Chapter 7

Time-varying Risk and Stock Price Reaction to Large One-day Price Changes

7.1. Introduction

The Capital Asset Pricing Model (CAPM) of Sharp (1964) and Linter (1965) assumes that all investors have common expectations about the mean, variances and covariances of return. However, in a dynamic world, investors may have common but *conditional* expectations on the moments of future return resulting on time-varying rather than constant model parameters. Static asset pricing models exhibit serious pricing errors. Indeed, various anomalies challenge the unconditional versions of the CAPM and its multifactor extension models. Fama and French (1996) argue that their three-factor model can beat the CAPM anomalies such as size, book-to-market, earnings/price, cash flow/price and long-term price reversal. However, it cannot explain the short-term momentum profits. On the other hand, dynamic asset pricing models that allow for time-varying systematic risks are found to perform considerably better than the static models.[1]

Early, in 1978, Fabozzi and Francis suggest that stock beta coefficient varies randomly over time. Similarly, Bollerslev et al. (1988) also find that the covariance matrix of the asset returns is time-varying. These findings have inspired a large

[1] See Hansen and Richard (1987), Dybvig and Ross (1985) and Wu (2002), among others.

number of studies to test and confirm the time-varying nature of expected returns and common risk factors. [1]

A related set of studies concentrate on whether the time-varying risks can explain the momentum and price reversal anomalies. Chan (1988) and Ball and Kothari (1989) find evidence in favour of the market efficiency hypothesis. Particularly, they find that if returns are adjusted for time-varying risks, the abnormal profits of the long-term contrarian strategies of DeBondt and Thaler (1985) disappear. On the other hand, Chordia and Shivakumar (2002) demonstrate that time-varying returns which in turn are predicted by common macroeconomic factors can account for the short-term momentum profits of the Jegadeesh and Titman's (1993) relative strength strategies. Moreover, Wu (2002) develops a conditional version of the Fama and French (1993) three-factor model that can explain the observed short-term momentum and long-term reversal. In contrast, Karolyi and Kho (2004) find that time-varying risk can explain 75%–80% of the momentum profits. Lewellen and Nagel (2006) argue that neither the unconditional CAPM nor the conditional CAPM can explain the momentum profits.

Brown et al. (1988) argue that both the risk and the expected return increase in a systematic manner around major informational surprises. Thus, we argue that these variations may explain the abnormal returns around price shocks. In fact, this thesis is the first to investigate whether time-varying risk can explain the price anomalies

[1] The list includes, among others, Ferson et al. (1987), Bollerslev et al. (1988), Harvey (1989), Shanken (1990), Cochrane (1996), He et al. (1996), Jagannathan and Wang (1996), Ferson and Siegel (1998), Ferson and Harvey (1999), Wang (2003), Ferson et al. (2006) and Ammann and Verhofen (2008).

following large one-day price changes. The findings of Chapter 6 and the growing literature of the time-varying nature of risk and return have motivated us to question whether a conditional version of Carhart's (1997) four-factor model can account for the documented price reversal and momentum puzzles. We argue that these pricing anomalies could result from the poor performance of the static multi-factor asset pricing models used in Chapter 6. Thus, a conditional asset pricing model may resolve these pricing errors and thus support the efficient market hypothesis.

We examine the reaction of the 642 companies of the FTSEALL share index to large one-day shocks. The analysis covers 1^{st} July 1992 to 29^{th} June 2007. In fact, we repeat the same analysis of Chapter 6, but after adjusting stock returns to time-varying risks. Thus, we first examine the short-term reaction of all the stocks of the FTSEALL share index. Next, in order to examine the relative importance of systematic liquidity risk and time-varying risk, we analyse the reaction of the stocks assigned to decile portfolios according to their historical liquidity betas. Consistent with Chapter 6, three liquidity measures are used, reflecting three different aspects of liquidity. These are the proportional quoted bid-ask spread, the illiquidity ratio of Amihud (2002) 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 represents a proxy for the trading activity.

Estimating the time-varying common risk factors can be a difficult task. Several different econometric methods have been used to model the time-varying risk. Kalman filter and bi-variate GARCH models are the most well-known approaches that have been used in the literature. A debate exists on which the best approach to estimate the conditional asset pricing models is. Faff et al. (2000) argue that the three methods, the Kalman filter, the GARCH and the time-varying beta market model approach suggested by Schwert and Seguin (1990), are successful in forecasting time-varying beta. Some studies compare between different specifications of the GARCH model. Franses and Van Dijk (1996) compare the performance of the standard GARCH model and non-linear Quadratic GARCH and GARCH-GJR models for forecasting the volatility of different European stock market indices on a weekly basis. They find evidence in favour of the standard GARCH model. Conversely, Brailsford and Faff (1996) find that the GJR-GARCH model performs better than the standard GARCH model when predicting monthly Australian stock volatility.

In spite of the differences between the various approaches for forecasting time-varying beta, all of them seem complex and difficult to use. Moreover, some of them become problematic when more dynamics are added to the forecasting process (Harris et al., 2007). Therefore, this thesis applies a simple, easy and flexible approach to estimate the time-varying common risk factors. Particularly, we are the first to use the Simplified GARCH model (S-GARCH) of Harris et al. (2007) to estimate time-varying betas. It is based on the estimation of only univariate GARCH models, both for the individual return series and for the sum and difference of each pair of series. The covariance between each pair of return series is then imputed from these variance estimates. Harris et al. (2007) also estimate an asymmetric specification of the S-GARCH model (the AS-GARCH model), which allows for asymmetry in the response of the conditional variances of the two assets and the conditional covariance between them to negative lagged return shocks. Harris et al.

(2007) compare the S-GARCH and the AS-GARCH models to four of the most widely used multivariate GARCH models, namely the diagonal Vech, constant correlation, diagonal BEKK and dynamic conditional correlation models. More specifically, they evaluate the performance of each model both statistically, using a regression of each element of the realised covariance matrix on the corresponding element of the estimated covariance matrix and economically, by estimating the minimum variance hedge ratio for the FTSE100 index portfolio, hedged using index futures.. Harris et al. (2007) find that the S-GARCH and AS-GARCH models perform at least as well as the other models they have considered.

Our findings can be summarised as follows. The reaction of FTSEALL stocks to large one-day price shocks differs dramatically when stock returns are adjusted for time-varying risks. In particular, FTSEALL stocks react efficiently to shocks of 10% and 20% or more and to shocks of -5%, -10% and -20% or less. Only one-day price reversal is documented following shocks of 5% or more. Thus, time-varying risk plays a key role in explaining the documented price reversal and return continuation anomalies following large one-day price shocks. In fact, it explains most of them. Time-varying risk is reported to be more important than systematic liquidity risk in explaining the price reaction of the stocks of different liquidity portfolios. Regardless of liquidity measures, most of the stocks of the liquid and illiquid portfolios exhibit no significant CAARs following both positive and negative shocks after their returns are adjusted to time-varying risks. A few portfolios display price reversal following positive shocks. The stocks in the least liquid portfolio underreact to the negative large one-day shocks. Overall, the conditional four-factor model of Carhart (1997) and the conditional version of the same model augmented with the systematic liquidity risk factor are superior in explaining the variations of FTSEALL stock returns than their static versions. These finding are robust to different periods of time and different specifications of the GARCH model.

The remainder of this chapter is organised as follows. Section 7.2 presents our methodology, Section 7.3 reports our empirical findings and Section 7.4 concludes on the main results.

7.2. Methodology

Various econometric methods are used to estimate time-varying coefficients. The most widely used approaches are the multivariate GARCH models and the Kalman filter[1] which is an efficient filtering process that estimates the state of a linear dynamic system from a series of noisy measurements. In particular, it estimates the conditional covariance series from an initial set of priors. On the other hand, the multivariate GARCH models apply the conditional variance information in order to create the conditional covariance series. Both approaches are complex and onerous. In some cases, when the number of parameters to be estimated simultaneously is large, multivariate GARCH models become problematic (Harris et al., 2007). In particular, the maximum likelihood estimation of the multivariate GARCH models may suffer from convergence problem, especially when the models are extended to incorporate more complicated dynamics, asymmetric terms and dummy variables.

[1] Examples of papers using GARCH models are Bollerslev et al. (1988), Engle and Rodrigues (1989), Ng (1991), Bodurtha and Mark (1991), Koutmos et al. (1994), Giannopoulos (1995), Braun et al. (1995), Gonzalez-Rivera (1996), Yun (2002) and Bali (2008). Similarly, many authors use the Kalman filter to estimate time-varying coefficients such as Black et al. (1992), Well (1994), Huang and Hueng (2008) and Adrian and Franzoni (2008).

In order to conquer these computational difficulties, Harris et al. (2007) suggest a simplified multivariate GARCH model (S-GARCH). The S-GARCH is based on estimating only univariate GARCH models for the individual return series and for the sum and differences of each pair of series. The conditional covariance between each pair of return series is then calculated from these conditional variances. Indeed, the S-GARCH effectively simplifies the estimation of time-varying coefficients. It is an easy, straightforward and flexible approach to use. It does not suffer from the convergence problem. The S-GARCH can be extended to take account of the more complex dynamics using alternative forms of GARCH models. On the other hand, unlike other approaches, the S-GARCH does not impose restrictions on the correlation coefficient between the return series. In the S-GARCH model, the covariance between two return series depends on the history of both their covariance and individual variances.

7.2.1. CAARs of time-varying C-F&F model

We begin our analysis by estimating the average cumulative abnormal returns (CAARs) of FTSEALL share index stocks following large one-day price shocks after adjusting their returns to *time-varying* common risk factors. Thus, we estimate a conditional version of the four-factor model of Carhart (1997) (C-F&F) for each of the constituents of FTSEALL share index over the period 1st July 1992 to 29th June 2007:

$$r_{i,t} = C_i + \beta_{mkt,i,t} MKT_t + \beta_{hml,i,t} HML_t + \beta_{smb,i,t} SMB_t + \beta_{mom,i,t} MOM_t + \varepsilon_{i,t} \qquad (7.1)$$

where $r_{i,t}$ is the excess return of stock i on day t. C_i is a stock-specific constant. MKT_t is the excess market rate of return. HML_t is the High Minus Low factor of Fama and French (1993) which represents the return difference between value and growth stocks. SMB_t is the Small Minus Big factor of Fama and French (1993) which represents the return difference between small- and large-sized stocks. MOM_t is the momentum factor of Carhart (1997), defined as the return difference between stocks with high prior returns and stocks with low prior returns. $\beta_{mkt,i,t}$, $\beta_{hml,i,t}$, $\beta_{smb,i,t}$ and $\beta_{mom,i,t}$ are the time-varying beta coefficients of stock i on day t. $\varepsilon_{i,t}$ is the residual (error term) of stock i on day t.

The estimation process includes the estimation of each time-varying beta separately. The estimation of the time-varying $\beta_{mkt,i,t}$ is as follows:

1. We estimate the conditional variance of the MKT_t series using the following uni-variate GARCH equation:

$$\sigma_{MKT,t}{}^2 = \beta_0 + \beta_1 \sigma_{MKT,t-1}{}^2 + \beta_2 \varepsilon_{MKT,t-1}{}^2 \quad (7.2)$$

2. We construct the sum series $S_{i,t} = r_{i,t} + MKT_t$ and the difference series $D_{i,t} = r_{i,t} - MKT_t$.

3. We estimate the conditional variances of both the sum and difference series using the equations of the uni-variate GARCH model:

$$\sigma_{S,t}{}^2 = \beta_0 + \beta_1 \sigma_{S,t-1}{}^2 + \beta_2 \varepsilon_{S,t-1}{}^2 \quad (7.3)$$

$$\sigma_{D,t}{}^2 = \beta_0 + \beta_1 \sigma_{D,t-1}{}^2 + \beta_2 \varepsilon_{D,t-1}{}^2 \quad (7.4)$$

4. The conditional covariance can then be estimated according to the following formula:

$$\mathrm{cov}_{i,t} = .25 * (\sigma_{S,t}{}^2 - \sigma_{D,t}{}^2) \quad (7.5)$$

5. Finally, the time-varying beta $\beta_{mkt,i,t}$ is given by the following equation:

$$\beta_{mkt,i,t} = \frac{\text{cov}_{i,t}}{\sigma_{MKT,t}^{2}} \quad (7.6)$$

The estimation of the other time-varying betas follows the same procedures.

