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Title	Japanese share returns in the immediate post-crash period
Author(s)	Maeda, Brooke Alexandra
Citation	大阪大学経済学. 2015, 64(4), p. 58-71
Version Type	VoR
URL	https://doi.org/10.18910/57074
rights	
Note	

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Osaka University

Vol.64 No.4 OSAKA ECONOMIC PAPERS March 2015

Japanese share returns in the immediate post-crash period*

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Abstract

This paper analyzes share return behavior following large one-day share market declines, otherwise known as market crashes. In this event study, returns of individual shares listed on the First Section of the Tokyo Stock Exchange are analyzed. The first aim of this paper is to provide new evidence using recent data from 2008 to analyze share return behavior. The second aim is to confirm that the results of Wang *et al*. (2009) are identical on the Japanese market, despite the trading rules being significantly different to the American market.

A multivariate regression is utilized with the three day post-crash cumulative returns as the dependent variable. Six events are selected with crash day returns ranging between -7% and -10%. The magnitude of the post-crash three day cumulative return varies significantly in the range of 20.48% to -16.06% and there is great variation in the pattern of the post-crash returns.

While the event days are limited, the overall results are consistent with previous research, and prove that there is a lead-lag relation with the returns of larger shares leading those of smaller shares. By analyzing dates with both subsequent positive reversals and continued negative declines, we can draw the conclusion that large firms respond faster to new information whether it be good news or bad news. Several robustness tests produced similar results.

Considering that the Japanese market and American market vary considerably with regards to trading rules, the fact that a lead-lag relation exists on both markets suggests that it is due to fundamental behavior of traders as opposed to institutional features.

JEL Codes: G10, G12, G14

Keywords: Share market crash, share returns, lead-lag, size, event study

1. INTRODUCTION

Numerous studies have analyzed share market rebounds and the behavior of shares in the period following a large one-day share market decline. Many papers focus on longer-term rebounds occurring

* The author is grateful to Wataru Ohta who gave helpful comments for improving this paper. Financial support from The Nomura Foundation for undertaking this project is also acknowledged.

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over three to five years, however another group of researchers have analyzed reversals in the short term using weekly and monthly data. This paper focuses on short-run price rebounds that occur over the subsequent days immediately following a share market crash. Other papers in the same category include Cox and Peterson (1994), Bremer and Sweeney (1991) and Bremer *et al*. (1997).

The general finding on post-crash returns is that share prices reverse. Bremer and Sweeney (1991) and Atkins and Dyl (1990) found that price declines of at least 10% are followed by reversals. Specifically, Bremer and Sweeney (1991) document significant positive three-day abnormal returns following days with a price decline of 10% or more. Research by Bremer *et al*. (1997) specifically on the Japanese share market proved that returns for shares listed on the Nikkei 300 tend to be significantly positive after large price declines.

Another finding which has been well documented is a size based lead-lag effect. Research by Lo and MacKinlay (1990) proved that returns of large-capitalization shares almost always lead those of smaller shares listed on the New York Stock Exchange. In their paper, Lo and MacKinlay (1990) document a positive correlation in weekly returns of small firms and the lagged weekly returns of large firms. Their analysis found virtually no correlation between the returns of large shares and lagged small shares returns. They argue that this size based lead-lag relation is important because it indicates the transmission of information from large firms to small firms. Similarly, Mills and Jordanov (2000) documented a very similar pattern on the London stock exchange. Their research proved that a lead-lag relation exists between portfolios of small firms and large firms constructed from the London stock exchange. Badrinath *et al.* (1995) analyze the process of information transmission between firms and show that for size-based portfolios a one month lead-lag relation exists, and for institutional ownership-based portfolios, portfolios of high institutional ownership lead the returns on portfolios with lower institutional ownership by up to two months.

While studies based on different share markets have proved that a lead-lag relation exists, the exact cause of it is still unclear. If market imperfections do not exist, then it would be expected that information transmission is instantaneous. Therefore researchers have attributed the lead-lag effect to the "thin trading" problem, noise traders, market liquidity, herd behavior, or as Jegadeesh and Titman (1995) suggest, to delayed reactions to common factors. Alternatively, Badrinath *et al.* (1995) suggest that firm size may proxy for the magnitude of information produced.

The aim of this paper is to examine the behavior of shares listed on the First Section of the Tokyo Stock Exchange in the period immediately following a large one-day share market decline. The event days are limited making it a small event study, nevertheless the results prove that a lead-lag relation exists on the Japanese share market. The First Section of the Tokyo Stock Exchange lists the largest and most traded shares in the Japanese market. It is an appropriate choice for this study for two main reasons. Firstly, Japan is an important and large market which requires attention, and secondly because it provides a market with a significantly different structure and trading rules on which to investigate if the lead-lag relation is due to institutional features or fundamental behavior of traders.

This study follows the methodology of Wang *et al.* (2009), and utilizes a multivariate regression with the three day post-crash returns as the dependent variable. Wang *et al.* (2009) studied the returns of individual shares on the American market on crash days and during the post-crash period, and found that shares of large firms lead small firms on crash days, and also that large shares lead small shares in the immediate three-day post crash period. In other words, the results show that large firms respond faster to new information. For the purpose of this study, a three day timeframe was selected to be the post crash period, as other researchers such as Bremer and Sweeney (1991), in addition to Wang *et al.* (2009) have based their analysis on these days.

