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THE DETERMINANTS OF STOCK RETURNS IN THE 1987 AND 2008 STOCK MARKET CRASHES

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ABSTRACT

In this research we study the determinants of stock returns in the 1987 and 2008 stock market crashes; the two most important financial crises in the U.S history since the Great Depression. We find that stocks with high betas, high debt ratios, and low profitability lost more value in both 1987 and 2008 crashes. Interestingly, since bankruptcy risk was a serious concern for investors in the 2008 crash, investors dumped riskier small firm stocks. However since bankruptcy risk was not as big a concern for investors in the 1987 crash, large firm stock prices lead small firm stock prices in the downward direction.

Keywords: *Financial Crisis; Bankruptcy Risk; Debt Ratio; Stock Beta; Profitability.*

JEL Classifications: G01; G30

1. INTRODUCTION

A stock market crash can be defined as a sudden dramatic decline of stock prices across a significant cross-section of a stock market, resulting in a significant loss of paper wealth. In a recent empirical study, Wang et al. (2009) define a stock market crash as 5% or greater decrease in stock prices in a single trading day. The stock price decline in most stock market crashes tends to continue for several days. In this study, we define a major stock market crash as an event with 20% or greater decline in stock prices in several consecutive trading days. The 1987 and 2008 stock market crashes fit this definition. These are the two most important stock market crashes in U.S. history since the Great Depression. In the 1987 crash, the stock market lost 28.5% of its value during the October 13-19 period. In the 2008 crash, the stock market lost 23.7% of its value during the September 30-October 10 period.

In the Capital Asset Pricing Model (CAPM), stock returns are explained by beta, the market risk. The empirical tests of the CAPM generally use data for normal periods. Whether beta is a significant determinant of stock returns in stock market crashes has not been studied sufficiently. One of our objectives in this paper is to determine if beta was a significant determinant of stock returns in the 1987 and 2008 stock market crashes.

In their three-factor capital asset pricing model, Fama and French (1992, 1993, 2012) demonstrate that, in addition to beta, firm size and the market-to-book ratio are also significant determinants of stock returns. Miyajima and Yafeh (2007) and Jiang and Lee (2007) find firm size and market-to-book ratio to be among the most important determinants of firm stock performance. The empirical tests of the Fama-French capital asset pricing model generally use data for normal periods. Whether firm size and the market-to-book ratio are significant determinant of stock returns in stock market crashes one of our objectives in this paper. We investigate if firm size and the market-to-book ratio were significant determinants of stock returns in the 1987 and 2008 stock market crashes.

The capital asset pricing models rely on market risk factors and they assume that firm-specific idiosyncratic risk can be diversified away. However, Amihud (2002), Xu and Malkiel (2003), and Wang et al. (2009) demonstrate that firm characteristics and stock returns may be related significantly. In this paper, we investigate if firm characteristics such as liquidity, indebtedness, and profitability were significant determinants of stock returns in the 1987 and 2008 stock market crashes.

2. LITERATURE REVIEW

Technical insolvency is described as a situation in which a firm is temporarily unable to service its debts. If persists, technical insolvency can lead to bankruptcy. Baek et al. (2004) and Wang et al. (2009, 2013) find that investors are concerned with the firm's technical insolvency risk in financial crisis periods and stock market crashes. In this study, we use the ratio of liquid assets (cash+marketable securities) to total assets as a proxy measure for the firm's technical insolvency risk. We assume that firms with a higher liquid-assets ratio would be better able to meet their maturing obligations and they would have less technical insolvency risk. Bonfim (2009) determines that the liquidity ratio has a negative impact on default probability. Bankruptcy-prediction models generally include a liquidity ratio (see, e.g., Altman, 1968). In this paper, we investigate if the liquid assets ratio (technical insolvency risk) was a determinant of stock returns in the 1987 and 2008 stock market crashes.

