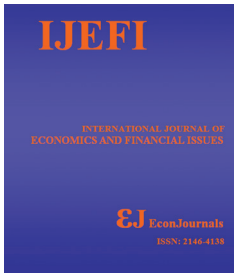

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Flight to Liquidity on the Tokyo Stock Exchange during the 2008 Share Market Crashes

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ABSTRACT

This paper explores the existence of the flight-to-liquidity phenomenon for shares which are traded on the Tokyo Stock Exchange (TSE) during share market crashes. Using data from the First section of the TSE, the existence of a flight-to-liquidity during the 2008 share market crashes is clearly documented. The TSE differs from other major exchanges as price limit rules restrict the daily price movements of shares. It provides a unique setting to test if a flight-to-liquidity occurs even when price limit rules may reduce market liquidity and delay price discovery. This study shows that despite having different trading rules, a flight-to-liquidity occurred during times of market uncertainty as investors were less willing to hold illiquid assets and rushed to sell these assets. The results are robust for smaller crash days and for different proxies of illiquidity.

Keywords: Crash, Flight-to-Liquidity, Share Returns
JEL Classifications: G01, G12, G14

1. INTRODUCTION

During times of financial crisis and market uncertainty such as a share market crash, it has been shown that both flight-to-quality and flight-to-liquidity phenomenon's often occur. These phenomenons occur because investors become increasingly risk averse when faced with market uncertainty, and endeavor to reduce risk by shifting their capital to safer assets. While these two phenomenons are distinctly different, they often occur together as low risk assets tend to be more liquid. To be specific, a flight-to-quality refers to a sudden shift in investors' investment behavior during uncertain times as they seek to move their capital from risky assets to safe assets, whereas a flight-to-liquidity is when investors sell less liquid investments and purchase more liquid assets.

Amihud et al. (1990) was one of the first researchers to demonstrate that a decline in liquidity contributed significantly to the sharp decline in share prices in the 1987 crash. He showed that investors reallocated assets towards high-liquidity shares due to fear of another crash. In more recent research, Vayanos (2004) suggested that during volatile time's investors' effective risk aversion increases, and the risk premium demanded increases. Similarly, Watanabe and Watanabe (2008) demonstrated that liquidity risk premium rises during times of high preference uncertainty. Research on the Japanese share market by Chang et al. (2010) analyzing the relationship between liquidity and share returns, proved that the liquidity variable is statistically important even when the market is contracting. Recently, Rosch and Christoph (2013) examined the relationship between share market liquidity and credit ratings on the German market and found that liquidity costs increase with credit risk and is more pronounced in times of crisis, suggesting that a flight-to-liquidity holds for the share market.

This paper explores the flight-to-liquidity phenomenon for shares which are traded on the Tokyo Stock Exchange (TSE) during share market crashes. The main aim of this paper is to prove the existence of the flight-to-liquidity theory, which to the best of our knowledge has never been tested on the Japanese share market. Through our analysis of individual shares traded on the First section of the TSE, we make a significant contribution to the existing literature on share market crashes by showing that the phenomenon does indeed exist. Secondly, this paper extends literature on share market crashes. The majority of papers on market crashes focus

on the factors which cause a crash (Barlevy and Veronesi, 2003; Limmack and Ward, 1990; Kleidon, 1995), and the co-movements of markets (Hon et al., 2004; Yang and Bessler, 2008). In this sense, this paper is rather unique. The volatility of share markets around the globe has been increasing in recent years, which has increased the need to further our understanding of crashes and the role of liquidity during a crash.

To the best of the authors' knowledge, there are no papers focusing on Japanese share returns for any share market crash. Yet the Japanese share market is a major international financial market, having a large market capitalization of 347,112,800 million yen in 2012, hence it is important that it receive greater attention (World Bank Group, 2012). The TSE, which is the focus of this paper, is the largest stock exchange in Japan with approximately 88% of the domestic trading value in 2012 (TSE Fact Book, 2012). The TSE differs from other international exchanges especially with regards to the trading rules. The TSE has price limit rules which restrict the maximum price variation and the daily price limit, meaning that the daily price movements of shares are limited. Critics of price limits argue that price limits reduce market liquidity, delay price discovery and weaken market efficiency. The possibility of reduced market liquidity due to price limits provides an important reason to research the flight-to-liquidity phenomenon on the Japanese share market.

This event study utilizes a multivariate regression analysis to examine the returns of individual shares on selected crash days. The six dates chosen all occur in October 2008, and are included in the list of the 10 largest daily declines in the TOPIX (TSE Fact Book, 2010). To contrast against these large crash days, days with a smaller decline during October 2008 are also analyzed. It is believed that the reason the TOPIX crashed throughout October 2008 was due to concerns about a financial crisis and recession due to the New York share market depression (TSE Fact Book, 2010).

The variable of most interest in the regression is illiquidity (ILLIQ). Many different proxies exist for ILLIQ (or liquidity), all of which estimate the ease with which an asset can be traded. In this paper we follow the methodology of other researchers such as Wang et al. (2009) and Chang et al. (2010), and employ the ILLIQ measure of Amihud (2002) as a proxy for ILLIQ. This proxy measures the absolute price change per yen of daily trading volume.

The results prove the existence of a flight-to-liquidity during share market crashes. The ILLIQ variable is positive and significant as predicted, which means that illiquid shares decrease more in value on crash days. This occurs as investors rush to sell illiquid assets and purchase more liquid assets, otherwise known as a flight-to-liquidity.

The remainder of this paper is organized as follows. In Section 2, the data and methodology used in this study is explained. The regression results are presented in Section 3 and robustness tests which support the findings are detailed in Section 4. In Section 5 the impact of price limit rules is considered, and the conclusions follow in Section 6.

2. EMPIRICAL FRAMEWORK

2.1. Hypothesis Development

Amihud et al. (1990) demonstrated that a decline in liquidity contributed significantly to the sharp decline in share prices in the 1987 crash, and showed that investors reallocated assets towards high-liquidity shares due to fear of another crash. Research specifically on the Japanese share market by Chang et al. (2010) analyzing the relationship between liquidity and share returns, proved that the liquidity variable is statistically important even when the market is in the contracting phase.

We hypothesis that a flight-to-liquidity occurs on days when the share market crashes, as investors rush to sell illiquid assets. In this study, we have followed the methodology of Wang et al. (2009) and utilized a multivariate regression, with the crash day return as the dependent variable and twelve independent variables which have explanatory effects on share returns. For the flight-to-liquidity phenomenon to hold, the ILLIQ variable must be positive and statistically significant.

2.2. Data

Firstly, a "crash" as defined by Garber (1992) is an abrupt decline in the value of securities. A crash, as Kleidon (1995) states, can be caused by a change in external information about fundamentals. Another possible cause suggested by Barlevy and Veronesi (2003) is the behavior of uninformed traders who panic and cause the price of shares to fall suddenly and drastically.

For the purpose of our study, we have followed the methodology of Wang et al. (2009) and classified a crash date as a daily decrease in the TOPIX index of more than 5%. In the 12 year period from January 1998 to December 2009, there are 13 days which are considered to be a share market crash. 10 of the 13 occurred during 2008, and six occurred during the month of October 2008. This paper focuses on the six October 2008 dates. The reason for this limitation is primarily due to the fact that the October dates, listed in Table 1, have the highest daily decrease of all the crashes in the 12 year period, with the TOPIX daily return >−7%. These six dates are referred to as "large crash days" in the regression tables. Crash days with a daily return of between −2% and −5%, referred to as "small crashes," are also analyzed to determine if the results are applicable to crashes in general or only to large scale crashes.

Data on the TOPIX index, closing prices for all individual shares listed on the First section of the TSE, plus all financial data, the price-to-book ratios and market capitalization data for all shares is obtained from the Nikkei Economic Electronic Databank System (NEEDS). The financial statements data is obtained from the

Table 1: Crash days

Date	Daily decrease in TOPIX %	Sample size
8th October 2008	−8.04	1170
10th October 2008	−7.1	1171
16th October 2008	−9.52	1174
22nd October 2008	−7.05	1174
24th October 2008	−7.52	1173
27th October 2008	−7.4	1174

firm's annual financial statements in the NEEDS database for the previous financial year.

Following Fama and French (1992), utilities and financial firms are excluded from the analysis. Utilities are excluded because their financial decisions are affected by regulation and financial firms are excluded because their financial ratios are not comparable to those of industrial firms.