The results are consistent with previous literature, and reveal that a size based lead-lag relation exists. The sign for the size variable supports the finding that large firms respond faster to new information, whether it is good news or bad news. This paper contributes to financial literature in two ways. The first aim is to provide new evidence using recent data regarding share return behavior following large one-day share market declines on the Japanese market. Bremer *et al.* (1997) analyzed events during the 1980`s, while we have used events which occurred over twenty years later during 2008, meaning this study provides new evidence on share behavior. The second aim is to confirm that the results of Wang *et al.* (2009) are identical on the Japanese market, despite the trading rules being significantly different to the American market.

The remainder of this paper is as follows. Section 2 discusses the data utilized in this study and section 3 explains the methodology used. The empirical results and the robustness tests are discussed in section 4, and the results are summarized in section 5.

2. DATA

This study specifically focuses on the individual shares listed on the First Section of the Tokyo Stock Exchange. The First Section comprises the largest shares on the Japanese share market, providing an ideal sample to test the existence of the lead-lag effect post large one-day share market declines.

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%. The six specific dates selected to be analyzed are the 8^{th} of October, 10^{th} of October, 16^{th} of October, 22^{nd} of October, 24^{th} of October and the 27^{th} of October 2008. As detailed in Table 1, the daily decrease in the index on all of these dates is reasonably large, ranging between -7% and -10%. As previously stated, in order to analyze share behavior in the post-crash period, the cumulative return over the three days immediately following the crash is utilized as other researchers such as Wang *et al.* (2009) and Bremer (1991) have done. The cumulative three day return is calculated as:

$$RET_i = (P_{it+3} - P_{it}) / P_{it} \qquad (1)$$

where RET_i denotes the three day cumulative return of share *i*, P_{it+3} denotes the share price at time $t+3$, and P_{it} denotes the share price at time *t,* the crash day. Table 1 summarizes the selected dates and data employed in this event study.

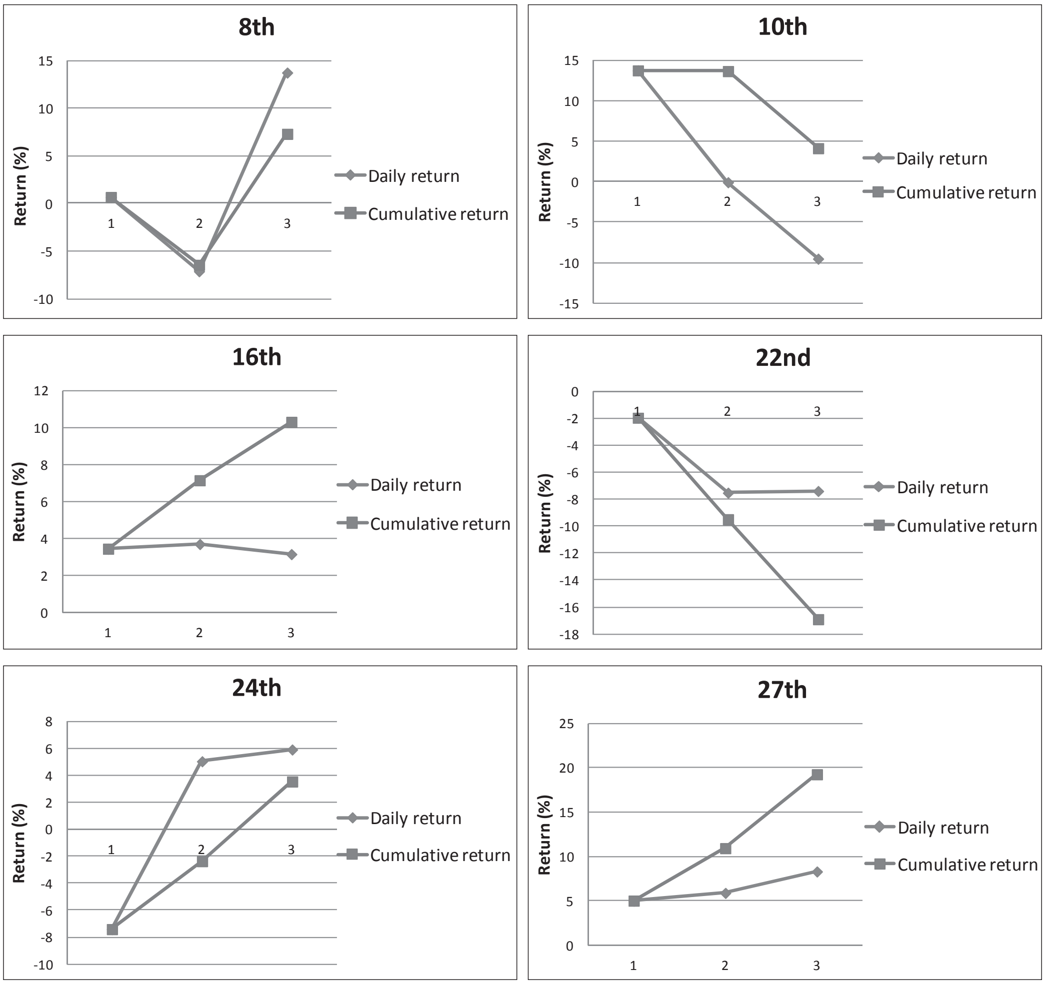
Table 1
Crash days, crash day returns and post-crash returns