After that, we construct the series of the daily S-GARCH-based abnormal returns for each stock as follows:

$$AR_{i,t} = r_{i,t} - \left(\alpha_i + \beta_{mkt,i,t} MKT_t + \beta_{hml,i,t} HML_t + \beta_{smb,i,t} SMB_t + \beta_{mom,i,t} MOM_t\right) \quad (7.7)$$

where $AR_{i,t}$ is the abnormal return of stock i on day t.

Consistent with Chapter 6, we define the days of positive price shocks as the days on which abnormal return is equal to or above 5%, 10% and 20%. On the other hand, the days on which abnormal return is equal to or under -5%, -10% and -20% are considered as the days of negative price shocks. To avoid any confounding effects, we consider only one shock within a range of 10 days.

Next, we calculate the S-GARCH-based cumulative abnormal returns $CAR_{i,d}$ for stock i over a window of d days starting one day after a shock as:

$$CAR_{i,d} = \sum_{t=1}^{d} AR_{i,t} \quad (7.8)$$

The cumulative abnormal returns are calculated for up to 10 days after a price shock. The S-GARCH-based average cumulative abnormal return associated with N stocks over a window of d days following a shock is calculated as:

$$CAAR_d = \frac{\sum_{i=1}^{N} CAR_{i,d}}{N} \quad (7.9)$$

The significance of the $CAAR_d$ is assessed using the Newey-West t-statistic.

7.2.2. CAARs of stocks in liquidity sorted portfolios

We estimate the relative importance of systematic liquidity risk and time-varying risk in explaining the abnormal returns of FTSEALL stocks following a large one-day price shock. At 1st July each year starting from 1992, we estimate the historical liquidity beta of each stock in the sample, using the most recent five years daily return data. The model that is estimated consists of the three common risk factors of Fama and French (1993), the momentum factor of Carhart (1997) and a mimicking liquidity factor constructed following Liu (2006). The mimicking liquidity factor is defined as the payoff from taking a long position on the most liquid portfolio and a short position on the least liquid portfolio. The Ordinary Least Squares (OLS) is used as an estimator with the Newey-West HAC Standard Errors & Covariance to account for serial correlation and heteroskedasticity. After the estimation is completed, we sort stocks according to their historical liquidity betas and assign them to decile portfolios. The process is repeated annually. We use three liquidity measures, the proportional bid-ask spread, the turnover rate and the Amihud (2002) illiquidity ratio. Thus, we do three different sorts according to each of the three liquidity measures. Next, we use equations (7.7) and (7.8) to calculate the S-GARCH-based abnormal returns $AR_{i,t}$ and cumulative abnormal returns $CAR_{i,d}$ of each stock in each portfolio. The S-GARCH-based average cumulative abnormal return on a certain day over the entire study period is calculated for each portfolio separately.

7.2.3. CAARs of time-varying liquidity augmented asset pricing models

We incorporate the time-varying systematic liquidity risk to the conditional version of the Carhart's (1997) model and investigate whether the resulting conditional liquidity augmented model can *fully* explain the abnormal returns following the one-day price shocks. Hence, the S-GARCH-based abnormal returns are defined as the residuals from the following model:

$$AR_{i,t} = r_{i,t} - (\alpha_i + \beta_{mkt,i,t} MKT_t + \beta_{hml,i,t} HML_t + \beta_{smb,i,t} SMB_t + \beta_{mom,i,t} MOM + \beta_{liq,i,t} LIQ_t) \quad (7.10)$$

where LIQ_t is a mimicking market liquidity factor measured using proportional quoted bid-ask spread ($PSPR_t$), turnover rate (TO_t) and Amihud's (2002) illiquidity ratio (AM_t). It is constructed following Liu (2006). $\beta_{liq,i,t}$ is the time-varying liquidity beta estimated using the S-GARCH approach described in Section 7.2.1.

Next, we replicate the whole analysis in Section 7.2.2 using the newly estimated abnormal returns. If time-varying systematic liquidity risk factor can *fully* explain the abnormal returns following the one-day price shocks, then no significant CAARs should be found for all stocks in all portfolios after considering this factor. In line with Chapter 6, we also use the Wilcoxon Signed Rank test (WSRT) to examine whether the CAARs before and after incorporating the time-varying systematic liquidity factor are significantly different.

7.3. Empirical findings

7.3.1. S-GARCH-based CAARs of FTSEALL stocks

This chapter analyses the reaction of the constituents of FTSEALL share index to large one-day price shocks after adjusting their returns to *time-varying* common risk factors. The analysis covers 1st July 1992 to 29th June 2007. Consistent with Chapter 6, we include only the stocks that have continuing returns on an annual basis. Thus, the total number of stocks studied is between 270 stocks in 1992 and 520 stocks in 2007. Table 7.1 presents the average CAARs of all the FTSEALL share index stocks following shocks of 5% (-5%), 10% (-10%) and 20% (-20%) or more (less), adjusted for time-varying risks. Obviously, the number of these shocks is much higher than their comparable ones in Chapter 6. The total numbers of shocks that equal 5%, 10% and 20% or more are 23920, 8062 and 2919, respectively. On the other hand, the total numbers of shocks that equal -5%, -10% and -20% or less are 21507, 7622 and 2912, respectively. The number of positive shocks is larger than the number of negative shocks.

Table 7.1 shows clear evidence in favour of the efficient market hypothesis when time-varying risk is considered. FTSEALL stocks react efficiently following shocks of 10% and 20% or more and following shocks of -5%, -10% and -20% or less. No significant CAARs are observed up to 10 days following these large one-day price shocks. Thus, allowing common risk factors to vary over time has mostly eliminated the CAARs. In other words, time-varying risk resolves the momentum and reversal puzzles following large one-day price shocks. Indeed, these two anomalies documented in Chapter 6 reflect the failure of the static asset pricing models to describe the cross-section of stock returns.

Table 7.1

S-GARCH-based CAARs of FTSEALL share index stocks

This table presents time-varying risk adjusted average cumulative abnormal returns of 642 constituents of the FTSEALL share index stocks following large one-day shocks. Analysis covers 1st July 1992 to 29th June 2007. Abnormal returns represent the residuals of the conditional version of the Carhart (1997) four-factor model. Time-varying coefficients are estimated using the S-GARCH of Harris et al. (2007). CAARs are calculated annually and only stocks with continuing returns throughout estimation period are considered. Positive shocks are defined as abnormal returns of 5%, 10% and 20% or more. Negative shocks are defined as abnormal returns of -5%, -10% and -20% or less. If two shocks happen within ten successive days, one of them is ignored to avoid confounding effects. $CAAR^{t}$ is average cumulative abnormal return on a certain day (t) averaged over entire study period. Level of significance of CAARs is estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level.

Shocks	# of Shocks	CAAR0	CAAR1	CAAR2	CAAR3	CAAR4	CAAR5	CAAR6	CAAR7	CAAR8	CAAR9	CAAR10
Shock (5%)	23920	0.1103[a]	-0.0037[b]	-0.0026	-0.0049	-0.0063	-0.0037	0.0025	0.0049	0.0039	0.0042	0.0053
Shock (-5%)	21507	-0.1256[a]	0.0020	0.0048	0.0094	0.0081	0.0004	0.0024	0.0019	0.0013	0.0162	0.0204
Shock (10%)	8062	0.2473[a]	0.0053	0.0380	0.0282	0.0291	0.0336	0.0383	0.0402	0.0426	0.0439	0.0460
Shock (-10%)	7622	-0.2466[a]	-0.0024	0.0112	0.0228	-0.0140	-0.0392	-0.0423	-0.0034	0.0029	0.0081	0.0130
Shock (20%)	2919	0.6717[a]	0.0539	0.0350	0.0088	0.0083	0.0092	0.0036	0.0069	0.0196	0.0159	0.0202
Shock (-20%)	2912	-0.5580[a]	0.0454	0.0769	0.0644	0.0553	0.0185	-0.0015	0.0089	0.0014	0.0121	0.0161

7.3.2. S-GARCH-based CAARs of stocks in liquidity sorted portfolios

This section investigates whether the time-varying risk can explain the anomalous reaction documented in Chapter 6, of the stocks of the liquidity portfolios to large one-day price shocks. Previous studies confirm the time-varying nature of risk and return (see, for example, Fabozzi and Francis, 1978; Bollerslev et al., 1988; Wang, 2003; Ferson et al., 2006; Ammann and Verhofen, 2008). Chan (1988), Ball and Kothari (1989), Chordia and Shivakumar (2002) and Wu (2002) are among the studies that explain overreaction and underreaction of winner and loser portfolios by the poor performance of the static asset pricing models. Indeed, those researchers claim that time-varying risk is the most important source of momentum and reversal profits documented by Jegadeesh and Titman (1993) and DeBondt and Thaler (1985), respectively. Brown et al. (1988) find that major informational surprises increase both the risk and the expected return in a systematic manner. Motivated by the findings of those researchers, we expect that time-varying risk may explain the abnormal returns following large one-day price changes**.** Thus, the static nature of the models used in Chapter 6 may explain the observed price anomalies. We sort the sample stocks according to their historical liquidity betas and assign them to decile portfolios. Port 1 is the most liquid portfolio whereas Port 10 is the least liquid. Thereafter, we examine the reaction of the stocks of these portfolios to large one-day price shocks after adjusting their returns for the time-varying risk. We sort the stocks according to three different liquidity measures, the proportional bid-ask spread, the turnover rate and the Amihud (2002) illiquidity ratio.

Table 7.2 reports the number of shocks of the stocks in the liquidity beta sorted portfolios. Specifically, it shows the number of shocks for Port 1, the most liquid portfolio and Port 10, the least liquid (results of remaining Ports 2 to 9 are reported in Appendix C.1). Panel A of Table 7.2 shows the total number of shocks for the stocks in the proportional spread portfolios after adjusting their returns to time-varying risk. Consistent with Chapter 6, we find that the number of both positive and negative shocks is larger for least liquid portfolios than for most liquid. For example, Port 1, the most liquid portfolio, displays 685 shocks of 10% or more over the entire study period. On the other hand, Port 10, the least liquid, exhibits 1701 shocks of 10% or more over the entire study period. Moreover, at all trigger values, the number of positive shocks is larger than the number of negative shocks.

Panel B of Table 7.2 presents the total number of shocks for the stocks in the turnover rate portfolios after adjusting their returns to time-varying risk. The results are consistent with those in Chapter 6. Over the entire study period, Ports 1 and 10 show the highest number of shocks at all trigger values. For instance, the number of shocks of 5% or more for Ports 1 and 10 are 3928 and 2969, respectively. However, the number of comparable shocks for Port 5 is 1870. The reason, as we have explained in Chapter 6, is that Port 1 includes the stocks with the highest negative liquidity betas, while Port 10 consists of the stocks with the highest positive liquidity betas. As a result, both portfolios will react strongly but conversely to the change in the overall market turnover rate. The strong reaction of these two extreme portfolios makes their number of shocks higher than the portfolios in the middle.

The total numbers of shocks for the stocks in the illiquidity ratio portfolios after adjusting for the time-varying risk are reported in Panel C of Table 7.2. These numbers are consistent with those of Panel B. Both Ports 1 and 10 exhibit the largest number of shocks at all trigger values. However, the middle portfolios display the lowest number of shocks. For example, the numbers of shocks of -5% or less for Ports 1 and 10 are 3112 and 3283, respectively. Nevertheless, the number of comparable shocks for Port 5 is 1580.

Table 7.2

Numbers of shocks of stocks in liquidity beta sorted portfolios

This table presents total number of one-day price shocks of the FTSEALL share index stocks which in turn are assigned to decile portfolios according to historical liquidity beta. Analysis covers 1st July 1992 to 29th June 2007. Positive shocks include price change equal to or above 5%, 10% and 20%. Negative shocks include price change equal to or under -5%, -10% and -20%. Port denotes portfolio. Panel A presents results of portfolios sorted according to historical liquidity beta when liquidity is measured by proportional bid-ask spread. Panel B reports results of portfolios sorted according to historical liquidity beta when liquidity is measured by turnover rate. Panel C shows results of portfolios sorted according to historical liquidity beta when liquidity is measured by Amihud's (2002) illiquidity ratio.

