Panel B reports results for sub-period 1st July 1992 to 29th June 2007.

Panel A: Results from 1st July 1987 to 29th June 2007					
Descriptive statistics	**Return**	**Market Capitalisation**	**PSPR**	**AM**	**TO**
Mean	0.0003	1835.3980	0.0232	0.0000	0.0047
Median	0.0000	231.2900	0.0150	0.0000	0.0017
Maximum	1.1737	229775.9000	1.9941	0.0354	21.6664
Minimum	-1.3892	0.3900	0.0000	0.0000	0.0000
Panel B: Results from 1st July 1992 to 29th June 2007					
Descriptive statistics	**Return**	**Market Capitalisation**	**PSPR**	**AM**	**TO**
Mean	0.0004	2073.9950	0.0241	0.0000	0.0043
Median	0.0000	263.3300	0.0155	0.0000	0.0016
Maximum	1.1737	229775.9000	1.9604	0.0118	21.6664
Minimum	-1.3892	0.4800	0.0000	0.0000	0.0000

5.3.1. Variable definitions

5.3.1.1. Explanatory variables

The models that we estimate include the following explanatory factors.

Market excess return (MKT)

The market excess return is calculated as the difference between market return and risk-free rate. The market return is the return on the FTSEALL index, while the risk-free rate is the return on the three-month UK Treasury bill. The return in both cases is calculated as the natural logarithm of the value resulting from dividing the price on day t by the price on day t-1.

Fama and French (1993) common risk factors

Besides the excess market return, Fama and French (1993) introduced two other factors affecting the stock return. These are the High minus Low (HML) and Small minus Big (SMB). Following Fama and French (1993), we construct the two factors as follows.

We rank all the stocks in the sample according to their market capitalisation at the end of June of each year over the period 1987-2007.The stocks are then separated into two groups according to the median value of the market capitalisation, the small market capitalisation group (S) and the big market capitalisation group (B). After that, we calculate the ratio of book-to-market value for each stock at the end of year t-1. The ratio is computed as the inverse of the price to book ratio obtained from the DataStream. After excluding the stocks with negative book-to-market value ratio, we rank all the remaining sample stocks according to their ratios and construct three groups. The first group consists of the 30% of stocks with the highest ratios (H), the second group contains 30% of the stocks with the lowest ratios (L) and the last group includes the remaining 40% of the stocks whose book to market values are around the middle (M). Each year, we construct six portfolios from the combinations of the two market capitalisation-based groups and the three book-to-market value ratio-based groups. These portfolios are S/L, S/M, S/H, B/L, B/M and B/H. The S/L portfolio contains the stocks in both the small size and the low book to market ratio groups at the same time. S/M portfolio contains the stocks in both the small size and the medium book to market ratio groups at the same time and so on. We calculate the daily value weighted returns on each of the six portfolios starting 1st July year t-1 to 30th June year t. The portfolios are reformed on a yearly basis. The High minus Low factor (HML) is calculated as the difference between the equally weighted average daily return on the two high book-to-market value ratio portfolios (S/H and B/H) and on the two low book-to-market value ratio portfolios (S/L and B/L). Similarly, the Small minus Big factor (SMB) is calculated as the difference between the equally weighted average daily return on the three small portfolios (S/L, S/M and S/H) and on the three big portfolios (B/L, B/M and B/H). All the preceding procedures are repeated annually.

Momentum factor

Carhart (1997) suggests a mimicking common risk factor affecting stocks returns called the momentum factor. This factor is defined as the return of buying one dollar of an equally weighted portfolio of the best past performing stocks and selling one dollar of an equally weighted portfolio of the worst ones. Following Pastor and Stambaugh (2003), we construct the momentum factor as follows.

At the end of each month, starting from 30th June 1987 to 29th June 2007, all the stocks in the sample are ranked according to their cumulative daily returns over the past 12 months. Then we calculate the daily equally weighted return of the top decile of stocks and of the bottom decile of stocks over the month following the ranking month. The momentum factor is constructed as the difference in the daily return between top and bottom deciles of stocks. The process is repeated on a monthly basis.

Market liquidity factor

Liu (2006) has constructed a mimicking liquidity factor reflecting the aggregate market liquidity risk. He defined his factor as "the profits of the mimicking portfolio that buys $1 of the low-liquidity portfolio and sells $1 of the high-liquidity portfolio" (p. 634). Following Liu (2006), we construct three mimicking liquidity factors for our three liquidity measures. Each mimicking factor represents a source of aggregate market liquidity risk. The steps are as follows. At the beginning of each month starting from 1st July 1987 to 1st July 2007, we calculate the daily equally weighted average of the liquidity proxy over that month. Stocks are then ranked according to the average values of the liquidity proxy to form two portfolios. The first consists of the 30% of stocks with the lowest average liquidity proxy and the second contains the 30% of the stocks with the highest average. We hold the two portfolios six months after the portfolio formation and calculate the mimicking liquidity factor as the difference in daily returns between the two portfolios. This process is repeated on a six-month basis.

The portfolios used to construct the proportional spread mimicking factor over the full period of the study contain between 44 and 190 stocks. However, the comparable portfolios used to construct the illiquidity ratio and turnover mimicking factors contain only between 17 and 190 stocks. In the sub-period from 1st July 1992 to 29th June 2007, more data are available. Thus, the portfolios used to construct the proportional spread mimicking factor contain no less than 100 stocks while those used for the illiquidity ratio and turnover mimicking factors contain at least 65 stocks.

Table 5.4 reports the descriptive statistics of all our explanatory variables. The liquidity measures and the HML factor show negative mean values over the full study period. However, the correlation matrix between these factors tells us much more about the whole picture. Panel A of Table 5.4 shows a negative correlation between each of the four market liquidity proxies and market excess return. The negative correlation is consistent with the evidence that investors require a higher liquidity risk premium when the market is down. All the liquidity measures are highly and positively correlated with the SMB factor, confirming the size as an important proxy for liquidity. For example, the correlation between the SMB and both the proportional spread and illiquidity ratio mimicking factors are .7524 and .6865, respectively. However, an unexpected negative correlation exists between the proportional spread mimicking factor and the HML factor. These correlation values are higher than their comparable ones in the US market. Pastor and Stambaugh (2003) report .23 and -.12 correlation values between their market liquidity proxy and each of the SMB and HML factors. Proportional spread, illiquidity ratio and turnover mimicking factors are highly positively correlated with each other. This finding demonstrates that the three factors measure the same phenomenon, which is liquidity, in spite of the fact that each of them measures different aspects. Panel B of Table 5.4 presents the descriptive statistics of our explanatory variables in the sub-period 1st July 1992-29th June 2007. The proportional spread and illiquidity ratio mimicking factor show positive means. The correlation matrix stays in the same directions as those in Panel A but with higher values.

Table 5.4

Descriptive statistics and correlation matrix of explanatory variables

This table presents descriptive statistics and correlation matrix for the main explanatory variables used in this study. MKT is market excess return. HML and SMB are the high minus low factor and the small minus big factor, respectively, of Fama and French (1993). MOM is the momentum factor of Carhart (1997). PSPR, AM and TO are mimicking liquidity factors representing proxies of aggregate market liquidity risk when liquidity is measured by proportional quoted spread, Amihud's (2002) illiquidity ratio and turnover rate, respectively. Panel A reports results for explanatory variables over the whole study period (from 1st July 1987 to 29th June 2007). Panel B reports results of the same variables over the sub-period extending from 1st July 1992 to 29th June 2007. All statistics represent cross-sectional statistics for the time series means. Sample includes 642 constituents of FTSEALL share index with at least one year of daily observations over entire sample period.

Panel A: Results from 1st July 1987 to 29th June 2007							
Descriptive Statistics							
	MKT	**HML**	**SMB**	**MOM**	**PSPR**	**AM**	**TO**
Mean	0.0003	-0.0001	0.0002	0.0009	-0.0001	0.0000	-0.0003
Median	0.0004	0.0000	0.0002	0.0007	0.0000	0.0000	-0.0001
Maximum	0.1689	0.0433	0.0389	0.0672	0.0299	0.0356	0.0373
Minimum	-0.1542	-0.0595	-0.0552	-0.0901	-0.0370	-0.0366	-0.0291
Correlation Matrix							
	MKT	**HML**	**SMB**	**MOM**	**PSPR**	**AM**	**TO**
MKT	1.0000	-0.0920	-0.4640	-0.0338	-0.3936	-0.3592	-0.3364
HML	-	1.0000	-0.1946	-0.1417	-0.0192	0.0459	0.1437
SMB	-	-	1.0000	0.1767	0.7524	0.6865	0.4058
MOM	-	-	-	1.0000	-0.0578	-0.0331	0.0135
PSPR	-	-	-	-	1.0000	0.7976	0.5255
AM	-	-	-	-	-	1.0000	0.5958
TO	-	-	-	-	-	-	1.0000
Panel B: Results from 1st July 1992 to 29th June 2007							
Descriptive Statistics							
	MKT	**HML**	**SMB**	**MOM**	**PSPR**	**AM**	**TO**
Mean	0.0004	-0.0001	0.0003	0.0008	0.0001	0.0002	-0.0003
Median	0.0004	0.0000	0.0002	0.0006	0.0000	0.0001	0.0000
Maximum	0.1689	0.0433	0.0389	0.0600	0.0282	0.0309	0.0373
Minimum	-0.1542	-0.0595	-0.0552	-0.0901	-0.0347	-0.0366	-0.0288
Correlation Matrix							
	MKT	**HML**	**SMB**	**MOM**	**PSPR**	**AM**	**TO**
MKT	1.0000	-0.0954	-0.5026	-0.0482	-0.4837	-0.4885	-0.4252
HML	-	1.0000	-0.1976	-0.1420	-0.0126	0.0801	0.1633
SMB	-	-	1.0000	0.1976	0.7779	0.7621	0.4837
MOM	-	-	-	1.0000	-0.0271	-0.0107	0.0559
PSPR	-	-	-	-	1.0000	0.8788	0.5967
AM	-	-	-	-	-	1.0000	0.6979
TO	-	-	-	-	-	-	1.0000

5.3.1.2. Dependent variables

Under the individual stock approach, our dependent variable is the daily excess returns of each stock in the sample over the period 1st July 1987 to 29th June 2007. The dependent variable in the portfolio approach is the daily excess returns on each portfolio sorted on a certain variable of interest over the period 1st July 1992 to 29th June 2007. The daily excess return is calculated as the daily return minus the daily risk free rate of return of the 3-month UK treasury bills.

5.3.2. Individual stock approach

Under the individual stock approach, we address our research questions by estimating a set of 12 different time series models for each individual stock in the sample. The models are:

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t \quad \textbf{(CAPM)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{hml,i} HML_t + \beta_{smb,i} SMB_t \quad \textbf{(F\&F)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{hml,i} HML_t + \beta_{smb,i} SMB_t + \beta_{mom,i} MOM_t \quad \textbf{(C-F\&F)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{pspr,i} PSPR_t \quad \textbf{(PSPR1)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{hml,i} HML_t + \beta_{smb,i} SMB_t + \beta_{pspr,i} PSPR_t \quad \textbf{(PSPR2)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{hml,i} HML_t + \beta_{smb,i} SMB_t + \beta_{mom,i} MOM + \beta_{pspr,i} PSPR_t \quad \textbf{(PSPR3)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{to,i} TO_t \quad \textbf{(TO1)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{hml,i} HML_t + \beta_{smb,i} SMB_t + \beta_{to,i} TO_t \quad \textbf{(TO2)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{hml,i} HML_t + \beta_{smb,i} SMB_t + \beta_{mom,i} MOM + \beta_{to,i} TO_t \quad \textbf{(TO3)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{am,i} AM_t \quad \textbf{(AM1)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{hml,i} HML_t + \beta_{smb,i} SMB_t + \beta_{am,i} AM_t \quad \textbf{(AM2)}$$

$$(R_{i,t} - R_{f,t}) = \alpha_i + \beta_{mkt,i} MKT_t + \beta_{hml,i} HML_t + \beta_{smb,i} SMB_t + \beta_{mom,i} MOM + \beta_{am,i} AM_t \quad \textbf{(AM3)}$$

where $R_{i,t}$ is the return on stock i on day t, $R_{f,t}$ is the risk-free rate of return on day t, MKT_t is the excess market rate of return, HML_t is the High Minus Low factor defined as the difference in returns between value and growth stocks, SMB_t is the Small Minus Big factor defined as the difference in returns between small- and large-sized stocks, MOM_t is the momentum factor defined as the difference in returns between stocks with high prior returns and stocks with low prior returns, $PSPR_t$ is a mimicking market liquidity factor of the proportional quoted bid-ask spread, TO_t is a mimicking market liquidity factor of the turnover rate and AM_t is a mimicking market liquidity factor of the Amihud (2002) illiquidity ratio. These variables are defined in Section 5.3.1.