To be included in the data set, a firm must be listed on the first section, have a share price for both the crash date and the previous day, and have all other required data. That is, data on firm size, the market-to-book ratio and the daily trading volume for the year prior to October 1st, plus end of year financial statements for the previous year must be available with the required data on debt, liquid assets, cash flow, and earnings. In addition, shares prices must be available for the 3 years prior to October 1st 2008, and monthly close prices for the period January 2002-December 2006 must be available for the calculation of beta. This period was selected to calculate beta because it is considered a relatively non-volatile period. Following Wang et al. (2009) monthly data was used to calculate the capital asset pricing model (CAPM) beta. Since monthly data is being utilized, a long timeframe of 5 years was selected to increase the accuracy of the beta calculation.

Firms with financial data missing for any of the requirements listed above are excluded from the sample. Some firms have no data for 2002 and 2003 which meant they failed the requirements needed to calculate beta. Due to the data requirements listed above and the exclusion of utilities and financial firms, the sample size is smaller than the number of shares listed on the TSE. At the time of data collection there were 1702 shares listed in the first section, however as the sample size in the Table 1 shows, a little over 500 shares have been excluded from the sample. The sample size varies slightly for each crash due to the fact that some of the shares have no price for either the crash day or the previous day, and hence the return cannot be calculated. Analysis of the trading volume data showed that on the days with no price there was no volume traded, and historically they tend to be thinly traded shares. The six large crash dates to be analyzed and their respective sample sizes are listed in Table 1.

From here on, the 8th of October 2008 crash will be referred to as the 08/10 crash, the 10th of October 2008 crash will be referred to as the 10/10 crash, the 16th of October 2008 crash will be referred to as the 16/10 crash, the 22nd of October 2008 crash will be referred to as the 22/10 crash, the 24th of October 2008 crash will be referred to as the 24/10 crash and the 27th of October 2008 crash will be referred to as the 27/10 crash.

In the regression tables, "small crashes" refers to selected days when the TOPIX daily return was between −5% and −2%. The specific days analyzed are: 2nd of October 2008 (−2.19%), 3rd of October 2008 (−2.69%), 6th of October 2008 (−4.67%) and the 7th of October 2008 (−2.15%).

2.3. Methodology

A multivariate regression analysis is utilized in this event study to examine the returns of individual shares listed on the first section of the TSE on the chosen crash days. The model and methodology follows that of Wang et al. (2009), except for the exclusion of the industry dummy variable. This variable was excluded because Wang found that overall it was not significant.

A 1-day event window is used for each crash. The crash day share return (RET_{it}) is the dependent variable in the linear regression model. It is calculated as the realized daily return using the equation:

$$R_{it} = (P_{it} - P_{it-1})/P_{it-1} \quad (1)$$

Where R_{it} denotes the realized rate of return of share i at time t, P_{it} denotes the share price at time t, and P_{it-1} denotes the share price at time $t-1$. Since all the crash days occur during a very short time frame, that is October 2008, the independent variables are all calculated at the 1st of October for simplicity. Calculating the variables specifically for each single crash day gave the same overall results, however we have not included them in the paper. The linear regression model is:

$$RET_{it} = \beta_0 + \beta_1 BETA + \beta_2 SIZE + \beta_3 MVBV + \beta_4 ILLIQ + \beta_5 TDTA + \beta_6 LAR + \beta_7 CFPS + \beta_8 BEP + \beta_9 SDLR + \beta_{10} LR1 + \beta_{11} LR2 + \beta_{12} LR3 + e_t \quad (2)$$

In this model the dependent variable RET_{it}, is the raw share return for the event day, and is calculated using Equation (1). β_0 is the a constant and β_1, β_2 … β_{12} are the regression coefficients. There are 12 independent variables included in the model. BETA is the CAPM beta of the share computed with monthly return data for the 5 year period from January 2002 to December 2006. SIZE is the logarithm of the firm's market capitalization, calculated as the average of the daily figures for the year directly prior to October 1st. MVBV is the market-to-book ratio, calculated as the average of the weekly market/book ratios for the year directly prior to October 1st. ILLIQ is the ILLIQ ratio employed by Amihud (2002), calculated as:

$$ILLIQ = \frac{1}{Di}\sum_{t=1}^{Di}\frac{|Ri|}{VOLDid} * 1000$$

Where R_i is the share i's daily returns, $VOLD_{id}$ is the daily volume, and D_i is the number of days in the period −252 to −30 days prior to October 1st for which it traded. We have following the methodology of Wang et al. (2009) and multiplied the Amihud ratio by 1000 to scale the figure. TDTA is the debt ratio (total debt/total assets) and liquid assets ratio (LAR) ([cash + marketable securities]/total assets), both calculated from the previous year's financial statements. CFPS is the cash flow per share, and basic earning power (BEP) is the ratio (EBIT / total assets). Standard deviation of the lagged share returns (SDLR) is calculated from −252 to −30 days prior to October 1st. In addition three lagged returns (LR) are included in the model: LR1 which is the cumulative return from −7 to −2 days prior to October 1st, LR2 which is the cumulative return from −70 to −2 days prior to October 1st, and LR3 which is the cumulative return from −756 to −2 days prior to October 1st.

2.4. The Variables

The variable of most interest, ILLIQ, calculated as the average ratio of the daily absolute return to yen trading volume in the period −252 to −30 days prior to October 1st, is predicted to have a coefficient which is positive and significant. It is predicted to be positive as previous research has documented a positive relationship between ILLIQ and share returns during both normal periods (Amihud, 2002; Chang et al., 2010) and during crashes (Wang et al., 2009). A positive sign during a share market crash shows that illiquid shares decrease more in value on crash days. This occurs as investors rush to sell illiquid assets and purchase more liquid assets during times of uncertainty, otherwise known as a flight-to-liquidity.

The other eleven variables in the model act as control variables in our research. We have employed the model of Wang et al. (2009), except for the exclusion of the industry dummy variable, as previous research has demonstrated that each of the eleven variables have a significant influence on share returns. Beta, size and market-to-book ratio, the variables in the Fama and French (1992) three factor model, have continually been shown over time to explain share returns. Based on the research by Wang et al. (2009) and other researchers, it is expected that beta will be statistically significant and negative in the regressions. It is reasonable to expect that since shares with high betas are more volatile, during a crash they will incur greater losses. Previous research regarding firm size has found that large firms lead small firms (Lo and MacKinlay, 1990). We expect that size will be significant and negative in the regression, implying that large firms incur more losses on the crash day. While Wang et al. (2009) found that the market-to-book ratio was not a significant variable during American share market crashes, due to the fact that the ratio is more closely linked to share returns in Japan, it is expected that it may be significant and negative.

Wang et al. (2009) included the debt ratio as a firm's debt ratio is likely to impact on the magnitude of the share price decrease during a crash. Based on Wang's results for the American market, the debt ratio variable is expected to be negative. The liquid cash ratio is included as this ratio is likely to impact on which firms are considered safer and favored. A high liquid asset level can be viewed in two-ways, as a safe firm and as a firm with no profitable investment opportunities, causing difficulty in predicting the expected sign on this variable. Wang et al. (2009) found it to be negative for the American market, therefore it is expected to be negative in our regression on the Japanese market.

Previous research by Carpenter and Guariglia (2008) showed that cash flow helps determine a firm's share price, leading to the inclusion of this variable. Wang et al. (2009) argue that investors would be likely to favor firms with high cash flow levels during a crash. Based on this reasoning and the results of Wang et al. (2009), this variable is expected to be positive. Similarly, Pastor and Veronesi (2003) proved that firm profitability is closely related to share prices, therefore the BEP ratio is included as a variable. Based on the belief that profitable firms should lose less during a crash, and the findings of Wang et al. (2009), this ratio is expected to be positive.

The standard deviation of LRs, considered to be a proxy for the volatility of share returns, will obviously impact on a shares return on a crash day. It is assumed that shares with more volatility prior to the crash are likely to have larger decreases during a share market crash. Hence it is expected that this variable will be significant and negative, as Wang's research found.

Lastly, three LR variables are included in the regression to capture the short-term and long-term momentum effects. Over the last 20 years numerous papers have discussed momentum in returns. De Bondt and Thaler (1985) found long-term reversals of portfolio returns, and Li et al. (2008) found that "losers" react slower to negative shocks in the short-term. It is difficult to predict the expected sign of these variables, as it will vary depending on the timeframe selected.

