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MARKET BETA AS A MEASURE OF RISK IN THE CONTEXT OF OUTLIER EVENTS

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ABSTRACT

This event study examines the effectiveness of an equity's market beta as a measurement of market risk in the context of a black swan event. To evaluate beta's effectiveness, I examine abnormal returns over a 10-day time window for 30 industry portfolios across 18 negative black swan events. I perform two analyses. The first determines if the abnormal return on the date of a black swan event, as predicted by CAPM, is statistically similar to the abnormal returns of the five days preceding and following the event. The second examines each black swan event's impact on each industry portfolio's market beta to determine if the event changes the value of beta. Ultimately, my tests reveal a mixed message. Based on my results, I conclude that beta is an effective measure of risk in the context of a black swan event. This study is particularly relevant to academics who seek to expand their understanding of market beta and to portfolio managers who strive to improve their downside risk management.

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Chapter 1

Introduction

A primary concern of money managers is downside risk. Money managers are compensated based on the relative performance of their portfolios to the overall market and their respective benchmarks. Estrada and Vargas (2012) address the relevance of downside risk to portfolio managers.

> Chan and Lakonishok (1993) suggest that extensive conversations with money managers indicate that their main concern is downside risk. Furthermore, Grundy and Malkiel (1996) suggest that most investors think of risk as the possibility of losing money in a declining market.

It is clear that downside risk is a critical concern of portfolio managers across the board. Beta, which summarizes an asset's market sensitivity, is one of the primary tools portfolio managers utilize to measure an asset's price movements relative to the market. Beta measures the risk resulting from the covariance between an asset's price movements and the market's price movements. I raise the question, how well does beta measure an asset's market risk when a low probability, highly impactful event occurs in the market? In particular, how well does beta measure an asset's market risk when the event causes widespread, negative returns, as in the case of a negative black swan event?

The purpose of this event study is to determine if beta is an effective measure of risk in the context of a negative black swan event. Estrada and Vargas quantitatively define a black swan event as an event that produces a monthly return in the world market higher than or equal to 5% in absolute value. As a more qualitative definition, Taleb (2007) introduces the idea of a black swan event in his book "The Black Swan: The Impact of the Highly Improbably."

> First, it is an outlier, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Second, it carries an extreme impact. Third, in spite of its outlier status, human nature makes us concoct explanations for its occurrence *after* the fact, making it explainable and predictable.

In my study, I combine the quantitative definition of Estrada and Vargas with the qualitative definition of Taleb. I examine events that have caused negative returns in the market and are "rare, extreme, and seemingly explainable."

Black swan events are of particular interest to portfolio managers due to the immediate and impactful downswing in market returns and loss of asset value that can be expected as a result of a negative black swan event. To protect assets from the downside risk of a negative black swan event, money managers and other investors use beta to measure equity asset exposure to market movements. It is in this context, the case of a negative black swan event, that I evaluate how effectively beta can be used to measure market risk.

After reviewing past studies and papers, I find that there is a lack of evidence supporting or opposing the effective use of beta as a measure of risk in the context of a black swan event. Most recently, Estrada and Vargas examine whether high-beta stocks outperform low-beta stocks, and whether compensation for beta risk is equal to an asset's excess return, as implied by the Capital Asset Pricing Model, specifically when negative black swan events hit the market. More precisely, Estrada and Vargas examine whether high-beta portfolios of countries and industries fall more than low-beta portfolios in the event of a negative black swan. Estrada and Vargas find that in the months in which negative black swans hit the market, high-beta portfolios of countries fall on average 350 basis points more than low-beta portfolios; whereas, high-beta portfolios of industries fall 610 basis points more than low-beta portfolios.

My study builds on the work of Estrada and Vargas. I examine abnormal returns over a 10-day time window for 30 industry portfolios across 18 negative black swan events. I perform two analyses to answer my underlying question. First, I perform a single sample t-test to

determine if the abnormal return on the date of the event, as implied by CAPM, is statistically different from the abnormal returns of the five days preceding and following each event. Secondly, I determine if the inclusion of the excess return for each industry portfolio on the date of the event changes the value of beta over a 60 month and 60 day time horizon.

Through my analysis, I find that the excess return on the date of the event does not generally impact the value of beta across both the 60 month and 60 day time horizon. However, I also find that CAPM does not hold. Meaning, the abnormal returns predicted by the Capital Asset Pricing Model for the 10 days surrounding the event are statistically different than the abnormal return on the day of the event. In summary, the results of my event study deliver mixed evidence supporting beta as a measure of market risk for negative black swan events.

In Chapter 2, I will provide necessary background information on which my study builds upon. In Chapter 3, I offer a detailed account of the data used in my analysis and the methodology I conduct to perform my event study. In Chapter 4, I present my results and provide an in depth discussion of outcomes. Lastly, I offer a conclusion to my fundamental question in Chapter 5.

Chapter 2

Background Information

The asset-pricing model first introduced by Sharpe (1964), and later refined by Litner (1965) and Black (1972) has long influenced the minds of academics and investors in their evaluation of average returns and risk. The central prediction of the model hinges upon the theory that the market portfolio of invested wealth is mean-variance efficient as Markowitz (1959) introduced. As the efficiency of the market portfolio implies, expected returns on securities are a positive linear function of their market betas. This indicates that beta is the slope in the regression of an equity's return on the market's return, and also that market betas alone effectively define the cross-section of expected returns.