Panel A: Results of proportional spread portfolios						
Port	**5%**	**-5%**	**10%**	**-10%**	**20%**	**-20%**
Port 1	2383	2219	685	675	202	219
Port 10	4092	3793	1701	1532	641	620
Panel B: Results of turnover rate portfolios						
Port	**5%**	**-5%**	**10%**	**-10%**	**20%**	**-20%**
Port 1	3928	3546	1380	1313	403	435
Port 10	2969	2717	1150	1047	470	440
Panel C: Results of illiquidity ratio portfolios						
Port	**5%**	**-5%**	**10%**	**-10%**	**20%**	**-20%**
Port 1	3405	3112	1082	1032	315	326
Port 10	3479	3283	1364	1267	512	501

7.3.2.1. Proportional bid-ask spread portfolios

Panel A of Table 7.3 reports the S-GARCH-based CAARs of the stocks in the proportional spread Ports 1 and 10, following positive shocks (results of remaining proportional spread Ports 2 to 9 are reported in Appendix C.2). The shocks of 5% or more are significant for all portfolios and larger than their comparable values in Chapter 6. They range from 9.4% for Port 2 to 12.3% for Port 10. Panel A provides evidence of the failure of the four-factor static model used in the previous chapter to explain the variations of stock returns. Indeed, the results differ dramatically when the stock returns are adjusted for time-varying risk. The most liquid portfolios, namely Ports 2 and 4, exhibit significant price reversal following shocks of 5% or more. However, allowing for time-varying risk has totally eliminated the CAARs for the least liquid portfolios. While Ports 9 and 10 exhibit a significant return continuation under the static four-factor model, they show efficient reaction to the 5% or more shocks in Panel A of Table 7.3. These findings corroborate the asymmetric reaction of the most and least liquid portfolios to large one-day price changes, but at the same time confirm the importance of the time-varying risk in explaining the momentum payoffs. Figure 7.1 shows the S-GARCH-based CAARs of the stocks of the proportional spread portfolios following shocks of 5% or more.

The results of the shocks of 10% or more are very similar to those of the smaller shocks. All the shocks of 10% or more are significant and larger than their analogous values in Chapter 6. The values of these shocks are between 20.6% for Port 1 and 29.4% for Port 6. Ports 2, 4 and 7 display significant price reversal following shocks of 10% or more. For example, Port 4 realises significant CAAR of -2.47% three days after the shock. In contrast, Ports 8, 9 and 10, the least liquid portfolios, react efficiently to these shocks. Once again, the results are different from their comparable ones in Chapter 6. Thus, the conditional four-factor model performs substantially better than its static version in explaining the variations of stock returns.

The results of the 20% or more shocks are also similar to those of the smaller shocks. Shocks of 20% or more are significant, ranging from 47.5% for Port 3 to 147% for Port 9. Again these values are larger than their comparable counterparts in Chapter 6. Ports 4 and 7 show significant price reversals that continue for 10 days following shocks of 20% or more. Port 2 breaks its price reversal pattern in one day after these shocks. On the other hand, the least liquid portfolios, Ports 8, 9 and 10, do not display any significant CAARs up to 10 days following shocks of 20% or more. Overall, the analysis demonstrates that the static four-factor model used in Chapter 6 over-estimates the stock returns. In general, the most liquid portfolios display efficient reaction following positive shocks before adjusting for time-varying risk. However, some of them show negative CAARs when their returns are adjusted to time-varying risk. Conversely, the least liquid portfolios exhibit significant return continuation under the static four-factor model, whereas no significant CAARs are documented after allowing for time-varying risk. Thus, time-varying risk does matter when considering the reversal and momentum anomalies following large one-day shocks.

Panel A of Table 7.4 reports CAARs of the stocks in the proportional spread Ports 1 and 10, following negative shocks (results of remaining proportional spread Ports 2 to 9 are reported in Appendix C.3). Shocks of -5% or less are between -9.5% for

Port 3 and -24.7% for Port 6. Although all these shocks are statistically significant, they show higher values but lower levels of significance than their analogous ones in Chapter 6. Most of the portfolios react efficiently to shocks of -5% or less. Thus, allowing for time-varying risk, most of the CAARs following the large one-day decline are eliminated. However, Port 10, the least liquid portfolio, exhibits significant CAAR on day 1 following these shocks. In fact, compared with Chapter 6, Port 10 exhibits significant momentum following shocks of -5% or less, regardless of whether a static or a conditional asset pricing model is used to estimate its CAARs. This confirms that the most and least liquid portfolios react differently to shocks even after considering the time-varying nature of common risk factors. Figure 7.4 shows the S-GARCH-based CAARs of the stocks of the proportional spread portfolios following shocks of -5% or less.

Shocks of -10% or less are all significant, ranging from -21.9% for Port 3 to 29.0% for Port 7. The results differ slightly from those of -5% or less shocks. While the behaviour of most of the portfolios supports the market efficiency hypothesis, Ports 2 and 4 shows significant price reversal for several days after shocks of -10% or less. Port 10 achieves a significant CAAR of -3.77% on day 1. Once again, the time-varying risk cannot explain the momentum of this least liquid portfolio. Overall, the asymmetric reaction of the most and least liquid portfolios is still there, even when a conditional four-factor model is used. This is evidence of the role of the systematic liquidity risk in explaining the price anomalies.

Shocks of -20% or less are all statistically significant. The smallest shock is 47.4% for Port 5 and the largest is 63.2% for Port 7. The results are the opposite of their analogous ones in Chapter 6. The most liquid portfolios, Ports 1 and 2, react efficiently to shocks of -20% or less under the static four-factor model. However, they show a significant overreaction when CAARs are adjusted to time-varying risk. The least liquid portfolio, Port 10, shows no significant CAARs in Panel C when a conditional asset pricing model is used. Yet it exhibits a significant reversal when unconditional returns are considered. This contrast affords evidence of the misleading behaviour of static stock returns and simultaneously of the important function that time-varying risk plays.

7.3.2.2. Turnover rate portfolios

Panel B of Table 7.3 reports the S-GARCH-based CAARs of the stocks in the turnover rate Ports 1 and 10, following positive shocks (results of remaining turnover rate Ports 2 to 9 are reported in Appendix C.4). The 5% or more shocks are all significant, ranging from 9.6% for Port 4 to 13.1% for Port 8. Again, these shocks are larger than their analogous ones in Chapter 6. The results are similar to those in Panel A of Table 7.3 when liquidity is measured by proportional bid-ask spread. However, they are dramatically different from their comparable ones in Chapter 6. Allowing for time-varying risk has cleared up the momentum anomaly documented in Chapter 6. Hence, Panel B of Table 7.3 shows that the stocks of most portfolios react efficiently to shocks of 5% or more. Stocks of Ports 3, 6 and 8 exhibit significant price reversals following these shocks. These results confirm the importance of time-varying risk in explaining the variations of stock returns.

Shocks of 10% or more are all significant, ranging from 20.0% for Port 1 to 37.5% for Port 6. They are much larger than the comparable ones in Chapter 6. The results are consistent with those of smaller shocks. All portfolios show significant momentum when a static asset pricing model is applied in Chapter 6. However, the overall picture is changed when a conditional asset pricing model is used to calculate the CAARs. Panel B of Table 7.3 shows that after adjusting for the time-varying risk, the stocks of most turnover rate portfolios react efficiently to shocks and only the stocks of a few portfolios overreact. Figure 7.2 shows the S-GARCH-based CAARs of the stocks of the turnover rate portfolios following shocks of 10% or more.

Not all shocks of 20% or more are significant. Port 9 exhibits the largest but insignificant shock of 157%. The results are generally in line with the previous analysis. The stocks of Ports 5, 6 and 7 display significant price reversal following shocks of 20% or more. However, the reversal pattern of Port 7 breaks on day 1 after these shocks. All the stocks in the other portfolios react in an efficient manner to shocks of 20% or more, supporting the efficient market hypothesis. Overall, evidence sheds light on the weight of the time-varying risk in explaining the momentum puzzle following positive one-day shocks documented in Chapter 6. The time-varying risk seems to be more essential in explaining the variations of stock returns than the systematic liquidity risk.

Panel B of Table 7.4 reports the S-GARCH-based CAARs of the stocks in the turnover rate Ports 1 and 10, following negative shocks (results of remaining turnover rate Ports 2 to 9 are reported in Appendix C.5). All shocks of -5% or less are significant and larger than their comparable ones in Chapter 6. The smallest shock is -9.8% for Port 4 and the largest is -26.9% for Port 7. The price reaction following negative shocks brings back the importance of the systematic liquidity risk. There is an asymmetry between the reactions of the most and least liquid portfolios. The most liquid portfolios exhibit no significant CAARs following shocks of -5% or less, presenting evidence in favour of the market efficiency hypothesis. Time-varying risk factors can fully explain the variations of stock returns of all portfolios except Ports 7 and 10. The stocks of Port 7 show significant price reversal that accumulates to a S-GARCH-based CAAR value of 1.87% on day 4. However, Port 10, the least liquid portfolio, shows a significant return continuation on day 1 with a S-GARCH-based CAAR value of -1.58%.

Shocks of -10% or less are significant and are between -19.7% for Port 1 and -29.3% for Port 6. The results are consistent with those of smaller shocks. Price anomalies of the stocks in most of the turnover rate portfolios can be attributed to time-varying risk. Thus, most portfolios exhibit efficient reaction shocks of -10% or less. However, the stocks of Port 10, the least liquid portfolio, underreact to these shocks, causing a significant return continuation on day 1 following shocks of -10% or less. Hence, the significance of the S-GARCH-based CAARs of Port 10 is limited to day 1 and the momentum breaks much quicker than the cases in which we do not adjust for the time-varying risk. This indicates that time-varying risk does a good job in explaining the variations of stock returns, but it cannot *fully* account for the documented anomalies. Figure 7.5 shows the S-GARCH-based CAARs of the stocks of the turnover rate portfolios following shocks of -10% or less.

All shocks of -20% or less are significant, ranging from -41.2% for Port 1 to -65.9% for Port 6. In contrast with the results of the smaller shocks, the evidence indicates that time-varying common risk factors can *fully* explain the momentum and reversal anomalies following shocks of -20% or less. The stocks of all portfolios, with no exception, react efficiently to shocks of -20% or less. Thus, both liquid and illiquid portfolios provide evidence in favour of the market efficiency hypothesis. The evidence also tells a story about the success of the conditional four-factor model to account for the serious pricing errors of its static version.

7.3.2.3. Illiquidity ratio portfolios

Panel C of Table 7.3 reports the S-GARCH-based CAARs of the stocks in the illiquidity ratio Ports 1 and 10, following positive shocks (results of remaining illiquidity ratio Ports 2 to 9 are reported in Appendix C.6). All the 5% or more shocks are significant and higher than their analogous shocks in Chapter 6. The values of the shocks range from 10.4% for Port 1 and 12.1% for Port 5. These results are robust to other liquidity measures. However, the results reported in this section differ radically from their counterparts in Chapter 6. The findings of Chapter 6 confirm the momentum anomaly following positive shocks of 5% or more. On the other hand, time-varying risk totally clears up this anomaly. The most liquid Ports, 2, 3 and 4, demonstrate significant patterns of price reversal following shocks of 5% or more, whereas all the other portfolios react efficiently to shocks.

The results following shocks of 10% or more are consistent with those following the smaller shocks. Shocks of 10%, or more, range from 22.5% for Port 1 to 32.2% for Port 7. In particular, the vital task of the time-varying risk in explaining the variations of stock returns is apparent. All the portfolios react efficiently to shocks of 10% or more, except Ports 3, 4 and 7 which overreact to these shocks. These results are totally different from the comparable results in Chapter 6. Thus, when the static rather than the conditional four-factor model is applied, the least liquid portfolio exhibits a significant return continuation.