Mitton (2002), Baek et al. (2004), Bonfim (2009), and Wang et al. (2009, 2013) demonstrate that investors are seriously concerned with bankruptcy risk in financial crisis periods and stock market crashes. The debt ratio is generally used as a proxy measure for the firm's bankruptcy risk in empirical studies. The Hamada (1969) equation specifies the effect of financial leverage on beta. However, the leveraged beta only captures the volatility risk contribution of the debt ratio. The debt ratio can have an added importance in stock market crashes because of the bankruptcy risk concerns of investors. In this paper, we investigate if the debt ratio (bankruptcy risk) was a significant determinant of stock returns in the 1987 and 2008 stock market crashes.

Pastor and Veronesi (2003) demonstrate that firm profitability is a key determinant of stock price. Bonfim (2009) demonstrates that firm profitability is significantly related to bankruptcy risk. In this paper, we investigate if profitability was a determinant of stock returns in the 1987 and 2008 stock market crashes. We use two measures of profitability: 1) Return on Equity (Net Income/Common Equity); and, 2) Earning Power Ratio (Operating Income/Total Assets). These are the profitability measures most commonly used in previous empirical studies.

Industry classification is a commonly used dummy variable in cross-sectional regressions to control for the industry effect. Mitton [2002], Baek et al. [2004], and Wang et al. [2009] use industry dummies in their cross-sectional regressions of financial crisis periods and stock market crashes. We also use an industry dummy variable in our multivariate cross-sectional regressions for the 1987 and 2008 stock market crashes to control for the industry effect.

3. METHODOLOGY AND DATA

We use the following two linear multivariate regression models with the stock cumulative log returns during the crash period as the dependent variable:

Model 1:

$$RET_i = a_0 + a_1 BETA_i + a_2 SIZE_i + a_3 MKBK_i + a_4 LAR_i + a_5 ROE_i + a_6 ID + e_i \quad \text{Equation (1)}$$

Model 2:

$$RET_i = b_0 + b_1 BETA_i + b_2 SIZE_i + b_3 MKBK_i + b_4 DR_i + b_5 EPR_i + b_6 ID + f_i \quad \text{Equation (2)}$$

where RET_i is the stock cumulative log returns for firm i for the crash period, $BETA_i$ is the firm's stock beta, $SIZE_i$ is the log of the market capitalization of the firm, $MKBK_i$ is the market-to-book ratio, LAR_i is the liquid-assets ratio, DR_i is the debt ratio, ROE_i is the return-on-equity ratio, EPR_i is the earning power ratio, ID is the industry dummy variable, $a_1, a_2, \ldots, a_6$ are the regression coefficients for Model 1, $b_1, b_2, \ldots, b_6$ are the regression coefficients for Model 2, a_0 and b_0 are constants in the Model 1 and Model 2 regressions, respectively, and e_i and f_i are the error terms of the Model 1 and Model 2 regressions, respectively.

The Pearson correlation coefficients between the variable used in the study are presented in Table 1. The coefficients in the correlation matrix indicate that the technical insolvency risk variable liquid-assets ratio (LAR) and the bankruptcy risk variable debt ratio (DR) are highly correlated. Therefore, to avoid multicollinearity in the regressions, we have these two variables in two different regression models. Similarly, the profitability variables ROE and EPR are also highly correlated. Therefore, to avoid multicollinearity, we also have these two variables in two different regression models. Since LAR is less correlated with ROE than with EPR, we have LAR and ROE in the same regression model (Model 1). Since DR is less correlated with EPR than with ROE, we have DR and EPR in the same regression model (Model 2).

Table 1
Pearson Correlation Coefficients Between the Variables*

	RET	BETA	SIZE	MKBK	LAR	DR	ROE	EPR
RET		-0.2733	-0.3657	-0.0842	-0.0214	-0.0652	-0.0870	-0.1043
BETA	-0.0989		0.0433	0.1030	0.0978	-0.0348	-0.0294	-0.0271
SIZE	0.0317	-0.0610		0.0336	-0.0613	0.0431	0.2881	0.3820
MKBK	0.0230	0.0771	0.2087		0.1442	0.0651	-0.2002	-0.1183
LAR	0.1218	0.2198	-0.2182	0.1909		-0.4725	0.0191	-0.0976
DR	-0.1382	-0.0997	0.2470	0.1840	-0.4604		-0.1602	-0.0086
ROE	0.0797	-0.1191	0.3596	0.0203	-0.2248	0.0407		0.6635
EPR	0.0998	-0.1255	0.3901	-0.0032	-0.3579	0.0970	0.7523	