CAPM, F&F and C-F&F are the capital asset pricing model, the Fama and French (1993) three-factor model and the Carhart (1997) four-factor model, respectively. PSPR1, PSPR2 and PSPR3 are the proportional spread augmented CAPM, F&F and C-F&F, respectively. Similarly, TO1, TO2 and TO3 (AM1, AM2 and AM3) are the turnover rate (Amihud's (2002) illiquidity ratio), augmented CAPM, F&F and C-F&F, respectively.

The decision whether liquidity risk is priced under the individual stock-based approach depends on the percentage of stocks that have significant liquidity coefficients out of the 642 stocks. A higher percentage indicates a stronger evidence of liquidity risk. The best model to explain the variations of assets returns is decided according to three criteria. The first criterion is the percentage of the stocks with significant intercepts. The lower the percentage of stocks with significant intercepts, the more powerful the model. The second criterion is the adjusted R-squared statistic. We calculate the average adjusted R-squared for all the 642 stocks for each model. The model with the highest average will be the best. The third is the Akaike information criteria (AIC). Similar to the adjusted R-squared procedures, for each model we calculate the average value of the AIC across the 642 stocks. The lower the AIC, the better the fit of the model.

Furthermore, we decide the best model that explains the variations in stock returns using the following process. We estimate the set of 12 models for each of our 642 stocks. We compare the adjusted R-squared of each stock across the 12 models. The model that produces the highest adjusted R-squared for a given stock will receive a score of one and rest of the models will receive a score of zero. We repeat this process for all stocks in our sample. We sum the scores assigned to each model. We then calculate the percentage of the stocks that shows highest values of adjusted R-squared under each model by dividing the sum of scores of that model by 642 (the total number of the sample stocks). The model receiving the highest percentage of stocks is regarded as the best model. The whole process is repeated using the AIC instead of the adjusted R-squared.

A Lagrange Multiplier (LM) test shows that approximately 80% of the stock returns have ARCH effects. As a result, the estimation of the models uses four methods. These are the OLS, the GARCH model by Engle (1982) and Bollerslev(1986), the Exponential GARCH (EGARCH) model by Nelson (1991) and the Glosten-Jagannathan-Runkle GARCH (GJR-GARCH) model by Glosten et al. (1993).

EGARCH and GJR-GARCH account for asymmetric volatility effect in returns. Given that the returns are not normally distributed, the three GARCH models are estimated by both normal and generalised error distributions. The results of the LM test are reported in Table 5.5.

Table 5.5

Lagrange Multiplier (LM) test

This table reports results of Lagrange Multiplier (LM) test for sample stocks under all estimated models. %SIG represents percentage of FTSEALL share index stocks with significant LM test (ARCH effects) from 1st July 1987 to 29th June 2007.

LM-TEST	
MODEL	**%SIG**
CAPM	80.69%
F&F	79.28%
C-F&F	79.60%
PSPR1	80.84%
PSPR2	79.75%
PSPR3	79.91%
AM1	80.53%
AM2	79.75%
AM3	79.75%
TO1	81.15%
TO2	79.44%
TO3	79.60%

5.3.3. Portfolio approach

We begin by sorting stocks to decile portfolios according to their liquidity from the least to the most liquid deciles. We conduct an annual sort according to each of the three liquidity measures, the estimated historical beta of each measure and the market capitalisation as size has been considered as a proxy for liquidity. In order to estimate the historical liquidity betas, we use C-F&F and the OLS with the Newey-West HAC Standard Errors & Covariance to adjust for serial correlation and heteroskedasticity[1]. After each sort, the liquidity risk premium is calculated as the difference in return between the most and least liquid portfolios. Moreover and

[1] Details of the Newey-West HAC Standard Errors & Covariance are in Appendix D.1.

consistent with the individual stock approach, we estimate CAPM, F&F, C-F&F and the liquidity augmented models for each portfolio.

The portfolio approach covers the period 1st July 1992 to 29th June 2007. However, the individual stock approach starts from 1st July 1987. The reason for that difference is that sorting stocks to portfolios according to historical liquidity betas needs the betas to be estimated for the most recent five years. Panel B of Table 5.3 presents descriptive statistics of our main variables over the period 1st July 1992 to 29th June 2007. The descriptive statistics in panel B show higher values than those reported in panel A of the table. The daily average return for each stock of the FTSEALL index equals 0.4%. On average, each stock is quoted at a daily proportional bid-ask spread of .024. The average illiquidity ratio is still around zero. However, the daily average of turnover rate has increased to .004 over this period of analysis. Again, all the mean values are higher than the median values, indicating that the distributions of our variables are skewed to the right.

5.4. Empirical findings

The empirical findings show clear evidence that market-wide liquidity risk is priced in LSE. The three mimicking liquidity factors, reflecting three different liquidity measures, show significant coefficients when added to CAPM, F&F or C-F&F. The results of the individual stock approach and the portfolio approach are reported in Sections 5.4.1 and 5.4.2, respectively.

5.4.1. Individual stock approach

The individual stock approach includes the estimation of our 12 models for each stock in the sample. Section 5.4.1.1 presents the estimation results of CAPM, F&F and C-F&F. Section 5.4.1.2 describes the estimation results of the proportional spread augmented models. Section 5.4.1.3 reports the estimation results of the turnover rate augmented models. Finally, Section 5.4.1.4 documents the estimation results of the illiquidity ratio augmented models.

5.4.1.1. Preliminary results

Table 5.6 presents the OLS estimation results of CAPM, F&F and C-F&F for our sample stocks. The estimation also uses GARCH, GJR-GARCH and EGARCH and the results are reported in Appendix A.1. The results show that all of MKT, HML, SMB and MOM are important factors in explaining the returns of the FTSEALL shares. Thus, MKT coefficient is significant for almost all stocks across all models and estimation methods. More than 90% of our sample stocks have a significant SMB coefficient in all cases. The coefficient of the HML factor is also reported as significant for about 70% of our stocks. MOM is the last in terms of its explanatory power of stock returns. The percentage of stocks with significant MOM coefficient ranges from 31.15% under the OLS estimation to 57.63% under the EGARCH estimation method. CAPM explains returns of between 72.90% and 92.52% of the FTSEALL shares.

We use the statistical significance of the intercept to judge the explanatory power of the different models in our study[1]. The higher the percentage of stocks with statistically insignificant intercept, the more powerful is the model. F&F and C-F&F do a better job in explaining the returns of the FTSEALL shares. Under F&F, the intercept is not significant of between 66.04% (using EGARCH estimation) and 95.17% (using OLS estimation) of the sample stocks. Under C-F&F, the intercept is not significant of between 69.63% (using EGARCH estimation) and 96.73% (using OLS estimation) of the sample stocks. Although these results seem to support CAPM, F&F and C-F&F, an important question is whether the picture will change upon comparing these models with their liquidity augmented versions. We will answer this question in the following sections. One important issue is that we compare the adjusted R-squared (the AIC) of each stock across the 12 estimated models[2]. The model producing the highest adjusted R-squared (the lowest AIC) for a given stock will receive a score of one and other models will receive zero. We repeat this process for all the stocks in our sample. We sum the scores assigned to each model and then calculate the percentage of stocks showing highest values of adjusted R-squared (lowest values of AIC) under each model by dividing the sum of scores of that model by 642 (the total number of the sample stocks). The model with the highest percentage of stocks is regarded as the best. Table 5.6 shows that, under all estimation methods, the percentage of the stocks showing highest adjusted R-squared and lowest AIC does not exceed 2.02% under CAPM, F&F and C-F&F across the 12 estimated models.

[1] Fama and French (1993), Lewellen (1999), Chen and Tu (2002), Pastor and Stambaugh (2003), Liu (2006) and Gharghori et al. (2007) are among studies that depend on significance of the intercept when judging performance of their time series models.

[2] The 12 estimated models are CAPM, F&F, C-F&F, PSPR1, PSPR2, PSPR3, TO1, TO2, TO3, AM1, AM2 and AM3.

Table 5.6

Estimates of CAPM, F&F and C-F&F

This table presents Ordinary Least Squares (OLS) estimation results of three time series asset pricing models for each individual stock in the sample. Sample consists of 642 stocks of FTSEALL share index constituents' list of February (2008). Analysis covers the period 1st July 1987 to 29th June 2007. We use the Newey-West HAC Standard Errors & Covariance to estimate each OLS time series regression in order to account for any heteroskedasticity and serial correlation in the regression residuals. CAPM, F&F and C-F&F models are defined in Section 5.3.1. Explanatory variables of the three models are defined in Section 5.3.3.1. Cross-sectional averages of time series slope coefficients are reported. Levels of significance of coefficients are estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level. % significant represents the percentage of significant slope coefficients at 5% level. Adjusted R^2 is cross-sectional mean of adjusted R-squared values across all sample stocks. AIC is cross-sectional mean of Akaike information criteria values across all sample stocks. The process of determining Best AIC and Best Adjusted R^2 is described in Section 5.3.1.

MODEL	CAPM	F&F	C-F&F
INTERCEPT	0.0002[a]	-0.0001[b]	0.0000
%Significant	7.48%	4.83%	3.27%
MKT	0.7624[a]	0.9771[a]	0.9787[a]
%Significant	98.91%	99.07%	99.07%
HML	-	0.3087[a]	0.3027[a]
%Significant	-	72.43%	73.21%
SMB	-	0.6870[a]	0.6979[a]
%Significant	-	91.12%	91.12%
MOM	-	-	-0.0459[a]
%Significant	-	-	31.15%
Adjusted R^2	0.2693	0.3295	0.3318
AIC	-5.3883	-5.4904	-5.4929
Best AIC	0.78%	1.87%	1.40%
Best Adjusted R^2	0.16%	0.31%	0.78%

5.4.1.2. Proportional spread augmented models

The OLS estimates of PSPR1, PSPR2 and PSPR3 models are reported in Panel A of Table 5.7. The estimation also uses GARCH, GJR-GARCH and EGARCH. Since the GARCH-based analysis does not alter our conclusions, we choose to report the details of the GARCH-based results in Appendix A.2. The percentage of the stocks with significant liquidity coefficients ranges from 59.03% of the OLS-estimated PSPR3 to 88.94% of the GARCH-estimated PSPR1. Moreover, the null hypothesis that the mean of the liquidity coefficients for all the sample stocks is equal to zero is rejected under PSPR1, PSPR2 and PSPR3. The cross-sectional average adjusted R-squared is between .297 and .337 for the three proportional spread augmented models. PSPR3 is the best to explain the variations in stock returns. Thus, the lowest percentage of the stocks with significant intercepts is reported under this model. PSPR3 explains the variations in stock returns better than both PSPR1 and PSPR2. In fact, under PSPR3, 3.43%, 22.90%, 19.00% and 32.24% of the sample stocks have significant intercepts when each of OLS, GARCH, GJR-GARCH and EGARCH, respectively, is used as an estimator. The comparable values for PSPR1 and PSPR2 are higher in most cases. We calculate the percentage of the stocks showing highest values of adjusted R-squared (lowest values of AIC) under each model, following the same procedures in Section 5.4.1.1. We find that 15.42% and 19.63% of the sample stocks show lowest AIC and highest adjusted R-squared values, respectively, when their returns are estimated using the OLS-estimated PSPR3 across the 12 estimated models. The comparable values for PSPR2 are 10.59% and 7.63%, respectively. The percentages of stocks showing lowest AIC and highest adjusted R-squared values under PSPR1 are less than 2.00%.

5.4.1.3. Turnover rate augmented models

Panel B of Table 5.7 presents the OLS estimates of TO1, TO2 and TO3 models. The estimation also uses GARCH, GJR-GARCH and EGARCH. The conclusions from using the GARCH-type models are not too different from those of OLS. Thus we report the details of the GARCH results in Appendix A.3. The estimates show strong evidence of systematic liquidity risk in our sample stocks. The percentage of the stocks with significant turnover coefficients ranges from 58.26% of the OLS-estimated TO3 to 84.42% of the GARCH-estimated TO1. Moreover, under the three turnover augmented models and when OLS is the estimation method, the hypothesis of zero mean liquidity coefficient across stocks is highly rejected. The cross-sectional average adjusted R-squared ranges from .2782 for the EGARCH-estimated TO1 to .3380 for the OLS-estimated TO3. Comparing the three turnover augmented models, we find again that TO3 performs better than both TO1 and TO2. Thus, the OLS-estimated TO3 can fully explain the returns of 96.11% of the sample stocks, given their insignificant intercepts. Additionally, we calculate the percentage of the stocks showing highest values of adjusted R-squared (lowest values of AIC) under each model, following the same procedures in Section 5.4.1.1. Under the OLS-estimated TO3, 19.78% and 24.92% of the stocks in the sample show lowest AIC and highest adjusted R-squared values, respectively. The comparable values for TO1 and TO2 are lesser.