Date	Daily decrease in TOPIX %	Cumulative post-crash three day return %	Sample size
8th October 2008	-8.04	6.37	1170
10th October 2008	-7.1	2.81	1171
16th October 2008	-9.52	10.66	1174
22nd October 2008	-7.05	-16.06	1174
24th October 2008	-7.5	3.0	1173
27th October 2008	-7.4	20.48	1174

The magnitude of the three day post-crash cumulative return varies significantly depending on the date. As Figure 1 shows, the index had three consecutive days of positive returns for the 16th and 27th, three consecutive negative returns for the 22nd, and a combination of both positive and negative returns for the 8th, 10th and 24th. This variation in the pattern of returns is one reason why these six dates were selected, and it is promising that the analysis may produce interesting results.

Figure 1

Graphs of the three day cumulative returns and daily returns



Data on the TOPIX index, closing prices for individual shares, plus all financial data and ratios is obtained from the Nikkei Economic Electronic Databank System (NEEDS). The financial statements data is obtained from the firm`s annual financial statements in the NEEDS database for the previous financial year.

Following Fama and French (1992) and Wang *et al.* (2009), 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. Excluding shares which fail to meet the data requirements and utilities and financial firms reduced the sample size by approximately 500 shares, however the sample is still reasonably large at approximately 1174.

3. METHODOLOGY

3.1 Hypothesis

We hypothesize that the lead-lag relation documented by Lo and MacKinlay (1990) exists in the days immediately following a large one-day market decline. That is, that large share returns lead small share returns on the First Section of the Tokyo Stock Exchange. In this study, the post-crash three day cumulative return is the dependent variable in a multivariate regression, with twelve independent variables, all of which have explanatory effects on share returns.

If the share market experiences a reversal after the large decline, then for the lead-lag relation to hold, we predict that the size variable will be positive and significant in the regressions. A positive sign will indicate that larger firms have higher post-crash returns, and imply that large firms respond faster to new information. In other words, a positive sign will imply that a size-based lead-lag relation exists in the days immediately following a large market decline. In previous research by Wang *et al.* (2009) the size variable is positive as reversals occurred.

If however the share market continues declining in the following days, then we predict that the size variable will be negative and significant as a negative sign will indicate that large firms decrease more in value than small firms. Wang *et al.* (2009) likewise found that size is negative on crash days.

Therefore if our research proves that size is positive when the market is trending upward in the days following a large decline, and negative when the market is continuing to trend downward, it will imply that large firms respond faster to new information and a size-based lead-lag relation exists. To be specific, we predict that for the 10^{th} and 22^{nd} size will be negative as the cumulative return is trending down, and for the other four days it will be positive as it is generally trending upward, as depicted in the graphs in Figure 1.

3.2 The Model

For the purpose of our study, we have followed the methodology of Wang *et al.* (2009), with the only difference being the exclusion of the industry dummy variable. Wang *et al.* (2009) employed a multivariate regression analysis to determine how firm characteristics affect returns on both crash days and in the three day post-crash period.

As stated in section 3.1, this study employs a multivariate regression with the post-crash three day cumulative return as the dependent variable and twelve independent variables, all of which are believed to have explanatory effects on share returns. For simplicity, the independent variables are calculated as of the 1st of October, 2008. The linear regression model:

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

In this model the dependent variable RET_{it}, is the cumulative share return for the three trading days immediately after the crash day. The cumulative three day post-crash share return RET_{it} is calculated using equation (1). β_0 is the a constant and β_1, $\beta_2 \ldots \beta_{12}$ are the regression coefficients. There are twelve independent variables included in the model. BETA is the CAPM beta of the share computed with monthly return data for the five 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 M/B ratios for the year directly prior to October 1st. ILLIQ is the illiquidity 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 LAR is the liquid assets ratio [(cash + marketable securities) / total assets], both calculated from the previous year's financial statements. CFPS is the cash flow per share, and BEP is the basic earning power ratio (EBIT / total assets). SDLR is the standard deviation of the lagged share returns from -252 to -30 days prior to October 1st. In addition three lagged returns are included in the model: LR1 (lagged return 1) which is the cumulative return from -7 to -2 days prior to October 1st, LR2 (lagged return 2) which is the cumulative return from -70 to -2 days prior to October 1st, and LR3 (lagged return 3) which is the cumulative return from -756 to -2 days prior to October 1st.

3.3 Control Variables

In Section 3.1 our predictions regarding the size variable are explained. In this section, we detail our predictions for the other eleven control variables included in the regression. Since this event study contains both days which are followed by positive reversals and days with continued negative declines, both situations are considered.

For beta, since beta measures the risk arising from general market movements, it is predicted that when the share market is declining beta will be negative and when the market is reversing upward that beta will be positive. Market-to-book is not expected to be highly significant, reflecting the results of Wang *et al.* (2009). The illiquidity variable is predicted to be positive as Amihud (2002) documented a positive cross-sectional relationship between illiquidity and share returns, which signifies that illiquid shares reaction is smaller in magnitude compared to liquid shares. For the debt ratio we predict the sign to be negative during a market decline as firms with high debt are considered to have higher risk and be positive during a market reversal. The liquid assets variable is expected to be negative as Wang *et al.* (2009) found, however not highly significant. For cash flow, we predict it to be negative during a positive market reversal and positive during days when the market is trending down. The basic earning power ratio is expected to be positive as more profitable firms decrease less in value during crashes. Regarding the standard deviations of lagged returns variable, it is predicted that shares which are highly volatile prior to a market decline will continue to be more volatile after the decline. As such, we predict this variable to be negative if the market is continuing to decrease and positive if the market is reversing. For the three lagged return variables we cannot make justified predications as it will vary depending on the day.