Shocks of 20% or more are not all statistically significant. Port 7 exhibits the largest, but statistically insignificant shock of 190%. All other shocks are significant. In line with the results of the smaller shocks, time-varying common risk factors do fully explain the variations of stock returns for nearly all portfolios. Hence, most of the S-GARCH-based CAARs of the stocks in most portfolios are not significantly different from zero across the ten day window following shocks. This evidence supports the market efficiency hypothesis. In other words, the anomalies documented in the previous chapter are nothing other than pricing errors resulting from the malfunction of the static asset pricing model. This is consistent with Fama (1998) who argues that model misspecification results in estimation errors and, in turn, emphasises the observed price anomalies. Figure 7.3 shows the S-GARCH-based CAARs of the stocks of the illiquidity ratio portfolios following shocks of 20% or more.

Panel C of Table 7.4 reports the S-GARCH-based CAARs of the stocks in the illiquidity ratio Ports 1 and 10, following negative shocks (results of remaining illiquidity ratio Ports 2 to 9 are reported in Appendix C.7). The -5% or less shocks are between -9.7% for Port 2 and -21.5% for Port 9. All of them are significant. The portfolio's reaction to the negative shocks confirms the power of the conditional four-factor model in explaining both the momentum and reversal anomalies reported in Chapter 6. Specifically, all the portfolios absorb shocks of -5% or less immediately. Thus, both liquid and illiquid portfolios react efficiently to these shocks.

All the shocks of -10% or less are significant, ranging from -19.8% for Port 1 and 29.2% for Port 5. The results of these shocks are consistent with the results of the smaller shocks. Most of the portfolios respond in an efficient manner to shocks of -10% or less. The one exception is Port 4 which reverses the loss one day after the shock with a S-GARCH-based CAAR of 3.61%. The subsequent CAARs are not significant, however. Taken as a whole, the results suggest that time-varying risk explains more of the observed price reaction anomaly than the systematic liquidity risk.

Shocks of -20% or less are significant and range from -43.7% for Port 1 to -61.9% for Port 8. The stocks in all portfolios, regardless of whether they are liquid or not, react efficiently to shocks of -20% or less. Hence, the documented overreaction and underreaction in Chapter 6 can be attributed to the time-varying risks. We argue that these anomalies are not puzzles anymore and are caused by the poor performance of the static asset pricing models. That is, when a conditional version of the four-factor model rather than a static one is applied, no significant CAARs are found following large one-day changes. Figure 7.6 shows the S-GARCH-based CAARs of the stocks of the illiquidity ratio portfolios following shocks of -20% or less.

Table 7.3

S-GARCH-based CAARs of stocks in liquidity beta sorted portfolios following positive shocks

This table presents time-varying risk adjusted average cumulative abnormal returns of stocks of decile portfolios sorted according to historical liquidity beta following positive shocks of 5%, 10% and 20% or more. Liquidity is measured by 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 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 the model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking liquidity factor constructed following Liu (2006). After estimation, we sort stocks according to their historical liquidity betas and assign them to decile portfolios, held for the following 12 months. The process is repeated annually. Each decile portfolio includes 27 to 52 stocks. Portfolio1 represents most liquid portfolio while portfolio10 is least liquid portfolio. Abnormal returns for each stock in each portfolio represent the residuals of the conditional version of the Carhart (1997) four-factor model. Time-varying coefficients are estimated using the S-GARCH approach of Harris et al. (2007). CAARs are calculated annually and only stocks with continuing returns throughout estimation period are considered. Shocks are defined as abnormal returns of 5%, 10% and 20% or more. If two shocks happen within ten successive days, one of them is ignored to avoid confounding effects. $CAAR_d$ is average cumulative abnormal return after (d) days following shock averaged over entire study period and over all stocks in portfolio. *Port* denotes portfolio. Level of significance of CAARs is estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level. Panel A presents S-GARCH-based CAARs of stocks in proportional spread portfolios. Panel B presents S-GARCH-based CAARs of stocks in turnover rate portfolios. Panel C presents S-GARCH-based CAARs of stocks in illiquidity ratio portfolios.

Panel A: S-GARCH-based CAARs of stocks in proportional spread portfolios											
S-GARCH-based CAARs following shocks of 5% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.0974[a]	-0.0012	0.0026	-0.0006	0.0027	0.0066	0.0075	0.0026	0.0051	0.0091	0.0089
Port 10	0.1229[a]	-0.0018	0.0125	-0.0100	-0.0109	-0.0101	0.0056	0.0234	0.0188	0.0096	0.0119
S-GARCH-based CAARs following shocks of 10% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.2061[a]	0.0094	-0.0106	0.0132	0.0123	0.0221	0.0259	0.0235	0.0328	0.0331	0.0411
Port 10	0.2466[a]	0.0623	0.1254	0.0558	0.0578	0.0616	0.0599	0.0592	0.0714	0.0635	0.0812
S-GARCH-based CAARs following shocks of 20% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.4820[a]	0.0145	-0.0419	0.0325	0.0230	0.0306	0.0393	0.0423	0.0715	0.0662	0.1016
Port 10	0.6474[a]	0.1675	0.2736	0.1556	0.1264	0.1111	0.1187	0.1046	0.1381	0.1075	0.1448

Table 7.3 (continued)

Panel B: S-GARCH-based CAARs of stocks in turnover rate portfolios											
S-GARCH-based CAARs following shocks of 5% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.0986[a]	-0.0011	0.0011	0.0012	0.0051	0.0100	0.0146[b]	0.0152[c]	0.0179[b]	0.0165[b]	0.0134
Port 10	0.1271[a]	0.0011	0.0014	-0.0261	-0.0300	-0.0253	-0.0036	0.0283	0.0383	0.0294	0.0301
S-GARCH-based CAARs following shocks of 10% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.1997[a]	0.0014	-0.0064	0.0008	0.0020	0.0095	0.0192	0.0282	0.0387	0.0389	0.0372
Port 10	0.2818[a]	0.1089	0.1486	0.0712	0.0693	0.0801	0.0699	0.0751	0.0999	0.0912	0.1154
S-GARCH-based CAARs following shocks of 20% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.4740[a]	0.0682	0.0751	0.1189	0.1092	0.1095	0.1198	0.1305	0.1353	0.1395	0.1476
Port 10	0.6193[a]	0.2293	0.3498	0.2417	0.2071	0.1908	0.1962	0.1697	0.2284	0.2258	0.2541
Panel C: S-GARCH-based CAARs of stocks in illiquidity ratio portfolios											
S-GARCH-based CAARs following shocks of 5% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.1037[a]	-0.0017	0.0023	-0.0031	-0.0005	0.0018	0.0042	0.0045	0.0138	0.0147	0.0135
Port 10	0.1166[a]	-0.0001	0.0011	-0.0267	-0.0297	-0.0207	-0.0242	-0.0266	-0.0393	-0.0447	-0.0383
S-GARCH-based CAARs following shocks of 10% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.2252[a]	0.0068	-0.0014	-0.0072	-0.0089	-0.0059	0.0021	0.0108	0.0398	0.0382	0.0406
Port 10	0.2456[a]	0.0050	-0.0078	-0.0816	-0.0853	-0.0601	-0.0587	-0.0559	-0.0956	-0.1082	-0.0910
S-GARCH-based CAARs following shocks of 20% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.5341[a]	0.0381	0.0441	0.0619	0.0468	0.0500	0.0516	0.0606	0.1447	0.1373	0.1427
Port 10	0.5909[a]	0.0317	-0.0066	-0.1093	-0.1430	-0.1548	-0.2406	-0.2484	-0.2502	-0.2996[c]	-0.2595

Table 7.4

S-GARCH-based CAARs of stocks in liquidity beta sorted portfolios following negative shocks

This table presents time-varying risk adjusted average cumulative abnormal returns of stocks of decile portfolios sorted according to historical liquidity beta following negative shocks of -5%, -10% and -20% or less. Liquidity is measured by 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 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 the model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking liquidity factor constructed following Liu (2006). After estimation, we sort stocks according to their historical liquidity betas and assign them to decile portfolios, held for the following 12 months. The process is repeated annually. Each decile portfolio includes 27 to 52 stocks. Portfolio1 represents most liquid portfolio while portfolio10 is least liquid portfolio. Abnormal returns for each stock in each portfolio represent the residuals of the conditional version of the Carhart (1997) four-factor model. Time-varying coefficients are estimated using the S-GARCH approach of Harris et al. (2007). CAARs are calculated annually and only stocks with continuing returns throughout estimation period are considered. Shocks are defined as abnormal returns of -5%, -10% and -20% or less. If two shocks happen within ten successive days, one of them is ignored to avoid confounding effects. $CAAR_d$ is average cumulative abnormal return after (d) days following shock averaged over entire study period and over all stocks in portfolio. *Port* denotes portfolio. Level of significance of CAARs is estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level. Panel A presents S-GARCH-based CAARs of stocks in proportional spread portfolios. Panel B presents S-GARCH-based CAARs of stocks in turnover rate portfolios. Panel C presents S-GARCH-based CAARs of stocks in illiquidity ratio portfolios.

Panel A: S-GARCH-based CAARs of stocks in proportional spread portfolios											
S-GARCH-based CAARs following shocks of -5% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.0964[a]	0.0053	0.0070	0.0081	0.0140	0.0123	0.0230	0.0201	0.0220	0.0178	0.0189
Port 10	-0.1180[a]	-0.0165[b]	0.0003	0.0237	0.0057	-0.0223	-0.0095	-0.0189	-0.0162	0.0021	-0.0007
S-GARCH-based CAARs following shocks of -10% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.2215[a]	0.0096	0.0182	0.0192	0.0391	0.0368	0.0772	0.0649	0.0671	0.0648	0.0703
Port 10	-0.2564[a]	-0.0377[b]	0.0232	0.0803	0.0182	-0.0500	-0.0765	-0.0464	-0.0506	-0.0193	-0.0022
S-GARCH-based CAARs following shocks of -20% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.5160[a]	0.0896[c]	0.0439	0.0399	0.0450	0.0532	0.0497	0.1341	0.1391	0.2058	0.1977
Port 10	-0.6097[a]	-0.0048	0.0319	-0.0143	-0.0827	-0.2197[c]	-0.3238[b]	-0.2381	-0.2507[c]	-0.2245	-0.2216

Table 7.4 (continued)

Panel B: S-GARCH-based CAARs of stocks in turnover rate portfolios											
S-GARCH-based CAARs following shocks of -5% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.0987[a]	0.0009	-0.0077	-0.0040	-0.0002	0.0044	0.0101	0.0090	0.0105	0.0101	0.0097
Port 10	-0.1175[a]	-0.0158[c]	0.0121	0.0453	0.0340	0.0040	0.0189	0.0042	0.0078	0.0130	0.0123
S-GARCH-based CAARs following shocks of -10% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.1973[a]	-0.0138	-0.0049	-0.0016	0.0033	0.0049	0.0239	0.0119	0.0166	0.0126	0.0197
Port 10	-0.2621[a]	-0.0463[c]	0.0465	0.1303	0.0847	0.0037	-0.0305	0.0058	-0.0028	-0.0076	0.0233
S-GARCH-based CAARs following shocks of -20% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.4120[a]	-0.0261	-0.0151	-0.0203	-0.0333	-0.0360	-0.0508	-0.0268	-0.0247	0.0047	0.0080
Port 10	-0.6353[a]	-0.0033	0.0378	-0.0210	-0.0810	-0.2404	-0.3642[c]	-0.2323	-0.2561	-0.2512	-0.2648
Panel C: S-GARCH-based CAARs of stocks in illiquidity ratio portfolios											
S-GARCH-based CAARs following shocks of -5% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.0993[a]	-0.0023	-0.0018	-0.0011	0.0041	0.0081	0.0231	0.0203	0.0195	0.0150	0.0169
Port 10	-0.1281[a]	-0.0073	-0.0098	-0.0064	-0.0093	-0.0321	-0.0304	-0.0396	-0.0361	-0.0330	-0.0334
S-GARCH-based CAARs following shocks of -10% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.1976[a]	-0.0172	-0.0137	-0.0110	-0.0024	-0.0056	0.0166	0.0275	0.0198	0.0135	0.0218
Port 10	-0.2508[a]	-0.0211	-0.0162	-0.0160	-0.0361	-0.0952[c]	-0.1329[b]	-0.1476[b]	-0.1496[b]	-0.1433[b]	-0.1252[c]
S-GARCH-based CAARs following shocks of -20% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.4374[a]	0.0442	0.0171	0.0216	-0.0064	-0.0111	-0.0202	0.0324	0.0022	0.0406	0.0493
Port 10	-0.5752[a]	-0.0337	0.0308	0.0117	-0.0246	-0.1782	-0.2747[c]	-0.2571	-0.2712	-0.2463	-0.2471