5.4.1.4. Illiquidity ratio augmented models

Panel C of Table 5.7 reports the OLS estimates of AM1, AM2 and AM3. The estimation also uses GARCH, GJR-GARCH and EGARCH and the results are reported in Appendix A.4. The percentage of the sample stocks with significant liquidity coefficient ranges from 53.43% for the OLS-estimated AM3 to 89.72% for the EGARCH-estimated AM1. This indicates powerful evidence of a liquidity risk premium in our sample stocks. The cross-sectional average adjusted R-squared ranges from .2966 for the EGARCH-estimated AM1 to .3374 for the OLS-estimated AM3. We calculate the percentage of the stocks showing highest values of adjusted R-squared (lowest values of AIC) under each model, following the same procedures as in Section 5.4.1.1. We find that around 9.66% and 12.15% of the sample stocks show lowest AIC and highest adjusted R-squared values, respectively, when their returns are estimated by the OLS-estimated AM3. The comparable values for AM2 are 5.76% and 4.21%, respectively. Under AM1, the percentages of the stocks showing highest values of adjusted R-squared and lowest values of AIC are less than 2.00%. However, the results indicate that the null hypothesis of a zero mean of the liquidity coefficients across stocks cannot be rejected for all the estimated versions of AM3 and most of the estimated versions of AM2.

One important issue is the relative importance of each of the common risk factors in explaining the stock returns. The most important factor is the market excess returns since in all models and under the different estimation methods, the minimum percentage of sample stocks with significant market excess return coefficient is 98.91%. The second most important factor is the small minus big SMB, with at least 86.92% of stocks having a statistically significant SMB. Next is the high minus low factor. The percentage of stocks with significant HML ranges from 72.43% to 82.71%. Across all models and estimation methods, the percentage of stocks with significant liquidity coefficients is higher than the percentage with significant momentum factor coefficients. As a result, liquidity seems to have more important effect on stock returns than the momentum factor[1].

[1] Returns of the sample stocks are not normally distributed. Thus, we repeat GARCH, TGARCH and EGARCH estimation of all the models for every stock in the sample using generalised error distribution. We find consistent results. Tables are not reported but are available on request.

Table 5.7

Estimates of liquidity augmented asset pricing models

This table presents Ordinary Least Squares (OLS) estimation results of nine time series liquidity augmented asset pricing models for each individual stock in the sample. Sample consists of 642 stocks of FTSEALL share index constituents' list of February (2008). Analysis covers 1st July 1987 to 29th June 2007. We use Newey-West HAC Standard Errors & Covariance to estimate each OLS time series regression in order to account for any heteroskedasticity and serial correlation in regression residuals. Models and explanatory variables are defined in Sections 5.3.1 and 5.3.3.1, respectively. Cross-sectional averages of time series slope coefficients are reported. Levels of significance of these coefficients are estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level. % significant represents percentage of significant slope coefficients at 5% critical level in t-test. Adjusted R^2 is cross-sectional mean of adjusted R-squared values across all sample stocks. AIC is cross-sectional mean of Akaike information criteria values across all sample stocks. The process of determining Best AIC and Best Adjusted R^2 is described in Section 5.3.1.

Panel A: Estimates of proportional bid-ask spread augmented asset pricing models

MODEL	PSPR1	PSPR2	PSPR3
INTERCEPT	0.0001[a]	-0.0001[b]	0.0000
%Significant	9.19%	4.98%	3.43%
MKT	0.9048[a]	0.9809[a]	0.9815[a]
%Significant	99.22%	99.22%	99.22%
HML	-	0.2960[a]	0.2939[a]
%Significant	-	72.43%	72.90%
SMB	-	0.6367[a]	0.6632[a]
%Significant	-	86.92%	89.25%
MOM	-	-	-0.0439[a]
%Significant	-	-	32.24%
PSPR	-	0.0861[a]	0.0558[b]
%Significant	-	59.50%	59.03%
Adjusted R^2	0.3042	0.3348	0.3372
AIC	-5.4407	-5.4976	-5.5005
Best AIC	1.25%	10.59%	15.42%
Best Adjusted R^2	0.31%	7.63%	19.63%

Panel B: Estimates of turnover rate augmented asset pricing models

Model	TO1	TO2	TO3
INTERCEPT	0.0002[a]	-0.0001[a]	-0.0001[b]
%Significant	17.29%	4.98%	3.89%
MKT	0.8178[a]	0.9667[a]	0.9699[a]
%Significant	99.07%	99.22%	99.38%
HML	-	0.3175[a]	0.3112[a]
%Significant	-	73.83%	73.68%
SMB	-	0.7058[a]	0.7172[a]
%Significant	-	91.74%	92.37%
MOM	-	-	-0.0492[a]
%Significant	-	-	30.53%
TO	0.3307[a]	-0.0732[b]	-0.0725[b]
%Significant	77.10%	59.03%	58.26%
Adjusted R^2	0.2862	0.3357	0.3380
AIC	-5.4136	-5.4988	-5.5012
Best AIC	0.47%	13.71%	19.78%
Best Adjusted R^2	0.47%	9.81%	24.92%

Panel C: Estimates of illiquidity ratio augmented asset pricing models

Model	AM1	AM2	AM3
INTERCEPT	0.0001[a]	-0.0001[b]	0.0000[c]
%Significant	6.07%	4.83%	3.12%
MKT	0.8965[a]	0.9761[a]	0.9775[a]
%Significant	99.22%	99.22%	99.22%
HML	-	0.3014[a]	0.2985[a]
%Significant	-	72.74%	73.36%
SMB	-	0.6719[a]	0.6942[a]
%Significant	-	89.41%	90.50%
MOM	-	-	-0.0498[a]
%Significant	-	-	30.22%
AM	0.5274[a]	0.0194	0.0000
%Significant	83.80%	53.58%	53.43%
Adjusted R^2	0.3037	0.3351	0.3374
AIC	-5.4425	-5.4978	-5.5004
Best AIC	1.40%	5.76%	9.66%
Best Adjusted R^2	0.62%	4.21%	12.15%

5.4.2. Portfolio approach

Most asset pricing tests follow a portfolio approach to examine whether a certain factor is priced or not (see, for example, Fama and French, 1993; Pastor and Stambaugh, 2003; Liu, 2006). To test whether liquidity risk is priced, we sort our sample stocks according to different liquidity variables. Then, we construct 10 portfolios, ranging from the least liquid to the most liquid, from each sort. Finally, we compare the performance of these decile portfolios.

One of the most important indicators of a stock's level of liquidity is its historical liquidity beta. On 1st July each year starting from 1992, we estimate the historical liquidity beta of each stock based on the daily return observations of the previous 5 years[1]. Only the stocks with continuing returns through the estimation period are included in our analysis. Our approach follows Pastor and Stambaugh (2003) who have estimated the historical liquidity beta for the stocks with continuing monthly return during the most recent five years. For estimation purposes, we use the model consisting of the three Fama and French (1993) factors, the momentum factor and the liquidity factor measured by different liquidity proxies. Thus, the models used are PSPR3, TO3 and AM3. After the estimation, we sort stocks according to their historical liquidity betas and construct 10 equally weighted portfolios. The first portfolio (Port 1) includes the most liquid stocks and the last portfolio (Port 10) contains the least liquid stocks. These portfolios are held for the following 12 months. The process is repeated annually. The post-formation returns of each portfolio are linked across years to form a single return series from 1st July 1992 to

[1] The choice of July comes deliberately in order to avoid any seasonal January effects and to minimize the look-ahead bias which in turn is defined as "the case where data used in the study is assumed to be publicly available at time t while in reality this data was only available at a later time"(Andrikopoulos et al., 2007). This sort of bias largely affects UK research given the inconsistency on accounting year closing dates for British companies.

29th June 2007. Table 5.8 shows the mean returns of Port 1, Port 10 and Diff (10-1) constructed from the historical betas of our three liquidity proxies (the average returns of the remaining Ports 2 to 9 are reported in Appendix A.5). Diff (10-1) is the portfolio whose returns are calculated as the difference in daily returns between Ports 10 and 1. Each decile portfolio includes from 27 to 52 stocks. Port 1 represents the most liquid portfolio while Port 10 is the least liquid. Proportional spread portfolios and Amihud's (2002) illiquidity ratio portfolios show a significant liquidity risk premium. Although in both cases the returns are not increasing systematically from the most liquid to the least liquid portfolios, illiquid portfolios seem to generate higher and more significant returns than liquid portfolios. Statistically significant risk premiums of 0.04% and 0.05% per day are detected when proportional spread and Amihud (2002) illiquidity ratio are used as liquidity proxies, respectively. Liu (2006) documents a comparable significant monthly liquidity risk premium for the US market of 0.454% (approximately 0.02% on a daily basis) when liquidity is measured by the standardised turnover-adjusted number of zero daily trading volume over the previous 12 months. Turnover rate shows a positive liquidity risk premium of 0.001%. However, the liquidity premium associated with the turnover rate is not significantly different from zero.

Table 5.8

Daily mean returns of liquidity beta sorted portfolios

This table presents daily mean returns of equally weighted decile portfolios constructed according to historical betas of three liquidity proxies. Sample consists of 642 stocks of FTSEALL share index constituents' list of February (2008). Analysis covers 1st July 1992 to 29th June 2007. At 1st July of each year, we estimate historical liquidity beta of each stock based on daily data of previous 5 years. Only stocks with continuing returns through the estimation period are considered. For estimation purposes, we use the model that consists of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking market liquidity factor measured by a different liquidity proxy each time. The liquidity proxies are proportional quoted bid ask spread (PSPR), Amihud's (2002) illiquidity ratio (AM) and turnover rate (TO). After the estimation, we sort stocks according to their historical liquidity betas and construct 10 equally weighted decile portfolios, held for the following 12 months. The process is repeated annually. Post-formation returns of each portfolio are linked across years to form one series of daily returns from 1st July 1992 to 29th June 2007. Each decile portfolio includes 27 to 52 stocks. Port 1 represents most liquid portfolio while Port 10 is least liquid portfolio. Diff (10-1) is portfolio whose returns are calculated as difference in daily returns between Ports 10 and 1. Averages of daily portfolio returns are reported. Levels of significance of average portfolio returns are estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level.

Liquidity Measure	Port 1	Port 10	Diff(10-1)
PSPR	0.0002	0.0006[a]	0.0004[b]
TO	0.0003	0.0004[a]	0.0001
AM	0.0001	0.0006[a]	0.0005[a]

Table 5.9 summarises the performance of Port 1, Port 10 and Diff(10-1), using different versions of the asset pricing models (results associated with Ports 2 to 9 are reported in Appendices A.6 to A.8). Panel A of Table 5.9 presents the results of the proportional spread portfolios. Despite the proportional spread beta's being significant for most of the portfolios and under the three proportional spread augmented models, C-F&F can fully explain the variations in stock returns. Indeed, none of the intercepts for the ten portfolios is statistically significant under C-F&F. Moreover, C-F&F is the only model that produces an intercept of Diff (10-1) not statistically different from zero. We use the Gibbons et al. (1989) statistic[1] (GRS

[1] GRS statistic is F-statistic of Gibbons et al. (1989). It tests the null hypothesis that intercepts of the ten portfolios are jointly equal to zero. It is described as

$$GRS = \left(\frac{T}{N}\right)\left(\frac{T-N-L}{T-L-1}\right)\left[\frac{\hat{\alpha}'\hat{\Sigma}^{-1}\hat{\alpha}}{1+\bar{\mu}'\hat{\Omega}^{-1}\bar{\mu}}\right] \sim F(N, T-N-L)$$

hereafter) to test the hypothesis that the intercepts of the ten portfolios are jointly equal to zero. All the models in Panel A of Table 5.9 show significant GRS values, indicating that none can fully explain the variations of stocks' returns.