*The figures in the upper diagonal half of the table are the correlation coefficients for the 1987 crash. The figures in the lower diagonal half of the table are the correlation coefficients for the 2008 crash. The stock returns data for the 1987 and 2008 stock market crashes were obtained from the CRSP database. The CAPM betas of the firms were computed by regressing monthly stock returns against the CRSP composite monthly index returns with data covering the five-year (60 months) period prior to the year of the crash.

The definitions of the independent variables of the regressions are presented in Table 2. The firm size, market-to-book ratio, liquid-assets ratio, debt ratio, return on equity, and earnings power ratio are computed with data obtained from the year-end financial statements of the firms in the COMPUSTAT database for the year prior to the year of the crash. Firms with missing data were excluded from the sample. Following Gadarowski et al. (2007) and Wang et al. (2009), the distributions of the variables were winsorized 1% at both ends to prevent outliers from influencing the results

Table 2
The Explanatory Variables Used in the Regressions

Variable Name	Variable Definition
Asset-Pricing Model Variables	
BETA	Market-risk variable in the Capital Asset Pricing Model; Calculated with monthly returns data for the 5-year time period prior to the year of crash.
SIZE	Market-risk variable in the Fama-French three-factor asset-pricing model; The natural logarithm of the market valuation of the company.
Market-to-Book Ratio (MKBK)	Market-risk variable in the Fama-French three-factor asset-pricing model; The market value of the company divided by the book value.
Technical Insolvency Risk and Bankruptcy Risk Variables	
Liquid-Assets Ratio (LAR)	(Cash+Marketable Securities) / Total Assets; A proxy measure for technical insolvency risk.

Debt Ratio (DR)	Total Debt/Total Assets; A proxy measure for bankruptcy risk.
Profitability	
Return on Equity (ROE)	Net Income / Common Equity
Earning Power Ratio (EPR)	Operating Income / Total Assets

Following Fama and French (2001) and Gadarowski et al. (2007), utilities (SIC 4900-4999) and financial firms (SIC 6000-6999) were excluded from the study. The utilities were excluded because their financial decisions are affected by regulation and the financial firms were excluded because their financial ratios are not comparable to those of other firms. The final sample consists of 2,738 firms for the 1987 crash and 2,866 firms for the 2008 crash. The descriptive statistics of the variables used in the study are presented in Table 3. There is a high level of similarity in the descriptive statistics of the variables for the two stock market crashes. All variables appear to have wide ranges of values in both crashes. The range between the minimum and maximum return figures is wider for the 2008 crash than for the 1987 crash. The RET, ROE, and EPR variables have negative skewness and the BETA, SIZE, MKBK, and LAR variables have positive skewness for both stock market crashes. The RET, SIZE, and DR variables have negative kurtosis and all the other variables have positive kurtosis for both stock market crashes.

Table 3
Descriptive Statistics

	RET	BETA	SIZE	MKBK	LAR	DR	ROE	EPR
1987 Stock Market Crash								
Mean	-0.1702	1.1352	4.1504	2.5574	0.1488	0.4734	-0.0153	0.0477
Median	-0.1667	1.0866	3.9934	1.7909	0.0847	0.4884	0.0834	0.0726
Std Dev.	0.1013	0.5595	1.8720	2.8486	0.1663	0.1949	0.3963	0.1467
Minimum	-0.4464	0.0673	-0.1154	0.3842	0.0011	0.0440	-5.4714	-0.8919
Maximum	0.0645	3.2407	9.3081	37.260	0.8005	0.9403	0.6004	0.3576
Skewness	-0.2004	0.5723	0.3847	5.1591	1.6164	-0.0709	-5.4889	-2.0253
Kurtosis	-0.5324	0.3685	-0.3327	38.603	2.1951	-0.7139	46.353	7.0253
2008 Stock Market Crash								
Mean	-0.1886	1.4024	6.6023	3.2149	0.2052	0.4490	0.0381	0.0516
Median	-0.1794	1.3144	6.4709	2.2765	0.1229	0.4481	0.0945	0.0758
Std Dev.	0.1115	0.7175	1.8954	2.9933	0.2109	0.2076	0.3095	0.1396
Minimum	-0.5166	0.1022	2.3358	0.5116	0.0010	0.0572	-2.6376	-0.8108
Maximum	0.0932	3.9222	11.7938	31.136	0.8981	0.9366	1.4774	0.3550
Skewness	-0.3205	0.7542	0.2333	3.3509	1.2364	0.1238	-2.5461	-2.1923
Kurtosis	-0.0776	0.4881	-0.3033	16.199	0.6475	-0.8339	14.023	7.8071