As shown in Figure 2-1, Sharpe first defines beta as the slope of the regression line representing the relationship between the returns of a single asset (R_i) and an efficient combination of assets (R_g). Beta represents the return movements of a single asset to changes in the returns of an efficient combination of assets. From this relationship, Sharpe derives the equation for beta.

$$B_{ig} = r_{ig}\sigma_{Ri} / \sigma_{Rg} \quad (1)$$

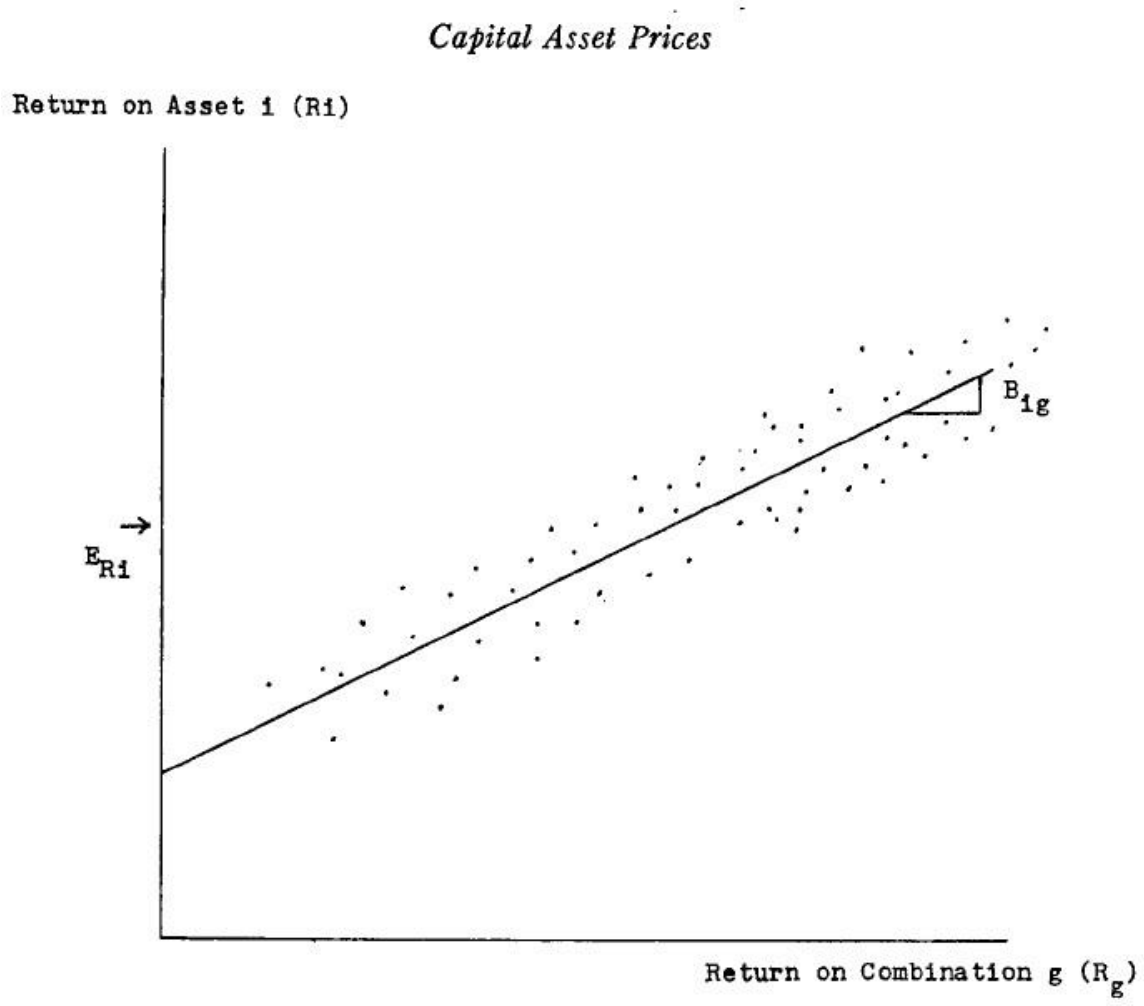


Figure 2-1. Capital Asset Prices

As published in 1972, Fischer Black refines the definition of market beta. Black identifies beta as the "market sensitivity" of asset *i.* Beta is the slope of the regression line of the relationship between the return on asset *i* and the return on the market. Black algebraically defines beta as Equation 2.

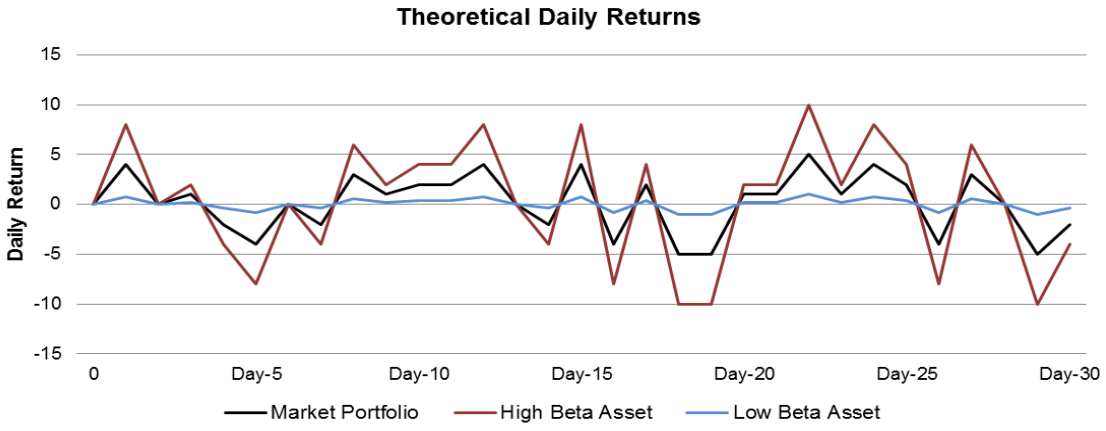
$$\beta = \text{cov}(\tilde{R}_i, \tilde{R}_m) / \text{var}(\tilde{R}_m) \quad (2)$$

In which $\text{cov}(\tilde{R}_i, \tilde{R}_m)$ represents the covariance between the return of asset *i* and the return of the market portfolio and $\text{var}(\tilde{R}_m)$ represents the variance of the market portfolio's returns.