Panel B of Table 5.9 presents the results of the turnover rate portfolios. Consistent with the proportional spread portfolios, the turnover rate portfolios provide no evidence of a liquidity risk premium. Even though the turnover coefficients are highly significant and increasing in value when moving from the most to the least liquid decile portfolios, C-F&F fully explains the portfolios' returns. The statistically insignificant intercept indicates that C-F&F can fully explain the return of Diff (10-1). Moreover, C-F&F is the only model for which the GRS statistic is not significantly different from zero. This model can fully explain the variations of returns for all portfolios.

Turning to illiquidity ratio portfolios in Panel C of Table 5.9, strong evidence of a liquidity risk premium can be easily detected. None of CAPM, F&F and C-F&F can fully explain the returns of the liquidity-sorted portfolios. The intercept of Diff (10-1) is positive and significant for all of these models, indicating a risk premium. The risk premium ranges from 0.02% for C-F&F, to 0.03% for F&F and 0.06% for CAPM. On the other hand, the intercept of Diff (10-1) is not statistically significant under AM3. This indicates that the risk premium is a liquidity risk premium. AM3 shows the highest values of adjusted R-squared ranging from .8499 for Port 10 to

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where $\hat{\alpha}$ is N×1 vector of estimated intercepts. $\hat{\Sigma}$ is unbiased estimate of residual covariance matrix. $\overline{\mu}$ is L×1 vector of factor portfolios' sample means. $\hat{\Omega}$ is unbiased estimate of factor portfolios' covariance matrix. The larger the intercepts are in absolute value, the greater will be GRS statistic.

.9363 for Port 5. Additionally, the illiquidity ratio coefficient is significant for most of the portfolios and under AM1, AM2 and AM3. Illiquid portfolios show higher levels of significance in their liquidity betas than liquid portfolios. For instance, the t-statistic of the liquidity beta for Port 10 in AM2 is 13.161, while the comparable t-statistic for Port 1 is -8.890. However, the significant GRS indicates that AM3 does not provide a perfect fit to return series of all portfolios.

Our evidence of the portfolio approach contradicts the US evidence of Pastor and Stambaugh (2003) who reported positive and significant intercepts of Diff (10-1) under the three models, CAPM, F&F and C-F&F, indicating the inability of these models to explain the liquidity risk effect. However, our evidence is consistent with the Spanish evidence of Martinez et al. (2005) who find that liquidity risk is priced exclusively when liquidity is measured by the Amihud (2002) illiquidity ratio.

Table 5.9

Asset pricing models of liquidity beta sorted portfolios

This table presents ordinary least squares (OLS) estimation results of 12 time series asset pricing models for equally weighted decile portfolios constructed according to historical liquidity betas. Sample consists of 642 stocks of FTSEALL share index constituents' list of February (2008). Analysis covers 1^{st} July 1992 to 29^{th} June 2007. At 1^{st} July each year, we estimate historical liquidity beta of each stock based on daily data of previous 5 years. Only stocks with continuing returns through the estimation period are considered. For estimation, we use the model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking market liquidity factor. After estimation, we sort stocks according to their historical liquidity betas and construct 10 equally weighted decile portfolios, held for the following 12 months. The process is repeated annually. Post-formation returns of each portfolio are linked across years to form one series of daily returns from 1^{st} July 1992 to 29^{th} June 2007. Each decile portfolio includes 27 to 52 stocks. Port 1 represents most liquid portfolio while Port 10 is least liquid portfolio. Diff(10-1) is portfolio whose returns are calculated as difference in daily returns between Ports 10 and 1. Models and their explanatory variables are defined in Sections 5.3.1 and 5.3.3.1, respectively. Time series slope coefficients are reported. Levels of significance of these coefficients are estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level. Adjusted R^2 is value of adjusted R-squared in each regression while AIC is value of Akaike information criteria. GRS is F-statistic of Gibbons et al. (1989) which tests null hypothesis that intercepts of ten portfolios are jointly equal to zero. Bold values of GRS are statistically significant.

Panel A: Results of proportional spread portfolios				**Panel B: Results of turnover rate portfolios**				**Panel C: Results of illiquidity ratio portfolios**			
Model	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**
CAPM				**CAPM**				**CAPM**			
INTERCEPT	-0.0001	0.0004[a]	0.0005[a]	INTERCEPT	0.0001	0.0003[a]	0.0002	INTERCEPT	-0.0001	0.0004[a]	0.0006[a]
MKT	0.9884[a]	0.7209[a]	-0.2675[a]	MKT	0.9674[a]	0.7023[a]	-0.2651[a]	MKT	0.9423[a]	0.7670[a]	-0.1753[a]
Adjusted R^2	0.8378	0.5905	0.1466	Adjusted R^2	0.7672	0.6664	0.1447	Adjusted R^2	0.7926	0.6599	0.0655
AIC	-7.5123	-6.8675	-6.724	AIC	-7.1058	-7.2456	-6.7269	AIC	-7.3067	-7.0405	-6.675
GRS	**3.9884**			GRS	**4.7084**			GRS	**3.8994**		
F&F				**F&F**				**F&F**			
INTERCEPT	-0.0002[b]	0	0.0002[c]	INTERCEPT	-0.0001	0	0.0001	INTERCEPT	-0.0002[c]	0.0001	0.0003[b]
MKT	1.0998[a]	0.9984[a]	-0.1013[a]	MKT	1.1215[a]	0.9240[a]	-0.1974[a]	MKT	1.0368[a]	1.0158[a]	-0.021
HML	0.3524[a]	0.3433[a]	-0.0091	HML	0.2277[a]	0.3426[a]	0.1148[a]	HML	0.2980[a]	0.3486[a]	0.0506
SMB	0.3377[a]	0.9132[a]	0.5755[a]	SMB	0.5021[a]	0.7206[a]	0.2185[a]	SMB	0.2870[a]	0.8134[a]	0.5265[a]
Adjusted R^2	0.8676	0.8062	0.316	Adjusted R^2	0.8145	0.8277	0.1672	Adjusted R^2	0.8149	0.8296	0.2064
AIC	-7.7142	-7.6153	-6.9447	AIC	-7.3325	-7.906	-6.753	AIC	-7.4195	-7.7308	-6.838
GRS	**2.6826**			GRS	**1.9647**			GRS	**2.7846**		

Table 5.9 (Continued)

Panel A: Results of proportional spread portfolios				**Panel B: Results of turnover rate portfolios**				**Panel C: Results of illiquidity ratio portfolios**			
Model	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**
C-F&F				**C-F&F**				**C-F&F**			
INTERCEPT	-0.0001	0.0001	0.0002	INTERCEPT	0	0	0	INTERCEPT	-0.0001	0.0001[c]	0.0002[c]
MKT	1.1039[a]	1.0013[a]	-0.1026[a]	MKT	1.1271[a]	0.9254[a]	-0.2017[a]	MKT	1.0426[a]	1.0176[a]	-0.025
HML	0.3288[a]	0.3270[a]	-0.0017	HML	0.1960[a]	0.3348[a]	0.1389[a]	HML	0.2648[a]	0.3384[a]	0.0736[c]
SMB	0.3713[a]	0.9363[a]	0.5650[a]	SMB	0.5473[a]	0.7316[a]	0.1843[a]	SMB	0.3342[a]	0.8280[a]	0.4938[a]
MOM	-0.1337[a]	-0.0919[a]	0.0419[c]	MOM	-0.1800[a]	-0.0437[a]	0.1362[a]	MOM	-0.1882[a]	-0.0580[a]	0.1302[a]
Adjusted R^2	0.8752	0.811	0.3176	Adjusted R^2	0.8277	0.829	0.186	Adjusted R^2	0.8306	0.8314	0.2243
AIC	-7.7731	-7.6398	-6.9468	AIC	-7.4059	-7.913	-6.7756	AIC	-7.5079	-7.7413	-6.8605
GRS	**2.3959**			GRS	1.4251			GRS	**1.6661**		
PSPR1				**TO1**				**AM1**			
INTERCEPT	-0.0001	0.0002[b]	0.0003[b]	INTERCEPT	0	0.0005[a]	0.0004[a]	INTERCEPT	-0.0001	0.0002[b]	0.0003[b]
MKT	1.0042[a]	0.9688[a]	-0.0354[b]	MKT	0.9203[a]	0.8290[a]	-0.0914[a]	MKT	0.9491[a]	0.9769[a]	0.0278
PSPR	0.0758[a]	1.1908[a]	1.1150[a]	TO	-0.3200[a]	0.8619[a]	1.1819[a]	AM	0.0299	0.9141[a]	0.8842[a]
Adjusted R^2	0.8385	0.8192	0.5086	Adjusted R^2	0.7754	0.7646	0.4266	Adjusted R^2	0.7927	0.8177	0.3469
AIC	-7.5162	-7.6848	-7.2756	AIC	-7.1413	-7.5941	-7.1266	AIC	-7.3069	-7.664	-7.0331
GRS	**4.0471**			GRS	**8.3826**			GRS	**2.3928**		
PSPR2				**TO2**				**AM2**			
INTERCEPT	-0.0002[b]	0.0001	0.0003[a]	INTERCEPT	-0.0004[a]	0.0002[b]	0.0005[a]	INTERCEPT	-0.0002[c]	0.0001	0.0003[b]
MKT	1.0824[a]	1.0278[a]	-0.0546[a]	MKT	1.0725[a]	0.9554[a]	-0.1171[a]	MKT	1.0186[a]	1.0344[a]	0.0158
HML	0.4134[a]	0.2399[a]	-0.1736[a]	HML	0.3818[a]	0.2440[a]	-0.1377[a]	HML	0.4193[a]	0.2245[a]	-0.1948[a]
SMB	0.5900[a]	0.4861[a]	-0.1039[a]	SMB	0.7054[a]	0.5905[a]	-0.1149[a]	SMB	0.5780[a]	0.5154[a]	-0.0626
PSPR	-0.4454[a]	0.7541[a]	1.1996[a]	TO	-0.7740[a]	0.4950[a]	1.2690[a]	AM	-0.4662[a]	0.4774[a]	0.9436[a]
Adjusted R^2	0.8791	0.8503	0.5175	Adjusted R^2	0.854	0.8543	0.4342	Adjusted R^2	0.8302	0.8498	0.3575
AIC	-7.8056	-7.8733	-7.2934	AIC	-7.5715	-8.0734	-7.1393	AIC	-7.5059	-7.8571	-7.0489
GRS	**4.0596**			GRS	**9.4755**			GRS	**2.7994**		
PSPR3				**TO3**				**AM3**			
INTERCEPT	-0.0001	0.0001	0.0002[b]	INTERCEPT	-0.0002[b]	0.0002[b]	0.0004[a]	INTERCEPT	0	0.0001	0.0002
MKT	1.0828[a]	1.0279[a]	-0.0549[a]	MKT	1.0779[a]	0.9566[a]	-0.1213[a]	MKT	1.0207[a]	1.0346[a]	0.0139
HML	0.3990[a]	0.2387[a]	-0.1603[a]	HML	0.3503[a]	0.2368[a]	-0.1135[a]	HML	0.4127[a]	0.2241[a]	-0.1886[a]
SMB	0.7204[a]	0.4969[a]	-0.2235[a]	SMB	0.7522[a]	0.6013[a]	-0.1509[a]	SMB	0.7269[a]	0.5245[a]	-0.2023[a]
MOM	-0.1939[a]	-0.0161	0.1778[a]	MOM	-0.1825[a]	-0.0422[a]	0.1403[a]	MOM	-0.2439[a]	-0.015	0.2289[a]
PSPR	-0.5897[a]	0.7421[a]	1.3318[a]	TO	-0.7776[a]	0.4942[a]	1.2718[a]	AM	-0.6066[a]	0.4688[a]	1.0753[a]
Adjusted R^2	0.894	0.8504	0.5472	Adjusted R^2	0.8675	0.8555	0.4542	Adjusted R^2	0.8552	0.8499	0.4103
AIC	-7.9361	-7.8737	-7.3567	AIC	-7.6687	-8.0811	-7.1751	AIC	-7.665	-7.8574	-7.1343
GRS	**2.6461**			GRS	**4.7862**			GRS	**1.895**		

5.4.3. Robustness check

5.4.3.1. Sorting by liquidity measures

This time we analyse the performance of portfolios sorted according to our three liquidity measures, namely proportional bid-ask spread, Amihud's (2002) illiquidity ratio and turnover rate. At the beginning of each month starting from July 1992, we calculate the daily average value of one of the liquidity measures for every stock with a complete set of daily observations over that month. Then, we sort all the underlying stocks according to the average values of the liquidity measure. Thereafter, 10 equally weighted portfolios are constructed and held for 12 months. We repeat the process on an annual basis. The post-formation returns of each portfolio are linked across years to form one series of returns from 1st July 1992 to 29th June 2007. Table 5.10 shows the mean returns of Port 1, Port 10 and Diff(10-1) constructed from our three liquidity proxies (average returns of the remaining Ports 2 to 9 are reported in Appendix A.9). Each decile portfolio constructed on the basis of proportional spread includes 33 to 62 stocks; the number of stocks in each decile portfolio constructed on the basis of illiquidity ratio ranges from 21 to 62; the comparable number for the decile portfolios constructed according to turnover rate is between 22 and 62. Port 1 represents the most liquid portfolio while Port 10 is the least liquid. This part of the analysis provides less support for the view that liquidity is priced than the liquidity beta-sorted portfolios. Table 5.10 shows that the daily risk premium for the proportional spread portfolios is 0.03% and is significant only at the 10% level. The risk premium for the illiquidity ratio is 0.01% and is not statistically significant. Liu (2006) reports a comparable significant monthly liquidity risk premium for the US market of 0.682% when liquidity is measured by the standardised turnover-adjusted number of zero daily trading volume over the previous 12 months. The results of the turnover rate-sorted portfolios are quite different. They are consistent with Lee and Swaminathan (2000) who find a positive relationship between turnover rate and stock returns. Table 5.10 shows that high turnover rate portfolios earn higher and more significant returns than low turnover rate portfolios. The return difference between the most and least turnover portfolios is -0.03%. However, these findings contradict the liquidity perspective of the issue. Datar et al. (1998) argue that high turnover stocks are more liquid and thus generate lower rates of return than low turnover stocks.