3.4 Descriptive Statistics

The descriptive statistics of the variables used in the analysis are detailed in Table 2. The mean return figures in the table are lower than the figures for the TOPIX index, suggesting that larger firms have higher returns than small firms in the immediate post-crash period. Positive skewness is present in the majority of the variables, which is reasonable during volatile times.

Table 2

Descriptive statistics of the variables

Variables	Mean	Std. Dev	Skewness	Kurtosis	Maximum	Minimum
8th October						
RET	0.6766	12.0928	23.9320	578.7373	304.1948	-0.9965
BETA	0.9958	0.6092	4.7950	58.8562	9.7847	-0.3876
SIZE	24.8257	1.5648	0.6449	2.9973	30.5853	21.7333
MVBV	1.2902	0.8738	2.7252	15.1957	8.3837	0.2597
ILLIQ	0.0006	0.0019	9.5121	117.5535	0.0287	0.0000
TDTA	0.5026	0.1962	-0.1171	2.1749	0.9311	0.0416
LAR	0.1294	0.0979	1.7294	7.5788	0.7321	0.0006
CFPS	1326.3980	13914.5400	15.7776	280.4415	280912.500	-2083.6500
BEP	6.1789	5.2751	1.0311	9.9188	46.3900	-25.3400
SDLR	0.0271	0.0079	1.0638	6.3403	0.0819	0.0056
LR1	-0.0397	0.0717	4.7154	73.8085	1.1235	-0.4321
LR2	-0.1655	0.1704	0.2582	3.3447	0.6111	-0.7573
LR3	-0.2499	0.3676	2.3408	17.0627	3.1548	-0.9844
10th October						
RET	0.0569	0.0761	0.5620	4.8682	0.4759	-0.2894
BETA	0.9956	0.6093	4.7886	58.7802	9.7847	-0.3876
SIZE	24.8283	1.5666	0.6433	2.9884	30.5853	21.7333
MVBV	1.2912	0.8737	2.7214	15.1801	8.3837	0.2597
ILLIQ	0.0006	0.0020	9.2213	107.6823	0.0287	0.0000
TDTA	0.5027	0.1962	-0.1181	2.1767	0.9311	0.0416

Variables	Mean	Std. Dev	Skewness	Kurtosis	Maximum	Minimum
LAR	0.1293	0.0979	1.7308	7.5834	0.7321	0.0006
CFPS	1325.5490	13908.6200	15.7845	280.6825	280912.500	-2083.6500
BEP	6.1817	5.2745	1.0294	9.9128	46.3900	-25.3400
SDLR	0.0271	0.0079	1.0636	6.3430	0.0819	0.0056
LR1	-0.0397	0.0717	4.7177	73.8713	1.1235	-0.4321
LR2	-0.1654	0.1704	0.2559	3.3439	0.6111	-0.7573
LR3	-0.2499	0.3675	2.3419	17.0726	3.1548	-0.9844
16th October						
RET	0.0957	0.0642	-0.3869	5.3376	0.3188	-0.3315
BETA	0.9952	0.6086	4.7946	58.9088	9.7847	-0.3876
SIZE	24.8271	1.5649	0.6457	2.9956	30.5853	21.7333
MVBV	1.2901	0.8729	2.7247	15.2076	8.3837	0.2597
ILLIQ	0.0006	0.0020	9.0768	105.2207	0.0287	0.0000
TDTA	0.5027	0.1959	-0.1187	2.1806	0.9311	0.0416
LAR	0.1293	0.0978	1.7310	7.5896	0.7321	0.0006
CFPS	1322.4620	13890.9600	15.8049	281.4047	280912.500	-2083.6500
BEP	6.1770	5.2704	1.0308	9.9230	46.3900	-25.3400
SDLR	0.0271	0.0079	1.0661	6.3524	0.0819	0.0056
LR1	-0.0397	0.0716	4.7175	73.9409	1.1235	-0.4321
LR2	-0.1649	0.1705	0.2517	3.3327	0.6111	-0.7573
LR3	-0.2496	0.3672	2.3397	17.0751	3.1548	-0.9844
22nd October						
RET	-0.1298	0.0740	-0.0735	3.0830	0.1542	-0.3682
BETA	0.9953	0.6086	4.7949	58.9193	9.7847	-0.3876
SIZE	24.8277	1.5646	0.6451	2.9964	30.5853	21.7333
MVBV	1.2902	0.8728	2.7254	15.2127	8.3837	0.2597
ILLIQ	0.0006	0.0020	9.0929	105.5163	0.0287	0.0000
TDTA	0.5025	0.1960	-0.1158	2.1784	0.9311	0.0416
LAR	0.1292	0.0978	1.7348	7.6034	0.7321	0.0006
CFPS	1322.5060	13890.9500	15.8049	281.4048	280912.500	-2083.6500
BEP	6.1824	5.2678	1.0304	9.9374	46.3900	-25.3400
SDLR	0.0271	0.0079	1.0643	6.3451	0.0819	0.0056
LR1	-0.0397	0.0716	4.7187	73.9591	1.1235	-0.4321
LR2	-0.1652	0.1704	0.2546	3.3410	0.6111	-0.7573
LR3	-0.2497	0.3673	2.3399	17.0732	3.1548	-0.9844
24th October						
RET	0.0454	0.0747	0.0381	4.8746	0.3687	-0.4051
BETA	0.9959	0.6085	4.7994	58.9824	9.7847	-0.3876
SIZE	24.8242	1.5631	0.6480	3.0050	30.5853	21.7333
MVBV	1.2891	0.8731	2.7273	15.2175	8.3837	0.2597
ILLIQ	0.0006	0.0020	9.1257	106.0865	0.0287	0.0000
TDTA	0.5027	0.1961	-0.1190	2.1777	0.9311	0.0416
LAR	0.1293	0.0978	1.7297	7.5828	0.7321	0.0006
CFPS	1323.2940	13896.8500	15.7981	281.1635	280912.500	-2083.6500
BEP	6.1737	5.2711	1.0327	9.9286	46.3900	-25.3400
SDLR	0.0271	0.0079	1.0622	6.3478	0.0819	0.0056
LR1	-0.0397	0.0717	4.7175	73.9135	1.1235	-0.4321
LR2	-0.1654	0.1703	0.2564	3.3453	0.6111	-0.7573
LR3	-0.2500	0.3672	2.3438	17.0996	3.1548	-0.9844
27th October						
RET	0.1867	0.1141	0.2149	3.1124	0.6278	-0.2216
BETA	0.9957	0.6083	4.8014	59.0214	9.7847	-0.3876
SIZE	24.8243	1.5625	0.6481	3.0074	30.5853	21.7333
MVBV	1.2888	0.8728	2.7289	15.2301	8.3837	0.2597