2.5. Descriptive Statistics and Correlations

The descriptive statistics of the variables used in the analysis are presented in Table 2. Overall, the descriptive statistics for the six crashes appear to have similar characteristics. The standard deviation, minimum and maximum figures have a wide range of values suggesting good regression results. There is a decreasing trend in skewness for returns from the 10/10 crash, which is in line with the findings by Wang et al. (2009) that skewness is negative on a crash day. One possible explanation for this gradual decrease is the existence of price limit rules on the TSE, which can limit the daily movement of a share and thus slow down the price discovery process. This issue and the implications for our research are considered in more detail in Section 5.

Kurtosis is higher than the normal figure of 3 for all days except 16/10, however distribution graphs of the returns suggest that there is not a problem of outliers. With regards to the variable of most interest, ILLIQ, both high skewness and high kurtosis are evident.

The correlation coefficients between the variables used in the regression analysis for the six large crash dates are shown in Table 3. Correlations between the explanatory variables are generally not very high, suggesting that multicollinearity will not be an issue in the regressions.

3. REGRESSION RESULTS

The regression results are presented in Table 4, with Panel A showing the results for the pooled large crash days, Panel B lists the results for the individual days, and Panel C shows the results for the pooled small crash days. Overall, the results for both the large crash days and the small crash days are very similar. The most important result from Table 4 is that ILLIQ, the ILLIQ variable, is positive and highly significant at the 5% level. To be specific, it is 0.682 for the pooled large crash days and 0.841 for the pooled small crash days. Analyzing the large crash days individually also showed that for 5 of the 6 days ILLIQ is positive and highly significant at either the 1% level or the 5% level. The 10/10 crash is the only day which gave a negative sign for ILLIQ. The 10th is also the only day analyzed for which SDLR, a proxy for volatility, is not significant, reinforcing the proposition that on the 10th investors reaction was abnormal. Nevertheless, pooling the six large crash

Table 2: Summary statistics of the samples used in the regression analysis for the six share market crashes

Variables	Mean	Standard deviation	Skewness	Kurtosis	Maximum	Median	Minimum
October 8th (*N*=1170)							
RET	−0.0887776	0.0469064	0.1610891	4.11901	0.1398601	−0.0906977	−0.2594937
BETA	0.9957661	0.6091922	4.795033	58.85617	9.784703	0.9205934	−0.3875517
SIZE	24.82572	1.564781	0.6449326	2.997315	30.58525	24.59074	21.73332
MVBV	1.290229	0.8737826	2.725197	15.1957	8.383704	1.049051	0.25965
ILLIQ	0.0005801	0.0018772	9.512084	117.5535	0.0287334	0.0001126	3.42E-07
TDTA	0.5026445	0.1962375	−0.1170937	2.174867	0.9311291	0.5163914	0.0416077
LAR	0.1293834	0.097898	1.729436	7.578825	0.7321356	0.1068236	0.0005873
CFPS	1326.398	13914.54	15.77764	280.4415	280912.5	116.335	−2083.65
BEP	6.178897	5.275094	1.031102	9.918788	46.39	5.28	−25.34
SDLR	0.0270812	0.0079331	1.063759	6.340309	0.0819203	0.026287	0.00561
LR1	−0.039677	0.0717377	4.715422	73.80845	1.123457	−0.042362	−0.4321429
LR2	−0.165491	0.1704481	0.2582227	3.34474	0.6111111	−0.1641006	−0.7572519
LR3	−0.2498688	0.3676484	2.340844	17.06268	3.154762	−0.2922807	−0.9844444
October 10th (*N*=1171)							
RET	−0.0512642	0.0483252	0.3598551	4.947783	0.25	−0.0505166	−0.227758
BETA	0.9956066	0.6092755	4.788578	58.78019	9.784703	0.9219098	−0.3875517
SIZE	24.82825	1.566559	0.6433176	2.988443	30.58525	24.5908	21.73332
MVBV	1.291203	0.8736526	2.721419	15.18013	8.383704	1.049344	0.25965
ILLIQ	0.0005949	0.0019642	9.221306	107.6823	0.0287334	0.0001136	3.42E-07
TDTA	0.5027086	0.196158	−0.118059	2.176677	0.9311591	0.5169947	0.0416077
LAR	0.1293152	0.0978782	1.730824	7.583446	0.7321356	0.1068164	0.0005873
CFPS	1325.549	13908.62	15.78446	280.6825	280912.5	116.4	−2083.65
BEP	6.181734	5.274527	1.029442	9.912778	46.39	5.28	−25.34
SDLR	0.0270811	0.0079307	1.063571	6.34304	0.0819203	0.0262893	0.00561
LR1	−0.0396865	0.0717077	4.717701	73.87134	1.123457	−0.0424077	−0.4321429
LR2	−0.1653841	0.1703941	0.2559076	3.343921	0.6111111	−0.164	−0.7572519
LR3	−0.2499448	0.3675282	2.341931	17.07263	3.154762	−0.2933333	−0.9844444
October 16th (*N*=1174)							
RET	−0.0786378	0.0478468	0.1673933	2.801042	0.1115242	−0.0798936	−0.1931818
BETA	0.9951547	0.6085896	4.794592	58.90881	9.784703	0.9205934	−0.3875517
SIZE	24.8271	1.564879	0.645717	2.995644	30.58525	24.59074	21.73332
MVBV	1.290054	0.8729118	2.724655	15.20763	8.383704	1.049232	0.25965
ILLIQ	0.0006057	0.0019737	9.076796	105.2207	0.0287334	0.0001137	3.42E-07
TDTA	0.5027445	0.1959473	−0.1186825	2.180626	0.9311291	0.5170425	0.0416077
LAR	0.1293205	0.097796	1.730973	7.589618	0.7321356	0.1067784	0.0005873
CFPS	1322.462	13890.96	15.80487	281.4047	280912.5	116.335	−2083.65
BEP	6.177036	5.270436	1.03078	9.923007	46.39	5.28	−25.34
SDLR	0.0270719	0.0079244	1.066144	6.352373	0.0819203	0.026287	0.00561
LR1	−0.0396762	0.0716443	4.717537	73.94092	1.123457	−0.042362	−0.4321429
LR2	−0.1649148	0.1704869	0.2517363	3.33271	0.6111111	−0.1629793	−0.7572519
LR3	−0.2496098	0.3672391	2.339737	17.07513	3.154762	−0.2922807	−0.9844444
October 22nd (*N*=1174)							
RET	−0.0541583	0.0321041	0.0304732	3.242571	0.0813008	−0.053998	−0.1814516
BETA	0.9952752	0.6085525	4.794933	58.91933	9.784703	0.9205934	−0.3875517
SIZE	24.82766	1.564647	0.6451216	2.996367	30.58525	24.59074	21.73332
MVBV	1.290176	0.8728138	2.725427	15.21265	8.383704	1.049232	0.25965
ILLIQ	0.000605	0.0019723	9.092891	105.5163	0.0287334	0.0001137	3.42E-07
TDTA	0.5025165	0.1959979	−0.1158146	2.178364	0.9311291	0.5163914	0.0416077
LAR	0.1292141	0.0977745	1.734804	7.603448	0.7321356	0.106585	0.0005873
CFPS	1322.506	13890.95	15.80487	281.4048	280912.5	116.335	−2083.65
BEP	6.182402	5.267807	1.030364	9.937436	46.39	5.29	−25.34
SDLR	0.0270758	0.0079261	1.064291	6.345096	0.0819203	0.026287	0.00561
LR1	−0.0396893	0.0716407	4.718749	73.95911	1.123457	−0.042362	−0.4321429
LR2	−0.1651848	0.1703598	0.2546324	3.341029	0.6111111	−0.163584	−0.7572519
LR3	−0.2496934	0.3672611	2.339949	17.07321	3.154762	−0.2922807	−0.9844444
October 24th (*N*=1173)							
RET	−0.0586465	0.0426697	−0.051948	3.566071	0.1333333	−0.0558824	−0.2033898
BETA	0.9958736	0.6084671	4.799402	58.98239	9.784703	0.9219098	−0.3875517
SIZE	24.82419	1.563122	0.6480277	3.005012	30.58525	24.59013	21.73332
MVBV	1.289143	0.8731142	2.727321	15.21754	8.383704	1.049119	0.25965
ILLIQ	0.0006024	0.0019702	9.125684	106.0865	0.0287334	0.0001136	3.42E-07
TDTA	0.5027402	0.1960669	−0.1189861	2.177665	0.9311291	0.5170902	0.0416077
LAR	0.1293477	0.0978326	1.729716	7.582788	0.7321356	0.1068164	0.0005873
CFPS	1323.294	13896.85	15.79805	281.1635	280912.5	116.23	−2083.65
BEP	6.173683	5.271112	1.032662	9.928584	46.39	5.28	−25.34

