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INVESTOR REACTION IN STOCK MARKET CRASHES AND POST-CRASH MARKET REVERSALS

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ABSTRACT

We study investor overreaction using data for five major stock market crashes during the 1987-2008 period. We find some evidence of investor overreaction in all five stock market crashes. The prices of stocks investors bid down more than the average during crashes tend to increase more than the average in post-crash market reversals. In line with CAPM, we find that high beta stocks lose more value in crashes and gain more value in post-crash market reversals relative to low beta stocks. We further find that smaller firms and those with a low market-to-book ratio lose more value in stock market crashes. However, they do not gain more value in post-crash market reversals, implying that investor reaction against these firms in stock market crashes is not an overreaction. In examining industry-specific behavior, our results indicate that investors overbid down the prices of high-tech stocks in the 1997 crash and manufacturing stocks in the 2008 crash relative to other stocks. However, the prices of stocks in these industries increased more than other stocks in the post-crash market reversals, implying investor overreaction for these industries in these stock market crashes.

JEL: G00, G01, G10, G14

KEYWORDS: Stock Market Crash, Post-Crash Market Reversal, Determinants of Stock Returns, Investor Overreaction

INTRODUCTION

In this paper, we study investor overreaction using data for five major stock market crashes during the 1987-2008 period. A stock market crash is commonly defined as a sudden dramatic decline of stock prices across a significant cross-section of a stock market. There is no generally accepted threshold for duration or magnitude for the decline in stock prices. Wang et al. (2009) and Gulko (2002) define a stock market crash as 5% or greater decrease in stock prices in a single trading day. In this paper, we study the stock market crashes with a minimum of 9.8% cumulative decline in stock prices in several consecutive trading days.

Stock market crashes are generally followed by several days of sharp market reversal. If there is an overreaction towards stocks with certain financial characteristics during a crash, the reaction is reversed with a sharp market correction during the post-crash market reversal period. For instance, Wang et al. (2013) find that investors overreacted to the technical insolvency risk and bankruptcy risk characteristics of firms by bidding down their stock prices sharply in the 2008 crash. These stocks gained more value relative to other stocks in the post-crash market reversal. In this study, following the methodology used in Wang et al. (2013), we compare the crash and post-crash market reversal periods to determine if there was any investor overreaction in the five most important stock market crashes of the 1987-2008 period. The crash and post-crash market reversal periods included in the study are presented in Table 1.

Table 1: Crash and Recovery Event Characteristics

Event	Crash dates	Crash return (%)	Recovery dates	Recovery return (%)
October 1987	Oct 14 – Oct 19	-28.51	Oct 20 – Oct 21	+14.92
October 1997	Oct 22 – Oct 27	-9.80	Oct 28	+5.12
August 1998	Aug 26 – Aug 31	-12.41	Sep 1	+3.86
April 2000	Apr 10 – Apr 14	-10.54	Apr 17 – Apr 18	+6.27
October 2008	Oct 1 – Oct 10	-22.90	Oct 13	+11.58

This table details the five crash and recovery events that are the subject of this study. Included are the dates for crash and recovery, as well as the S&P 500 index returns for each.

Our research makes several important contributions to the literature. We document a consistent pattern of investor overreaction in a large cross-sectional sample across five of the most significant stock market crashes of the past three decades. We also find that different stock characteristics had varying impact on the magnitude of overreaction among the events included in our study. The paper is organized as follows: The next section examines prior related literature. We then provide information about our data and methodology, and follow with a presentation of our results on stock market crashes during the crash and recovery periods. In the final section, we conclude the paper and note suggestions for future research.

LITERATURE REVIEW

Stock market crashes have received considerable attention in finance literature. Arshanapalli and Doukas (1993) and Lau and McInish (1993) study the co-movements of the world's stock markets before and after the 1987 stock market crash. Roll (1988) and Pan et al. (2001) study the effects of emerging markets in stock market crashes. Wang et al. (2009 and 2010) study the determinants of stock returns in stock market crashes. De Bondt and Thaler (1985, 1987) argue that investors tend to overreact to economic events. Chopra et al. (1992), Rozeff and Zaman (1998), Bauman et al. (1999) and others provide empirical evidence for investor overreaction. In a recent article, Wang et al (2013) demonstrate that investors overreacted to the bankruptcy risk and technical insolvency risk characteristics of firms in the 2008 stock market crash. There are many possible explanations for this 'investor overreaction' phenomenon, from behavioral sentiment issues (Baker, Wurgler, 2006; Barberis, et al., 1998), to herding (Puckett, Yan, 2008) to market microstructure constraints (Park, 1995; Kaul, Nimalendran, 1990; Atkins, Dyl, 1990), to appropriate response to changing risk (Brown et al., 1993).

Dreman and Lufkin (2000) conclude that investor overreaction is psychological. Amini et al. (2013) present an overview of the literature on price reversals. Analysis of price reversals accompanying issue-specific public news or lack thereof on a shorter time frame tends to find evidence of overreaction (e.g. Chan, 2003; Larson, 2003; Bremer, Sweeney, 1991). Chopra et al. (1992) examine a longer time frame and also conclude there is evidence of overreaction. While some researchers attempt to measure investor sentiment directly (Baker, Wurgler, 2006), in this study we follow most prior research and focus on the price movements and company financials to investigate the issue of investor overreaction in general stock market crashes with data for the five most important stock market crashes during the 1987-2008 period.