The value of an asset's beta summarizes its reaction to market stimuli in relation to the price movements of the market portfolio. If for example, an asset had a beta of 1, the asset would deliver the same return as the market. If the asset had a beta of 2, the asset would deliver twice the positive return of the market portfolio if the market was up, or it would return twice the negative return of the market portfolio if the market was down. Similarly, if an asset had a beta of 0.2, the asset would be expected to return 20 percent of the market's positive return in an up market, or it would be expected to return 20 percent of the market's negative return in a down market. Figure 2-2 compares theoretical and randomized return movements over a 30-day time window between the market portfolio, an asset with a comparatively high beta of 2, and an asset with a comparatively low beta of 0.2.

In a perfect world, the graph in Figure 2-2 would accurately demonstrate the return movements of the market portfolio, the high beta asset, and the low beta asset. The purpose of this study is to explore whether the relationship demonstrated in Figure 2-2 between the market portfolio and the high beta and low beta assets holds true. In particular, I ask the question if beta accurately measures the risk exposure to black swan events—large market declines.

Figure 2-2. Theoretical Daily Returns



Chapter 3

Data and Methodology

In this section, I first describe my data and present my definition of a black swan. I then detail the methodology I use to demonstrate the effectiveness of beta as a measure of risk, as exemplified by the significance of the abnormal returns surrounding each event and the changes in the value of beta resulting from each event.

Data Collection and Black Swan Definition

My sample consists of 30 industry portfolios downloaded from the data library of Kenneth French, the Roth Family Distinguished Professor of Finance at the Tuck School of Business at Dartmouth College. The industry portfolios consist of all stocks on the New York Stock Exchange, the American Stock Exchange, and the NASDAQ, as of June 2011. Each stock is assigned a portfolio based on its four-digit SIC code at that time. The daily returns for each portfolio were calculated from July of t to June of t+1, with returns data available from July 1, 1926 to September 28, 2012. Also included in my data set are a market portfolio, consisting of all NYSE, AMEX, and NASDAQ firms, and a one-month Treasury bill rate portfolio. The daily returns for each portfolio are calculated from July 1, 1926 to October 31, 2012 for July of year t to June of t+1. Table 3-1 summarizes the 18 events I analyze, and the date for each event that I utilize.

Table 3-1. Summary of Events

Summary of Events		
Event No.	**Event Title**	**Event Date**
Event 1	JFK Assasination	11/22/1963
Event 2	MLK Jr. Assasination	04/05/1968
Event 3	Ford Assasination Attempt 1	09/05/1975
Event 4	Ford Assasination Attempt 2	09/22/1975
Event 5	Three Mile Island	03/08/1979
Event 6	Iran Hostage Crisis	11/05/1979
Event 7	Regan Assasination Attempt	03/30/1981
Event 8	Challenger Explosion	01/28/1986
Event 9	Hurricane Andrew	08/24/1992
Event 10	Storm of the Century	03/12/1993
Event 11	Northridge Earthquake	01/17/1994
Event 12	Kobe Earthquake	01/17/1995
Event 13	North American Blizzard	01/09/1996
Event 14	September 11 Terrorist Attacks	09/17/2001
Event 15	Columbia Space Shuttle Explosion	02/04/2003
Event 16	Hurricane Katrina	08/30/2005
Event 17	Hurricane Ike	09/15/2008
Event 18	Tohoku Earthquake and Tsunami	03/14/2011

I utilize the aforementioned industry, market, and Treasury portfolios in my study to first exam abnormal returns surrounding black swan events, then to evaluate the impact each event has on beta. I focus my study on 18 outlier events that are rare, unpredictable, and seemingly explainable while simultaneously causing a negative market impact. The majority of the events in my study are composed of natural disasters and terrorist attacks. My definition of a black swan event makes a distinction from Taleb's more broad and qualitative definition: a rare, extreme, and seemingly explainable event. Estrada and Vargas provide a more empirical definition of a black swan, so as to be applied to several events over a longer time horizon. Estrada and Vargas define a black swan as a monthly return in the world market greater than or equal to 5% or less than or

equal to 5%. My definition of a black swan incorporates the qualitative definition of Taleb and the quantitative definition of Estrada and Vargas.

Abnormal Return Analysis

In order to evaluate whether beta is an effective measure of market risk, I first examine the abnormal returns of 30 industry portfolios within a 10-day time frame. More precisely, I analyze whether the abnormal returns in the five days immediately following a black swan event are significantly different from the abnormal returns five days prior to the event. The significance of this analysis relies on one of the central implications of the Capital Asset Pricing Model. As CAPM implies, alpha is equal to zero for all assets, given an asset's market beta and the average excess market return. In which, alpha represents the estimated expected return on an asset that is not attributed to risk—the abnormal return of an asset.

For the purpose of this study, I only examine the return data for the 30 industry portfolios, market portfolio, and Treasury portfolio for the five years prior to the event and the one year following the event. For each daily industry portfolio and market return, the excess return is exclusively used in this study, meaning that the one-month Treasury bill rate (the risk free rate) is subtracted from each return. Based on the excess return data of the 30 industry portfolios and the market portfolio, I calculate a set of summary of statistics which is located in the Appendix.