Figure 7.1
S-GARCH-based CAARs of the proportional spread portfolios following shocks of 5% or more

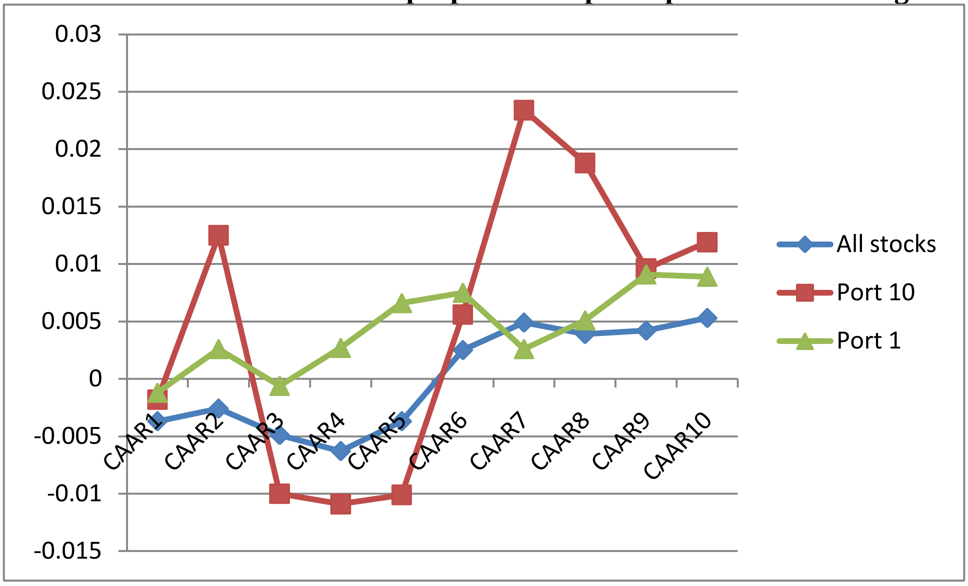


Figure 7.2
S-GARCH-based CAARs of the turnover rate portfolios following shocks of 10% or more

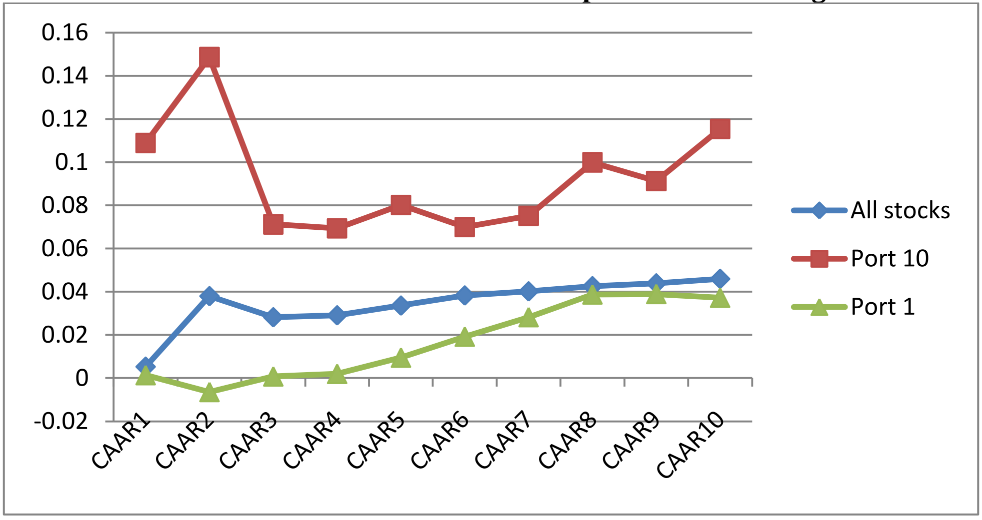


Figure 7.3
S-GARCH-based CAARs of the illiquidity ratio portfolios following shocks of 20% or more

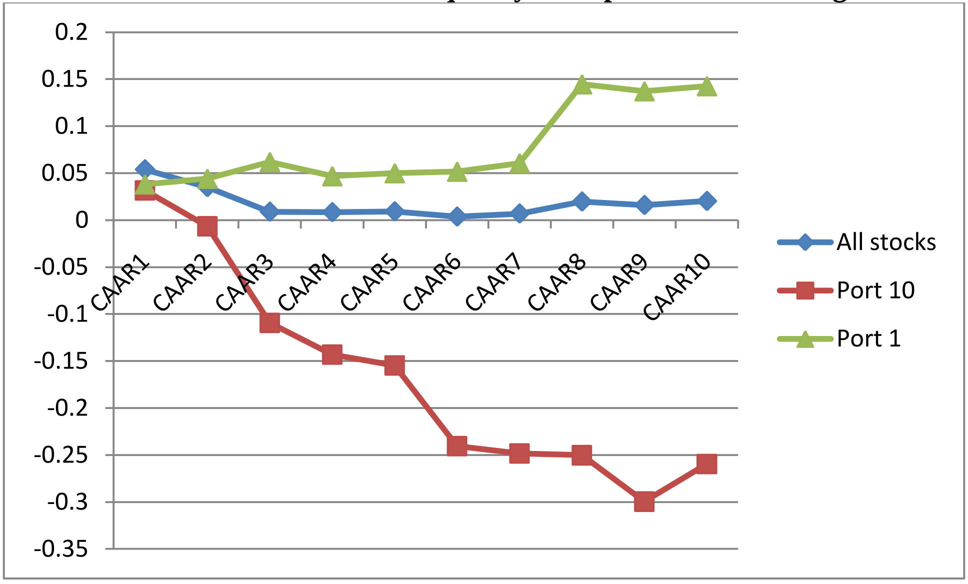


Figure 7.4
S-GARCH-based CAARs of the proportional spread portfolios following shocks of -5% or less

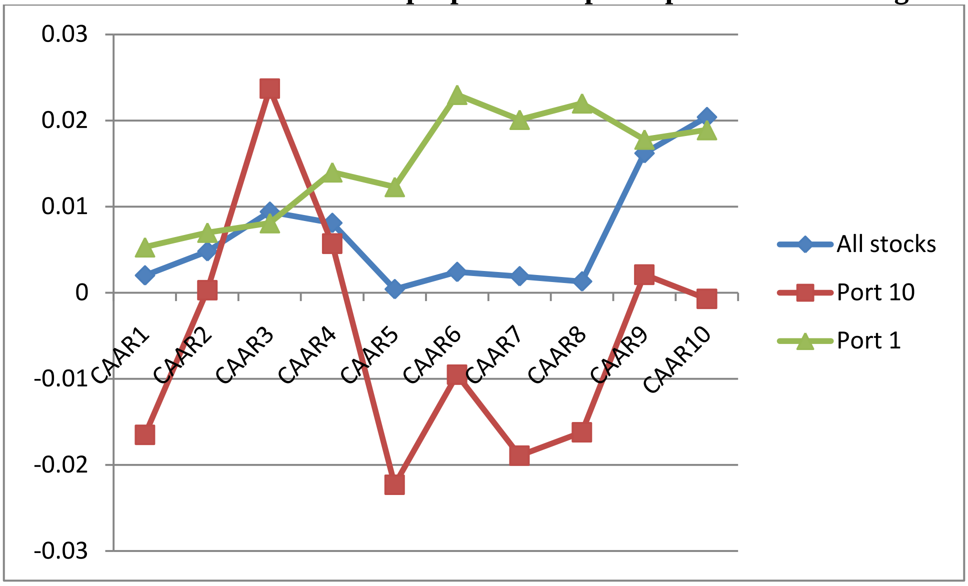


Figure 7.5
S-GARCH-based CAARs of the turnover rate portfolios following shocks of -10% or less

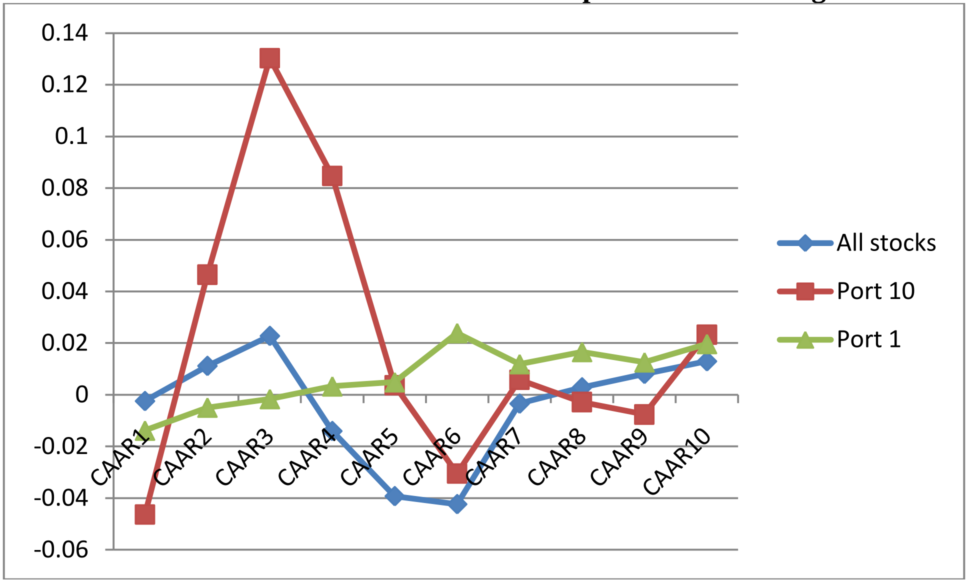
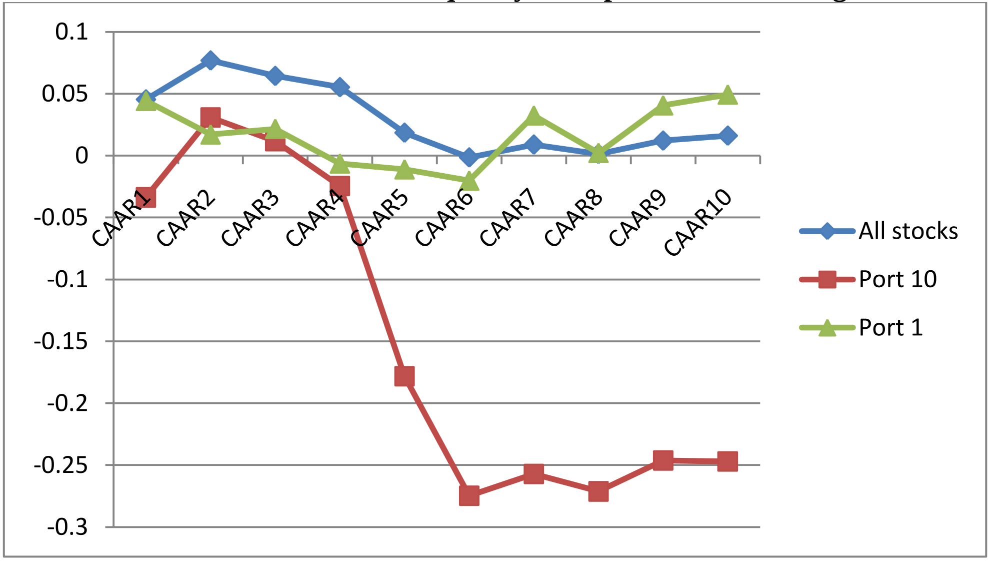


Figure 7.6
S-GARCH-based CAARs of the illiquidity ratio portfolios following shocks of -20% or less



7.3.3. Time-varying liquidity augmented asset pricing model

7.3.3.1. Proportional bid-ask spread portfolios

Panel A of Table 7.5 reports the liquidity-adjusted S-GARCH-based CAARs of the stocks in the proportional spread Ports 1 and 10, following positive shocks of different magnitude (results of remaining proportional spread Ports 2 to 9 are reported in Appendix C.8) Taken as a whole, the results are not really affected by adding the systematic liquidity risk factor to the conditional C-F&F model. The stocks in most proportional spread portfolios react efficiently to shocks of different trigger values. The Wilcoxon Signed Rank test (WSRT) suggests that the S-GARCH-based CAARs are the same as liquidity-adjusted S-GARCH-based CAARs, indicating the negligible effect of adding the systematic liquidity risk factor to the conditional C-F&F model.