(*Contd*)

Table 2: (*Continued...*)

Variables	Mean	Standard deviation	Skewness	Kurtosis	Maximum	Median	Minimum
SDLR	0.0270883	0.0079246	1.062189	6.347766	0.0819203	0.0262938	0.00561
LR1	−0.0396881	0.071667	4.717471	73.91349	1.123457	−0.0423163	−0.4321429
LR2	−0.1653549	0.1703291	0.2564493	3.345282	0.6111111	−0.164	−0.7572519
LR3	−0.2499689	0.3672297	2.343807	17.09957	3.154762	−0.2933333	−0.9844444
October 27th (*N*=1174)							
RET	−0.0606535	0.0465019	−0.0443986	3.995247	0.1706485	−0.060967	−0.2666667
BETA	0.9956526	0.6082547	4.801356	59.02139	9.784703	0.9205934	−0.3875517
SIZE	24.82428	1.562459	0.6481221	3.007395	30.58525	24.59041	21.73332
MVBV	1.288845	0.8728017	2.728893	15.23009	8.383704	1.049051	0.25965
ILLIQ	0.0006068	0.0019751	9.058736	104.9076	0.0287334	0.0001137	3.42E-07
TDTA	0.5026619	0.1960017	−0.1178915	2.178555	0.9311291	0.5170425	0.0416077
LAR	0.1293246	0.0977941	1.730975	7.589898	0.7321356	0.1067784	0.0005873
CFPS	1322.398	13890.96	15.80486	281.4045	280912.5	116.25	−2083.65
BEP	6.173739	5.268865	1.03307	9.937001	46.39	5.28	−25.34
SDLR	0.027083	0.0079233	1.063407	6.349756	0.0819203	0.0262915	0.00561
LR1	−0.0396568	0.0716444	4.716709	73.93535	1.123457	−0.042312	−0.4321429
LR2	−0.1651398	0.170416	0.2548269	3.338436	0.6111111	−0.163584	−0.7572519
LR3	−0.2496374	0.3672488	2.339749	17.07405	3.154762	−0.2922807	−0.9844444

The dependent variable is the return on the crash day. The explanatory variables are as follows. BETA is the CAPM beta calculated over a 5 year period. SIZE is the average logarithm of the firm`s market capitalisation for the year prior to October 1st. MVBV is the average of the market value/book value ratio for the year prior to October 1st. ILLIQ is Amihud's illiquidity ratio based on the period −252 to −30 days prior to October 1st. TDTA is the debt ratio (total debt/total assets) for the previous financial year. LAR is the liquid assets ratio ([cash+marketable securities]/total assets) for the previous financial year. CFPS is the cash flow per share, and BEP is the basic earning power (EBIT/total assets) for the previous financial year. SDLR is the standard deviation of the lagged share returns for the period −252 to −30 days prior to October 1st. LR1 (lagged return) is the cumulative return for the period −7 to −2 days prior to October 1st, LR2 is the cumulative return for the period −70 to −2 days prior to October 1st, and LR3 is the cumulative return for the period −756 to −2 days prior to October 1st and et is the error term. Large crashes is defined as days where the TOPIX index decreased by more than −5%, and small crashes are when the decrease is <−5%

Table 3: Correlation coefficients between the variables used in the six share market crashes (*t*-statistics in parentheses)

Variables	RET	BETA	SIZE	MVBV	ILLIQ	TDTA	LAR	CFPS	BEP	SDLR	LR1	LR2	LR3
												October 8th	
RET		−0.1385	−0.0528	−0.1370	0.1084	−0.1799	0.1066	0.0572	−0.0774	−0.3066	0.1665	0.2404	−0.0415
		(0.0000)	(0.0712)	(0.0000)	(0.0002)	(0.0000)	(0.0003)	(0.0503)	(0.0081)	(0.000)	(0.0000)	(0.0000)	(0.1560)
BETA	0.0531		−0.0125	0.0824	−0.0287	0.2154	−0.0682	−0.0298	0.0161	0.3746	−0.1271	−0.3128	−0.1258
	(0.0694)		(0.6694)	(0.0048)	(0.3263)	(0.000)	(0.0196)	(0.3088)	(0.5819)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
SIZE	−0.1858	−0.0143		0.4479	−0.1799	−0.0705	0.0422	0.1969	0.3780	−0.1444	0.0702	0.0515	0.3895
	(0.0000)	(0.6248)		(0.0000)	(0.0000)	(0.0158)	(0.1494)	(0.0000)	(0.0000)	(0.0000)	(0.0164)	(0.0783)	(0.0000)
MVBV	−0.0705	0.0813	0.4486		−0.0311	0.0800	0.1775	0.0598	0.5217	0.0862	0.0055	−0.0510	0.4259
	(0.0158)	(0.0054)	(0.0000)		(0.2884)	(0.0062)	(0.0000)	(0.0408)	(0.0000)	(0.0032)	(0.8516)	(0.0815)	(0.0000)
ILLIQ	−0.0525	−0.0238	−0.1696	−0.0279		−0.1305	0.0912	0.0565	0.0004	−0.0081	−0.0089	0.0032	−0.0825
	(0.0726)	(0.4167)	(0.0000)	(0.3393)		(0.0000)	(0.0018)	(0.0534)	(0.9887)	(0.7815)	(0.7616)	(0.9136)	(0.0047)
TDTA	0.0244	0.2156	−0.0710	0.0795	−0.1211		−0.5240	0.0369	−0.3484	0.2770	−0.0634	−0.1852	−0.0498
	(0.4049)	(0.0000)	(0.0150)	(0.0065)	(0.0000)		(0.0000)	(0.2067)	(0.0000)	(0.0000)	(0.0302)	(0.0000)	(0.0884)
LAR	0.0094	−0.0680	0.0413	0.1769	0.0819	−0.5240		−0.0619	0.2737	−0.0381	0.0319	0.0616	0.0138
	(0.7488)	(0.0199)	(0.1579)	(0.0000)	(0.0050)	(0.0000)		(0.0343)	(0.0000)	(0.1924)	(0.2751)	(0.0351)	(0.6381)
CFPS	−0.0738	−0.0297	0.1964	0.0597	0.0535	0.0369	−0.0618		0.0352	−0.0634	0.0635	0.0695	0.0645
	(0.0116)	(0.3094)	(0.0000)	(0.0411)	(0.0672)	(0.2067)	(0.0345)		(0.2291)	(0.0301)	(0.0298)	(0.0175)	(0.0273)
BEP	−0.0570	0.0152	0.3786	0.5220	−0.0007	−0.3486	0.2733	0.0351		−0.0151	−0.0153	−0.0981	0.2829
	(0.0510)	(0.6032)	(0.0000)	(0.0000)	(0.9817)	(0.0000)	(0.0000)	(0.2297)		(0.6048)	(0.6005)	(0.0008)	(0.0000)
SDLR	0.1413	0.3750	−0.1456	0.0851	−0.0056	0.2770	−0.0380	−0.0634	−0.0158		−0.1428	−0.4262	−0.1541
	(0.0000)	(0.0000)	(0.0000)	(0.0036)	(0.8493)	(0.0000)	(0.1938)	(0.0301)	(0.5886)		(0.0000)	(0.0000)	(0.0000)
LR1	−0.0741	−0.1265	0.0698	0.0055	−0.0052	−0.0630	0.0318	0.0635	−0.0155	−0.1423		0.3405	0.0893
	(0.0112)	(0.0000)	(0.0169)	(0.8501)	(0.8578)	(0.0312)	(0.2762)	(0.0297)	(0.5957)	(0.0000)		(0.0000)	(0.0022)
LR2	−0.2398	−0.3127	0.0531	−0.0496	0.0107	−0.1846	0.0609	0.0694	−0.0975	−0.4259	0.3402		0.2564
	(0.0000)	(0.0000)	(0.0691)	(0.0899)	(0.7157)	(0.0000)	(0.0371)	(0.0175)	(0.0008)	(0.0000)	(0.0000)		(0.0000)
LR3	−0.1315	−0.1246	0.3883	0.4259	−0.0715	−0.0490	0.0136	0.0645	0.2824	−0.1530	0.0894	0.2558	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0144)	(0.0938)	(0.6431)	(0.0272)	(0.0000)	(0.0000)	(0.0022)	(0.0000)	
October 10th													
												October 16th	
RET		−0.2554	−0.2786	−0.1412	0.1362	−0.1579	0.1168	0.0499	−0.1272	−0.3549	0.0893	0.3868	−0.0300
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0875)	(0.0000)	(0.0000)	(0.0022)	(0.0000)	(0.3038)
BETA	−0.1083		−0.0141	0.0817	−0.0253	0.2155	−0.0682	−0.0297	0.0156	0.3750	−0.1267	−0.3131	−0.1249
	(0.0002)		(0.6295)	(0.0051)	(0.3857)	(0.0000)	(0.0195)	(0.3098)	(0.5938)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
SIZE	−0.4194	−0.0143		0.4488	−0.1699	−0.0713	0.0409	0.1965	0.3789	−0.1454	0.0698	0.0523	0.3881
	(0.0000)	(0.6248)		(0.0000)	(0.0000)	(0.0145)	(0.1610)	(0.0000)	(0.0000)	(0.0000)	(0.0168)	(0.0733)	(0.0000)
MVBV	−0.1524	0.0815	0.4486		−0.0306	0.0792	0.1763	0.0598	0.5224	0.0854	0.0052	−0.0511	0.4252
	(0.0000)	(0.0052)	(0.0000)		(0.2946)	(0.0066)	(0.0000)	(0.0405)	(0.0000)	(0.0034)	(0.8582)	(0.0800)	(0.0000)