4. MULTIVARIATE LINEAR REGRESSION ANALYSIS RESULTS

The multivariate linear regression analysis results for the 1987 and 2008 stock market crashes are presented in Table 4. The F statistics indicate that all regressions for both 1987 and 2008 crashes are statistically significant at the 1-percent level.

Table 4
Multivariate Linear Regression Analysis Results

	1987 Crash		2008 Crash	
	Model 1	Model 2	Model 1	Model 2
Intercept	-0.0468	-0.0272	-0.2627***	-0.1957***
BETA	-0.0547***	-0.0549***	-0.0255***	-0.0225***
SIZE	-0.0232***	-0.0240***	0.0052***	0.0045***
MKBK	-0.0018**	-0.0016**	-0.0004	0.0025***
LAR	-0.0079		0.1064***	
DR		-0.0369***		-0.1130***
ROE	0.0032		0.0392***	
EPR		0.0381**		0.0910***
Indus. Dummies	yes	yes	yes	yes
Adj. R-Square	0.1957	0.2004	0.0716	0.0781
F-Value	56.50***	58.17***	19.41***	21.24***
Number of firms	2,738	2,738	2,866	2,866

*** Significant at the 1-percent level.
** Significant at the 5-percent level.

The coefficient of BETA is significant in all regressions for both crashes with a negative sign. This result is in conformity with the prediction of the Capital Asset Pricing Model (CAPM). The model predicts that the prices of stocks with high betas increase faster in up markets and fall faster in down markets compared with the prices of stocks with low betas. Our finding in this study indicates that the CAPM works well as a predictor of stock returns in major stock market crashes. Wang et al. (2009) also find similar results for beta with data for seven smaller one-day stock market crashes and the one-day crash of 1987.

The coefficient of the SIZE variable is significant at the 1-percent level with a negative sign in the 1987 regressions and with a positive sign in the 2008 regressions. In the Fama-French (1992, 1993, 2012) three-factor asset pricing model, small firms have greater market risk compared with larger firms. Therefore, the model predicts that small firms would lose more value and large firms would lose less value in down markets. The positive sign of the coefficient for the SIZE variable indicates that the 2008 regression results are in conformity with the prediction of the model. However, the negative sign of the coefficient for the SIZE variable in the 1987 regressions indicates that large firms lost more value relative to small firms in the 1987 crash.

Wang et al. (2009) also find a negative sign for the SIZE variable for the one-day crash of 1987 and in seven other smaller one-day crashes. They explain it with the Lo-MacKinley (1990) theory which posits that large firms respond to economic events (a stock market crash in this case) faster than small firms and large firm stock returns lead small firm stock returns (in the downward direction in a stock market crash).

One can conclude that the Fama-French and Lo-MacKinley size effects may be influencing stock prices in opposite directions in stock market crashes. It appears that, since bankruptcy risk was a greater concern for investors in the 2008 crash then in the 1987 crash, the Fama-French effect had a stronger influence on stock prices in the 2008 crash, hence the positive sign of the regression coefficient for the SIZE variable in the 2008 regressions. The negative sign of the regression coefficient for the SIZE variable in the 1987 regressions implies that, since bankruptcy risk was not as big a concern for investors in the 1987 crash, the Lo-MacKinley effect had a stronger influence on stock prices in the 1987 crash.