DATA AND METHODOLOGY

The daily stock trading prices, used in the calculation of daily returns, are obtained from the Center for Research in Security Prices (CRSP) database. The 'crash return' is defined as the cumulative return over several consecutive daily price decreases in the S&P 500 index during the crash event. The 'recovery return' is defined as the cumulative return over several consecutive daily price increases in the S&P 500 index immediately following the crash event. We use the event study methodology and calculate the cumulative stock returns during the crash and recovery windows using trading price data. We compute the CAPM betas of the stocks using the daily stock returns for the past 90 calendar days and the CRSP-provided returns on a value-weighted index which includes NYSE, NASDAQ, and ARCA securities. Firms with missing trading prices on key event dates and those with fewer than 30 trading quotes in the past 90 calendar days are excluded from the sample. Following Wang et al. (2009), we also exclude firms with a trading price of less than one dollar. We use the Research Insight (COMPUSTAT) quarterly database to collect balance-sheet information on the individual securities. For each security and each event, we select the latest available COMPUSTAT quarterly observation within the year prior to the start of the event. Firms with missing data are excluded from the sample.

The study by Wang et al. (2013) finds that investors overreacted to the technical insolvency risk and bankruptcy risk characteristics of firms in the 2008 stock market crash. The current ratio measures the ability of a firm to meet its maturing obligations and is a standard measure of technical insolvency risk (see: Wang et al, 2013). The debt ratio is commonly used in empirical studies as a measure of firm bankruptcy risk (see, e.g., Mitton, 2002; Baek et al., 2004; Wang et al., 2013). The current ratio and the debt ratio are the two key financial ratios used in Ohlson's (1980) bankruptcy prediction model. We use these two financial ratios in our empirical tests to study investor reaction to technical insolvency risk and bankruptcy risk characteristics of firms in the five stock market crashes and post-crash market reversals included in the paper. Sharpe's CAPM has been generally tested with data for normal time periods. Beta has not been studied sufficiently as a determinant of stock returns in stock market crashes and post-crash market reversals. We use beta as a control variable in our empirical tests and we study if it was a significant determinant of stock returns in the stock market crashes and post-crash market reversals included in the paper. In their three-factor CAPM, in addition to beta, Fama and French (1992, 1993) use firm size and the market-to-book ratio as determinants of stock returns. In our empirical tests, we also use these two variables as controls and investigate if they were significant determinants of stock returns in the stock market crashes and post-crash market reversals included in the study.

Industry dummy variables are commonly used in cross-sectional studies of stock returns (see, e.g., Mitton, 2002; Baek at al., 2004; Wang et al., 2009). To control for the industry effect, we construct five broad industry portfolios (French, 2008) based on SIC codes. The portfolios are 'cnsmr', including consumer durables, nondurables, wholesale, retail, and some services; 'manuf', including manufacturing, energy, and utilities; 'hitec', including business equipment, telephone and television transmission; 'hlth', including healthcare, medical equipment, and drugs; and 'allother', which includes mines, construction, building materials, transportation, hotels, business services, entertainment, and finance. Utility firms' financial decisions are affected by regulation, while financial firm financial ratios are not comparable to those of other firms. Therefore, following Fama and French (2001, 2002), Gadarowski et al. (2007), and Wang (2009 and 2013), we exclude utilities (SIC code 4900-4999) and financial firms (SIC code 6000-6999) from our sample. The data items used in the study from the CRSP and COMPUSTAT databases are presented in Table 2. We list the variables constructed with the data in Table 3. After excluding observations with missing values, we winsorize extreme values using robust median-based measures of center and scale. At the end, we have 2591 observations for 1987, 4642 observations for 1997, 4443 observations for 1998, 4442 observations for 2000, and 3277 observations for 2008, a total of 19395 observations for the entire sample.

The descriptive statistics for the sample are presented in Table 4. The statistics in the table show a pattern of growing firm size over time, both in terms of total assets and market cap. Mean total assets gradually increases from 968 million in 1987 to 5,184 million in 2008, which is expected given the general growth of the economy as well as dollar inflation over the time period. The mean current ratio steadily grows from 2.8 in 1987 to 3.06 in 2000, then drops back down to 2.77 in 2008. The mean debt-to-equity ratio starts out high at 1.34 in 1987, decreases to 1.25 in 1997, then gradually increases to 1.29 by 2008. The crash and recovery returns are highly variable within each event sample showing that, even during significant overall market moves, there is wide variation in the performance of individual stocks.

Table 2: Data Items Used in the Study

Variable	Source	Description
Indtret	CRSP	Combined index return, including NYSE, Nasdaq, ARCA
Adjtprc	CRSP	Adjusted trading price, present only if trades occurred during the day
Tprc	CRSP	Trading price, present only if trades occurred during the day
SIC	CRSP	SIC code
TCap	CRSP	Market cap, in thousands (rescaled to millions for convenience)
ACTQ	COMPUSTAT	Total current assets, in millions
LCTQ	COMPUSTAT	Total current liabilities, in millions
LTQ	COMPUSTAT	Total liabilities, in millions
ATQ	COMPUSTAT	Total assets, in millions

This table lists all the data items used in this study, along with their descriptions and source databases.