This event study utilizes a 10-day time window; abnormal returns are calculated for the five trading days prior to the event (date t-5 through date t-1) and for the five trading days following the event (date t+1 through date t+5). To compute the daily abnormal return for each day prior to and following the event, I first calculate the average excess market return for the 60

months prior to date t-5. I then calculate the industry portfolio beta from the daily excess returns for the 60 months prior to the event utilizing Equation 3.

$$\beta = Covariance\ (r_p, r_m) / Variance\ (r_p) \quad (3)$$

Each daily abnormal return is then calculated by subtracting the product of the 60 month average excess market return and the 60 month industry portfolio beta from the a 60 month average daily return of the industry portfolio. Equation 4 summarizes the abnormal return calculation.

$$Abnormal\ Return = r_p - r_{m*}\beta \quad (4)$$

Once the daily abnormal returns are calculated and collected for the 10-day time window, I perform a statistical test of significance. I use two methods to test for significance. First, I use a one-sample t-test to evaluate whether or not the abnormal returns for the five days prior to the event and the five days after the event are statistically different from the abnormal return for the date of the event. I perform this test for all 18 events across all 30 industry portfolios. And secondly, I prepare graphs for each industry portfolio that graphed the mean abnormal return on each date and an upper band and a lower band for each date. I begin by describing the steps I took to perform a statistical t-test, and then I detail the steps I took to form the 30 industry abnormal return graphs.

One-Sample T-Test

The goal of the one-sample t-test is to determine if the abnormal returns for the five days leading up to each event and the abnormal returns for the five days following each event are statistically different from the abnormal return on the day of the event. In my study, I examine 30 industry portfolios for 18 different black swan events. In order to gain a complete analysis, I

perform the same one-sample t-test on each industry portfolio for every day of the 10-day window using the average abnormal returns and average standard deviations for each date across all 18 events. I arrange this portfolio data into a 30 matrices for each industry portfolio composed of the 10-day time window for all 18 events. Refer to Table 3-2 for an example.

Utilizing the abnormal return figures in the abnormal return matrix, I calculate the average abnormal return for each date and the average standard deviation for each date across the 18 black swan events. From these calculations, I determine my null hypothesis. In words, if the average abnormal return for each date prior to the event and following the event equals the average abnormal return on the date of the event, with a 95% confidence interval and 17 degrees of freedom, then the null hypothesis is accepted.

Null Hypothesis:

H_0: $\mu = \bar{x}_{it}$ and H_1: $\mu \neq \bar{x}_{it}$ in which *i* represents the industry portfolio, ranging from 1-30, and *t* represents the date, ranging from t-5 to t+5.

Table 3-2. Industry Abnormal Return Matrix Example

Food Abnormal Return Matrix																		
Time	**Event 1**	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Event 6**	**Event 7**	**Event 8**	**Event 9**	**Event 10**	**Event 11**	**Event 12**	**Event 13**	**Event 14**	**Event 15**	**Event 16**	**Event 17**	**Event 18**
t-5	-0.42	0.86	1.88	-0.66	0.51	-0.01	0.05	-0.40	0.30	-0.64	0.96	-0.01	1.26	1.01	0.02	-0.58	0.78	-0.77
t-4	-0.82	1.38	0.91	-0.76	0.20	0.77	-1.00	-0.74	0.40	0.79	-0.73	-0.14	0.07	0.77	-1.77	-0.60	-2.05	0.83
t-3	0.14	0.11	-1.23	0.24	0.33	-0.50	0.92	0.49	-0.45	-0.80	-0.36	-0.06	-0.76	-0.74	-2.13	0.10	0.16	0.23
t-2	-0.32	0.47	-0.21	1.58	-0.19	0.15	-0.80	1.06	0.18	0.37	-0.89	1.21	-1.47	-0.59	3.02	-0.39	1.99	-0.60
t-1	-0.59	0.10	-0.01	2.77	-0.21	0.38	-0.80	0.66	-0.41	0.28	-0.33	-0.28	0.19	-0.01	0.01	0.73	1.68	0.41
t	-2.01	-0.31	-0.49	-0.41	-0.18	-0.65	0.18	1.35	-0.76	-1.21	-0.58	-0.10	-0.32	-0.90	0.44	-0.60	-2.66	-0.82
t+1	1.98	1.33	-0.24	-0.70	-0.72	-0.46	0.34	0.54	-0.17	-0.25	-0.11	-0.15	-1.90	1.01	-0.26	0.78	1.24	-0.57
t+2	-0.13	1.55	-1.24	0.96	-0.09	-0.78	0.20	-0.07	0.68	-0.08	0.43	-0.97	0.08	-1.14	-1.11	0.20	-2.63	-1.07
t+3	0.89	0.98	-1.41	0.11	-0.42	0.43	0.12	1.27	0.27	-0.84	0.36	-0.69	0.83	-1.82	-1.16	0.01	2.42	0.21
t+4	0.31	-0.01	-0.08	0.59	1.11	1.03	-0.24	0.97	0.62	0.49	-0.32	0.57	-0.42	-3.32	0.55	0.54	2.59	1.20
t+5	0.06	0.58	0.09	-0.72	-0.49	1.29	-0.55	0.09	0.21	-0.51	-0.26	-0.11	0.99	1.96	-1.62	-0.30	-2.04	1.01