(*Contd*)

Table 3: (*Continued...*)

Variables	RET	BETA	SIZE	MVBV	ILLIQ	TDTA	LAR	CFPS	BEP	SDLR	LR1	LR2	LR3
ILLIQ	0.1154	−0.0249	−0.1693	−0.0301		−0.1203	0.0815	0.0527	−0.0025	−0.0081	−0.0045	0.0169	−0.0687
	(0.0001)	(0.3945)	(0.0000)	(0.3031)		(0.0000)	(0.0052)	(0.0710)	(0.9311)	(0.7819)	(0.8784)	(0.5636)	(0.0186)
TDTA	−0.0595	0.2158	−0.0709	0.0801	−0.1224		−0.5233	0.0369	−0.3488	0.2771	−0.0631	−0.1842	−0.0494
	(0.0416)	(0.0000	(0.0151)	(0.0060)	(0.0000)		(0.0000)	(0.2065)	(0.0000)	(0.0000)	(0.0306)	(0.0000)	(0.0906)
LAR	0.0612	−0.0678	0.0415	0.1773	0.0795	−0.5233		−0.0618	0.2723	−0.0374	0.0323	0.0613	0.0131
	(0.0361)	(0.0202)	(0.1556)	(0.0000)	(0.0064)	(0.0000)		(0.0343)	(0.0000)	(0.2007)	(0.2692)	(0.0358)	(0.6528)
CFPS	0.0166	−0.0297	0.1965	0.0598	0.0528	0.0370	−0.0617		0.0352	−0.0633	0.0635	0.0691	0.0644
	(0.5708)	(0.3095)	(0.0000)	(0.0405)	(0.0706)	(0.2054)	(0.0345)		(0.2283)	(0.0302)	(0.0296)	(0.0179)	(0.0272)
BEP	−0.1723	0.0152	0.3786	0.5218	−0.0004	−0.3486	0.2732	0.0351		−0.0160	−0.0159	−0.0985	0.2822
	(0.0000)	(0.6033)	(0.0000)	(0.0000)	(0.9878)	(0.0000)	(0.0000)	(0.2293)		(0.5849)	(0.5869)	(0.0007)	(0.0000)
SDLR	−0.1233	0.3749	−0.1455	0.0850	−0.0073	0.2763	−0.0377	−0.0633	−0.0158		−0.1420	−0.4259	−0.1536
	(0.0000)	(0.0000)	(0.0000)	(0.0036)	(0.8020)	(0.0000)	(0.1963)	(0.0301)	(0.5893)		(0.0000)	(0.0000)	(0.0000)
LR1	0.0431	−0.1266	0.0699	0.0054	−0.0049	−0.0634	0.0320	0.0635	−0.0155	−0.1419		0.3403	0.0896
	(0.1404)	(0.0000)	(0.0165)	(0.8532)	(0.8663)	(0.0299)	(0.2740)	(0.0295)	(0.5954)	(0.0000)		(0.0000)	(0.0021)
LR2	0.1548	−0.3128	0.0532	−0.0498	0.0138	−0.1845	0.0605	0.0693	−0.0974	−0.4266	0.3401		0.2564
	(0.0000)	(0.0000)	(0.0686)	(0.0880)	(0.6376)	(0.0000)	(0.0382)	(0.0176)	(0.0008)	(0.0000)	(0.0000)		(0.0000)
LR3	−0.1433	−0.1249	0.3881	0.4253	−0.0690	−0.0490	0.0134	0.0645	0.2822	−0.1538	0.0896	0.2569	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0180)	(0.0931)	(0.6469)	(0.0272)	(0.0000)	(0.0000)	(0.0021)	(0.0000)	
October 22nd													
												October 24th	
RET		−0.1343	−0.4094	−0.2367	0.1352	−0.0163	0.0337	0.0061	−0.2492	−0.1801	−0.0071	0.1571	−0.2032
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.5764)	(0.2493)	(0.8342)	(0.0000)	(0.0000)	(0.8093)	(0.0000)	(0.0000)
BETA	−0.1109		−0.0122	0.0826	−0.0237	0.2152	−0.0687	−0.0298	0.0164	0.3741	−0.1268	−0.3121	−0.1249
	(0.0001)		(0.6768)	(0.0046)	(0.4169)	(0.0000)	(0.0186)	(0.3082)	(0.5744)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
SIZE	−0.2226	−0.0122		0.4482	−0.1727	−0.0706	0.0419	0.1969	0.3783	−0.1443	0.0701	0.0506	0.3894
	(0.0000)	(0.6761)		(0.0000)	(0.0000)	(0.0156)	(0.1517)	(0.0000)	(0.0000)	(0.0000)	(0.0164)	(0.0829)	(0.0000)
MVBV	−0.0970	0.0828	0.4482		−0.0316	0.0800	0.1769	0.0599	0.5219	0.0854	0.0054	−0.0512	0.4263
	(0.0009)	(0.0045)	(0.0000)		(0.2795)	(0.0061)	(0.0000)	(0.0402)	(0.0000)	(0.0034)	(0.8531)	(0.0794)	(0.0000)
ILLIQ	0.1216	−0.0246	−0.1720	−0.0324		−0.1204	0.0822	0.0529	−0.0031	−0.0046	−0.0053	0.0120	−0.0715
	(0.0000)	(0.3997)	(0.0000)	(0.2674)		(0.0000)	(0.0049)	(0.0699)	(0.9144)	(0.8762)	(0.8572)	(0.6807)	(0.0143)
TDTA	−0.0596	0.2153	−0.0706	0.0801	−0.1211		−0.5232	0.0369	−0.3486	0.2759	−0.0631	−0.1831	−0.0488
	(0.0412)	(0.0000)	(0.0155)	(0.0060)	(0.0000)		(0.0000)	(0.2067)	(0.0000)	(0.0000)	(0.0307)	(0.0000)	(0.0948)
LAR	0.1015	−0.0686	0.0419	0.1770	0.0813	−0.5230		−0.0618	0.2727	−0.0382	0.0323	0.0623	0.0134
	(0.0005)	(0.0187)	(0.1517)	(0.0000)	(0.0053)	(0.0000)		(0.0343)	(0.0000)	(0.1908)	(0.2694)	(0.0328)	(0.6461)
CFPS	0.0439	−0.0297	0.1969	0.0599	0.0526	0.0369	−0.0618		0.0353	−0.0635	0.0635	0.0694	0.0646
	(0.1325)	(0.3085)	(0.0000)	(0.0401)	(0.0715)	(0.2062)	(0.0343)		(0.2276)	(0.0298)	(0.0296)	(0.0175)	(0.0270)
BEP	−0.0851	0.0164	0.3783	0.5219	−0.0031	−0.3486	0.2727	0.0353		−0.0152	−0.0158	−0.0995	0.2826
	(0.0035)	(0.5744)	(0.0000)	(0.0000)	(0.9153)	(0.0000)	(0.0000)	(0.2274)		(0.6024)	(0.5897)	(0.0006)	(0.0000)
SDLR	−0.1870	0.3742	−0.1443	0.0857	−0.0063	0.2762	−0.0380	−0.0634	−0.0152		−0.1418	−0.4251	−0.1536
	(0.0000)	(0.0000)	(0.0000)	(0.0033)	(0.8301)	(0.0000)	(0.1928)	(0.0299)	(0.6021)		(0.0000)	(0.0000)	(0.0000)
LR1	0.1432	−0.1270	0.0701	0.0052	−0.0041	−0.0633	0.0322	0.0635	−0.0158	−0.1420		0.3402	0.0891
	(0.0000)	(0.0000)	(0.0163)	(0.8578)	(0.8883)	(0.0301)	(0.2710)	(0.0297)	(0.5897)	(0.0000)		(0.0000)	(0.0023)
LR2	0.1191	−0.3123	0.0507	−0.0517	0.0153	−0.1835	0.0619	0.0692	−0.0994	−0.4256	0.3405		0.2560
	(0.0000)	(0.0000)	(0.0826)	(0.0766)	(0.6010)	(0.0000)	(0.0339)	(0.0177)	(0.0006)	(0.0000)	(0.0000)		(0.0000)
LR3	−0.1205	−0.1252	0.3893	0.4257	−0.0689	−0.0492	0.0132	0.0645	0.2825	−0.1541	0.0895	0.2570	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0182)	(0.0920)	(0.6523)	(0.0272)	(0.0000)	(0.0000)	(0.0021)	(0.0000)	
October 27th													