Table 3: Constructed Variables Used in the Study

Variable	Description
crash.return	Simple total return for the 'crash' period for each event.
recovery.return	Simple total return for the 'recovery' period for each event.
beta	Stock beta calculated over the past 90 calendar days of daily stock data.
mkbk	Market to book equity ratio. TCap / (ATQ – LTQ)
dr	Debt to equity ratio. LTQ / (ATQ – LTQ)
cr	Current ratio. ACTQ / LCTQ
cnsmr	Dummy variable set to 1 for the 'consumer' industry portfolio.
manuf	Dummy variable set to 1 for the 'manufacturing' industry portfolio.
hitec	Dummy variable set to 1 for the 'high technology' industry portfolio.
hlth	Dummy variable set to 1 for the 'healthcare' industry portfolio.

This table lists all the constructed variables used in this study, along with their detailed descriptions.

We use the following multivariate regression model for each of the five crash events with the dependent variable as the crash return:

$$crash.return = a_0 + a_1 beta + a_2 TCap + a_3 mkbk + a_4 dr + a_5 cr + a_6 cnsmr + a_7 hitec + a_8 hlth + a_9 manuf + \varepsilon \quad (1)$$

where a_0 is a constant (the intercept term), ε is the error term, and $a_1, a_2, \ldots a_9$ are the regression coefficients. The independent variables in the model are beta (*beta*), size (*TCap*), market-to-book ratio (*mkbk*), debt-to-equity ratio (*dr*), current ratio (*cr*), and the dummy variables for the industry portfolios (*cnsmr*, *hitec*, *hlth*, and *manuf*). The effect of the fifth portfolio, *allother*, is left in the intercept. We use the following multivariate regression model for each of the five post-crash market reversal events with the dependent variable as the recovery return:

Table 4: Summary Statistics

Variable	Min	1st Qu.	Median	Mean	3rd Qu.	Max	StDev
Panel 1: October 1987 crash (N = 2591)							
ATQ	1.149	31.832	91.966	816.51	316.44	70011	3563.8
LTQ	0.0780	12.045	41.785	453.38	160.12	37783	2000.2
TCap	1.464	30.892	83.050	770.58	320.23	90131	3393.4
cr	0.0087	1.556	2.234	2.913	3.418	10.280	2.134
dr	0.0106	0.4826	0.9761	1.306	1.636	5.978	1.221
mkbk	0.0058	1.337	1.999	2.578	3.109	11.733	2.024
beta	-2.388	0.1750	0.5484	0.5738	0.9545	4.553	0.6293
crash.return	-0.6316	-0.2609	-0.1905	-0.1931	-0.1228	0.5532	0.1020
recovery.return	-0.4576	-0.0837	-0.0282	-0.0130	0.0428	0.6667	0.1146
Panel 2: October 1997 Crash (N = 4642)							
ATQ	1.441	36.252	108.82	1051.8	449.40	97123	4393.2
LTQ	0.0260	9.947	40.838	610.93	230.78	58537	2701.8
TCap	1.832	54.739	165.41	1480.1	617.79	167169	7473.1
cr	0.0271	1.452	2.229	2.998	3.572	10.280	2.369
dr	0.0006	0.344	0.7755	1.213	1.552	5.978	1.310
mkbk	0.0029	1.710	2.800	3.747	4.768	11.733	2.932
beta	-5.023	0.0694	0.4545	0.4323	0.8180	4.833	0.6817
crash.return	-0.5000	-0.1299	-0.0798	-0.0862	-0.0385	0.4884	0.0768
recovery.return	-0.3824	-0.0134	0.0155	0.0237	0.0558	0.4444	0.0618
Panel 3: August 1998 Crash (N = 4443)							
ATQ	1.605	43.629	137.94	1217.4	561.02	93216	4661.2
LTQ	0.0470	12.086	51.172	712.19	289.75	58535	2839.1
TCap	1.482	44.312	139.24	1650.2	530.50	280297	9682.6
cr	0.0580	1.485	2.257	3.051	3.648	10.280	2.397
dr	0.0011	0.3489	0.7932	1.229	1.576	5.978	1.319
mkbk	0.0030	1.184	1.965	2.888	3.512	11.733	2.667
beta	-4.390	0.3863	0.7696	0.7988	1.179	3.778	0.6648
crash.return	-0.6826	-0.2048	-0.1349	-0.1439	-0.0769	0.5476	0.1011
recovery.return	-0.4326	-0.0192	0.0141	0.0227	0.0583	1.500	0.0852
Panel 4: April 2000 Crash (N = 4442)							
ATQ	1.786	51.508	176.84	1709.5	685.69	244192	8340.4
LTQ	0.0230	13.711	59.798	960.33	333.68	114871	4524.9
TCap	1.379	57.436	228.02	3019.5	915.03	490266	18498
cr	0.0447	1.397	2.210	3.161	3.798	10.280	2.619
dr	0.0008	0.3078	0.7918	1.230	1.594	5.978	1.334
mkbk	0.0011	1.120	2.364	3.928	5.645	11.733	3.698
beta	-3.641	0.1954	0.5736	0.6757	1.095	4.989	0.7540
crash.return	-0.7903	-0.2777	-0.1309	-0.1643	-0.0366	0.5000	0.1627
recovery.return	-0.5000	-0.0166	0.0250	0.0509	0.1021	1.250	0.1279
Panel 5: October 2008 Crash (N = 3277)							
ATQ	1.680	138.62	507.64	4962.0	2150.9	342679	19707
LTQ	0.0090	38.369	200.83	2812.1	1155.7	200770	11704
TCap	0.5337	113.40	414.16	3425.6	1568.4	403366	14974
cr	0.0000	1.343	2.077	2.828	3.366	10.280	2.294
dr	0.0003	0.3633	0.8211	1.252	1.556	5.978	1.338
mkbk	0.0021	0.9472	1.629	2.410	2.912	11.733	2.425
beta	-1.328	0.5052	0.8322	0.8328	1.138	3.076	0.5048
crash.return	-0.8080	-0.3386	-0.2441	-0.2542	-0.1697	0.4119	0.1338
recovery.return	-0.4110	0.0461	0.0960	0.1061	0.1532	1.100	0.0982
Panel 6: All Data (N = 19395)							
ATQ	1.149	46.394	160.85	1869.6	691.11	342679	9739.2
LTQ	0.0090	13.787	60.454	1065.0	339.91	200770	5709.7
TCap	0.5337	52.760	181.69	2105.6	736.12	490266	12388
cr	0.0000	1.443	2.206	3.007	3.594	10.280	2.396
dr	0.0003	0.3575	0.8221	1.239	1.581	5.978	1.311
mkbk	0.0011	1.233	2.167	3.210	3.970	11.733	2.955
beta	-5.023	0.2434	0.6337	0.6586	1.043	4.989	0.6793
crash.return	-0.8080	-0.2375	-0.1398	-0.1600	-0.0652	0.5532	0.1313
recovery.return	-0.5000	-0.0180	0.0242	0.0387	0.0862	1.500	0.1048