Table 3-3. Event Abnormal Return Matrix Example

Event 1 Abnormal Return Matrix																													
Time	**Food**	**Beer**	**Smoke**	**Games**	**Books**	**Hshld**	**Clths**	**Hlth**	**Chems**	**Txtls**	**Cnstr**	**Steel**	**FabPr**	**ElcEq**	**Autos**	**Carry**	**Mines**	**Coal**	**Oil**	**Util**	**Telcm**	**Servs**	**BusEq**	**Paper**	**Trans**	**Whlsl**	**Rtail**	**Meals**	**Fin**	**Other**
t-5	-0.42	-0.05	0.23	-1.52	0.12	-0.93	-0.78	-0.60	-0.35	-0.19	-0.25	-0.73	-0.58	-0.88	-2.34	-0.60	0.12	-0.09	-1.42	-0.07	-0.54	-0.26	-0.69	-0.50	-0.32	-0.45	-1.00	-0.98	-0.71	-0.89
t-4	-0.82	-0.17	0.24	-1.22	-0.79	-1.44	-0.81	-1.27	-0.60	-0.34	-0.59	-0.37	-0.82	-0.68	-0.23	-0.48	-1.45	-0.47	-1.81	-0.29	-0.28	-0.84	-0.76	-0.88	-0.77	-0.41	-0.54	0.54	-0.86	-1.57
t-3	0.14	-0.79	-0.54	-0.08	-0.50	-0.25	0.14	0.36	0.33	0.20	-0.22	-0.10	0.01	-0.41	1.05	0.01	0.20	-0.15	0.68	0.09	-0.59	-0.47	-1.14	-0.60	0.49	-0.11	-0.08	-0.57	-0.16	-0.07
t-2	-0.32	-0.33	-1.24	0.08	0.04	0.36	-0.43	0.23	0.66	-0.35	0.22	-0.09	0.30	-0.53	-0.07	-0.10	0.94	0.21	1.41	-0.18	4.73	-0.59	-0.10	0.16	0.01	-1.00	0.26	-1.15	-0.05	-0.27
t-1	-0.59	-0.52	-1.11	-2.99	-1.30	-1.86	-1.04	-1.66	-1.11	-0.61	-1.12	-1.82	-1.64	-0.63	-2.46	-0.88	-0.04	-1.08	-0.51	-0.71	-1.65	-1.07	-2.31	-1.23	-2.01	-0.84	-0.49	-1.03	-0.75	-1.65
t	-2.01	-0.96	-0.49	-3.98	-2.32	-2.26	-2.75	-3.85	-3.09	-3.43	-2.88	-3.69	-2.80	-5.49	-3.76	-3.73	-3.81	-0.73	-2.65	-1.12	-4.58	-2.11	-2.63	-4.26	-3.41	-4.78	-2.89	-2.04	-2.13	-2.51
t+1	1.98	0.40	2.20	4.89	1.48	4.03	2.39	4.48	4.96	2.75	2.88	5.88	2.77	5.21	5.95	4.27	3.66	1.95	3.28	0.99	6.28	3.07	4.22	4.77	4.39	4.14	3.42	1.64	2.41	2.98
t+2	-0.13	0.25	-1.03	-0.14	0.79	-0.15	-0.43	0.11	-0.34	-0.06	-0.12	-0.29	0.16	0.16	-0.57	0.29	-0.24	-0.17	-0.25	-0.26	-0.54	-0.07	0.54	-0.39	0.14	-0.60	-0.05	-0.15	-0.34	0.22
t+3	0.89	0.48	0.57	3.41	1.45	2.41	0.84	1.76	0.64	1.53	0.78	1.39	1.62	2.41	0.65	2.66	1.84	2.01	1.94	0.40	0.92	0.81	1.93	1.47	1.56	1.13	1.16	0.15	1.21	2.66
t+4	0.31	0.50	-2.07	0.75	0.50	0.41	0.75	0.40	0.99	0.87	0.12	0.12	0.25	-0.22	0.33	-0.48	0.02	0.47	1.03	0.27	0.53	0.13	1.29	0.19	0.66	-0.24	-0.36	0.39	0.31	-0.48
t+5	0.06	-0.21	1.99	-0.43	-0.45	-0.22	0.62	-0.08	0.78	0.25	-0.01	-0.69	-0.14	-0.93	-0.70	-0.82	0.50	0.35	-0.12	0.08	0.00	-0.76	-0.30	-0.10	-0.43	-0.37	0.09	0.77	-0.07	-0.29

After stating the hypothesis, I prepare my t-test based on the criterion in Table 3-4.

Table 3-4. T-Test (1) Criterion

T-Test Criterion	
Type	One-Sample Test
Alpha (α)	0.05
Degrees of Freedom (df)	17
Critical T-Value	1.74

Next, I use the data I collected and the calculations I made to compute the test statistic. I use the following equation to calculate the t-value.

$$t_{obt} = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}} \tag{5}$$

I calculate the t-test value for every date t-5 through t+5 for every industry portfolio using the averages from all 18 events. Using the critical t-value as reference, I reject my hypothesis for all t-values that exceeded the critical t-value.

To perform a complete analysis, I also perform a one-sample t-test for each black swan event for every day of the 10-day window using the average abnormal returns and average standard deviations for each date across each industry portfolio. I arrange this event data into 18 matrices for each black swan event composed of the 10-day time window for all 30 events. Refer to Table 3-3 for an example.

Just as before, I calculate the average abnormal return for each date and the average standard deviation for each date across the 30 industries. My null hypothesis remains almost the same as before: if the average abnormal return for each date prior to the event and following the event equals the average abnormal return on the date of the event, with a 95% confidence interval, and 29 degrees of freedom, then the null hypothesis is accepted.

Null Hypothesis:

H_0: $\mu = \bar{x}_{et}$ and H_1: $\mu \neq \bar{x}_{et}$ in which e represents the black swan event, ranging from 1-18, and t represents the date, ranging from t-5 to t+5.

Just as before, I prepare my t-test based on the following criterion:

Table 3-5. T-Test (2) Criterion

T-Test Criterion	
Type	One-Sample Test
Alpha (α)	0.05
Degrees of Freedom (df)	29
Critical T-Value	1.699

Next, I use the data I collected and the calculations I made to compute the test statistic, using Equation 5. I calculate the t-test value for every date t-5 through t+5 for every black swan event using the averages from all 30 industry portfolios. Using the critical t-value as reference, I reject my hypothesis for all t-values that exceeded the critical t-value.