Panel A of Table 7.6 reports the liquidity-adjusted S-GARCH-based CAARs of the stocks in the proportional spread Ports 1 and 10, following negative shocks of different magnitude (results of remaining proportional spread Ports 2 to 9 are reported in Appendix C.9). The portfolios' reaction to negative shocks is also similar before and after incorporating the systematic liquidity risk factor. Thus, most of the portfolios respond in an efficient manner to shocks of -5%, -10% and -20% or less. Nevertheless, the least liquid portfolio, Port 10, shows significant underreaction one day following shocks of -5% and -10% or less. The majority of Wilcoxon Signed Rank test values are not statistically significant. Once more, it is apparent that the time-varying risk rather than the systematic liquidity risk does the central job in explaining the variations of stock returns.

7.3.3.2. Turnover rate portfolios

Panel B of Table 7.5 reports the liquidity-adjusted S-GARCH-based CAARs of the stocks in the turnover rate Ports 1 and 10, following positive shocks of different magnitude (results of remaining turnover rate Ports 2 to 9 are reported in Appendix C.10). Consistent with the results of the proportional spread liquidity measure, Panel B of Table 7.5 shows a minor improvement after incorporating the time-varying systematic liquidity risk to the conditional four-factor model. The results are consistent before and after adding this liquidity factor. Thus, the liquidity-adjusted S-GARCH-based CAARs of the stocks in most of the portfolios are not statistically significant following shocks of 5%, 10% and 20% or more. Additionally, most of the values of the WSRT values are not statistically significant. For example, the liquidity-adjusted S-GARCH-based CAAR of the stocks in Port 10 has changed from 22.93% before adding the systematic liquidity to the conditional C-F&F to 31.69% after adding it on day 1 following shocks of 20% or more.

Panel B of Table 7.6 reports the liquidity-adjusted S-GARCH-based CAARs of the stocks in the turnover rate Ports 1 and 10, following negative shocks of different magnitude (results of remaining turnover rate Ports 2 to 9 are reported in Appendix C.11). The portfolios' reaction to the negative shocks is also consistent before and after incorporating the systematic liquidity risk factor. While most of the portfolios react efficiently to shocks of -5%, -10% and -20% or less, Port 10, the least liquid portfolio, exhibits significant return continuations. These continuations last from one to several days after the shock, depending on its magnitude. For example, the return continuation of the stocks in Port 10 lasts only one day following shocks of -5% or less, with a liquidity-adjusted S-GARCH-based CAAR value of -3.28%. However, it lasts four days following shocks of -20% or less, with a liquidity-adjusted S-GARCH-based CAAR value of -21.52% on day 4. Nearly all the values of the WSRT are not statistically significant. Overall, the absence of significant differences before and after adding the systematic liquidity to the conditional C-F&F suggests that adjusting for the time-varying risk is more important than the systematic liquidity risk in explaining the price anomalies following large one-day price changes.

7.3.3.3. Illiquidity ratio portfolios

Panel C of Table 7.5 reports the liquidity-adjusted S-GARCH-based CAARs of the stocks in the illiquidity ratio Ports 1 and 10, following positive shocks of different magnitude (results of remaining illiquidity ratio Ports 2 to 9 are reported in Appendix C.12). In agreement with the other liquidity measures, the portfolios sorted according to the illiquidity ratio show similar reaction to positive shocks before and after adding the systematic liquidity risk to the conditional four-factor model. Although a few portfolios overreact to positive shocks, the other majority demonstrate an efficient reaction. The values of the WSRT are not statistically different from zero.

Panel C of Table 7.6 reports the liquidity-adjusted S-GARCH-based CAARs of the stocks in the illiquidity ratio Ports 1 and 10, following negative shocks of different magnitude (results of remaining illiquidity ratio Ports 2 to 9 are reported in Appendix C.13). The situation is also consistent before and after the time-varying systematic liquidity risk is added in the case of negative shocks. Nearly all the values of the WSRT are not statistically significant. Both the conditional four-factor and five-factor models can clear up all the CAARs following shocks of -5%, -10% and -20% or less. Overall, the evidence confirms the powerful ability of the time-varying risk to explain the documented price and robustly supports the efficient market hypothesis.

Table 7.5

Liquidity-adjusted S-GARCH-based CAARs of stocks in liquidity beta sorted portfolios following positive shocks

This table presents time-varying risk adjusted average cumulative abnormal returns of stocks of decile portfolios sorted according to historical liquidity beta following positive shocks of 5%, 10% and 20% or more. Liquidity is measured by 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 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 the model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking liquidity factor constructed following Liu (2006). After estimation, we sort stocks according to their historical liquidity betas and assign them to decile portfolios, held for the following 12 months. The process is repeated annually. Each decile portfolio includes 27 to 52 stocks. Portfolio1 represents most liquid portfolio while portfolio10 is least liquid portfolio. Abnormal returns for each stock in each portfolio represent the residuals of the conditional version of the liquidity augmented model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and the mimicking liquidity factor of Liu (2006). Time-varying coefficients are estimated using the S-GARCH approach of Harris et al. (2007). CAARs are calculated annually and only stocks with continuing returns throughout estimation period are considered. Shocks are defined as abnormal returns of 5%, 10% and 20% or more. If two shocks happen within ten successive days, one of them is ignored to avoid confounding effects. $CAAR_d$ is average cumulative abnormal return after (d) days following shock averaged over entire study period and over all stocks in portfolio. *Port* denotes portfolio. Level of significance of CAARs is estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level. Panel A presents S-GARCH-based CAARs of stocks in proportional spread portfolios. Panel B presents S-GARCH-based CAARs of stocks in turnover rate portfolios. Panel C presents S-GARCH-based CAARs of stocks in illiquidity ratio portfolios.

Panel A: Liquidity-adjusted S-GARCH-based CAARs of stocks in proportional spread portfolios											
Liquidity-adjusted S-GARCH-based CAARs following shocks of 5% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	**0.1008[a]**	-0.0084[b]	-0.0083	-0.0125[c]	-0.0109	-0.0058	-0.0057	-0.0051	-0.0052	-0.0008	0.0016
Port 10	**0.1328[a]**	0.0109	0.0292	0.0080	0.0059	0.0023	0.0240	0.0450	0.0458	0.0454	0.0439
Liquidity-adjusted S-GARCH-based CAARs following shocks of 10% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.2082[a]	-0.0073	-0.0069	-0.0226	-0.0147	0.0043	0.0033	0.0086	0.0119	0.0158	0.0166
Port 10	**0.2758[a]**	0.0067	0.0252	-0.0346	-0.0343	-0.0355	0.0351	0.0808	0.0959	0.0899	0.1040
Liquidity-adjusted S-GARCH-based CAARs following shocks of 20% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.5774[a]	0.0103	-0.0257	0.0128	0.0018	0.0139	0.0142	0.0486	0.0791	0.0677	0.0691
Port 10	**0.7018[a]**	0.2149	0.3489	0.1860	0.1709	0.1385	0.1312	0.1243	0.1684	0.1876	0.2236

Table 7.5 (continued)

Panel B: Liquidity-adjusted S-GARCH-based CAARs of stocks in turnover rate portfolios											
Liquidity-adjusted S-GARCH-based CAARs following shocks of 5% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	**0.1024**[a]	-0.0026	-0.0058[c]	-0.0072[b]	-0.0072[c]	-0.0012	-0.0004	-0.0018	-0.0012	0.0059	0.0026
Port 10	**0.1152**[a]	0.0140	0.0067	-0.0091	0.0018	0.0133	0.0347	0.0776	0.0610	0.0477	0.0507
Liquidity-adjusted S-GARCH-based CAARs following shocks of 10% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	**0.2115**[a]	-0.0136	-0.0211[c]	-0.0311[b]	-0.0342[b]	-0.0280[c]	-0.0203	-0.0153	-0.0113	0.0031	-0.0026
Port 10	0.2510[a]	0.1077	0.1419	0.1068	0.1338	0.1439	0.1277	0.1752	0.1576	0.1251	0.1478
Liquidity-adjusted S-GARCH-based CAARs following shocks of 20% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.4567[a]	0.0227	-0.0074	0.0245	0.0104	0.0316	0.0504	0.0605	0.0687	0.0582	0.0591
Port 10	0.5805[a]	0.3169	0.4355	0.3771	0.3602	0.3078	0.3142	0.4118	0.3531	0.4092	0.4201
Panel C: Liquidity-adjusted S-GARCH-based CAARs of stocks in illiquidity ratio portfolios											
Liquidity-adjusted S-GARCH-based CAARs following shocks of 5% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	**0.1158**[a]	-0.0046	-0.0018	-0.0081	-0.0072	-0.0056	-0.0043	0.0015	0.0037	0.0133	0.0126
Port 10	0.1287[a]	-0.0002	-0.0041	-0.0173	-0.0271	-0.0273	-0.0299	-0.0338	-0.0456[c]	-0.0493[c]	-0.0543[b]
Liquidity-adjusted S-GARCH-based CAARs following shocks of 10% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.1855[a]	-0.0028	-0.0072	-0.0218	-0.0186	-0.0201	-0.0143	0.0005	0.0138	0.0490	0.0433
Port 10	0.2733[a]	-0.0267	-0.0490	-0.0998[b]	-0.1324[b]	-0.1150[c]	-0.1164[c]	-0.1211[c]	-0.1139[c]	-0.1375[b]	-0.1374[b]
Liquidity-adjusted S-GARCH-based CAARs following shocks of 20% or more											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.4388[a]	-0.0172	-0.0225	-0.0026	0.0090	0.0348	0.0814	0.1000	0.1916	0.1768	0.1825
Port 10	0.6365[a]	-0.0532	-0.0914	-0.1614	-0.2858[b]	-0.3184[b]	-0.3877[b]	-0.3783[b]	-0.3564[b]	-0.4164[b]	-0.4134[b]

Table 7.6

Liquidity-adjusted S-GARCH-based CAARs of stocks in liquidity beta sorted portfolios following negative shocks

This table presents time-varying risk adjusted average cumulative abnormal returns of stocks of decile portfolios sorted according to historical liquidity beta following negative shocks of -5%, -10% and -20% or less. Liquidity is measured by 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 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 the model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking liquidity factor constructed following Liu (2006). After estimation, we sort stocks according to their historical liquidity betas and assign them to decile portfolios, held for the following 12 months. The process is repeated annually. Each decile portfolio includes 27 to 52 stocks. Portfolio1 represents most liquid portfolio while portfolio10 is least liquid portfolio. Abnormal returns for each stock in each portfolio represent the residuals of the conditional version of the liquidity augmented model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and the mimicking liquidity factor of Liu (2006). Time-varying coefficients are estimated using the S-GARCH approach of Harris et al. (2007). CAARs are calculated annually and only stocks with continuing returns throughout estimation period are considered. Shocks are defined as abnormal returns of -5%, -10% and -20% or less. If two shocks happen within ten successive days, one of them is ignored to avoid confounding effects. $CAAR_d$ is average cumulative abnormal return after (d) days following shock averaged over entire study period and over all stocks in portfolio. *Port* denotes portfolio. Level of significance of CAARs is estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level. Panel A presents S-GARCH-based CAARs of stocks in proportional spread portfolios. Panel B presents S-GARCH-based CAARs of stocks in turnover rate portfolios. Panel C presents S-GARCH-based CAARs of stocks in illiquidity ratio portfolios.