This table shows the summary statistics of the data samples for the five individual crash events in Panels 1-5, in chronological order, and for all data aggregated together in Panel 6. Included are the minimum, first quartile, median, mean, third quartile, maximum, and standard deviation. All variables are as defined earlier in Tables 2 and 3.

$$recovery.return = b_0 + b_1 crash.return + b_2 beta + b_3 TCap + b_4 mkbk + b_5 dr + b_6 cr + b_7 cnsmr + b_8 hitec + b_9 hlth + b_{10} manuf + e \quad (2)$$

where b_0 is a constant (the intercept term), e is the error term, and $b_1, b_2, \ldots b_{10}$ are the regression coefficients. The independent variables of Model (2) are the same as in Model (1) except the crash returns (*crash.return*) variable. Crash returns are used as an independent variable in Model (2) to determine if crash returns can explain post crash returns.

RESULTS AND DISCUSSION

Crash Periods

The multivariate regression analysis results for the five crash periods using Equation (1) are presented in Table 5. The F statistics indicate that all five regressions in the table are statistically significant. The explanatory power of the model varies between the events with the adjusted R-squared ranging from a low of 8.5 percent for 1997 to 44.9 percent for 2000. For all the events, the regression coefficient of beta is significant and negative, which indicates that stocks with a higher beta lost more value in all five stock market crashes relative to lower beta stocks. This result is in line with the CAPM, which predicts that stocks with higher betas would lose more value in down markets relative to low beta stocks. The regression coefficient of the size (TCap) variable is significant with a negative sign for the 1987 crash and with a positive sign for the 1998, 2000, and 2008 crashes. It is not statistically significant for the 1997 crash. The Fama and French (1992, 1993) three-factor CAPM argues that large firms are less risky than smaller firms. Therefore, the TCap variable should have a positive sign in a stock market crash. The 1998, 2000, and 2008 results confirm the prediction of the model. However, our results indicate that larger firms lost more value compared with smaller firms in the 1987 crash. There was a major market correction in stock prices in the 1987 crash. Investors might have thought that large firm stocks were more overvalued compared with small company stocks prior to the crash.

The regression coefficient of the market-to-book (mkbk) variable is significant with a negative sign for the 1987, 1997, 1998 and 2000 crashes and with a positive sign for the 2008 crash. According to Fama and French's (1992, 1993) three-factor CAPM, the market-to-book ratio is a risk factor in capital-asset pricing. A low market-to-book ratio implies that the firm may be in financial distress. These firms are expected to perform worse compared with high market-to-book firms in stock market crashes. Our regression result for the 2008 crash confirms the theory's prediction. However, the results for the 1987, 1997, 1998, and 2000 crashes do not support the theory's prediction. Wang et al. (2013) determine that bankruptcy risk was a serious concern for investors in the 2008 crash. Therefore, we find that firms with a low market-to-book ratio and greater risk lost more value in the 2008 crash. In the 1987, 1997, 1998, and 2000 crashes, however, perhaps investors considered firms with a high market-to-book ratio to be overvalued prior to crash and they simply bid down their prices more relative to low market-to-book ratio firms during the crash.