I will now briefly describe the steps I took to arrange the average abnormal return graphs that help demonstrate the statistical significance of the mean abnormal return on the date of the event.

Average Abnormal Return Graphs

I form average graphs to help demonstrate the statistical significance of the difference between the average abnormal return on the date of the event and the average abnormal returns on the five days prior and post the event. I first graph the average abnormal returns I had previously calculated for each date of each industry portfolio, with the date on the x-axis and the abnormal return on the y-axis. Next, I calculate the upper and lower bands. The upper band is calculated by adding the average standard deviation of the 18 events for each date to the mean abnormal return for the same date. The lower band is determined in a similar fashion. I subtract the average standard deviation of the 18 events for each date from the mean abnormal return for the corresponding date. I use these upper and lower band calculations to graph the upper band and the lower band on the same graph as the mean. I repeat the same process by using the average abnormal industry portfolio returns and average industry standard deviations for each date for each black swan event.

Change in Beta Test

Beta is the slope of the regression line representing the relationship between the returns of a single asset and the returns of the market. In the case of a negative black swan event, one might expect that the dramatic decline in individual asset prices compared to the market would significantly impact the regression line, and therefore, the market beta of an asset. To test the impact negative black swan events have on the value of beta, I perform a test to measure the change in beta as result of a negative black swan event.

Using return data for 30 industry portfolios, I calculate the changes in beta over two time windows for 18 negative black swan events. I utilize Equation 2 to make my beta calculations. The first time window, I calculate beta 60 months before the event, 60 months including the event, and 12 months after the event. The second time window, I calculate beta 60 days before the event, 60 days including the event, and 60 days after the event. I then measure the changes, if any, in beta for each calculation.

In the next section, I will provide more detail about my results and provide an interpretation of my findings.

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Chapter 4

Results

The results of the tests deliver a mixed message. Based on my results it appears that beta can be a useful tool to measure the market risk of an asset, in the context of a black swan event. However, the Capital Asset Pricing Model does not hold in this context. The results of each test are presented as tables preceded by a summary of observations and conclusions.

Abnormal Return T-Test Results

The results of the single sample t-test of abnormal returns by industry present a very clear message: the average abnormal returns for each event across the 30 industry portfolios are statistically different than the average abnormal return on the date of the black swan event. Of the 30 industry portfolios tested, 91 percent of each date tested rejects the null hypothesis. Meaning, the average abnormal return for each industry on the five days preceding and succeeding the black swan event are statistically different than the mean abnormal return for each industry on the date of the black swan event. I uncover the same message but to a lesser degree when I test the average abnormal returns across the 30 industry portfolios for each black swan event. I find that 71 percent of each date tested rejects the null hypothesis. From this observation, it is fair to conclude that some of the black swan events resulted in larger asset declines than others. But despite the impact of the more negatively perceived black swan events, the null hypothesis is rejected in the majority of instances tested. Table 4-1 summarizes the results of the t-tests performed.

Table 4-1. Test Results

Test Results by Industry				Test Results by Event			
	Total	t-5	t+5		Total	t-5	t+5
Food	0.9	1.0	0.8	Event 1	1.0	1.0	1.0
Beer	0.6	0.8	0.4	Event 2	1.0	1.0	1.0
Smoke	0.7	0.6	0.8	Event 3	0.6	0.8	0.4
Games	0.9	0.8	1.0	Event 4	0.8	0.8	0.8
Books	1.0	1.0	1.0	Event 5	0.7	0.8	0.6
Hshld	0.9	1.0	0.8	Event 6	0.8	0.8	0.8
Clths	1.0	1.0	1.0	Event 7	0.5	0.4	0.6
Hlth	0.9	1.0	0.8	Event 8	0.2	0.2	0.2
Chems	1.0	1.0	1.0	Event 9	1.0	1.0	1.0
Txtls	0.9	1.0	0.8	Event 10	0.9	1.0	0.8
Cnstr	0.9	1.0	0.8	Event 11	0.7	0.6	0.8
Steel	1.0	1.0	1.0	Event 12	0.2	0.4	0.0
FabPr	0.9	1.0	0.8	Event 13	0.9	1.0	0.8
ElcEq	1.0	1.0	1.0	Event 14	1.0	1.0	1.0
Autos	1.0	1.0	1.0	Event 15	0.6	0.8	0.4
Carry	1.0	1.0	1.0	Event 16	0.5	0.4	0.6
Mines	0.7	0.8	0.6	Event 17	0.8	0.8	0.8
Coal	0.6	0.4	0.8	Event 18	0.6	0.6	0.6
Oil	0.8	0.8	0.8	**Average**	**0.71**	**0.74**	**0.68**
Util	0.8	1.0	0.6				
Telcm	1.0	1.0	1.0				
Servs	1.0	1.0	1.0				
BusEq	1.0	1.0	1.0				
Paper	1.0	1.0	1.0				
Trans	1.0	1.0	1.0				
Whlsl	0.9	1.0	0.8				
Rtail	1.0	1.0	1.0				
Meals	1.0	1.0	1.0				
Fin	0.9	1.0	0.8				
Other	1.0	1.0	1.0				
Average	**0.91**	**0.94**	**0.88**				

As CAPM implies, the abnormal returns of an asset relative to the market can be calculated using the return of the asset, the average return of the market, the asset's market beta. See Equation 3. If CAPM is true, the abnormal returns of an asset would be the same despite the asset's price movements on each date and the abnormal returns would be zero. Through my study, I find that the large majority of abnormal returns on the date of each black swan event across the 30 industry portfolios are statistically different than the abnormal returns of the 10-day

time window. This observation signifies two conclusions. First, the CAPM model does not hold and cannot be used to measure expected price movement of an asset in the context of a black swan event. And secondly, the price movement of an asset as a result of a black swan event is statistically different than an asset's price movement resulting from more ordinary, everyday news. The following sets of tables summarize the results of the two one-sample t-tests performed.