Panel A: Liquidity-adjusted S-GARCH-based CAARs of stocks in proportional spread portfolios											
Liquidity-adjusted S-GARCH-based CAARs following shocks of -5% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	**-0.1019[a]**	**0.0099**	**0.0064**	0.0101	0.0164	0.0169	0.0211	0.0238	0.0260	0.0254	0.0226
Port 10	**-0.1278[a]**	-0.0155[b]	-0.0050	-0.0073	-0.0408[c]	-0.0280	0.0149	0.0013	0.0131	0.0207	0.0150
Liquidity-adjusted S-GARCH-based CAARs following shocks of -10% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.2142[a]	0.0153	0.0024	0.0085	0.0151	0.0083	0.0211	0.0216	0.0389	0.0432	0.0570
Port 10	**-0.2584[a]**	-0.0338[c]	0.0534	0.1167	0.0456	-0.0147	-0.0207	0.0238	0.0158	0.0339	0.0571
Liquidity-adjusted S-GARCH-based CAARs following shocks of -20% or less											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.5105[a]	0.0883	0.0231	0.0389	0.0699	0.0667	0.0524	0.0631	0.1300	0.1372	0.1904
Port 10	-0.5530[a]	-0.0195	0.1943	0.3146	0.1827	0.0960	0.0263	0.1094	0.0918	0.0951	0.1185

Table 7.6 (continued)

Panel B: Liquidity-adjusted S-GARCH-based CAARs of stocks in turnover rate portfolios

Liquidity-adjusted S-GARCH-based CAARs following shocks of -5% or less

Port	CAAR0	CAAR1	CAAR2	CAAR3	CAAR4	CAAR5	CAAR6	CAAR7	CAAR8	CAAR9	CAAR10
Port 1	**-0.1043[a]**	-0.0019	-0.0119[c]	-0.0124[c]	-0.0071	-0.0008	0.0031	0.0033	0.0084	0.0012	-0.0024
Port 10	**-0.1262[a]**	**-0.0328[c]**	**0.0008**	**0.0254**	**0.0155**	-0.0102	-0.0088	-0.0026	-0.0059	-0.0057	-0.0090

Liquidity-adjusted S-GARCH-based CAARs following shocks of -10% or less

Port	CAAR0	CAAR1	CAAR2	CAAR3	CAAR4	CAAR5	CAAR6	CAAR7	CAAR8	CAAR9	CAAR10
Port 1	**-0.2051[a]**	-0.0139	-0.0169	-0.0169	-0.0006	0.0052	0.0230	0.0079	0.0083	0.0030	0.0023
Port 10	-0.2755[a]	-0.1123[b]	-0.0074	0.0589	0.0481	0.0181	0.0590	0.0547	0.0508	0.0362	0.0589

Liquidity-adjusted S-GARCH-based CAARs following shocks of -20% or less

Port	CAAR0	CAAR1	CAAR2	CAAR3	CAAR4	CAAR5	CAAR6	CAAR7	CAAR8	CAAR9	CAAR10
Port 1	-0.4199[a]	-0.0133	-0.0218	-0.0159	-0.0127	-0.0080	-0.0212	0.0062	0.0080	0.0304	0.0320
Port 10	-0.5719[a]	**-0.1884[c]**	**-0.1389[c]**	-0.1648[c]	-0.2152[c]	-0.2484	-0.1584	-0.0047	-0.0221	-0.1027	-0.1309

Panel C: Liquidity-adjusted S-GARCH-based CAARs of stocks in illiquidity ratio portfolios

Liquidity-adjusted S-GARCH-based CAARs following shocks of -5% or less

Port	CAAR0	CAAR1	CAAR2	CAAR3	CAAR4	CAAR5	CAAR6	CAAR7	CAAR8	CAAR9	CAAR10
Port 1	**-0.0868[a]**	0.0028	0.0002	0.0015	0.0088	0.0139	0.0375[c]	0.0382[c]	0.0392[c]	**0.0400[c]**	**0.0339[c]**
Port 10	**-0.1241[a]**	-0.0083	-0.0002	-0.0054	-0.0267	-0.0458[b]	-0.0468[b]	-0.0482[b]	-0.0411[c]	-0.0543[b]	-0.0586[b]

Liquidity-adjusted S-GARCH-based CAARs following shocks of -10% or less

Port	CAAR0	CAAR1	CAAR2	CAAR3	CAAR4	CAAR5	CAAR6	CAAR7	CAAR8	CAAR9	CAAR10
Port 1	-0.1731[a]	0.0106	0.0009	0.0173	0.0383	0.0364	0.0451	0.0716	0.0700	0.0650	0.0647
Port 10	-0.3068[a]	-0.0129	-0.0140	-0.0077	-0.0550	-0.0997[c]	-0.1125[c]	-0.0928	-0.1048[c]	-0.0993[c]	-0.0761

Liquidity-adjusted S-GARCH-based CAARs following shocks of -20% or less

Port	CAAR0	CAAR1	CAAR2	CAAR3	CAAR4	CAAR5	CAAR6	CAAR7	CAAR8	CAAR9	CAAR10
Port 1	-0.3791[a]	0.0596	0.0310	0.0538	0.0527	0.0378	0.0323	0.0444	0.0870	0.0824	0.1344
Port 10	-0.5991[a]	-0.0243	0.0193	0.0017	-0.1232	-0.2447[c]	-0.2971[b]	-0.2675	-0.2593	-0.2416	-0.2301

7.3.4. Robustness check

7.3.4.1. S-GARCH versus AS-GARCH

As a robustness check, we re-estimate the time-varying risk coefficients using the asymmetric version of the S-GARCH model. In particular, we use the GJR-GARCH to estimate the AS-GARCH model of Harris et al. (2007). Table 7.7 shows the FTSEALL stocks' reaction to positive and negative shocks of different magnitude when the AS-GARCH model is used to estimate the time-varying risk coefficients. The results are nearly the same regardless of whether an asymmetric or symmetric version of the GARCH is used. The FTSEALL stocks show efficient reactions to shocks of 20% or more and shocks of -5%, -10% and -20% or less. There is no significant pattern of price reversal or return continuation following these large one-day shocks. Thus, all these anomalies documented in Chapter 6 can be attributed to the time-varying risk. This is clear evidence in favour of the market efficiency hypothesis. However, the time-varying risk factors cannot explain the price reversal that follows shocks of 5% and 10% or more. However, the observed reversals following shocks of 5% and 10% last only for one day. Overall, the results are robust to different versions of the GARCH model used to estimate the time-varying common risk coefficients.

Table 7.7

AS-GARCH-based CAARs of FTSEALL share index stocks

This table presents time-varying risk adjusted average cumulative abnormal returns of 642 constituents of the FTSEALL share index stocks following large one-day shocks. Analysis covers 1st July 1992 to 29th June 2007. Abnormal returns represent the residuals of the conditional version of the Carhart (1997) four-factor model. Time-varying coefficients are estimated using the AS-GARCH of Harris et al. (2007). CAARs are calculated annually and only stocks with continuing returns throughout estimation period are considered. Positive shocks are defined as abnormal returns of 5%, 10% and 20% or more. Negative shocks are defined as abnormal returns of -5%, -10% and -20% or less. If two shocks happen within ten successive days, one of them is ignored to avoid confounding effects. $CAAR^{t}$ is average cumulative abnormal return on a certain day (t) averaged over entire study period. Level of significance of CAARs is estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level.

Shocks	# of Shocks	CAAR0	CAAR1	CAAR2	CAAR3	CAAR4	CAAR5	CAAR6	CAAR7	CAAR8	CAAR9	CAAR10
Shock (5%)	26885	0.1175[a]	-0.0045[b]	-0.0059	-0.0484	-0.0512	-0.0481	-0.0549	-0.0541	-0.0510	-0.0533	-0.0533
Shock (-5%)	24531	-0.1241[a]	-0.0045	-0.0057	-0.0137	-0.0182[c]	-0.0259[a]	-0.0303[a]	-0.0278[a]	-0.0673	-0.0701	-0.0690
Shock (10%)	10009	0.2741[a]	-0.0117[c]	-0.1187	-0.1489	-0.1488	-0.1628	-0.1682	-0.1667	-0.1581	-0.1605	-0.1613
Shock (-10%)	9456	-0.2764[a]	-0.0104	-0.0074	-0.0263	-0.0314	-0.0606[b]	-0.1771	-0.1777	-0.1725	-0.1798	-0.1716
Shock (20%)	3913	0.6042[a]	0.0092	-0.2413	-0.3069	-0.3091	-0.3530	-0.3458	-0.3391	-0.3362	-0.3452	-0.3507
Shock (-20%)	3859	-0.6221[a]	-0.0229	-0.0711	-0.0817	-0.0890	-0.3972	-0.4591	-0.4399	-0.4157	-0.4293	-0.4055

7.3.4.2. Sub-period analysis

As another robustness check, we test whether our results vary over time. Particularly, we divide the entire study period into three equal sub-periods. Then, we examine the reaction of all our portfolios to shocks of 5% or more and shocks of -5% or less over the three sub-periods[1]. Table 7.8 presents the sub-period CAARs of the stocks in liquidity beta sorted Ports 1 and 10, following shocks of 5% or more (results of remaining proportional spread, turnover rate and illiquidity ratio portfolios are reported in Appendices C.14, C.16 and C.18, respectively). Starting with the proportional spread portfolios, the results are consistent over the three sub-periods. While few portfolios exhibit significant price reversal following shocks of 5% or more, most of them react efficiently to these shocks. For example, Port 8 shows a price reversal that lasts to day 10 with a value of -3.59%, following shocks of 5% or more in the first period. This evidence reinforces the importance of time-varying risk in explaining the variations of stock returns. This conclusion is robust to the different sub-periods. Moving to the turnover portfolios, the same conclusion can be detected over the three sub-periods. Specifically, under all sub-periods, the reaction of most portfolios is efficient to shocks of 5% or more and only a few of them show overreaction. For example, Port 4 shows efficient reaction to shocks of 5% or more in the first two sub-periods while it shows significant negative CAARs that last to day 10 with a value of -1.69% in the third sub-period. This confirms that the time-varying nature of the stock returns is a characteristic not restricted to a certain period of time. The reaction of the stocks in the illiquidity ratio portfolios to shocks of 5% or more over the three sub-periods is consistent with the other measures of liquidity. The results are robust to the three sub-periods. Most of the

[1] We only repeat the analysis of a trigger value of 5% because the magnitude of the shock did not seem to matter in the previous sections.

portfolios react efficiently to shocks of 5% or more, while only few show significant price reversal.

Table 7.9 presents the sub-period CAARs of the stocks in liquidity beta sorted Ports 1 and 10, following shocks of -5% or less (results of remaining proportional spread, turnover rate and illiquidity ratio portfolios are reported in Appendices C.15, C.17 and C.19, respectively). Starting with the shocks of -5% or less, the results are almost consistent over the three sub-periods. Most of the portfolios display efficient reaction to shocks of -5% or less. The least liquid portfolio, Port 10, shows significant return continuation only in the first sub-period, specifically a CAAR of -4.92% on day 1, while responding efficiently to the underlying shocks in the last two sub-periods. The stocks in the turnover rate portfolios also show consistent reaction following shocks of -5% or less over the three sub-periods. Thus, the results do not change over time. The time-varying risk can fully explain the stock returns of most portfolios in all sub-periods. The reaction of the stocks in the illiquidity ratio portfolios following shocks of -5% or less is consistent over the three sub-periods. Thus, the same conclusion is valid over the three sub-periods. Most of the portfolios show no significant CAARs up to 10 days following shocks of -5% or less. This highlights the robustness of the key role of the time-varying risk in explaining the variations of stock returns to the different periods of time.