Our findings with the debt-to-equity (dr) variable also confirm our conclusion with the size (TCap) and mkbk variables. Bankruptcy risk was a significant concern for investors in the 2008 crash. Therefore, firms with a smaller size, lower mkbk, and higher dr lost more value in the 2008 crash. However, the dr variable is significant with a positive sign in the 1997, 1998, and 2000 crashes. Firms with a high dr performed better in these crashes relative to low dr firms. Since technical insolvency risk and bankruptcy risk were significant concerns for investors in the 2008 crash, like the dr variable, the current ratio (cr) variable is also significant for the 2008 crash with a positive sign. Firms with a higher cr (i.e., firms with a better ability to meet their maturing obligations) lost less value in the 2008 crash. We find a similar result for the 1987 crash. However, the sign of the cr variable is significant but negative for the 1998 and 2000 crashes. Firms with more investment in less profitable liquid assets lost more value in these crashes.

The regression coefficients for the industry dummy variables indicate that there is significant variation ithe industry effect between the five crash events. With the exception of the 1987 crash, it appears that the consumer goods industry segment (cnsmr) generally performed better during crashes with positive and significant regression coefficients. Firms in the 'hitec' industry group performed better than the average in the 2008 crash and worse than the average in the 1997, 1998 and 2000 crashes. The healthcare (hlth) industry regression coefficient is significant only for the 1987 and 2000 crashes with firms in this industry underperforming the average in the former and outperforming the average in the latter event. The regression coefficient for the manufacturing (manuf) industry segment is positive and significant for 1997, 1998, and 2000, and negative for 2008, indicating that manufacturing firms performed better than the average in the 1997,1998, and 2000 crashes and worse than the average in the 2008 crash. We observe a pattern of opposition between the effects of the hitec and manuf industry sectors in stock market crashes. Whenever the regression coefficient of one is positive the other is negative, and vice versa. The cnsmr sector appears to perform consistently better than the average in crashes.

Table 5: Multivariate Regression Analysis Results for the Crash Events

	Dependent Variable: Crash.Return									
	1987		**1997**		**1998**		**2000**		**2008**	
	Result	**VIF**	**Result**	**VIF**	**Result**	**VIF**	**Result**	**VIF**	**Result**	**VIF**
Intercept	-0.1473 ***		-0.0737 ***		-0.1069 ***		-0.0685 ***		-0.2271 ***	
	(-21.271)		(-19.509)		(-20.962)		(-11.165)		(-29.607)	
beta	-0.0513 ***	1.072	-0.0147 ***	1.053	-0.0327 ***	1.051	-0.0438 ***	1.313	-0.0528 ***	1.081
	(-16.916)		(-9.027)		(-14.722)		(-15.922)		(-11.641)	
TCap	-0.0024 ***	1.059	0.0000	1.060	0.0006 ***	1.063	0.0008 ***	1.050	0.0003 **	1.029
	(-4.274)		(0.3134)		(3.745)		(7.863)		(2.170)	
mkbk	-0.0063 ***	1.078	-0.0036 ***	1.161	-0.0046 ***	1.197	-0.0133 ***	1.449	0.0057 ***	1.191
	(-6.709)		(-9.197)		(-7.804)		(-22.522)		(5.742)	
dr	-0.0013	1.210	0.0061 ***	1.302	0.0027 **	1.279	0.0106 ***	1.275	-0.0109 ***	1.376
	(-0.7928)		(6.485)		(2.203)		(6.894)		(-5.647)	
cr	0.0026 ***	1.278	-0.0003	1.349	-0.0014 **	1.275	-0.0089 ***	1.395	0.0041 ***	1.271
	(2.637)		(-0.5933)		(-2.024)		(-10.937)		(3.783)	
cnsmr	-0.0020	1.168	0.0135 ***	1.216	0.0181 ***	1.187	0.0292 ***	1.356	0.0277 ***	1.171
	(-0.329)		(3.652)		(3.677)		(4.695)		(3.914)	
hitec	-0.0074	1.168	-0.0163 ***	1.216	-0.0142 ***	1.187	-0.0569 ***	1.356	0.0197 ***	1.171
	(-1.164)		(-4.481)		(-2.952)		(-9.313)		(2.954)	
hlth	-0.0257 ***	1.168	0.0048	1.216	-0.0009	1.187	0.0188 **	1.356	0.0018	1.171
	(-3.127)		(1.070)		(-0.1613)		(2.516)		(0.2137)	
manuf	0.0015	1.168	0.0095 **	1.216	0.0118 **	1.187	0.0519 ***	1.356	-0.0342 ***	1.171
	(0.2521)		(2.520)		(2.348)		(7.998)		(-4.832)	
N	2591		4642		4443		4442		3277	
Adj. R-squared	0.1530		0.0853		0.1002		0.4492		0.1142	
F statistic	52.974 ***		49.092 ***		55.981 ***		403.36 ***		47.922 ***	
	(0.0000)		(0.0000)		(0.0000)		(0.0000)		(0.0000)	