Variables	Mean	Std. Dev	Skewness	Kurtosis	Maximum	Minimum
ILLIQ	0.0006	0.0020	9.0587	104.9076	0.0287	0.0000
TDTA	0.5027	0.1960	-0.1179	2.1786	0.9311	0.0416
LAR	0.1293	0.0978	1.7310	7.5899	0.7321	0.0006
CFPS	1322.3980	13890.9600	15.8049	281.4045	280912.500	-2083.6500
BEP	6.1737	5.2689	1.0331	9.9370	46.3900	-25.3400
SDLR	0.0271	0.0079	1.0634	6.3498	0.0819	0.0056
LR1	-0.0397	0.0716	4.7167	73.9354	1.1235	-0.4321
LR2	-0.1651	0.1704	0.2548	3.3384	0.6111	-0.7573
LR3	-0.2496	0.3672	2.3397	17.0741	3.1548	-0.9844

4. EMPIRICAL RESULTS

4.1 Regression results

The regression results on the post-crash share returns for the six chosen dates are shown in Table 3. To ensure that multicollinearity between the variables is not an issue, variance inflation (VIF) tests are carried out. As shown in Table 3, the figures for the variance inflation tests are in the range of 1.0 and 2.0, which is significantly low indicating that multicollinearity is not a problem in the regressions.

As detailed in Table 3, the size variable is positive in the post-crash period for the 8th, 16th, 24th and the 27th, and highly significant for the 8th, 24th and 27th. Size is negative and highly significant at the 1% level for the 10th and 22nd, as the cumulative return is trending downward over both of these three day periods. The results are in line with the predictions detailed in section 3.1, and imply that larger firms increase more than small firms when the market is trending upward in the days following a large decline, and decrease more in value when the market continues to trend downward. This result suggests that large firms respond faster to new information and a size-based lead-lag relation exists. Our results support previous research by Wang *et al.* (2009), which documented the existence of a lead-lag relation in the post-crash period on the American share market for seven out of eight crashes, and is consistent with research by Lo and MacKinlay (1990), which proved that returns of large shares lead those of smaller shares. Wang *et al.* (2009) specifically documented that on crash days the size variable is negative and in the post-crash period is positive.

The results for the eleven control variables are similar to our predictions in section 3.3 however significance is lower than that for the size variable, suggesting that in the period following a large market decline size has the highest influence on share returns. The results for the control variables can be summarized as follows. Beta has mixed results however only the 8th has significance at the 10% level. Similarly, the sign for market-to-book variable is mixed and only highly significant for two of the eight days. The results for illiquidity are not as strong as expected, as the sign is positive for only two days and only one day has high significance. Overall the debt ratio is found to not be significant, which is similar to the findings in Wang *et al.* (2009), and the results for cash flow are mixed as the 10th and 22nd are positive and significant, and the 24th and 27th are negative and significant. For the basic earning power ratio, the sign is negative for four days however overall high significance is not evident. The results for the standard deviations of lagged returns variable is as expected, with a negative sign and high significance for the 10^{th,} 16th, 22nd and 24th and for the 27th is positive and significant as the three day post crash period contains three positive daily returns. The returns for the lagged variables are mixed and vary in the level of significance depending on the day.