Industry Average Abnormal Return T-Test Results

Food T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.23	0.77	4.36
t-4	-0.14	0.97	1.82
t-3	-0.24	0.72	1.88
t-2	0.25	1.14	3.02
t-1	0.25	0.84	4.07
t	-0.56	0.87	0.00
t+1	0.09	0.92	2.99
t+2	-0.29	0.98	1.16
t+3	0.09	1.04	2.64
t+4	0.34	1.15	3.31
t+5	-0.02	0.98	2.35

Beer T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.33	0.91	3.92
t-4	0.40	1.17	3.32
t-3	-0.52	1.06	-0.03
t-2	0.42	1.16	3.42
t-1	0.18	1.04	2.82
t	-0.51	0.79	0.00
t+1	-0.29	0.90	1.03
t+2	-0.38	1.16	0.48
t+3	-0.02	1.05	1.99
t+4	0.26	1.16	2.80
t+5	0.01	1.36	1.64

Smoke T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.41	0.82	4.25
t-4	0.01	1.19	1.49
t-3	-0.33	0.75	0.47
t-2	0.26	1.30	2.17
t-1	0.39	1.14	2.95
t	-0.41	1.07	0.00
t+1	0.33	1.03	3.04
t+2	-0.83	1.75	-1.03
t+3	0.32	0.96	3.23
t+4	0.45	1.15	3.14
t+5	0.16	1.27	1.90

Games T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.48	1.55	6.18
t-4	0.22	1.42	5.96
t-3	-0.87	2.22	1.73
t-2	-0.04	1.44	5.10
t-1	0.18	1.45	5.75
t	-1.77	2.73	0.00
t+1	0.35	2.06	4.37
t+2	-0.62	1.87	2.61
t+3	0.17	2.51	3.29
t+4	0.78	1.55	7.02
t+5	-0.09	2.31	3.10

Books T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.49	1.35	4.50
t-4	0.14	1.29	3.55
t-3	-0.31	0.76	3.56
t-2	0.07	1.07	4.04
t-1	0.19	0.89	5.46
t	-0.95	1.41	0.00
t+1	-0.18	0.77	4.23
t+2	-0.10	1.56	2.31
t+3	-0.02	2.26	1.74
t+4	0.39	0.58	9.79
t+5	0.03	1.50	2.76

Hshld T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.68	1.16	5.25
t-4	0.10	1.28	2.82
t-3	-0.16	0.86	2.91
t-2	0.24	1.11	3.76
t-1	0.23	1.00	4.12
t	-0.75	0.88	0.00
t+1	-0.02	1.35	2.28
t+2	-0.41	1.11	1.30
t+3	0.23	1.28	3.27
t+4	0.10	1.46	2.46
t+5	-0.11	1.53	1.78

Clths T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.50	1.31	5.91
t-4	0.24	1.14	5.78
t-3	-0.23	0.84	5.47
t-2	-0.06	1.04	5.17
t-1	0.25	0.98	6.79
t	-1.32	2.27	0.00
t+1	0.21	1.10	5.93
t+2	-0.29	1.38	3.18
t+3	0.02	1.76	3.25
t+4	0.10	1.22	4.95
t+5	0.32	1.72	4.07

Hlth T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.38	1.02	4.92
t-4	0.28	1.21	3.84
t-3	-0.35	0.78	2.52
t-2	0.21	1.37	3.14
t-1	0.27	1.07	4.28
t	-0.81	1.16	0.00
t+1	0.10	1.53	2.51
t+2	-0.61	1.20	0.70
t+3	0.01	1.10	3.13
t+4	0.41	1.04	4.94
t+5	-0.13	1.18	2.41

Chems T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.21	1.12	5.73
t-4	0.07	1.62	3.59
t-3	-0.31	1.09	3.86
t-2	0.18	1.37	4.60
t-1	0.29	1.09	6.17
t	-1.30	2.28	0.00
t+1	0.43	1.52	4.84
t+2	-0.50	1.41	2.40
t+3	-0.15	1.33	3.64
t+4	0.73	1.77	4.86
t+5	0.09	1.84	3.20

Txtls T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.23	1.09	5.80
t-4	0.11	1.43	4.07
t-3	0.17	0.80	7.55
t-2	-0.37	1.16	3.27
t-1	0.15	0.72	8.24
t	-1.26	2.25	0.00
t+1	0.11	1.60	3.63
t+2	-0.57	1.79	1.64
t+3	-0.24	1.80	2.40
t+4	0.41	1.95	3.63
t+5	0.14	2.23	2.66

Cnstr T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.36	0.98	6.39
t-4	0.13	1.96	2.68
t-3	-0.14	1.12	3.66
t-2	0.10	1.30	3.98
t-1	0.27	1.07	5.51
t	-1.11	1.99	0.00
t+1	0.49	1.54	4.41
t+2	-0.57	1.62	1.42
t+3	-0.05	2.14	2.11
t+4	0.68	1.85	4.11
t+5	-0.02	2.16	2.14

Steel T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	-0.12	1.37	4.97
t-4	-0.31	2.09	2.87
t-3	0.15	1.50	5.33
t-2	-0.02	1.35	5.36
t-1	0.34	1.92	4.57
t	-1.73	2.74	0.00
t+1	0.59	1.67	5.88
t+2	-0.48	1.80	2.93
t+3	-0.32	2.19	2.73
t+4	0.50	2.03	4.66
t+5	0.06	2.01	3.76