This table shows the results of multiple regression analysis on the data for the individual events. The dependent variable is the crash return, and the independent variables are as listed in the table in the leftmost column. The regression specification is as follows: crash.return = $a_0 + a_1 beta + a_2 TCap + a_3 mkbk + a_4 dr + a_5 cr + a_6 cnsmr + a_7 hitec + a_8 hlth + a_9 manuf + \varepsilon$ *Each column shows the regression results for one of the events, left to right in chronological order, as labeled. Shown are the coefficients with significance indicators, and t-statistics below in parentheses. All variables are as defined earlier in Tables 2 and 3, but with TCap rescaled to billions. The last three rows list the number of observations, the adjusted R-squared, and the F statistic (with p-value in parentheses), for each of the regressions. The variance inflation factors (VIF) are listed to the right of each coefficient for each regression. The VIF is used to test for multicollinearity in the model. Prior literature suggests that there is no major multicollinearity associated with a variable if the VIF value is less than 10 (Belsley et al., 2009). ***, **, * indicate significance at the 1, 5, and 10 percent levels, respectively.*

Post-Crash Market Reversal Periods

The results of the regressions specified by Equation (2) are shown in Table 6. The F statistics indicate that all five regressions are statistically significant. The explanatory power of the model varies between the events but is on average higher than in the crash regressions with the adjusted R-squared ranging from a 14.7 percent for 1998 to 36.5 percent for 2000.

Table 6: Multivariate Regression Analysis Results for the Post-Crash Market Reversal Events

	Dependent Variable: Recovery.Return									
	1987		1997		1998		2000		2008	
	Result	**VIF**	**Result**	**VIF**	**Result**	**VIF**	**Result**	**VIF**	**Result**	**VIF**
Intercept	-0.1407 *** (-19.266)		-0.0188 *** (-6.435)		-0.0226 *** (-5.159)		-0.0214 *** (-3.749)		-0.0043 (-0.7503)	
crash.return	-0.6303 *** (-32.912)	1.185	-0.3346 *** (-30.672)	1.095	-0.2936 *** (-23.842)	1.114	-0.3016 *** (-21.848)	1.819	-0.3111 *** (-26.534)	1.132
beta	-0.0024 (-0.7661)	1.190	0.0062 *** (5.097)	1.072	0.0097 *** (5.214)	1.103	0.0156 *** (5.997)	1.388	0.0304 *** (9.808)	1.126
TCap	0.0054 *** (9.809)	1.066	0.0003 *** (2.995)	1.060	0.0003 *** (2.775)	1.067	0.0002 ** (2.281)	1.064	0.0003 *** (3.346)	1.031
mkbk	0.0004 (0.3911)	1.097	0.0017 *** (5.613)	1.183	0.0008 * (1.693)	1.213	0.0026 *** (4.615)	1.615	0.0022 *** (3.267)	1.203
dr	-0.0007 (-0.4099)	1.210	-0.0012 * (-1.784)	1.314	-0.0028 *** (-2.751)	1.280	-0.0026 * (-1.803)	1.288	-0.0020 (-1.566)	1.389
cr	-0.0012 (-1.304)	1.282	-0.0002 (-0.4664)	1.349	-0.0004 (-0.6623)	1.276	0.0006 (0.7674)	1.432	-0.0006 (-0.7816)	1.277
cnsmr	0.0148 ** (2.514)	1.174	0.0084 *** (3.075)	1.246	-0.0020 (-0.4876)	1.206	0.0015 (0.2597)	1.495	-0.0127 *** (-2.666)	1.207
hitec	-0.0045 (-0.7287)	1.174	0.0103 *** (3.808)	1.246	-0.0055 (-1.387)	1.206	0.0079 (1.395)	1.495	0.0072 (1.609)	1.207
hlth	-0.0024 (-0.2971)	1.174	0.0056 * (1.689)	1.246	0.0023 (0.4889)	1.206	-0.0207 *** (-3.008)	1.495	0.0058 (1.037)	1.207
manuf	0.0144 ** (2.446)	1.174	0.0029 (1.037)	1.246	-0.0063 (-1.534)	1.206	0.0104 * (1.735)	1.495	0.0175 *** (3.677)	1.207
N	2591		4642		4443		4442		3277	
Adj. R-squared	0.3655		0.2203		0.1473		0.2476		0.2604	
F statistic	150.22 *** (0.0000)		132.14 *** (0.0000)		77.748 *** (0.0000)		147.17 *** (0.0000)		116.34 *** (0.0000)	

This table shows the results of multiple regression analysis on the data for the individual events. The dependent variable is the recovery return, and the independent variables are as listed in the table in the leftmost column. The regression specification is as follows: recovery.return = b_0 + $b_1$crash return + $b_2$beta + b_3TCap + $b_4$mkbk + $b_5$dr + $b_6$cr + $b_7$cnsmr + $b_8$hitec + $b_9$hlth + b_{10}manuf + e Each column shows the regression results for one of the events, left to right in chronological order, as labeled. Shown are the coefficients with significance indicators, and t-statistics below in parentheses. All variables are as defined earlier in Tables 2 and 3, but with TCap rescaled to billions. The last three rows list the number of observations, the adjusted R-squared, and the F statistic (with p-value in parentheses), for each of the regressions. The variance inflation factors (VIF) are listed to the right of each coefficient for each regression. The VIF is used to test for multicollinearity in the model. Prior literature suggests that there is no major multicollinearity associated with a variable if the VIF value is less than 10 (Belsley et al., 2009).
****, **, * indicate significance at the 1, 5, and 10 percent levels, respectively.*

For all the events, the regression coefficient of the crash return variable is significant with a negative sign indicating that firms that experience a larger negative return during the crash period make up for it with a larger positive return in the post-crash market reversal. It implies investor overreaction during the crash period with a significant market correction in the post-crash market reversal.