Table 5.10

Daily mean returns of liquidity sorted portfolios

This table presents daily mean returns of equally weighted decile portfolios constructed according to three liquidity proxies. Sample consists of 642 stocks of FTSEALL share index constituents' list of February (2008). Analysis covers 1st July 1992 to 29th June 2007. At 1st July each year, we calculate daily average value of one of the liquidity measures over that month for every stock having available data. Then we sort all underlying stocks according to their average values of the liquidity measure. Thereafter, 10 equally weighted portfolios are constructed and held for 12 months. We repeat the process on an annual basis. Post-formation returns of each portfolio are linked across years to form one series of returns from 1st July 1992 to 29th June 2007. Liquidity proxies used are proportional quoted bid ask spread (PSPR), Amihud's (2002) illiquidity ratio (AM) and turnover rate (TO). Each decile portfolio constructed on basis of proportional bid-ask spread includes 33 to 62 stocks. Number of stocks in each decile portfolio constructed on basis of illiquidity ratio ranges from 21 to 62. Comparable number for decile portfolios constructed according to turnover rate is between 22 and 62 stocks. Port 1 represents most liquid portfolio while Port 10 is least liquid portfolio. Diff (10-1) is portfolio whose returns calculated as difference in daily returns between Ports 10 and 1. Averages of daily portfolio returns are reported. Levels of significance of average portfolio returns are estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level.

Liquidity Measure	Port 1	Port 10	Diff(10-1)
PSPR	0.0003[c]	0.0005[a]	0.0003[c]
TO	0.0007[a]	0.0004[a]	-0.0003[b]
AM	0.0003[c]	0.0004[b]	0.0001

Further, we estimate CAPM, F&F, C-F&F and the liquidity augmented models for all the portfolios. Table 5.11 summarises the results of Port 1, Port 10 and Diff(10-1) (results associated with Ports 2 to 9 are reported in Appendices A.10 to A.12). Panel A of Table 5.11 reports the results of the proportional spread portfolios. We notice that the intercepts of Diff (10-1) associated with both F&F and C-F&F are not significantly different from zero. Consequently, evidence indicates absence of liquidity risk premium in our sample stocks. Moreover, the fact that GRS statistic is not significantly different from zero indicates that C-F&F can fully explain return variations of the ten portfolios.

In contrast, Panel B of Table 5.11 shows evidence that liquidity risk of turnover rate portfolios is priced. While both F&F and C-F&F show significant negative intercepts for Diff (10-1), TO1, TO2 and TO3 yield comparable intercepts not significantly different from zero. Most of the liquidity coefficients are highly significant and display an increasing pattern as we move from Port 1 to Port 10, demonstrating evidence of a liquidity risk premium. For instance, the value of the turnover rate coefficient of TO1 is -.202 for Port 1 while it is 1.091 for Port 10. TO3 shows the lowest AIC and highest adjusted R-squared values. The values of the adjusted R-squared associated with TO3 range from .866 to .930. They are higher than the values of the adjusted R-squared of the other models in Table 5.11. However, the significant GRS statistic suggests that none of the models in Table 5.11 can fully explain the variations in the portfolios' returns.

The results for the Amihud (2002) illiquidity ratio portfolios in Panel C of Table 5.11 show no evidence of a liquidity risk premium. This contradicts the analysis of the liquidity beta-sorted portfolios. Both the liquidity coefficients themselves and their level of significance increase as we move from the most to the least liquid portfolios. However, since the intercept of Diff (10-1) is not significant, all of

CAPM, F&F and C-F&F can fully explain the liquidity risk premium in the illiquidity ratio-sorted portfolios.

Overall, our results suggest that evidence on a liquidity risk premium is sensitive to the different sorts. Sorting by historical liquidity betas yields different results from sorting by the liquidity measures themselves. According to the historical liquidity beta-sort, liquidity risk is priced only when liquidity is measured by the Amihud (2002) illiquidity ratio. However, when the sort is based on liquidity measures, the turnover rate is the only liquidity proxy that is priced.

Table 5.11

Asset pricing models of liquidity sorted portfolios

This table presents ordinary least squares (OLS) estimation results of 12 time series asset pricing models for equally weighted decile portfolios constructed according to three liquidity measures. Liquidity measures are the proportional bid-ask spread, the turnover rate and the illiquidity ratio of Amihud (2002). Sample consists of 642 stocks of FTSEALL share index constituents' list of February (2008). Analysis covers 1st July 1992 to 29th June 2007. At 1st July each year, we calculate daily average value of each liquidity proxy over that month for every stock having available data. Only stocks with continuing returns through estimation period are considered. Then we sort all underlying stocks according to their average values of that measure of liquidity. Thereafter, 10 equally weighted portfolios are constructed and held for 12 months. We repeat the process on an annual basis. Post-formation returns of each portfolio are linked across years to form one series of returns from 1st July 1992 to 29th June 2007. Each decile portfolio includes 21 to 62 stocks. Port 1 represents most liquid portfolio while Port 10 is least liquid portfolio. Diff(10-1) is portfolio whose returns are calculated as difference in daily returns between Ports 10 and 1. Models and explanatory variables are defined in Sections 5.3.1 and 5.3.3.1, respectively. Time series slope coefficients are reported. Levels of significance of these coefficients are estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level. Adjusted R^2 is value of adjusted R-squared in each regression while AIC is value of Akaike information criteria. GRS is F-statistic of Gibbons et al. (1989) which tests null hypothesis that intercepts of ten portfolios are jointly equal to zero. Bold values of GRS are statistically significant.

Panel A: Results of proportional spread portfolios				**Panel B: Results of turnover rate portfolios**				**Panel C: Results of illiquidity ratio portfolios**			
Model	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**
CAPM				**CAPM**				**CAPM**			
INTERCEPT	0	0.0004[b]	0.0004[b]	INTERCEPT	0.0005[a]	0.0003[b]	-0.0002[c]	INTERCEPT	0	0.0003[c]	0.0003
MKT	0.9761[a]	0.6823[a]	-0.2938[a]	MKT	0.8973[a]	0.6713[a]	-0.2260[a]	MKT	1.0073[a]	0.6806[a]	-0.3267[a]
Adjusted R^2	0.9616	0.5614	0.187	Adjusted R^2	0.8228	0.5838	0.148	Adjusted R^2	0.9567	0.5603	0.1951
AIC	-9.117	-6.8585	-6.8282	AIC	-7.5987	-6.9824	-7.0722	AIC	-8.9272	-6.859	-6.668
GRS	**3.9188**			GRS	**5.7434**			GRS	**6.6563**		
F&F				**F&F**				**F&F**			
INTERCEPT	0	0	0	INTERCEPT	0.0003[a]	-0.0001	-0.0004[a]	INTERCEPT	0	-0.0001	-0.0002
MKT	0.9915[a]	0.9687[a]	-0.0228[c]	MKT	1.0551[a]	0.9448[a]	-0.1103[a]	MKT	0.9796[a]	0.9653[a]	-0.0142
HML	0.0885[a]	0.3133[a]	0.2248[a]	HML	0.1542[a]	0.4640[a]	0.3098[a]	HML	0.0262	0.4023[a]	0.3761[a]
SMB	0.0412[b]	0.9477[a]	0.9064[a]	SMB	0.5244[a]	0.8832[a]	0.3588[a]	SMB	-0.0992[a]	0.9303[a]	1.0296[a]
Adjusted R^2	0.9629	0.8081	0.5958	Adjusted R^2	0.8869	0.8186	0.2484	Adjusted R^2	0.9594	0.7997	0.6365
AIC	-9.1499	-7.6843	-7.5264	AIC	-8.047	-7.8126	-7.197	AIC	-8.9902	-7.6447	-7.4625
GRS	**2.4685**			GRS	**6.1464**			GRS	**4.0848**		

Table 5.11 (Continued)

Panel A: Results of proportional spread portfolios				**Panel B: Results of turnover rate portfolios**				**Panel C: Results of illiquidity ratio portfolios**			
Model	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**
C-F&F				**C-F&F**				**C-F&F**			
INTERCEPT	0	0.0001	0.0001	INTERCEPT	0.0003[a]	0	-0.0003[b]	INTERCEPT	0.0001	0	-0.0001
MKT	0.9932[a]	0.9735[a]	-0.0197	MKT	1.0560[a]	0.9476[a]	-0.1085[a]	MKT	0.9813[a]	0.9689[a]	-0.0124
HML	0.0786[a]	0.2856[a]	0.2070[a]	HML	0.1486[a]	0.4483[a]	0.2997[a]	HML	0.0166	0.3823[a]	0.3656[a]
SMB	0.0552[a]	0.9869[a]	0.9317[a]	SMB	0.5323[a]	0.9055[a]	0.3732[a]	SMB	-0.0856[a]	0.9588[a]	1.0444[a]
MOM	-0.0559[a]	-0.1565[a]	-0.1006[a]	MOM	-0.0315[c]	-0.0888[a]	-0.0573[b]	MOM	-0.0543[a]	-0.1135[a]	-0.0592[b]
Adjusted R^2	0.9645	0.8227	0.6066	Adjusted R^2	0.8873	0.8237	0.2529	Adjusted R^2	0.9607	0.8074	0.6396
AIC	-9.1926	-7.7634	-7.5533	AIC	-8.051	-7.8406	-7.2028	AIC	-9.0243	-7.6837	-7.4708
GRS	1.5795			GRS	**5.7845**			GRS	**3.8502**		
PSPR1				**TO1**				**AM1**			
INTERCEPT	0	0.0002[b]	0.0002[b]	INTERCEPT	0.0005[a]	0.0005[a]	0	INTERCEPT	0	-0.0001	-0.0001
MKT	0.9653[a]	0.9539[a]	-0.0114	MKT	0.8677[a]	0.8316[a]	-0.0360[a]	MKT	0.9753[a]	0.9437[a]	-0.0316[a]
PSPR	-0.0521[a]	1.3044[a]	1.3564[a]	TO	-0.2020[a]	1.0907[a]	1.2927[a]	AM	-0.1396[a]	1.1454[a]	1.2850[a]
Adjusted R^2	0.962	0.8527	0.7535	Adjusted R^2	0.8268	0.7347	0.6227	Adjusted R^2	0.9598	0.8275	0.7037
AIC	-9.1266	-7.9492	-8.0211	AIC	-7.6215	-7.4323	-7.8865	AIC	-9.0008	-7.7945	-7.6669
GRS	**2.5317**			GRS	**8.8057**			GRS	**4.3175**		
PSPR2				**TO2**				**AM2**			
INTERCEPT	0	0.0001	0.0001	INTERCEPT	0.0001	0.0001	0	INTERCEPT	0	-0.0001[c]	-0.0002[b]
MKT	0.9846[a]	1.0045[a]	0.0198[b]	MKT	1.0152[a]	0.9853[a]	-0.0300[b]	MKT	0.9748[a]	0.9949[a]	0.0201[c]
HML	0.1125[a]	0.1873[a]	0.0748[a]	HML	0.2794[a]	0.3369[a]	0.0574[a]	HML	0.0583[a]	0.2052[a]	0.1469[a]
SMB	0.1404[a]	0.4272[a]	0.2868[a]	SMB	0.6898[a]	0.7153[a]	0.0255	SMB	-0.0223	0.4573[a]	0.4796[a]
PSPR	-0.1751[a]	0.9188[a]	1.0939[a]	TO	-0.6295[a]	0.6391[a]	1.2686[a]	AM	-0.1232[a]	0.7577[a]	0.8809[a]
Adjusted R^2	0.965	0.8776	0.773	Adjusted R^2	0.9194	0.8612	0.6239	Adjusted R^2	0.9605	0.8548	0.7492
AIC	-9.2081	-8.1337	-8.1032	AIC	-8.386	-8.0796	-7.8891	AIC	-9.0181	-7.9662	-7.8334
GRS	**3.6961**			GRS	**7.2966**			GRS	**4.3755**		
PSPR3				**TO3**				**AM3**			
INTERCEPT	0	0.0001	0.0001	INTERCEPT	0.0001[c]	0.0002[b]	0.0001	INTERCEPT	0.0001[c]	-0.0001	-0.0002[b]
MKT	0.9848[a]	1.0046[a]	0.0198[b]	MKT	1.0162[a]	0.9878[a]	-0.0284[b]	MKT	0.9754[a]	0.9953[a]	0.0199[c]
HML	0.1066[a]	0.1823[a]	0.0757[a]	HML	0.2737[a]	0.3219[a]	0.0482[b]	HML	0.0564[a]	0.2040[a]	0.1476[a]
SMB	0.1941[a]	0.4728[a]	0.2788[a]	SMB	0.6984[a]	0.7376[a]	0.0392[c]	SMB	0.02	0.4856[a]	0.4656[a]
MOM	-0.0798[a]	-0.0678[a]	0.012	MOM	-0.0335[a]	-0.0868[a]	-0.0532[a]	MOM	-0.0693[a]	-0.0464[a]	0.0229
PSPR	-0.2345[a]	0.8684[a]	1.1028[a]	TO	-0.6302[a]	0.6374[a]	1.2675[a]	AM	-0.1631[a]	0.7310[a]	0.8941[a]
Adjusted R^2	0.968	0.8801	0.7731	Adjusted R^2	0.92	0.866	0.6279	Adjusted R^2	0.9626	0.856	0.7496
AIC	-9.2959	-8.1543	-8.1034	AIC	-8.3926	-8.1147	-7.8995	AIC	-9.0731	-7.9742	-7.8347
GRS	**3.7236**			GRS	**6.4552**			GRS	**3.613**		