Table 7.8

Sub-period S-GARCH-based CAARS of stocks in liquidity beta sorted portfolios following shocks of 5% or more

This table presents time-varying risk adjusted average cumulative abnormal returns of stocks of decile portfolios sorted according to historical liquidity beta following shocks of 5% or more. Liquidity is measured by the proportional bid-ask spread, turnover rate and illiquidity ratio of Amihud (2002). Analysis covers three equal sub-periods. Panel A reports results for first sub-period from 1st July 1992 to 30th June 1997. Panel B presents results for second sub-period from 1st July 1997 to 28th June 2002. Panel C shows results for third sub-period from 1st July 2002 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 the model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking liquidity factor of the proportional bid-ask spread constructed following Liu (2006). After estimation, we sort stocks according to their historical liquidity betas and assign them to 10 decile portfolios, held for the following 12 months. The process is repeated annually. Each decile portfolio includes 27 to 52 stocks. Portfolio1 represents most liquid portfolio while portfolio10 is least liquid portfolio. Abnormal returns for each stock in each portfolio represent the residuals of the conditional version of the Carhart (1997) four-factor model. Time-varying coefficients are estimated using the S-GARCH approach of Harris et al. (2007). CAARs are calculated annually and only stocks with continuing returns throughout estimation period are considered. Shocks are defined as abnormal returns of 5% or more. If two shocks happen within ten successive days, one of them is ignored to avoid confounding effects. $CAAR_d$ is average cumulative abnormal return after (d) days following shock averaged over entire study period and over all stocks in portfolio. *Port* denotes portfolio. Level of significance of CAARs is estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level.

Panel A: S-GARCH-based CAARs from 1st July 1992 to 30th June 1997										
CAARs of stocks in proportional spread portfolios										
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.1350[a]	0.0104	0.0098	-0.0097	-0.0047	-0.0022	0.0037	-0.0114	0.0009	0.0094	0.0177
Port 10	0.1748[a]	0.0110	-0.0277	-0.0898	-0.0948	-0.1156[c]	-0.0344	0.0387	0.0575	0.0353	0.0336
CAARs of stocks in turnover rate portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.1215[a]	0.0044	-0.0004	-0.0006	-0.0013	-0.0023	0.0018	0.0014	0.0045	0.0043	0.0027
Port 10	0.1908[a]	0.0029	-0.0403[c]	-0.1257[c]	-0.1273[c]	-0.1512[c]	-0.0542	0.0406	0.0679	0.0435	0.0423
CAARs of stocks in illiquidity ratio portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.1710[a]	0.0028	-0.0020	-0.0308	-0.0317	-0.0357[c]	-0.0386[c]	-0.0389[c]	0.0074	0.0066	0.0031
Port 10	0.1693[a]	-0.0006	-0.0337[c]	-0.1104	-0.1140	-0.1324[c]	-0.1297	-0.1317	-0.1298	-0.1445[c]	-0.1265

Table 7.8 (Continued)

Panel B: S-GARCH-based CAARs from 1st July 1997 to 28th June 2002											
CAARs of stocks in proportional spread portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.0759[a]	-0.0024	-0.0081[a]	-0.0097[a]	-0.0114[a]	-0.0117[a]	-0.0088[b]	-0.0144[a]	-0.0098[b]	-0.0088[c]	-0.0072
Port 10	0.1201[a]	-0.0191[c]	0.0019	-0.0063	-0.0051	0.0089	0.0027	0.0000	-0.0217	-0.0262	-0.0209
CAARs of stocks in turnover rate portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.0907[a]	-0.0010	-0.0051	-0.0049	0.0001	0.0014	0.0048	0.0036	0.0087	0.0029	-0.0007
Port 10	0.1132[a]	0.0037	0.0427	0.0348	0.0265	0.0533	0.0383	0.0505	0.0591	0.0576	0.0598
CAARs of stocks in illiquidity ratio portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.0798[a]	0.0001	-0.0019	-0.0031	-0.0022	-0.0023	-0.0020	-0.0045	-0.0024	-0.0039	-0.0028
Port 10	0.1076[a]	-0.0077	0.0191	0.0057	0.0005	0.0229	0.0204	0.0174	0.0210	0.0165	0.0197
Panel C: S-GARCH-based CAARs from 1st July 2002 to 29th June 2007											
CAARs of stocks in proportional spread portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.0966[a]	-0.0055[c]	0.0074	0.0102	0.0166	0.0241	0.0214	0.0216	0.0182	0.0224	0.0169
Port 10	0.0901[a]	0.0075	0.0514	0.0411	0.0409	0.0430	0.0362	0.0372	0.0342	0.0291	0.0311
CAARs of stocks in turnover rate portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.0959[a]	-0.0036	0.0079	0.0080	0.0130	0.0241[c]	0.0303[b]	0.0329[b]	0.0332[b]	0.0355[b]	0.0322[c]
Port 10	0.0909[a]	-0.0029	-0.0057	-0.0070	-0.0085	-0.0028	-0.0043	-0.0025	-0.0045	-0.0084	-0.0078
CAARs of stocks in illiquidity ratio portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	0.0963[a]	-0.0055[b]	0.0080	0.0090	0.0147	0.0220	0.0288[c]	0.0320[c]	0.0316[c]	0.0355[c]	0.0333[c]
Port 10	0.0918[a]	0.0079	0.0054	-0.0058	-0.0062	0.0071	-0.0013	-0.0035	-0.0420	-0.0423	-0.0402

Table 7.9

Sub-period S-GARCH-based CAARS of stocks in liquidity beta sorted portfolios following shocks of -5% or less

This table presents time-varying risk adjusted average cumulative abnormal returns of stocks of decile portfolios sorted according to historical liquidity beta following shocks of -5% or less. Liquidity is measured by the proportional bid-ask spread, turnover rate and illiquidity ratio of Amihud (2002). Analysis covers three equal sub-periods. Panel A reports results for first sub-period from 1st July 1992 to 30th June 1997. Panel B presents results for second sub-period from 1st July 1997 to 28th June 2002. Panel C shows results for third sub-period from 1st July 2002 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 the model consisting of the three Fama and French (1993) common risk factors, the momentum factor of Carhart (1997) and a mimicking liquidity factor of the proportional bid-ask spread constructed following Liu (2006). After estimation, we sort stocks according to their historical liquidity betas and assign them to 10 decile portfolios, held for the following 12 months. The process is repeated annually. Each decile portfolio includes 27 to 52 stocks. Portfolio1 represents most liquid portfolio while portfolio10 is least liquid portfolio. Abnormal returns for each stock in each portfolio represent the residuals of the conditional version of the Carhart (1997) four-factor model. Time-varying coefficients are estimated using the S-GARCH approach of Harris et al. (2007). CAARs are calculated annually and only stocks with continuing returns throughout estimation period are considered. Shocks are defined as abnormal returns of -5% or less. If two shocks happen within ten successive days, one of them is ignored to avoid confounding effects. $CAAR_d$ is average cumulative abnormal return after (d) days following shock averaged over entire study period and over all stocks in portfolio. *Port* denotes portfolio. Level of significance of CAARs is estimated using Newey-West t-statistic. [a] denotes statistical significance at 1% level, [b] at 5% level and [c] at 10% level.

Panel A: S-GARCH-based CAARs from 1st July 1992 to 30th June 1997											
CAARs of stocks in proportional spread portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.1300[a]	0.0186	0.0278	0.0245	0.0278	0.0050	-0.0050	-0.0055	-0.0021	0.0011	0.0029
Port 10	-0.1290[a]	-0.0492[b]	0.0244	0.1008	0.0657	-0.0261	-0.0141	-0.0774	-0.0527	-0.0394	-0.0442
CAARs of stocks in turnover rate portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.1217[a]	-0.0018	-0.0037	0.0064	-0.0077	0.0019	-0.0101	-0.0155	-0.0115	-0.0132	-0.0128
Port 10	-0.1471[a]	-0.0485[b]	0.0406	0.1282	0.0825	-0.0306	-0.0098	-0.0872	-0.0583	-0.0360	-0.0409
CAARs of stocks in illiquidity ratio portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.1542[a]	-0.0355	-0.0358	-0.0410	-0.0526	-0.0498	-0.0217	-0.0245	-0.0419	-0.0512	-0.0468
Port 10	-0.1233[a]	-0.0259[c]	-0.0399	-0.0332	-0.0510[c]	-0.1284[c]	-0.1442[c]	-0.2098[b]	-0.1768[c]	-0.1603[c]	-0.1727[c]

Table 7.9 (continued)

Port	CAAR0	CAAR1	CAAR2	CAAR3	CAAR4	CAAR5	CAAR6	CAAR7	CAAR8	CAAR9	CAAR10
Panel B: S-GARCH-based CAARs from 1st July 1997 to 28th June 2002											
CAARs of stocks in proportional spread portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.0830[a]	-0.0011	0.0000	0.0016	0.0010	0.0030	0.0040	0.0063	0.0043	0.0022	0.0023
Port 10	-0.1307[a]	-0.0126	-0.0209[b]	-0.0169[c]	-0.0401	-0.0386	-0.0162	0.0066	-0.0011	0.0011	0.0001
CAARs of stocks in turnover rate portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.0954[a]	-0.0050	-0.0258	-0.0257	-0.0264	-0.0257	-0.0252	-0.0198	-0.0231	-0.0195	-0.0215
Port 10	-0.1119[a]	-0.0037	-0.0025	0.0175	0.0229	0.0365	0.0559	0.0809[c]	0.0697	0.0688	0.0697
CAARs of stocks in illiquidity ratio portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.0808[a]	0.0013	0.0039	0.0030	0.0020	0.0021	0.0029	0.0043	0.0051	0.0036	0.0039
Port 10	-0.1200[a]	-0.0010	-0.0027	-0.0054	-0.0028	0.0004	0.0124	0.0313	0.0217	0.0255	0.0239
Panel C: S-GARCH-based CAARs from 1st July 2002 to 29th June 2007											
CAARs of stocks in proportional spread portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.0919[a]	0.0045	0.0031	0.0059	0.0183	0.0232	0.0513	0.0431	0.0475	0.0381	0.0397
Port 10	-0.0956[a]	0.0041	0.0052	0.0095	0.0104	-0.0013	0.0013	-0.0021	-0.0048	0.0350	0.0319
CAARs of stocks in turnover rate portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.0908[a]	0.0079	0.0082	0.0121[b]	0.0293[b]	0.0353[b]	0.0546[b]	0.0491[b]	0.0541[b]	0.0506[c]	0.0511
Port 10	-0.0972[a]	-0.0001	0.0028	0.0019	0.0031	-0.0011	0.0036	0.0009	-0.0019	-0.0051	-0.0036
CAARs of stocks in illiquidity ratio portfolios											
Port	**CAAR0**	**CAAR1**	**CAAR2**	**CAAR3**	**CAAR4**	**CAAR5**	**CAAR6**	**CAAR7**	**CAAR8**	**CAAR9**	**CAAR10**
Port 1	-0.0930[a]	0.0086	0.0075	0.0123[b]	0.0306[b]	0.0390[b]	0.0615[b]	0.0548[b]	0.0597[b]	0.0545[c]	0.0566[c]
Port 10	-0.1402[a]	-0.0017	0.0027	0.0104	0.0116	-0.0033	-0.0012	-0.0036	-0.0053	-0.0120	-0.0031

7.4. Summary and Conclusions

We investigate whether a conditional version of the four-factor model of Carhart (1997) can explain the documented return continuation and price reversal of FTESALL stocks following large one-day price changes. Our approach of estimating time-varying common risk factors is easy, flexible, simple and efficient at the same time. We use the S-GARCH of Harris et al. (2007) which is based on estimating only univariate GARCH models, both for the individual return series and for the sum and difference of each pair of series. Harris et al. (2007) argue that their recommended approach performs equivalently and sometimes better than the complicated multivariate GARCH models.

Chan (1988) and Ball and Kothari (1989) find that time-varying risk explains the payoffs of the contrarian strategy of DeBondt and Thaler (1985). Chordia and Shivakumar (2002) argue that time-varying macroeconomic factors explain the payoffs of the relative strength strategies of Jegadeesh and Titman (1993). In contrast, Lewellen and Nagel (2006) point out that the momentum anomaly is a puzzle that cannot be accounted for by conditional or unconditional asset pricing models. In the middle of this debate, this thesis is the first to question whether time-varying risks can account for the abnormal returns of FSTALL stocks following large one-day shocks. The 15-year analysis indicates that time-varying risk does an important task in explaining the price anomalies. We also show that time-varying risk is more important than systematic liquidity risk in explaining the variations of stock returns. These findings are robust to different specifications of the GARCH model and are consistent over time. Overall, this chapter provides evidence in favour of the efficient market hypothesis. Thus, modeling them by static asset pricing models creates serious pricing errors. The conditional asset pricing models on the other hand can effectively explain the variations of stock returns.