The regression results indicate that larger firms respond faster to new information, and that a size based lead-lag relation exists in the days immediately following a large market decline on the Japanese share market. Previous studies focus on dates which are followed by positive reversals, and as such, they conclude that the size variable is positive and positive abnormal returns exist. This study analyses dates with both positive reversals and continued negative declines, meaning that the sign of the size variable depends on the trend of the share market. Nevertheless, the results imply that a size-based lead-lag relation exists with large firms responding faster to new information.

4.2 Robustness tests

In this section of our study, several robustness tests on the multivariate regression are presented. The first robustness test reruns the regression with a different proxy for illiquidity. In the original regression the illiquidity variable was calculated as the Amihud ratio, however for this part of the

Table 3
This table shows the results when the three day post-crash cumulative returns are regressed on twelve explanatory variables. The variance inflation factor (VIF) test is used to test for multicollinearity. The figures in parentheses are the corresponding standard errors. ***, **, and * indicate 1%, 5% and 10% level of significance respectively.

Explanatory variables	Oct. 8, 2008	VIF	Oct. 10, 2008	VIF	Oct. 16, 2008	VIF	Oct. 22, 2008	VIF	Oct. 24, 2008	VIF	Oct. 27, 2008	VIF
Intercept	-14.5406**		0.4882***		0.0926**		0.3470***		-0.1567***		-0.6917***	
	(7.26)		(0.043)		(0.038)		(0.037)		(0.044)		(0.056)	
BETA	-1.0624*	1.2	0.0019	1.2	0.0013	1.2	-0.0047	1.2	0.0008	1.2	0.0068	1.2
	(0.642)		(0.004)		(0.003)		(0.003)		(0.004)		(0.005)	
SIZE	0.6961**	1.5	-0.0172***	1.5	0.0012	1.5	-0.0174***	1.5	0.0087***	1.5	0.0328***	1.5
	(0.279)		(0.002)		(0.001)		(0.001)		(0.002)		(0.002)	
MVBV	0.8011	2.0	0.0170***	2.0	-0.0003	2.0	0.0054*	2.0	-0.0046	2.0	-0.0146***	2.0
	(0.575)		(0.003)		(0.003)		(0.003)		(0.003)		(0.004)	
ILLIQ	1.2233	1.0	-0.2604	1.0	-1.6265*	1.0	1.6854*	1.0	-1.5623	1.0	-4.2649***	1.0
	(194.716)		(1.100)		(0.974)		(0.953)		(1.120)		(1.42)	
TDTA	-3.2636	1.9	0.0139	1.9	-0.0160	1.9	0.0274**	1.9	0.0012	1.9	-0.0013	1.9
	(2.532)		(0.015)		(0.013)		(0.013)		(0.015)		(0.019)	
LAR	-6.7493	1.5	-0.0081	1.5	-0.0632***	1.5	0.0930***	1.5	-0.007	1.5	-0.1283***	1.5
	(4.465)		(0.027)		(0.024)		(0.023)		(0.027)		(0.034)	
CFPS	0.0000	1.0	0.0000**	1.0	-1.31e-07	1.0	0.0000***	1.0	-0.0000**	1.0	-0.0000***	1.0
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
BEP	-0.0727	1.8	-0.0008	1.8	-0.0000	1.8	-0.0014***	1.8	0.0010*	1.8	0.0032***	1.8
	(0.091)		(0.001)		(0.000)		(0.000)		(0.000)		(0.001)	
SDLR	20.4406	1.4	-1.1746***	1.4	-0.5273*	1.4	-2.3448***	1.4	-0.5435*	1.4	2.3802***	1.4
	(53.123)		(0.316)		(0.281)		(0.275)		(0.322)		(0.411)	
LR1	2.1083	1.1	-0.0311	1.1	-0.0032	1.1	0.0228	1.1	0.0270	1.1	-0.0738*	1.1
	(5.237)		(0.031)		(0.028)		(0.027)		(0.032)		(0.041)	
LR2	1.5138	1.5	0.0269*	1.5	-0.0363***	1.5	0.0589***	1.5	-0.0165	1.5	-0.1079***	1.5
	(2.557)		(0.015)		(0.014)		(0.013)		(0.015)		(0.020)	
LR3	-2.6144**	1.4	-0.0178***	1.4	0.0089	1.4	-0.0314***	1.4	0.0030	1.4	0.0312***	1.4
	(1.160)		(0.007)		(0.006)		(0.006)		(0.007)		(0.009)	
Adjusted R-squared	0.0084		0.1163		0.0131		0.2903		0.0409		0.3322	
Number of firms	1170		1171		1174		1174		1173		1174	

analysis the natural logarithm of the average of yen trading volume over a specified period, DVOL, is employed as a proxy for liquidity (Brennan *et al.* 1998). The results are shown in Table 4.

The size variable is positive and highly significant at the 1% level for the 8th, 24th and 27th, and negative and highly significant at the 1% level for the 10th and 22nd. These results indicate that our findings in the three day post-crash period are robust to the use of a different proxy for illiquidity, or in this case, substituting with a proxy for liquidity. The main conclusion to be drawn from this is that a lead-lag relation exists in the period following a large share market decline. The results for the control variables are mixed and no distinct pattern in the sign or significance levels is evident, as was documented in the original regression in Table 3.

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 0.05% and 99.5% 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.