5.4.3.2. Sorting by size

Size has been considered as an important measure of liquidity. Specifically, small firms tend to be less liquid than large firms[1]. We use size as a liquidity proxy and examine the performance of size-sorted portfolios. At the beginning of each month starting from July 1992, we calculate the daily average value of the market capitalisation for every stock with a complete set of daily observations over that month. We sort all the stocks according to their average values of the market capitalisation and construct ten equally weighted portfolios. The portfolios are held for 12 months and the whole process is repeated annually. The post-formation returns of each portfolio are linked across years to form a single series of returns for 1st July 1992 to 29th June 2007.

Panel A of Table 5.12 shows the mean returns of Port 1, Port 10 and Diff(10-1) that are constructed according to the market capitalisation (size factor) (average returns of the remaining Ports 2 to 9 are reported in Panel A of Appendix A.13). Each decile portfolio includes 34 to 62 stocks, depending on the formulation year. The average market capitalisation per stock ranges from 4.6 to 85.1 in the least liquid decile portfolio and from 5908.5 to 21171.3 in the most liquid. Size seems to be a very good measure of liquidity. The smallest size portfolios significantly outperform the largest by 0.05%. Not only the returns but also their levels of significance increase as we move from Port 1 (the largest in size) to Port 10 (the smallest in size). Thus, very clear evidence of a liquidity risk premium is found when size is used as a liquidity proxy.

[1] (See, for example, Stoll et al., 1983; Amihud and Mendelson, 1986; Puig, 2006)

Panel B of Table 5.12 shows the estimation results of 12 models of Port 1, Port 10 and Diff(10-1) (results associated with Ports 2 to 9 are reported in Panel B of Appendix A.13). For the 12 models, the intercepts for the highly liquid portfolios are insignificant while the low liquid portfolios show significant intercepts. This is clear evidence of a liquidity risk premium since the asset pricing models can explain the returns of the liquid portfolios but do nothing with regard to the illiquid portfolios. C-F&F shows lower AIC and higher adjusted R-squared values than F&F which, in turn, shows better values of both AIC and adjusted R-squared than CAPM. When liquidity is added to CAPM, F&F and C-F&F, it is almost always the case that the best model is the liquidity augmented C-F&F. Regardless of what liquidity proxy is used, most of the liquidity coefficients in all the estimated models are significant, confirming the strong evidence of a liquidity risk premium. This evidence is consistent with that of the US market where Pastor and Stambaugh (2003) find that smaller stocks are less liquid than large stocks.

Table 5.12

Asset pricing models of market capitalisation sorted portfolios

Panel A of this table presents daily mean returns of equally weighted decile portfolios constructed according to market capitalisation. Panel B of the table presents ordinary least squares (OLS) estimation results of twelve time series asset pricing models for equally weighted decile portfolios constructed according to market capitalisation. Sample consists of 642 stocks of FTSEALL share index constituents' list of February (2008). Analysis covers 1st July 1992 to 29th June 2007. At 1st July each year, we calculate daily average value of market capitalisation over that month for every stock having available data. Then we sort all underlying stocks according to their average values of market capitalisation. Thereafter, 10 equally weighted portfolios are constructed and held for 12 months. We repeat the process on an annual basis. Post-formation returns of each portfolio are linked across years to form one series of returns from 1st July 1992 to 29th June 2007. Each decile portfolio includes 34 to 62 stocks. Average market capitalisation per stock ranges from 4.6 to 85.1 in least liquid decile portfolio and from 5908.5 to 21171.3 in most liquid decile. Port 1 represents most liquid portfolio while Port 10 is least liquid portfolio. Diff(10-1) is portfolio whose returns are calculated as difference in daily returns between Ports 10 and 1. Models and explanatory variables are defined in Sections 5.3.1 and 5.3.3.1, respectively. Time series slope coefficients are reported. Levels of significance of these coefficients are estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level. Adjusted R^2 is value of adjusted R-squared in each regression while AIC is value of Akaike information criteria. GRS is F-statistic of Gibbons et al. (1989) which tests null hypothesis that intercepts of ten portfolios are jointly equal to zero. Bold values of GRS are statistically significant.

Panel A: Daily mean returns of decile portfolios sorted according to market capitalisation			
Port	**Port 1**	**Port 10**	**Diff(10-1)**
Size	0.0002[c]	0.0007[a]	0.0005[a]

Panel B: Estimates of twelve time series asset pricing models for ten equally weighted decile portfolios sorted according to market capitalisation									
	CAPM			**F&F**			**C-F&F**		
Portfolios	**Port 1**	**Port 10**	**Diff(10-1)**	**Port 1**	**Port 10**	**Diff(10-1)**	**Port 1**	**Port 10**	**Diff(10-1)**
INTERCEPT	0	0.0006[a]	0.0006[a]	0	0.0002[a]	0.0002[b]	0	0.0003[a]	0.0002[b]
MKT	1.0197[a]	0.6589[a]	-0.3608[a]	0.9923[a]	0.9385[a]	-0.0538[a]	0.9936[a]	0.9403[a]	-0.0532[a]
HML				0.015	0.3666[a]	0.3516[a]	0.0079	0.3563[a]	0.3484[a]
SMB				-0.0965[a]	0.9175[a]	1.0140[a]	-0.0864[a]	0.9321[a]	1.0185[a]
MOM							-0.0405[a]	-0.0584[a]	-0.018
Adjusted R^2	0.9611	0.5714	0.2445	0.9634	0.824	0.6843	0.9641	0.8262	0.6845
AIC	-9.0138	-6.9691	-6.758	-9.0742	-7.8588	-7.63	-9.0945	-7.8711	-7.6304
GRS	**12.6657**			**9.6138**			**9.2526**		

Table 5.12 (Continued)

	PSPR1			PSPR2			PSPR3		
Portfolios	**Port 1**	**Port 10**	**Diff(10-1)**	**Port 1**	**Port 10**	**Diff(10-1)**	**Port 1**	**Port 10**	**Diff(10-1)**
INTERCEPT	0	0.0004[a]	0.0004[a]	0	0.0003[a]	0.0003[a]	0	0.0003[a]	0.0002[a]
MKT	0.9839[a]	0.9042[a]	-0.0797[a]	0.9858[a]	0.9667[a]	-0.0191[b]	0.9859[a]	0.9667[a]	-0.0192[b]
HML				0.0380[b]	0.2674[a]	0.2294[a]	0.0333[b]	0.2686[a]	0.2353[a]
SMB				-0.0017	0.5075[a]	0.5093[a]	0.0402[b]	0.4963[a]	0.4561[a]
MOM							-0.0623[a]	0.0167	0.0790[a]
PSPR	-0.1717[a]	1.1785[a]	1.3502[a]	-0.1674[a]	0.7238[a]	0.8911[a]	-0.2137[a]	0.7362[a]	0.9499[a]
Adjusted R^2	0.9649	0.831	0.7307	0.9651	0.8711	0.7861	0.9668	0.8712	0.7915
AIC	-9.1179	-7.8992	-7.7895	-9.1232	-8.1698	-8.0193	-9.1712	-8.1706	-8.0443
GRS	**8.4968**			**11.9547**			**10.0378**		
	TO1			**TO2**			**TO3**		
Portfolios	**Port 1**	**Port 10**	**Diff(10-1)**	**Port 1**	**Port 10**	**Diff(10-1)**	**Port 1**	**Port 10**	**Diff(10-1)**
INTERCEPT	0	0.0008[a]	0.0008[a]	0	0.0003[a]	0.0003[a]	0	0.0004[a]	0.0003[a]
MKT	1.0051[a]	0.7847[a]	-0.2204[a]	0.9886[a]	0.9607[a]	-0.0278[a]	0.9898[a]	0.9624[a]	-0.0273[a]
HML				0.0269	0.2968[a]	0.2699[a]	0.0198	0.2869[a]	0.2670[a]
SMB				-0.0809[a]	0.8253[a]	0.9062[a]	-0.0705[a]	0.8400[a]	0.9105[a]
MOM							-0.0407[a]	-0.0573[a]	-0.0166
TO	-0.0992[a]	0.8558[a]	0.9550[a]	-0.0595[a]	0.3509[a]	0.4104[a]	-0.0603[a]	0.3497[a]	0.4101[a]
Adjusted R^2	0.9619	0.6658	0.4122	0.9636	0.837	0.7096	0.9644	0.8391	0.7098
AIC	-9.0364	-7.2175	-7.0088	-9.0809	-7.9353	-7.7136	-9.1016	-7.9481	-7.7139
GRS	**21.3969**			**13.6457**			**15.4756**		
	AM1			**AM2**			**AM3**		
Portfolios	**Port 1**	**Port 10**	**Diff(10-1)**	**Port 1**	**Port 10**	**Diff(10-1)**	**Port 1**	**Port 10**	**Diff(10-1)**
INTERCEPT	0	0.0003[a]	0.0003[a]	0	0.0002[a]	0.0002[b]	0.0001	0.0002[a]	0.0002[b]
MKT	0.9827[a]	0.8967[a]	-0.0860[a]	0.9856[a]	0.9600[a]	-0.0257[a]	0.9861[a]	0.9600[a]	-0.0261[a]
HML				0.0598[a]	0.2235[a]	0.1637[a]	0.0582[a]	0.2233[a]	0.1651[a]
SMB				0.011	0.5741[a]	0.5631[a]	0.0473[b]	0.5792[a]	0.5319[a]
MOM							-0.0594[a]	-0.0084	0.051
AM	-0.1609[a]	1.0355[a]	1.1964[a]	-0.1723[a]	0.5500[a]	0.7223[a]	-0.2065[a]	0.5452[a]	0.7517[a]
Adjusted R^2	0.9651	0.809	0.6972	0.9655	0.8556	0.762	0.9671	0.8556	0.7643
AIC	-9.1224	-7.7773	-7.6722	-9.135	-8.0564	-7.9126	-9.1803	-8.0562	-7.9218
GRS	**10.0017**			**11.2496**			**6.6783**		

5.4.3.3. Sub-period analysis

In order to check whether our results are not restricted to a certain time period, we perform a sub-period analysis for the historical liquidity beta sorted portfolios. We split our study period into three sub-periods. The first sub-period is from 1st July 1992 to 17th October 1997, the second from 20th October 1997 to 3rd November 2003 and the third from 4th November 2003 to 29th June 2007. The choice of these three sub-periods is deliberate, to reflect three different trading systems of FTSEALL index shares. In the first sub-period, the trading was happening through SEAQ (stock exchange automated quotation system), that is a dealership market, introduced in 1986. The second period reflects an order-driven market where SETS (Stock Exchange Trading System) was prevailing and was first introduced on 20th October 1997. Since 4th November 2003, a hybrid market prevails, thus a new trading system has been introduced, which is SETSmm (Stock Exchange Trading System with Market Makers).