LAR: Liquid assets ratio, CFPS: Cash flow per share, BEP: Basic earning power, LR: Lagged return, ILLIQ: Illiquidity

days gave the result that ILLIQ is positive and highly significant, and supports our hypothesis of a flight-to-liquidity on the TSE.

The results for the size variable support our hypothesis of a flight-to-liquidity. On large crash days size is negative and highly significant at the 1% level, suggesting that large firms' shares are sold first during highly uncertain times. Our result is consistent with previous research by Lo and MacKinlay (1990) and Wang et al. (2009). This finding links to the flight-to-quality phenomenon as investors are shifting towards low risk assets such as cash. As previously mentioned, low risk assets tend to be more liquid, furthermore large firms tend to be more liquid, strengthening our proposition of the existence of a flight-to-liquidity (Table 4).

Regarding the other variables, the results for the majority of the variables are consistent with our predictions and previous literature. Beta is negative and significant during a crash, as Limmack and Ward (1990) found during the 1987 crash, in addition to Ben-Zion et al. (1990) and Wang et al. (1990). The market-to-book ratio has mixed results for large and small crashes and the TDTA variable is insignificant, suggesting that these two variables do not have an effect on share returns. Both the LAR and CFPS variables are positive and significant overall, and the BEP and SDLR variables are negative and significant. The results for the three LRs, LR1, LR2 and LR3, are mixed as would be expected. In summary, the results for the control variables are generally in line with previous research and do not diverge significantly from our predictions. Only the signs for BEP and LAR differ from our predictions.

Table 4: Share returns and the ILLIQ level

INTERCEPT	BETA	SIZE	MVBV	ILLIQ	TDTA	LAR	CFPS
Panel A: Pooled regression for large crashes							
0.1470993***	−0.0024192**	−0.0075103***	0.0019403**	0.6823907**	−0.002697	0.0325401**	*1.83e-07***
(13.69)	(−2.54)	(−18.20)	(2.28)	(2.47)	(−0.72)	(4.91)	(4.72)
Panel B: Individual large crash days							
October 8th							
−0.0116999	(0.0011848)	−0.0010452	−0.0026804	1.908124***	−0.0153912*	0.037925**	1.62e-07*
(−0.45)	(0.51)	(−1.04)	(−1.30)	(2.73)	(−1.69)	(2.37)	(1.73)
October 10th							
0.0769212***	−0.0021866	−0.0054366***	0.0011901	−2.147315***	−0.0135688	0.0080873	−4.75e-08
(2.78)	(−0.89)	(−5.11)	0.54	(−3.03)	(−1.40)	(0.47)	(−0.47)
October 16th							
0.2364047***	−0.006032***	−0.0106418***	0.0039047**	1.317864**	−0.0026938	0.0445912***	2.92e-07***
(10.02)	(−2.88)	(−11.75)	(2.08)	(2.20)	(−0.33)	(3.07)	(3.43)
October 22nd							
0.205881***	−0.0016198	−0.0098202***	0.0047356***	0.2862164	−0.0069568	0.0147137	2.19e-07***
(12.23)	(−1.09)	(−15.20)	(3.54)	(0.67)	(−1.18)	(1.42)	(3.60)
October 24th							
0.2300704***	−0.0035567*	−0.0105909***	0.0018209	1.151947**	0.0093179	0.0332873**	2.20e-07***
(10.39)	(−1.81)	(−12.46)	(1.04)	(2.04)	(1.21)	(2.44)	(2.76)
October 27th							
0.1450979***	−0.0022981	−0.0075315***	0.0027541	1.520921**	0.0129297	0.0564533***	2.53e-07***
(5.58)	(−1.00)	(−7.55)	(1.34)	(2.31)	(1.43)	(3.53)	(2.70)
Panel C: Pooled regression for small crashes							
−0.0641645***	−0.0051571**	0.0022006***	−0.0010005	0.8413923***	−0.0015199	0.0189865***	5.89e-08
(−5.41)	(−4.91)	(4.83)	(−1.06)	(2.64)	(−0.37)	(2.59)	(1.38)

INTERCEPT	BEP	SDLR	LR1	LR2	LR3	Adjusted R^2	Obs
Panel A: Pooled regression for large crashes							
0.1470993***	−0.0004029***	−0.9502644***	0.0186572**	0.0143034***	−0.0069325***	0.1115	7036
(13.69)	(−2.97)	(−12.06)	(2.40)	(3.77)	(−4.03)		
Panel B: Individual large crash days							
October 8th							
−0.0116999	−0.0005343	−1.440429***	0.0648057***	0.0263954***	−0.0076302*	0.1590	1170
(−0.45)	(−1.63)	(−7.55)	(3.45)	(2.87)	(−1.83)		
October 10th							
0.0769212***	−0.0004158	0.2266575	0.0120689	−0.06821***	−0.0007266	0.0991	1171
(2.78)	(−1.19)	(1.11)	(0.60)	(−6.97)	(−0.16)		
October 16th							
0.2364047***	−0.0002683	−1.594797***	−0.0225665	0.077485***	−0.0049917	0.3261	1174
(10.02)	(−0.90)	(−9.21)	(−1.32)	(9.31)	(−1.32)		
October 22nd							
0.205881***	−0.0003929*	−0.5490391***	0.0047076	0.0199753***	−0.0047666*	0.2380	1174
(12.23)	(−1.85)	(−4.44)	(0.39)	(3.36)	(−1.77)		
October 24th							
0.2300704***	−0.000758***	−1.091298***	−0.0286794*	0.0268782***	−0.0118444***	0.2564	1173
(10.39)	(−2.72)	(−6.73)	(−1.79)	(3.44)	(−3.34)		
October 27th							
0.1450979***	−0.0000504	−1.254676***	0.0818031***	0.0029971	−0.011712***	0.1368	1174
(5.58)	(−0.15)	(−6.59)	(4.36)	(0.33)	(−2.82)		
Panel C: Pooled regression for small crashes							
−0.0641645***	0.0001254	−0.6409437***	0.0091329	0.045005***	−0.0013788	0.1083	4683
(−5.41)	0.84	(−7.38)	(1.07)	(10.76)	(−0.73)		