Table 4
This table shows the robustness test results when ILLIQ is replaced with a different proxy for illiquidity. That is, the results when ILLIQ (Amihud`s illiquidity ratio) is replaced with DVOL, a figure relating to trading volume. The figures in parentheses are the corresponding standard errors. ***, **, and * indicate 1%, 5% and 10% level of significance respectively.

Explanatory variables	Oct. 8, 2008	Oct.10, 2008	Oct.16, 2008	Oct. 22, 2008	Oct. 24, 2008	Oct. 27, 2008
Intercept	-25.7498***	0.4385***	0.1247***	0.2936***	-0.1552***	-0.5899***
	(8.313)	(0.049)	(0.044)	(0.043)	(0.050)	(0.064)
BETA	-0.7506	0.0032	-0.0000	-0.0029***	0.0004	0.0031
	(0.651)	(0.004)	(0.003)	(0.003)	(0.004)	(0.005)
SIZE	1.4446***	-0.0139***	-0.0014	-0.0134***	0.0082***	0.0249***
	(0.400)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
MVBV	0.6541	0.0163***	-0.0000	0.0050*	-0.0048	-0.0138***
	(0.574)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)
DVOL	-0.7976**	-0.0034*	0.0032**	-0.0048***	0.0010	0.0097***
	(0.311)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
TDTA	-1.6377	0.0213	-0.020	0.0347**	0.0015	-0.0146
	(2.586)	(0.015)	(0.014)	(0.013)	(0.016)	(0.020)
LAR	-7.848*	-0.0126	-0.0590**	0.0869***	-0.0059	-0.1154***
	(4.473)	(0.027)	(0.024)	(0.023)	(0.027)	(0.035)
CFPS	0.0000	2.17e-07	-4.79e-08	4.49e-07***	-3.28e-07*	-6.54e-07***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BEP	-0.0886	-0.0008	0.0001	-0.0015***	0.0010*	0.0034***
	(0.091)	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
SDLR	85.4761	-0.8971***	-0.7890**	-1.9568***	-0.6247*	1.5982***
	(58.746)	(0.349)	(0.310)	(0.302)	(0.356)	(0.452)
LR1	2.1968	-0.0306	-0.0035	0.0233	0.0270	-0.0745*
	(5.222)	(0.031)	(0.028)	(0.027)	(0.032)	(0.040)
LR2	1.0912	0.0250	-0.0344**	0.0561***	-0.0159	-0.1023***
	(2.555)	(0.015)	(0.014)	(0.013)	(0.016)	(0.020)
LR3	-2.589*	-0.0176**	0.0091	-0.0315***	0.0032	0.0317***
	(1.156)	(0.007)	(0.006)	(0.006)	(0.007)	(0.009)
Adjusted R-squared	0.0140	0.1189	0.0142	0.2940	0.0395	0.3367
Number of firms	1170	1171	1174	1174	1173	1174

The regression results with all variables trimmed are presented in Table 5. The results are virtually identical, with the only difference being that the significance level for size on the 8th has decreased.

As an additional robustness test the regression results including the DVOL variable as a proxy for liquidity were trimmed, and produced virtually the same results as Table 4, however they have not been included in this paper.

Table 5
This table shows the regression results when each explanatory variable is trimmed at the 99.5% and 0.5% levels to reduce the effect of outliers on the regression. The figures in parentheses are the corresponding standard errors. ***, **, and * indicate 1%, 5% and 10% level of significance respectively.

Explanatory variables	Oct. 8, 2008	Oct. 10, 2008	Oct. 16, 2008	Oct. 22, 2008	Oct. 24, 2008	Oct. 27, 2008
Intercept	-2.4600	0.4772***	0.0932**	0.3595***	-0.1299***	-0.6645***
	(8.292)	(0.049)	(0.043)	(0.043)	(0.050)	(0.064)
BETA	-1.8080**	-0.0110**	0.0058	-0.0093**	-0.0009	0.0120*
	(0.922)	(0.005)	(0.005)	(0.005)	(0.006)	(0.007)
SIZE	0.2653	-0.0170***	0.0011	-0.0175***	0.0078***	0.0316***
	(0.319)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
MVBV	1.4527*	0.0147***	-0.0039	0.0091**	-0.0075	-0.0211***
	(0.816)	(0.005)	(0.004)	(0.004)	(0.005)	(0.006)
ILLIQ	-1105.783***	-0.2345	-1.970	1.6689	-6.6372***	-12.2605***
	(401.613)	(2.394)	(2.071)	(2.033)	(2.406)	(3.015)
TDTA	-4.1837	0.0312*	-0.0170	0.0259*	0.0063	-0.0118
	(2.758)	(0.016)	(0.015)	(0.014)	(0.017)	(0.021)
LAR	-6.553	-0.0056	-0.0462*	0.0732***	-0.0036	-0.1153***
	(5.069)	(0.030)	(0.027)	(0.026)	(0.031)	(0.039)
CFPS	0.0013***	1.47e-06**	-1.47e-06**	-1.08e-06*	1.69e-06**	2.12e-06**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
BEP	-0.1254	-0.0001	-0.0001	-0.0013**	0.0012	0.0027***
	(0.121)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
SDLR	-10.2321	-1.0370***	-0.4791	-2.7056***	-0.6435*	2.9508***
	(64.071)	(0.378)	(0.336)	(0.330)	(0.386)	(0.490)
LR1	1.1406	0.0125	-0.0409	0.0737**	0.0092	-0.1472***
	(7.275)	(0.043)	(0.038)	(0.037)	(0.044)	(0.056)
LR2	0.4560	-0.0143	-0.0459***	0.0533***	-0.0178	-0.1056***
	(2.922)	(0.017)	(0.015)	(0.015)	(0.018)	(0.022)
LR3	-2.575*	-0.0248***	0.0186**	-0.0418***	0.0017	0.0425***
	(1.501)	(0.009)	(0.008)	(0.008)	(0.009)	(0.012)
Adjusted R-squared	0.1078	0.1164	0.0224	0.2927	0.0393	0.3377
Number of firms	1064	1064	1067	1067	1066	1067