Table 5.13 shows the returns for Port 1, Port 10 and Diff(10-1) over the three sub-periods (average returns of the remaining Ports 2 to 9 are reported in Appendix A.14). Proportional spread portfolios and illiquidity ratio portfolios show positive liquidity risk premiums through the three sub-periods. However, the proportional spread risk premium is significant only in the latest sub-period. The illiquidity ratio risk premium is significant at 10% and 5% during the first and the third sub-periods, respectively. The risk premiums associated with turnover rate portfolios are not significant in any of the three sub-periods. Turnover portfolios provide mixed evidence through the sub-periods, with the risk premium changes from a negative value in the first sub-period to positive in the two last sub-periods.

Table 5.13

Sub-period daily mean returns of liquidity beta sorted portfolios

This table presents daily mean returns of equally weighted decile portfolios constructed according to historical betas of three liquidity proxies. Analysis covers three sub-periods. Panel A reports results for first sub-period from 1st July 1992 to 17th October 1997. Panel B present results for second sub-period from 20th October 1997 to 3rd November 2003. Panel C shows results of third sub-period from 4th November 2003 to 29th June 2007.Sample consists of 642 stocks of FTSEALL share index constituents' list of February (2008). At 1st July each year, we estimate historical liquidity beta of each stock based on daily data of previous 5 years. Only stocks with continuing returns through estimation period are considered. For estimation, we use model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking market liquidity factor measured by a different liquidity proxy each time. Liquidity proxies used are proportional quoted bid ask spread (PSPR), Amihud's (2002) illiquidity ratio (AM) and turnover rate (TO). After estimation, we sort stocks according to their historical liquidity betas and construct 10 equally weighted decile portfolios, held for the following 12 months. The process is repeated annually. Post-formation returns of each portfolio are linked across years to form one series of daily returns along each sub-period. Each decile portfolio includes 27 to 52 stocks. Port 1 represents most liquid portfolio while Port 10 is least liquid portfolio. Diff(10-1) is portfolio whose returns are calculated as difference in daily returns between Ports 10 and 1. Averages of daily portfolio returns are reported. Levels of significance of average portfolio returns are estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level.

Panel A: Results from 1st July 1992 to 17th October 1997			
Liquidity Measure	**Port 1**	**Port 10**	**Diff(10-1)**
PSPR	0.0004[c]	0.0006[c]	0.0002
TO	0.0007[a]	0.0005[b]	-0.0002
AM	0.0004[b]	0.0008[a]	0.0004[c]
Panel B: Results from 20th October 1997 to 3rd November 2003			
Liquidity Measure	**Port 1**	**Port 10**	**Diff(10-1)**
PSPR	-0.0001	0.0003	0.0004
TO	-0.0001	0.0002	0.0003
AM	-0.0003	0.0002	0.0005
Panel C: Results from 4th November 2003 to 29th June 2007			
Liquidity Measure	**Port 1**	**Port 10**	**Diff(10-1)**
PSPR	0.0004	0.0009[a]	0.0005[a]
TO	0.0004	0.0008[a]	0.0003
AM	0.0003	0.0009[a]	0.0006[a]

Table 5.14 shows the sub-period results associated with Port 1, Port 10 and Diff(10-1) (results of Ports 2 to 9 are reported in Appendices A.15 to A.17). Starting with the proportional quoted bid-ask spread portfolios, we report no evidence of a liquidity risk premium in any of the three sub-periods. In the first, the liquidity coefficients and their levels of significance are increasing as we move from the most to the least liquid portfolios. For example, the liquidity coefficient value of PSPR2-estimated Port 1 is -.278 and its t-statistic is -5.043. On the other hand, the liquidity coefficient

value of PSPR2-estimated Port 10 is 1.386 with a t-statistic of 16.525. However, the intercept of Diff (10-1) associated with CAPM, F&F and C-F&F is not significantly different from zero. This evidence indicates the absence of a liquidity risk premium in the UK market. The second sup-period also shows no evidence of a liquidity risk premium. The intercept of Diff (10-1) is significant under CAPM but insignificant under both F&F and C-F&F. This suggests that F&F and C-F&F can fully explain the returns of the proportional spread portfolios. The GRS statistic is not significant, indicating absence of a liquidity risk premium. The results of the third sub-period are similar to those reported in the first two sub-periods. Specifically, the intercept of Diff (10-1) is significant across all the estimated models, CAPM, F&F, C-F&F, PSPR1, PSPR2 and PSPR3, indicating inability of these models to explain the liquidity risk premium. However, the fact that GRS statistic is not significant suggests that F&F can fully explain the return variations of the portfolios included in our analysis.

The results of the turnover rate portfolios also show no evidence of a liquidity risk premium across the three sub-periods. Most of the turnover rate coefficients are highly significant. These coefficients show an increasing pattern as we move from the most to least liquid portfolios. However, none of the three sub-periods shows evidence of a liquidity risk premium in LSE. Indeed, in the first sub-period, the intercept of Diff (10-1) is not statistically significant across all models. In the second sub-period, the intercept of Diff (10-1) is not statistically significant under CAPM, F&F and C-F&F. The GRS statistic is also not significant, indicating ability of C-F&F to explain the returns of all the turnover rate portfolios. Similar results are reported in the third sub-period. The intercept of Diff (10-1) is not statistically different from zero under both F&F and C-F&F. Thus, we report no evidence of a liquidity risk premium across the three sub-periods.

Illiquidity ratio portfolios provide some evidence that liquidity risk is priced in LSE. In the first sub-period, the intercept of Diff (10-1) associated with all the estimated models, CAPM, F&F, C-F&F, AM1, AM2 and AM3 is significant, indicating the presence of a liquidity risk premium. Additionally, the liquidity coefficients and their levels of significance are higher for illiquid than for liquid portfolios. For instance, the liquidity coefficient of AM3 has a value of .1413 and a t-statistic of 2.1588 for Port 1, whereas the liquidity coefficient of Port 10 is .7495 with a t-statistic of 9.8076. In the second sub-period, the intercept of Diff (10-1) is not statistically different from zero under both F&F and C-F&F, indicating absence of a liquidity risk premium. The GRS statistic of F&F and C-F&F is also not significant, indicating ability of these two models to explain the returns of all illiquidity ratio portfolios. In the third sub-period, the illiquidity ratio coefficients along with their t-values increase monotonically when we move from the most to least liquid portfolio portfolios. However, there is no evidence of a priced liquidity risk. The intercept of Diff (10-1) is significant across all models. The insignificant GRS statistic of both F&F and C-F&F indicates their ability to fully explain the returns of all the illiquidity ratio portfolios.

Overall, there is no evidence that liquidity risk is priced when liquidity is measured by the proportional bid-ask spread and the turnover rate over the three sub-periods. This is consistent with the reported results over the full study period 1st July 1992 to 29th June 2007. However, evidence that the Amihud (2002) illiquidity ratio is priced varies over time. It exists in the first sub-period but disappears in the second and third sub-periods. We argue that these results may be explained by the introduction of new trading systems of the FTSEALL share index stocks which has improved the aggregate liquidity of the market and reduces investors' concerns with the liquidity risk.

Table 5.14

Sub-period estimates of asset pricing models of liquidity beta sorted portfolio

This table presents ordinary least squares (OLS) estimation results of 12 time series asset pricing models for equally weighted decile portfolios constructed according to historical liquidity betas. Liquidity is measured by proportional bid-ask spread, turnover rate and illiquidity ratio of Amihud (2002). Analysis covers three sub-periods. Panel A reports results for first sub-period from 1st July 1992 to 17th October 1997. Panel B present results for second sub-period from 20th October 1997 to 3rd November 2003. Panel C shows results of third sub-period from 4th November 2003 to 29th June 2007.Sample consists of 642 stocks of FTSEALL share index constituents' list of February (2008). At 1st July each year, we estimate historical liquidity beta of each stock based on daily data of previous 5 years. Only stocks with continuing returns through estimation period are considered. For estimation, we use model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking market liquidity factor measured by a different liquidity proxy each time. After estimation, we sort stocks according to their historical liquidity betas and construct 10 equally weighted decile portfolios, held for the following 12 months. The process is repeated annually. Post-formation returns of each portfolio are linked across years to form one series of daily returns along each sub-period. Each decile portfolio includes 27 to 52 stocks. Port 1 represents most liquid portfolio while Port 10 is least liquid portfolio. Diff(10-1) is portfolio whose returns are calculated as difference in daily returns between Ports 10 and 1. Models and explanatory variables are defined in Sections 5.3.1 and 5.3.3.1, respectively. Time series slope coefficients are reported. Levels of significance of average portfolio returns are estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level. Adjusted R2 is value of adjusted R-squared in each regression while AIC is value of Akaike information criteria. GRS is F-statistic of Gibbons et al. (1989) which tests null hypothesis that intercepts of ten portfolios are jointly equal to zero. Bold values of GRS are statistically significant.

Panel A: Results from 1st July 1992 to 17th October 1997											
Results of proportional spread portfolios				**Results of turnover rate portfolios**				**Results of illiquidity ratio portfolios**			
Model	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**
CAPM				**CAPM**				**CAPM**			
INTERCEPT	-0.0001	0.0002	0.0003	INTERCEPT	0.0002	0.0001	-0.0002	INTERCEPT	0	0.0004	0.0004[c]
Adjusted R^2	0.9276	0.7346	0.014	Adjusted R^2	0.9045	0.8159	0.0244	Adjusted R^2	0.9105	0.7996	-0.0007
AIC	-8.245	-6.8549	-6.8471	AIC	-7.9191	-7.3197	-7.1511	AIC	-8.093	-7.153	-7.0546
GRS	**1.7349**			GRS	0.6853			GRS	**3.9851**		
F&F				**F&F**				**F&F**			
INTERCEPT	-0.0002	0.0000	0.0002	INTERCEPT	0.0002	-0.0001	-0.0002	INTERCEPT	-0.0001	0.0002	0.0003[c]
Adjusted R^2	0.9426	0.8257	0.1575	Adjusted R^2	0.9182	0.876	0.0924	Adjusted R^2	0.9278	0.8597	0.0824
AIC	-8.4749	-7.2737	-7.0029	AIC	-8.0732	-7.7135	-7.222	AIC	-8.3064	-7.5078	-7.1399
GRS	1.2223			GRS	0.9579			GRS	**4.2936**		
C-F&F				**C-F&F**				**C-F&F**			
INTERCEPT	-0.0001	0.0002	0.0003	INTERCEPT	0.0002[c]	0.0001	-0.0002	INTERCEPT	-0.0001	0.0004[b]	0.0005[b]
Adjusted R^2	0.9429	0.8436	0.2075	Adjusted R^2	0.9199	0.8815	0.0963	Adjusted R^2	0.9278	0.8698	0.1234
AIC	-8.4792	-7.3818	-7.0634	AIC	-8.093	-7.7579	-7.2256	AIC	-8.3054	-7.5821	-7.1849
GRS	**1.7892**			GRS	1.1498			GRS	**4.6915**		
PSPR1				**TO1**				**AM1**			
INTERCEPT	-0.0001	0.0000	0.0001	INTERCEPT	0.0002	0.0003[c]	0.0001	INTERCEPT	-0.0001	0.0002[c]	0.0003[c]
Adjusted R^2	0.9296	0.8942	0.4809	Adjusted R^2	0.9044	0.8626	0.2466	Adjusted R^2	0.9249	0.886	0.1478
AIC	-8.2727	-7.7734	-7.4879	AIC	-7.9182	-7.6111	-7.4089	AIC	-8.2679	-7.7161	-7.2146
GRS	1.1632			GRS	**1.7917**			GRS	**3.3181**		
PSPR2				**TO2**				**AM2**			
INTERCEPT	-0.0002	0.0000	0.0001	INTERCEPT	0.0001	0.0001	0.0000	INTERCEPT	-0.0001	0.0003[c]	0.0004[c]
Adjusted R^2	0.9456	0.8951	0.5267	Adjusted R^2	0.9217	0.8926	0.2534	Adjusted R^2	0.9286	0.8877	0.1704
AIC	-8.5282	-7.7814	-7.5788	AIC	-8.1153	-7.8566	-7.4165	AIC	-8.3172	-7.7295	-7.24
GRS	1.2388			GRS	0.6977			GRS	**4.878**		
PSPR3				**TO3**				**AM3**			
INTERCEPT	-0.0001	0.0001	0.0002	INTERCEPT	0.0002	0.0002	0.0000	INTERCEPT	-0.0001	0.0003[b]	0.0005[b]
Adjusted R^2	0.9468	0.8987	0.5287	Adjusted R^2	0.9238	0.8965	0.2537	Adjusted R^2	0.9286	0.8907	0.1854
AIC	-8.5509	-7.8147	-7.5824	AIC	-8.1429	-7.8923	-7.4162	AIC	-8.3158	-7.7563	-7.2575
GRS	1.2054			GRS	1.1503			GRS	**3.1238**		