The coefficient of the market-to-book ratio (MKBK) is significant with a positive sign in the Model 2 regression for 2008 and it is significant with a negative sign in both regression models for 1987. Wang et al. (2009) also find contradictory results for the MKBK variable in eight one-day stock market crashes. Fama and French (1992, 1993, 2012) argue that firms with a low MKBK ratio are likely to be in financial distress. Therefore, the model would predict that, because they are riskier for investors, firms with low MKBK ratios would lose more value in stock market crashes. Our finding in the Model 2 regression for 2008 confirms this prediction of the theory. We find that firms with high MKBK ratios lost less value and those with low MKBK ratios lost more value in the 2008 crash. This may be because bankruptcy risk was a major concern for investors in the 2008 crash and they may have dumped riskier low MKBK ratio firm stocks. However, we find the opposite results for the 1987 crash (i.e., high MKBK ratio firm stocks lost more value relative to low MKBK ratio firm stocks in the 1987 crash). A possible explanation for this is that investors may have bidden up the stock prices of high MKBK ratio firms too much before the 1987 crash and it may have resulted in a sharp market correction in the stock prices of these firms during the crash.

The coefficient of the liquid-assets ratio variable (LAR) is significant with a negative sign in the 2008 regression. A main characteristic of the 2008 crash was a severe credit crunch and liquidity shortage. Therefore, it is not surprising that firms with less liquid assets lost more value in the 2008 crash relative to those with more liquid assets. However, the coefficient of the liquid-assets ratio variable is not statistically significant for the 2007 regression. These results imply that the liquid-assets ratio is not a significant determinant of stock returns in all major stock market crashes.

The regression coefficient of the debt ratio is significant at the 1-percent level in the regressions for both stock market crashes with a negative sign. This result indicates that firms with a high debt ratio lost more value relative to low debt ratio firms in both crashes. The debt ratio is commonly used as a proxy measure for bankruptcy risk in empirical studies (see, e.g., Mitton, 2002; Baek et al., 2004; Wang et al., 2009). Our findings in this paper imply that bankruptcy risk is a significant concern for investors in major stock market crashes.

Bonfim (2009) demonstrates that firm profitability is significantly related to bankruptcy risk. Our profitability variables EPR and ROE are significant in three of the four regressions for 1987 and 2008 with a positive sign. These results indicate that firms with higher profitability ratios (i.e., firms with a

lower bankruptcy risk) tend to lose less value relative to other firms in major stock market crashes. Wang et al. (2009) also find that firm profitability was a significant determinant of stock returns in eight one-day stock market crashes including the one-day 1987 crash.

5. SUMMARY AND CONCLUSIONS

In a recent paper, Wang et al. (2009) study the determinants of stock returns in eight one-day stock market crashes in the U.S. They define a stock market crash as 5% or greater decrease in stock prices in a single trading day. This paper presents additional empirical evidence on this subject with data for two major stock market crashes. In this paper, we define a major stock market crash as an event with 20% or greater decline in stock prices in several consecutive trading days. The 1987 and 2008 stock market crashes are the two most important major stock market crashes in U.S. history since the Great Depression. In the 1987 crash, the stock market lost 28.5% of its value during the October 13-19 period. In the 2008 crash, the stock market lost 23.7% of its value during the September 30-October 10 period. In this study, we find the CAPM beta, the debt ratio, and profitability ratios to be reliable predictors of loss in major stock market crashes.

Wang et al.'s (2009) previous findings and our findings in this study indicate that the CAPM beta is a significant determinant of stock returns in stock market crashes including both smaller one-day crashes and major several day crashes. The CAPM theory predicts that stocks with high betas would lose more value relative to low beta stocks in down markets. Our findings in this study for the 1987 and 2008 crashes confirm the theory's prediction. Wang et al. (2009) also find supportive evidence with data for eight one-day stock market crashes including the October 19, 1987 (Black Monday) crash. In this paper, we also find that high beta stocks lost more value relative to low beta stocks in the 1987 and 2008 stock market crashes.