The three robustness tests all lead to the conclusion that the original regression results are robust, and that a size based lead-lag relation exists in the period following a large share market decline on the Tokyo Stock Exchange.

5. CONCLUSIONS

This paper investigates the returns of individual shares in the three day period following a large one-day market decline, otherwise known as a share market crash. The regression results show that large shares lead small shares, meaning that a lead-lag relation exists. The results are similar to those of Wang *et al.* (2009) using data on the American share market, and support previous research by Lo and MacKinlay (1990).

This event study is based on the data of approximately 1,174 shares listed in the First Section of the Tokyo Stock Exchange, meaning that the sample is composed of the largest and most frequently traded shares in the Japanese market. This study differs from other research as it analyses dates with both subsequent positive reversals and continued negative declines. Our analysis of six event days shows that when the share market is trending upward in the days following a large one-day decline the size variable is positive, and when the market is continuing to trend downward the size variable is negative. Larger firms have higher returns when the market is trending upward in the days immediately following a large decline, and decrease more in value when the market continues to trend downward. This result can be interpreted as the sign of the size variable in the regression being dependent on the trend of the share market. By analyzing dates with both subsequent positive reversals and continued negative declines, we can draw the conclusion that large firms respond faster to new information whether it be good news or bad news. Our research confirms that there is a definite relationship between firm size and share returns, and that a size-based lead-lag relation exists.

This paper contributes to financial literature by providing new evidence using recent data regarding share return behavior following large one-day share market declines on the Japanese market. Significant positive returns after large price declines are reported for the four events with an upward market trend, in line with the findings of Bremer *et al.* (1997). Furthermore, the analysis confirms that the results of Wang *et al.* (2009) are identical on the Japanese market. In other words, the data supports the existence of a lead-lag relation between large shares and small shares. As originally discovered by Lo and MacKinlay (1990), transmission of information from large firms to small firms occurs, with large firms responding faster to new information.

Our findings show that Japan has similar patterns regarding post-crash share returns to both America, as documented by Wang *et al.* (2009) and England, as replicated by Mills and Jordanov (2010). Considering that the Japanese market varies considerably to both of these markets with regards to trading rules, the fact that a lead-lag relation exists on all three markets suggests that it is due to fundamental behavior of traders as opposed to institutional features. Researchers are still unsure of the exact cause of the lead-lag relationship, however as Badrinath *et al.* (1995) suggests, it is possible that firm size may proxy for the magnitude of information produced.

REFERENCES

Amihud, Y. (2002) “Illiquidity and stock returns: Cross-section and time-series effects,” *Journal of Financial Markets*, 5, 31-56.

Atkins, A.B., Dyl, E.A. (1990) “Price reversals, bid-ask spreads, and market efficiency,” *Journal of Financial and Quantitative Analysis*, 25, 535-547.

Badrinath, S.G., Kale, J.R., and T.H. Noe. (1995) “Of shepherds, sheep, and the cross-autocorrelations in equity returns,” *Review of Financial Studies*, 8(2), 401-430.

Bremer, M., Hiraki, T., and R. Sweeney. (1997) "Predictable patterns after large stock price changes on the Tokyo Stock Exchange," *Journal of Financial and Quantitative Analysis*, 32(2), 345-365.

Bremer, M., Sweeney, R.J. (1991) "The reversal of large stock-price decreases," *Journal of Finance*, 46, 747-754.

Brennan, M.J., Chordia, T., and A. Subrahmanyam. (1998) "Alternative factor specifications, security characteristics, and the cross-section of expected returns," *Journal of Financial Economics*, 49, 345-373.

Cox, D.R., Peterson, D.D. (1994) "Stock returns following large one-day declines: Evidence on short-term reversals and longer-term performance," *Journal of Finance*, 49(1), 255-267.

Jegadeesh, N., Titman, S. (1995) "Overreaction, delayed reaction, and contrarian profits," *Review of Financial Studies*, 8(4), 973-993.

Lo, A.W., MacKinlay, A.C. (1990) "When are contrarian profits due to stock market overreaction?," *Review of Financial Studies*, 3, 175-206.

Mills, T.C., Jordanov, J.V. (2000) "Lead-lag patterns between small and large size portfolios in the London Stock Exchange," *Applied Financial Economics*, 11, 489-495.

Richardson, T., Peterson, D.R. (1999) "The cross-autocorrelation of size-based portfolio returns is not an artifact of portfolio autocorrelation," *Journal of Financial Research*, 22, 1-13.

Wang, J., Meric, G., Liu, Z., and I. Meric. (2009) "Stock market crashes, firm characteristics, and stock returns," *Journal of Banking & Finance*, 33, 1563-1574.