The regression results from the following model: $RET_t = \beta_0 + \beta_1$ BETA $+ \beta_2$ SIZE $+ \beta_3$ MVBV $+ \beta_4$ ILLIQ $+ \beta_5$ TDTA $+ \beta_6$ LAR $+ \beta_7$ CFPS $+ \beta_8$ BEP $+ \beta_9$ SDLR $+ \beta_{10}$ LR1 $+ \beta_{11}$ LR2 $+ \beta_{12}$ LR3 $+ e_t$. The dependent variable is the return on the crash day. The explanatory variables are as follows. BETA is the CAPM beta calculated over a 5 year period. SIZE is the average logarithm of the firm's market capitalisation for the year prior to October 1st. MVBV is the average of the market value/book value ratio for the year prior to October 1st. ILLIQ is Amihud's illiquidity ratio based on the period −252 to −30 days prior to October 1st. TDTA is the debt ratio (total debt/total assets) for the previous financial year. LAR is the liquid assets ratio ([cash+marketable securities]/total assets) for the previous financial year. CFPS is the cash flow per share, and BEP is the basic earning power (EBIT/total assets) for the previous financial year. SDLR is the standard deviation of the lagged share returns for the period −252 to −30 days prior to October 1st. LR1 (lagged return) is the cumulative return for the period −7 to −2 days prior to October 1st, LR2 is the cumulative return for the period −70 to −2 days prior to October 1st, and LR3 is the cumulative return for the period −756 to −2 days prior to October 1st and et is the error term. Large crashes is defined as days where the TOPIX index decreased by more than −5%, and small crashes are when the decrease is <−5%. The figures in parentheses are the corresponding t-statistics. ***.** and * indicate 1%, 5% and 10% level of significance respectively

BEP is negative for all individual days and when the large crash days are pooled. As previously explained, it is predicted that high profitability firms will lose less during a crash. However, the negative sign in the regression suggests that firms with higher profitability actually lose more value on crash days. Since this was an extended period of market uncertainty it is possible that the crashes were not unexpected, and investors purposely sold shares of profitable firms as a predetermined investment strategy.

Due to the difficulty in predicting the sign of the LAR variable, we predicted it to be negative in line with the results of Wang et al. (2009). However as Table 4 shows, LAR is positive and highly significant for both large crashes and small crashes, meaning that firms with high liquid assets decreased less in value, signaling that investors regarded these assets as safer with lower bankruptcy risk.

4. ROBUSTNESS TESTS

The first robustness test replaces the ILLIQ variable with a proxy for liquidity. The proxy chosen is DVOL, the natural logarithm of the average of yen trading volume over a specified period (Brennan et al., 1998). For consistency with the main regression, the same timeframe and methodology has been employed. That is, DVOL is calculated for the period −252 to −30 days prior to October 1st. The regression results with the DVOL variable replacing ILLIQ are presented in Table 5. The results are very similar to the original regression results presented in Table 4. The proxy for liquidity DVOL is negative and highly significant as expected for both the pooled large crash days and the pooled small crash days. It is also negative and highly significant for four of the individual crash days. This result reinforces the robustness of our regression results, and the existence of a flight-to-liquidity on the TSE.

As a second robustness test, the original sample is trimmed to reduce the possibility of outliers biasing the regression results. Each variable is trimmed at the 1% and 99% levels to ensure that the possibility of large outliers biasing the results is eliminated. Wang et al. (2009) used a similar test in their research on American share market crashes, leading us to replicate it as a robustness test. The regression results with all variables trimmed are presented in Table 6. The results are similar to those of the full sample, with the main differences being in the significance levels.

Several other robustness checks were carried out however the tables have not been included in this paper. One test replaced ILLIQ with LN-ILLIQ, the logarithm of the ILLIQ variable, and produced very similar results to Table 4. Another test replicated a robustness test of Wang et al. (2009) and replaced the SIZE variable which is defined as the logarithm of the firm`s market capitalization with the firm`s market capitalization SIZE-MC. In both results the ILLIQ variable is positive and highly significant, further strengthening our results (Tables 5 and 6).

5. THE PRICE LIMIT RULE AND THE POSSIBLE BIAS IN RESULTS

As previous explained, one feature of the TSE which distinguishes it from other major share markets is the trading rules, in particular the price limit rules. The purpose of these rules is to prevent extreme price movements by setting a maximum and minimum in the range in which the price can move within a day. According to Nobanee et al. (2009a), critics of price limits argue that price limits reduce market liquidity, delay price discovery and weaken market efficiency. That is, they reduce the initial price loss, but have no effect on the long-run response (Lauterbach and Ben-Zion, 1993). They can also cause volatility to remain for longer because price limits prevent large 1-day changes, and prevent an immediate bounce back. In the case of a share market crash when the prices of shares are falling suddenly and drastically, it is highly possible that a proportion of shares will hit the lower limit, and the daily movement will be limited. Al Shattarat et al. (2009b) found in their analysis of price limit hits on the TSE that shares of large firms, high beta shares, low market-to-book shares, high volatility shares and relatively less liquid shares tend to hit the lower limits.

Recalling the results of this paper (detailed in Section 3), it was found that illiquid shares decrease more in value on crash days, or in other words, that investors sell illiquid assets. This finding is in line with Al Shattarat et al.'s (2009b) result that less liquid shares tend to hit the lower limit, which led us to examine the possibility of bias in the regression results. The proportion of shares whose last ask price is affected by the price limit rules on each individual crash day are detailed in Table 7.

On average, approximately 0.02% of shares traded on the first section of the TSE hit the lower price limit on the six selected crash days. Based on these results, it can be concluded that only a small proportion of shares are affected by the price limit rules and the possibility of bias in the results is negligible. Another conclusion to be drawn is that the possibility of reduced market liquidity due to these rules does not appear to impact on investors' behavior, as a flight-to-liquidity is clearly documented. This result raises the question of whether price limit rules are actually effective or not, however that topic is out of scope of this paper.

6. CONCLUSIONS

In this paper we explore the flight-to-liquidity phenomenon for shares which are traded on the First Section of the TSE. Through a multivariate regression analysis of the returns of individual shares, we prove the existence of a flight-to-liquidity during share market crashes, specifically during the 2008 market crashes. The ILLIQ variable is positive and significant as predicted, which means that illiquid shares decrease more in value on crash days. This occurs as investors rush to sell illiquid assets and purchase more liquid assets, otherwise known as a flight-to-liquidity. Further analysis proved that the results are robust for smaller crash days and when different proxies for ILLIQ are employed.

Table 5: Robustness test results for the ILLIQ variable

INTERCEPT	beta	SIZE	MVBV	DVOL	TDTA	LAR	CFPS
Panel A: Pooled regression for large crashes							
0.1129886***	−0.0013195	−0.0050542***	0.0015792*	−0.0028298***	0.002024	0.0288072***	9.45e-08**
(9.20)	(−1.37)	(−8.59)	(1.85)	(−6.20)	(0.53)	(4.34)	(2.27)
Panel B: Individual large crash days							
October 8th							
−0.0487775	0.0025995	0.0019227	−0.0029179	−0.0037414***	−0.0107148	0.0330979**	5.95e-08
(−1.63)	(1.11)	(1.34)	(−1.41)	(−3.34)	(−1.15)	(2.06)	(0.59)
October 10th							
0.0717714**	−0.0025141	−0.0056488***	0.0008497	0.0008809	−0.0120533	0.0091089	−4.75e-08
(2.25)	(−1.00)	(−3.70)	(0.38)	(0.74)	(−1.21)	(0.53)	(−0.44)
October 16th							
0.1588192***	−0.0035599*	−0.0051087***	0.0030485*	−0.0063214***	0.0080753	0.036193**	9.22e-08
(5.98)	(−1.70)	(−4.03)	(1.65)	(−6.43)	(0.97)	(2.52)	(1.02)
October 22nd							
0.2004084***	−0.0014025	−0.0093799***	0.004698***	−0.0005585	−0.0062508	0.0140094	2.03e-07***
(10.41)	(−0.92)	(−10.20)	(3.51)	(−0.78)	(−1.04)	(1.34)	(3.11)
October 24th							
0.1915755***	−0.0022413	−0.0077226***	0.0014718	−0.0034057***	0.0144744*	0.0287269**	1.18e-07
(7.58)	(−1.13)	(−6.38)	(0.84)	(−3.63)	(1.84)	(2.11)	(1.38)
October 27th							
0.1066991***	−0.0009062	−0.0045751***	0.0024548	−0.0036121***	0.0179471*	0.0516684***	1.49e-07
(3.59)	(−0.39)	(−3.22)	(1.19)	(−3.29)	(1.94)	(3.22)	(1.48)
Panel C: Pooled regression for small crashes							
−0.0853256***	−0.0043862***	0.0038258***	−0.0011722	−0.0019879***	0.0013621	0.0165999**	1.87e-09
(−6.28)	(−4.11)	(5.87)	(−1.25)	(−3.91)	(0.32)	(2.26)	(0.04)