The regression coefficient of beta is significant with a positive sign for all events except the 1987 post-crash market reversal event. The 1997, 1998, 2000, and 2008 results are in line with the prediction of the CAPM. The model predicts that stocks with higher betas earn higher returns relative to low beta stocks in up markets. The regression coefficient of size (TCap) is significant with a positive sign for all post-crash market reversal events (i.e., large company stocks outperform small company stocks in all post-crash market reversals). This result is in line with the prediction of the Fama-French (1992, 1993) three-factor CAPM. The regression coefficient of the market-to-book ratio (mkbk) is positive and significant for all post-crash market reversal events except the 1987 event. The 1997, 1998, 2000, and 2008 results are in line with the prediction of the Fama-French model. The model predicts that high market-to-book stocks would outperform low market-to-book stocks in up markets.

The regression coefficient of the debt-to-equity ratio (dr) is negative and significant for the 1997, 1998, and 2000 market reversal events. Since these coefficients are positive and significant during the crash, it implies that investors overreacted by bidding down the prices of low dr firm stocks too much in these crashes, which resulted in a significant market correction after the crash. The regression coefficients for the current ratio (cr) variable are statistically insignificant in all five post-crash market reversal events. It implies that there was no investor overreaction to the cr variable in the market crashes which would have resulted in a significant market correction in the post-crash market reversal. The signs and significance of the regression coefficients for the industry portfolios vary between the events. The industry effect appears to be generally less significant in the post-crash market reversal period than in the crash period. The results imply investor overreaction in the hitec industry in the 1997 crash and in the manuf industry in the 2008 crash. Stocks that lost more value than the average in the hitec industry in the 1997 crash and in the manuf industry in the 2008 crash gained more value than the other stocks in the post-crash market reversal.

Combined Data for All Five Crashes

Although the five stock market crash events have a number of distinct characteristics, running regressions with the combined sample may provide some useful insights about the overall mean effects of the variables across all crashes. We present our regression results with the entire data set for all five market crash and post-crash market reversal events in Table 7. The F statistics indicate that both the crash regression and the post-crash market reversal regression are statistically significant at the 1-percent level.

The regression coefficient of the crash return variable is significant with a negative sign for the post-crash market reversal. It indicates that stocks that lose more value in crashes tend to gain more value in post-crash market reversals. It implies investor overreaction in stock market crashes. The regression coefficient of beta is significant in both regressions and it has a negative sign for the crash and a positive sign for the post-crash market reversal. It implies that stocks with higher betas lose more value in crashes and they gain more value in post-crash market reversals relative to low beta stocks. This finding is in line with the prediction of the CAPM that high beta stocks lose more value in down markets and gain more value in up markets relative to low beta stocks. The regression coefficient of size (TCap) is significant with a positive sign in both regressions. It implies that stocks with larger market capitalization perform better compared with stocks with smaller market capitalization both in crashes and in post-crash market reversals. This finding is in line with the Fama-French (1992, 1993) three-factor CAPM, which argues that large firms are less risky and investors require lower returns from these firms.

Table 7: Multivariate Regression Analysis Results with All data

	Crash		Recovery	
	Result	VIF	Result	VIF
Intercept	-0.1105 *** (-37.061)		-0.0303 *** (-13.120)	
crash.return			-0.3533 *** (-65.620)	1.175
beta	-0.0596 *** (-45.334)	1.056	0.0128 *** (12.327)	1.168
TCap	0.0003 *** (3.967)	1.039	0.0005 *** (8.519)	1.040
mkbk	-0.0043 *** (-13.529)	1.173	0.0020 *** (8.409)	1.184
dr	0.0027 *** (3.682)	1.262	-0.0022 *** (-3.918)	1.263
cr	-0.0024 *** (-5.855)	1.311	-0.0008 ** (-2.508)	1.313
cnsmr	0.0258 *** (8.855)	1.197	0.0000 (-0.0178)	1.214
hitec	-0.0131 *** (-4.573)	1.197	0.0032 (1.490)	1.214
hlth	0.0108 *** (3.048)	1.197	0.0004 (0.1694)	1.214
manuf	0.0165 *** (5.553)	1.197	0.0036 (1.609)	1.214
N	19395		19395	
Adj. R-squared	0.1488		0.2487	
F statistic	377.62 *** (0.0000)		643.08 *** (0.0000)	

This table shows the results of multiple regression analysis on the entire data sample. In the first column, labeled 'Crash', the dependent variable is the crash return, and the independent variables are as listed in the table in the leftmost column: crash.return = $a_0 + a_1 beta + a_2 TCap + a_3 mkbk + a_4 dr + a_5 cr + a_6 cnsmr + a_7 hitec + a_8 hlth + a_9 manuf + \varepsilon$ For the second column, labeled 'Recovery', the dependent variable is the recovery return, and the independent variables are as listed in the table in the leftmost column: recovery.return = $b_0 + b_1$crash return $+ b_2 beta + b_3 TCap + b_4 mkbk + b_5 dr + b_6 cr + b_7 cnsmr + b_8 hitec + b_9 hlth + b_{10} manuf + e$ Shown are the coefficients with significance indicators, and t-statistics below in parentheses. All variables are as defined earlier in Tables 2 and 3, but with TCap rescaled to billions. The last three rows list the number of observations, the adjusted R-squared, and the F statistic (with p-value in parentheses), for each of the regressions. The variance inflation factors (VIF) are listed to the right of each coefficient for each regression. The VIF is used to test for multicollinearity in the model. Prior literature suggests that there is no major multicollinearity associated with a variable if the VIF value is less than 10 (Belsley et al., 2009).
****, **, * indicate significance at the 1, 5, and 10 percent levels, respectively.*