Table 5.14 (continued)

Panel B: Results from 20th October 1997 to 3rd November 2003

Results of proportional spread portfolios				**Results of turnover rate portfolios**				**Results of illiquidity ratio portfolios**			
Model	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**diff(10-1)**
CAPM				**CAPM**				**CAPM**			
INTERCEPT	0.0000	0.0005[b]	0.0005[b]	INTERCEPT	0.000	0.0004[b]	0.0004	INTERCEPT	-0.0001	0.0004[b]	0.0006[b]
Adjusted R^2	0.7735	0.4528	0.2947	Adjusted R^2	0.6661	0.5367	0.2515	Adjusted R^2	0.7092	0.5379	0.1389
AIC	-6.9834	-6.7343	-6.5154	AIC	-6.5296	-7.1799	-6.3491	AIC	-6.7695	-6.8149	-6.3089
GRS	**3.6245**			GRS	**2.2615**			GRS	**2.1187**		
F&F				**F&F**				**F&F**			
INTERCEPT	-0.0003	0.0000	0.0003	INTERCEPT	-0.0003	0.0001	0.0004	INTERCEPT	-0.0003	0.0000	0.0003
Adjusted R^2	0.8286	0.7699	0.4108	Adjusted R^2	0.7502	0.7591	0.2509	Adjusted R^2	0.7443	0.7924	0.2823
AIC	-7.2611	-7.5996	-6.6939	AIC	-6.8187	-7.8328	-6.3471	AIC	-6.8971	-7.6137	-6.4898
GRS	**2.8315**			GRS	**2.4186**			GRS	1.2601		
C-F&F				**C-F&F**				**C-F&F**			
INTERCEPT	-0.0001	0.0000	0.0001	INTERCEPT	-0.0001	0.0001	0.0002	INTERCEPT	-0.0001	0.0000	0.0000
Adjusted R^2	0.8494	0.7728	0.4318	Adjusted R^2	0.7838	0.7592	0.3077	Adjusted R^2	0.7892	0.7927	0.3534
AIC	-7.3896	-7.6113	-6.7296	AIC	-6.9626	-7.8324	-6.4254	AIC	-7.0896	-7.6147	-6.5935
GRS	1.3747			GRS	0.5551			GRS	0.6833		
PSPR1				**TO1**				**AM1**			
INTERCEPT	0	0.0004[a]	0.0004	INTERCEPT	-0.0001	0.0006[a]	0.0007[a]	INTERCEPT	-0.0001	0.0001	0.0002
Adjusted R^2	0.7764	0.7501	0.523	Adjusted R^2	0.6905	0.6403	0.4862	Adjusted R^2	0.7101	0.7414	0.4137
AIC	-6.9956	-7.5176	-6.9059	AIC	-6.6047	-7.4326	-6.7247	AIC	-6.7722	-7.3948	-6.6925
GRS	**3.8215**			GRS	**5.4073**			GRS	1.1644		
PSPR2				**TO2**				**AM2**			
INTERCEPT	-0.0003[c]	0.0001	0.0005[b]	INTERCEPT	-0.0007[a]	0.0002[c]	0.0009[a]	INTERCEPT	-0.0003	0.0000	0.0003
Adjusted R^2	0.8381	0.8195	0.5424	Adjusted R^2	0.8167	0.7949	0.5129	Adjusted R^2	0.7786	0.8134	0.4483
AIC	-7.3171	-7.8418	-6.9462	AIC	-7.1276	-7.9932	-6.7768	AIC	-7.0406	-7.72	-6.7522
GRS	**3.237**			GRS	**6.6228**			GRS	1.262		
PSPR3				**TO3**				**AM3**			
INTERCEPT	-0.0001	0.0001	0.0003	INTERCEPT	-0.0005[a]	0.0003[b]	0.0007[a]	INTERCEPT	0.0000	0.0000	0.0000
Adjusted R^2	0.869	0.8194	0.6045	Adjusted R^2	0.8428	0.7958	0.5508	Adjusted R^2	0.8391	0.8133	0.5632
AIC	-7.5281	-7.8406	-7.0913	AIC	-7.2807	-7.9966	-6.8573	AIC	-7.3591	-7.7188	-6.985
GRS	**1.9002**			GRS	**4.327**			GRS	0.8578		

Table 5.14 (continued)

Panel C: Results from 4th November 2003 to 29th June 2007											
Results of proportional spread portfolios				**Results of turnover rate portfolios**				**Results of illiquidity ratio portfolios**			
Model	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**	**Model**	**Port 1**	**Port 10**	**Diff(10-1)**
CAPM				**CAPM**				**CAPM**			
INTERCEPT	-0.0001	0.0005[b]	0.0005[a]	INTERCEPT	0.0000	0.0003[b]	0.0003[c]	INTERCEPT	-0.0002	0.0005[a]	0.0006[a]
Adjusted R^2	0.8331	0.6087	0.2261	Adjusted R^2	0.7608	0.6551	0.2192	Adjusted R^2	0.7907	0.621	0.2117
AIC	-8.1037	-7.7584	-7.4479	AIC	-7.7948	-8.1382	-7.4748	AIC	-7.878	-7.8907	-7.3638
GRS	**2.6491**			GRS	**2.2897**			GRS	**2.4224**		
F&F				**F&F**				**F&F**			
INTERCEPT	-0.0002	0.0001	0.0003[c]	INTERCEPT	-0.0002	0.0000	0.0002	INTERCEPT	-0.0003[c]	0.0001	0.0004[b]
Adjusted R^2	0.8468	0.829	0.3988	Adjusted R^2	0.8056	0.8435	0.2570	Adjusted R^2	0.8143	0.8266	0.2993
AIC	-8.1874	-8.5839	-7.6983	AIC	-8	-8.9263	-7.5224	AIC	-7.9959	-8.6705	-7.4795
GRS	1.3188			GRS	1.297			GRS	0.8623		
C-F&F				**C-F&F**				**C-F&F**			
INTERCEPT	-0.0002	0.0001	0.0003[c]	INTERCEPT	-0.0002	0.0000	0.0002	INTERCEPT	-0.0003[c]	0.0001	0.0004[b]
Adjusted R^2	0.8471	0.8289	0.3985	Adjusted R^2	0.8055	0.8434	0.2563	Adjusted R^2	0.8145	0.8271	0.2986
AIC	-8.1882	-8.5826	-7.6967	AIC	-7.9985	-8.9246	-7.5204	AIC	-7.9957	-8.6724	-7.4774
GRS	**1.6362**			GRS	1.2942			GRS	1.0563		
PSPR1				**TO1**				**AM1**			
INTERCEPT	0	0.0003[b]	0.0003[b]	INTERCEPT	-0.0001	0.0003[b]	0.0004[b]	INTERCEPT	-0.0001	0.0002[c]	0.0004[b]
Adjusted R^2	0.8399	0.7686	0.5998	Adjusted R^2	0.773	0.7463	0.4668	Adjusted R^2	0.7958	0.7731	0.5058
AIC	-8.1445	-8.2827	-8.1063	AIC	-7.846	-8.4444	-7.8552	AIC	-7.902	-8.4027	-7.8296
GRS	1.5336			GRS	**2.7691**			GRS	0.8985		
PSPR2				**TO2**				**AM2**			
INTERCEPT	-0.0002[c]	0.0001	0.0003[b]	INTERCEPT	-0.0004[a]	0.0001	0.0005[a]	INTERCEPT	-0.0003[c]	0.0001	0.0004[b]
Adjusted R^2	0.8934	0.8386	0.605	Adjusted R^2	0.8621	0.8558	0.4939	Adjusted R^2	0.8664	0.84	0.5219
AIC	-8.5485	-8.6411	-8.1173	AIC	-8.3425	-9.0074	-7.9052	AIC	-8.3241	-8.7503	-7.8608
GRS	**2.0984**			GRS	**5.0286**			GRS	1.3171		
PSPR3				**TO3**				**AM3**			
INTERCEPT	-0.0002	0.0001	0.0003[b]	INTERCEPT	-0.0004[a]	0.0001	0.0004[a]	INTERCEPT	-0.0002[c]	0.0001	0.0004[b]
Adjusted R^2	0.8941	0.8397	0.6123	Adjusted R^2	0.8632	0.8565	0.5005	Adjusted R^2	0.8682	0.8435	0.539
AIC	-8.5542	-8.6469	-8.1349	AIC	-8.349	-9.0112	-7.9173	AIC	-8.3366	-8.7708	-7.896
GRS	**1.8264**			GRS	**5.5136**			GRS	1.0291		

5.5. Summary and conclusions

One critical issue has been investigated over years is the relationship between liquidity risk and asset prices. The empirical evidence of the commonality in the liquidity phenomenon submitted by Chordia et al. (2000) and supported by many others (see, for example, Hasbrouk and Seppi, 2001; Huberman and Halka, 2001) has changed the focus of liquidity research. The change is towards investigating whether aggregate market liquidity risk, rather than the individual stock liquidity risk, is priced in financial markets. Most researchers have concentrated on the US market. Amihud (2002), Pastor and Stambaugh (2003) and Liu (2006), among others, provide evidence that market liquidity risk represents a systematic risk affecting the common variations in stock returns. We examine the same issue in LSE, one of the major capital markets in the world. Consistent with the US evidence, our individual stock analysis shows strong evidence that market liquidity risk is priced in LSE. Evidence of individual stock approach holds for three liquidity measures: the proportional quoted bid-ask spread, the illiquidity ratio of Amihud (2002) and the turnover rate. Market liquidity factor seems to have a larger effect on stock returns than the momentum factor of Carhart (1997). Interestingly, regardless of the liquidity proxy, a model consisting of the three common risk factors of Fama and French (1993), the momentum factor and the market liquidity factor performs best in terms of explaining the variations in stock returns in LSE. This finding is quite different from the US evidence. Liu (2006) documents that a two-factor model of market excess return and market liquidity risk can fully explain the variations of returns of US stocks. Evidence from individual stock approach is robust to the different regression estimation methods. It is also consistent, regardless of whether we assume that the error terms of our regression models follow a normal or a generalised distribution. In contrast, our portfolio analysis is consistent with Martinez et al. (2005) who find that liquidity is priced in the Spanish Stock Exchange only when it is measured by the illiquidity ratio of Amihud (2002). This evidence is time-dependent. Specifically, a three sub-period analysis shows that the evidence that the Amihud (2002) illiquidity ratio is priced exists in the earliest sub-period but disappears in the two following sub-periods. We attribute this finding to the introduction of new trading systems of the FTSEALL share index stocks which may have improved the aggregate market liquidity and reduces investors concerns with the liquidity risk. The results of the portfolio approach are possibly more precise than those of the individual stock approach. Thus, using portfolios and particularly diversification may clear a lot of noise that the individual stocks may have.

This chapter provides evidence that systematic liquidity risk is priced in the UK market. Our results are in line with the US evidence of Pastor and Stambaugh (2003). The important role of the systematic liquidity risk in asset pricing motivates us, in the next chapter, to examine whether this type of risk can explain the short-term anomalous stock price behaviour following large one-day price changes.