Empirical studies generally use the debt ratio as a proxy measure for bankruptcy risk (see, e.g., Mitton, 2002: Baek et al., 2004; Bonfim, 2009; and, Wang et al., 2009, 2013). In this study we find that the debt ratio was a significant determinant of stock returns in the 1987 and 2008 stock market crashes. The stocks of firms with high debt ratios (and high bankruptcy risk) lost more value relative to the stocks of firms with low debt ratios (and low bankruptcy risk) in both crashes. This result implies that investors tend to have significant concern with bankruptcy risk in major stock market crashes. Pastor and Veronesi (2003) demonstrate that firm profitability is a key determinant of stock price. Bonfim (2009) demonstrates that firm profitability is significantly related to bankruptcy risk. In this study, we find that firm profitability (particularly as measured by the operating profit/total assets ratio) was a significant determinant of loss in the 1987 and 2008 stock market crashes. More profitable firms lost less value relative to less profitable firms in both crashes.

Different stock market crashes have different characteristics. Therefore, a variable that may be an important determinant of loss in some stock market crashes may not have a significant influence on stock prices in other crashes. For example, credit crunch and liquidity shortage were well-known characteristics of the 2008 stock market crash. Therefore, we find that firms with high liquidity ratios lost less value relative to low liquidity ratio firms in the 2008 stock market crash. However, the liquidity ratio was not a significant determinant of stock returns in the 1987 stock market crash.

Fama and French (1992, 1993, 2012) argue that firms with a low MKBK ratio are likely to be in financial distress. Therefore, the Fama-French three-factor capital asset pricing model predicts that, because they are riskier for investors, firms with low MKBK ratios would lose more value in stock market crashes. Our findings with the 2008 stock market crash confirm the theory's prediction. Because investors were overly concerned with bankruptcy risk, they appear to have dumped low MKBK ratio firm stocks and their values fell by more than the values of high MKBK ratio firm stocks in the 2008 stock market crash. However, high MKBK ratio stocks lost more value relative to low MKBK ratio firm stocks in the 1987 stock market crash. A possible explanation for this is that investors may have bidden up the stock prices of high MKBK ratio firms too much before the 1987 crash and it may have resulted in a sharp market correction in the stock prices of these firms during the crash.

In the Fama-French three-factor capital asset pricing model, firm size is a market risk factor and it is a key determinant of stock returns. Fama and French (1992, 1993, 2012) argue that small firms have greater market risk compared with large firms. Therefore, the model predicts that small firms would lose more value relative to large firms in down markets. Our findings for the 2008 stock market crash confirm the theory's prediction. Because investors were very concerned with bankruptcy risk, they appear to have dumped smaller and riskier firm stocks and their values fell by more than the values of large firm stocks in the 2008 stock market crash.

Unlike our 2008 crash finding, we find that large firm stocks lost more value relative to small firm stocks in the 2007 stock market crash. Wang et al. (2009) also have a similar finding for the one-day crash of October 19, 1987 (the Black Monday crash). They explain their finding with the Lo-MacKinlay theory. Lo and MacKinlay (1990) argue that large firms respond to economic events faster than small firms (a stock market crash in this case) and large firm stock returns lead small firm stock returns (in the downward direction in a stock market crash). Wang et al. (2009) find supporting evidence for the Lo-MacKinlay theory in all eight one-day stock market crashes covered in their study. However, their study does not include the 2008 stock market crash.

Having found contradictory results for the 1987 and 2008 crashes in this paper, we propose the following argument: the Fama-French and Lo-MacKinlay size effects may be influencing stock prices in opposite directions in stock market crashes. Since bankruptcy risk was a major concern for investors in the 2008 crash, the Fama-French effect may have had a stronger influence on stock prices and riskier small firm stocks lost more value relative to large firm stocks in this crash. Since bankruptcy risk was not as big a concern for investors in the 1987 crash, the Lo-MacKinley effect may have had a stronger influence on stock prices in this crash (i.e., large firm stocks responded to the 1987 crash faster and their stock returns led small firm stock returns in the downward direction).

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