When the regression coefficient of a variable is significant with different signs in the crash and post-crash market reversal periods, it implies investor overreaction during the crash. The regression coefficient of the mkbk variable is significant in both regressions and it has a negative sign for the crash and a positive sign for the post-crash market reversal. It implies that investors consider high mkbk stocks to be overvalued prior to crashes and they bid down their prices more relative to low mkbk stocks in stock market crashes. However, there is a significant market correction for the prices of high mkbk stocks in the post-crash reversals implying investor overreaction towards these stocks during the crash.

The regression coefficient of the debt-to-equity ratio (dr) variable is significant in both regressions and it has a positive sign for the crash and a negative sign for the post-crash market reversal implying investor overreaction during the crash period. The result implies that the stocks of firms with higher debt ratios generally perform better in crashes (excluding the 2008 crash when investors had a serious concern with bankruptcy risk) but they perform worse in post-crash market reversals compared with the stocks of firms with lower debt ratios. The regression coefficient of current ratio (cr) is significant with a negative sign in both regressions. It implies that the stocks of firms with more investment in less profitable current assets generally perform worse both in crashes and in post-crash market reversals. However, this is an aggregate result for all crashes. Because technical insolvency risk was a major concern for investors, low cr firms lost more value relative to high cr firms in the 1987 and 2008 stock market crashes (see Table 6). All regression coefficients for the industry dummy variables are statistically significant for the crash period. The sign of the regression coefficient for the cnsmr, hlth, and manuf industries is positive. It implies that the stocks of firms in these industries generally perform better than the average in stock market crashes. The sign of the regression coefficient for the hitec industry is negative in the crash regression. It implies that the stocks in this industry generally perform worse than the average in crashes. The regression coefficients of all four industries are insignificant for the post-crash market reversal period. This implies that the stocks in all four industries generally perform similarly in post-crash market reversals with no major market correction for any industry to correct an overreaction during the crash periods.

CONCLUSION

In this paper, we study the determinants of stock returns in five major stock market crashes and post-crash market reversals during the 1987-2008 period to investigate if there was any investor overreaction in these crashes. Using daily closing prices we calculate cumulative returns for the crash and reversal periods for the events listed in Table 1, and regress crash and reversal returns on a number of firm characteristics. The regression coefficient of the crash return variable is statistically significant with a negative sign in all post-crash market reversal regressions. This result implies that there is investor overreaction in stock market crashes. Stocks that lose more value in crashes tend to gain more value after the crash with a significant market correction in the post-crash market reversal. Sharpe's CAPM predicts that high beta firms lose more value in down markets and gain more value in up markets compared with low beta firms. As predicted by the theory, in this paper, we find that high beta companies lose more value in stock market crashes and gain more value in post-crash market reversals.

In the Fama-French (1992, 1993) three-factor CAPM, in addition to beta, firm size and market-to-book ratio are also market risk factors and determinants of stock returns. The model argues that smaller firms and those with lower market-to-book ratios are riskier. Therefore, investors would require a higher rate of return with a larger risk premium when valuing these firms. As predicted by the theory, we find that smaller firms and those with lower market-to-book ratios lose more value in stock market crashes. However, the sign of the regression coefficients for these variables does not change in the post-crash market reversals. It implies that investor reaction against smaller and lower market-to-book ratio firms in stock market crashes is not an overreaction. The regression coefficient of the debt ratio (dr) variable is significant with a positive sign in the 2008 crash. Since bankruptcy risk was a serious concern for investors, high-dr firms lost more value relative to low-dr firms in the 2008 crash. However, the regression coefficient for the dr variable is not significant in the post-crash market reversal. It implies that investors' bidding down the prices of high dr firms was not an overreaction in the 2008 crash.

Our crash regressions show that, because technical insolvency risk was an important concern for investors, firms with a higher current ratio (cr) and thus greater ability to meet their maturing obligations, lost less value relative to lower cr firms in the 1987 and 2008 crashes. However, the regression coefficient for the cr variable is not significant in the post-crash market reversal regressions. It implies that investors' bidding down the prices of low cr firms was not an overreaction in the 1987 and 2008 crashes.

The industry dummy variables indicate that there is no specific pattern of industry effect in stock market crashes. However, investors appear to have overreacted against high tech stocks in the 1997 crash and against manufacturing stocks in the 2008 crash with a significant market correction in the values of these stocks in the post-crash market reversals. The present research has several limitations. First, in this study we have a relatively short term definition of market crash and reversal, requiring consecutive stock index price declines for the crash, and consecutive increases for the reversal. It would be instructive to look at longer-term market crash and reversal periods. Additionally, we only look at U.S. firms; it is possible that international markets would exhibit different patterns of investor behavior. Investigating these issues in greater detail should be fertile ground for future research.

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