INTERCEPT	BEP	SDLR	LR1	LR2	LR3	Adjusted R^2	Obs.
Panel A: Pooled regression for large crashes							
0.1129886***	−0.0004639***	−0.7215125***	0.0189649**	0.0126504***	−0.0069708***	0.1155	7036
(9.20)	(−3.42)	(−8.30)	(2.45)	(3.34)	(−4.06)		
Panel B: Individual large crash days							
October 8th							
−0.0487775	−0.0006209*	−1.139922***	0.0649902***	0.024155***	−0.0079562*	0.1529	1170
(−1.63)	(−1.89)	(−5.40)	(3.46)	(2.63)	(−1.91)		
October 10th							
0.0717714**	−0.0003842	0.1574363	0.01216	−0.0676711***	−0.0003363	0.0830	1171
(2.25)	(−1.09)	(0.70)	(0.60)	(−6.87)	(−0.08)		
October 16th							
0.1588192***	−0.0004045	−1.082698***	−0.0216641	0.073569***	−0.0049952	0.3466	1174
(5.98)	(−1.38)	(−5.75)	(−1.29)	(8.95)	(−1.34)		
October 22nd							
0.2004084***	−0.000406*	−0.5040474***	0.0047591	0.0196474***	−0.004798*	0.2381	1174
(10.41)	(−1.91)	(−3.70)	(0.39)	(3.30)	(−1.78)		
October 24th							
0.1915755***	−0.000833***	−0.816891***	−0.0283884*	0.0249397***	−0.0119749***	0.2622	1173
(7.58)	(−2.99)	(−4.58)	(−1.78)	(3.20)	(−3.39)		
October 27th							
0.1066991***	−0.0001321	−0.9638183***	0.0820776***	0.0009157	−0.0119168***	0.1408	1174
(3.59)	(−0.40)	(−4.60)	(4.38)	(0.10)	(−2.87)		
Panel C: Pooled regression for small crashes							
−0.0853256***	0.0000797	−0.4810917***	0.0093012	0.0438717***	−0.0014752	0.1099	4683
(−6.28)	(0.53)	(−5.01)	(1.09)	(10.48)	(−0.78)		

The regression results when Amihud's illiquidity ratio (ILLIQ) is replaced with DVOL, a proxy for liquidity. DVOL is defined as the logarithm of the average of yen trading volume over the period −252 to −30 days prior to October 1st. All the other variables in the regression are the same as those in the original regression [Table 4]. The figures in parentheses are the corresponding t-statistics. ***. ** and * indicate 1%, 5% and 10% level of significance respectively. LAR: Liquid assets ratio, CFPS: Cash flow per share, BEP: Basic earning power, LR: Lagged return, ILLIQ: Illiquidity

The results are consistent with previous research by Wang et al. (2009) and Chang et al. (2010), who both found a positive relation between ILLIQ and returns during market downturns. We make a significant contribution to the existing literature on share market

Table 6: Share returns and the ILLIQ level for the trimmed sample

INTERCEPT	BETA	SIZE	MVBV	ILLIQ	TDTA	LAR	CFPS
Panel A: Pooled regression for large crashes							
0.1506076***	−0.0065414**	−0.007658***	0.0046975***	3.133279***	0.0024715	0.0255988***	−2.62e-07
(10.97)	(−4.43)	(−14.45)	(3.30)	(4.10)	(−0.58)	(3.06)	(−0.31)
Panel B: Individual large crash days							
October 8th							
−0.0426384	−0.0058189*	−0.0001016	0.0003377	4.685341**	−0.0112174	0.0149317	−2.33e-06
(−1.29)	(−1.65)	(−0.08)	(0.10)	(2.41)	(−1.09)	(0.75)	(−1.14)
October 10th							
0.1316859***	−0.0037656	−0.0077208***	0.0099394***	−3.653473*	−0.0221142*	−0.00007	1.59e-06
(3.79)	(−1.01)	(−5.77)	(2.76)	(−1.87)	(−2.04)	(−0.00)	(0.74)
October 16th							
0.2511624***	−0.0161411**	−0.0112025***	0.0057754*	4.475764***	0.003193	0.0374837**	−3.11e-07
(8.35)	(−4.97)	(−9.64)	(1.85)	(2.75)	(0.34)	(2.04)	(−0.17)
October 22nd							
0.2140707***	−0.0023682	−0.0099809***	0.0056755**	3.910365***	−0.0109797	0.0057843	9.50e-07
(9.83)	(−1.01)	(−11.87)	(2.51)	(3.21)	(−1.62)	(0.44)	(0.70)
October 24th							
0.2383337***	−0.010226***	−0.0106011****	0.0016973	4.310359***	0.0037168	0.0226226	−9.86e-07
((8.37)	(−3.33)	(−9.64)	(0.57)	(2.77)	(0.42)	(1.30)	(−0.56)
October 27th							
0.1169308***	−0.0010145	−0.0065388***	0.0050548	4.006983*	0.0218373**	0.0718263***	−2.67e-07
((3.53)	(−0.28)	(−5.10)	(1.47)	(2.21)	(2.11)	(3.54)	(−0.13)
Panel C: Pooled regression for small crashes							
−0.0896535***	−0.0072102***	0.0031466***	−0.0004859	3.862431***	−0.0031609	0.0157949*	−1.80e-06*
(−5.93)	(−4.45)	(5.41)	(−0.31)	(4.39)	(−0.67)	(1.72)	(−1.92)

INTERCEPT	BEP	SDLR	LR1	LR2	LR3	Adjusted R^2	Obs.
Panel A: Pooled regression for large crashes							
0.1506076***	−0.0003309	−0.9873676**	0.0148579	0.0154561***	−0.009209***	0.1190	5746
(10.97)	(−1.61)	(−9.34)	(1.27)	(3.24)	(−3.71)		
Panel B: Individual large crash days							
October 8th							
−0.0426384	−0.0000684	−1.130355***	0.0437547	0.0436248***	−0.0118985**	0.1200	955
(−1.29)	(−0.14)	(−4.47)	(1.56)	(3.83)	(−1.99)		
October 10th							
0.1316859***	−0.0007893	0.1149754	−0.0288019	−0.0777131***	−0.002127	0.1009	957
(3.79)	(−1.52)	(0.43)	(−0.97)	(−6.44)	(−0.34)		
October 16th							
0.2511624***	0.000239	−1.585752***	−0.0044896	0.0803116***	−0.0072766	0.3597	959
(8.35)	(0.53)	(−6.83)	(−0.17)	(7.67)	(−1.32)		
October 22nd							
0.2140707***	−0.0006231*	−0.6442553***	0.0125341	0.017951**	−0.0044003	0.2668	957
(9.83)	(−1.91)	(−3.85)	(0.68)	(2.38)	(−1.11)		
October 24th							
0.2383337***	−0.0007798*	−1.045375***	−0.0255981	0.0218155**	−0.0084754	0.2650	959
((8.37)	(−1.83)	(−4.77)	(−1.05)	(2.20)	(−1.63)		
October 27th							
0.1169308***	0.0000371	−1.656603***	0.0910335***	0.0066216	−0.0218115**	0.1448	959
((3.53)	(0.07)	(−6.48)	(3.21)	(0.57)	(−3.60)		
Panel C: Pooled regression for small crashes							
−0.0896535***	0.0000245	−0.4815548***	0.0009014	0.0452452***	−0.0016139	0.0943	3847
(−5.93)	(0.11)	(−4.16)	(0.07)	(8.68)	(−0.59)		

This table shows the regression results when each variable is trimmed at the 1% and 99% levels to reduce the possibility of outliers biasing the regression results. The dependent variable and the explanatory variables are the same as those in the original regresion [Table 4]. The figures in parentheses are the corresponding *t*-statistics. ***, **, and * indicate 1%, 5% and 10% level of significance respectively. LAR: Liquid assets ratio, CFPS: Cash flow per share, BEP: Basic earning power, LR: Lagged return, ILLIQ: Illiquidity

crashes by examining the role of liquidity during a crash and proving that the flight-to-liquidity phenomenon does indeed exist.

The TSE provides a unique setting to test if a flight-to- liquidity occurs even when price limit rules may reduce market liquidity

Table 7: Proportion of shares whose last ask price is affected by the price limit rules

Dates	Number affected	Percentage of sample
October 8th	31	0.027
October 10th	26	0.022
October 16th	46	0.039
October 22nd	12	0.010
October 24th	7	0.006
October 27th	9	0.008

and delay price discovery. The results show that during times of market uncertainty investors are less willing to hold illiquid assets. The price limit rules which limit shares movements and possibly reduce market liquidity and delay price discovery do not appear to impact on the behavior of investors.

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