FabPr T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.10	0.86	6.29
t-4	-0.10	1.76	2.59
t-3	-0.14	1.05	4.19
t-2	0.01	1.18	4.26
t-1	0.35	1.02	6.34
t	-1.17	2.00	0.00
t+1	0.25	1.51	3.99
t+2	-0.67	1.58	1.34
t+3	-0.01	1.65	2.98
t+4	0.62	1.32	5.76
t+5	0.31	1.39	4.53

ElcEq T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.50	0.96	8.68
t-4	0.01	1.86	3.35
t-3	-0.14	1.21	4.66
t-2	0.05	1.24	5.20
t-1	0.32	0.75	10.13
t	-1.47	2.05	0.00
t+1	0.28	1.78	4.19
t+2	-0.79	1.55	1.86
t+3	0.10	2.05	3.25
t+4	0.34	1.49	5.15
t+5	0.25	1.97	3.71

Autos T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.53	1.60	5.97
t-4	0.20	1.55	5.26
t-3	-0.25	1.27	4.94
t-2	0.24	1.61	5.17
t-1	0.18	1.34	6.03
t	-1.72	3.21	0.00
t+1	0.48	1.85	5.05
t+2	-1.06	1.53	1.83
t+3	-0.18	2.04	3.22
t+4	0.73	1.37	7.60
t+5	0.06	2.47	3.06

Carry T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.66	1.35	6.74
t-4	-0.19	1.36	4.05
t-3	-0.22	0.95	5.62
t-2	-0.03	1.58	3.91
t-1	0.33	1.05	7.36
t	-1.49	3.45	0.00
t+1	0.09	1.51	4.45
t+2	-0.75	1.59	1.96
t+3	-0.22	2.26	2.38
t+4	0.74	1.01	9.37
t+5	0.13	1.95	3.53

Mines T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.07	1.45	2.11
t-4	-0.53	2.43	0.22
t-3	0.16	1.55	2.22
t-2	-0.01	1.25	2.18
t-1	0.82	1.93	3.24
t	-0.65	2.12	0.00
t+1	0.81	1.67	3.71
t+2	-0.41	1.17	0.88
t+3	0.27	1.35	2.89
t+4	0.42	2.70	1.68
t+5	0.02	1.35	2.11

Coal T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	-0.24	2.57	0.90
t-4	-0.58	2.95	0.29
t-3	0.10	2.45	1.53
t-2	0.17	1.91	2.11
t-1	0.81	2.18	3.10
t	-0.78	3.46	0.00
t+1	0.25	1.35	3.24
t+2	-0.61	2.22	0.33
t+3	0.24	2.20	1.99
t+4	0.89	2.48	2.86
t+5	0.22	1.45	2.94

Oil T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.12	1.47	2.49
t-4	-0.09	2.11	1.31
t-3	0.12	1.26	2.91
t-2	0.43	1.49	3.36
t-1	0.43	1.22	4.08
t	-0.74	1.95	0.00
t+1	0.28	1.79	2.44
t+2	-0.41	1.65	0.87
t+3	-0.01	1.61	1.92
t+4	0.69	1.71	3.55
t+5	-0.01	1.58	1.97

Util T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.36	0.85	4.52
t-4	-0.11	1.03	1.76
t-3	0.03	0.54	4.52
t-2	0.13	0.67	4.24
t-1	0.31	0.68	5.28
t	-0.54	1.05	0.00
t+1	-0.13	0.75	2.31
t+2	-0.43	1.35	0.36
t+3	0.12	1.05	2.68
t+4	0.40	0.97	4.08
t+5	-0.16	0.95	1.72

Telcm T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.29	0.96	6.40
t-4	0.21	1.35	4.34
t-3	-0.50	1.03	2.71
t-2	0.47	1.52	4.56
t-1	0.05	0.88	5.87
t	-1.16	1.55	0.00
t+1	0.40	1.73	3.84
t+2	-0.36	1.32	2.58
t+3	0.06	1.13	4.59
t+4	0.24	1.39	4.29
t+5	-0.10	1.52	2.95

Servs T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.17	0.77	7.30
t-4	0.07	1.26	4.16
t-3	-0.21	1.25	3.27
t-2	0.11	1.06	5.11
t-1	0.52	0.80	8.96
t	-1.17	1.93	0.00
t+1	0.41	1.05	6.36
t+2	-0.41	1.52	2.12
t+3	-0.05	1.70	2.77
t+4	0.09	1.36	3.92
t+5	0.23	1.73	3.41

BusEq T-Test Results			
Time	Mean	Std. Dev.	tobs
t-5	0.40	1.59	4.87
t-4	-0.20	1.78	2.92
t-3	-0.65	1.70	1.93
t-2	0.14	0.95	7.01
t-1	0.23	1.14	6.14
t	-1.42	2.05	0.00
t+1	0.36	1.56	4.86
t+2	-0.66	1.71	1.88
t+3	-0.16	1.91	2.81
t+4	0.19	1.76	3.89
t+5	0.27	2.28	3.15

Paper T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.36	1.05	5.95
t-4	0.19	1.08	5.12
t-3	-0.34	0.83	3.92
t-2	-0.04	1.22	3.72
t-1	0.27	0.94	6.25
t	-1.11	1.87	0.00
t+1	0.29	1.39	4.28
t+2	-0.46	1.17	2.35
t+3	0.01	1.47	3.22
t+4	0.19	1.33	4.13
t+5	0.01	1.60	2.97

Trans T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.35	0.93	8.68
t-4	0.04	1.37	4.89
t-3	0.14	0.96	7.46
t-2	0.35	1.51	5.32
t-1	0.25	1.40	5.42
t	-1.54	3.22	0.00
t+1	0.39	1.56	5.24
t+2	-0.52	1.34	3.22
t+3	-0.11	1.59	3.83
t+4	0.62	0.95	9.68
t+5	-0.19	1.45	3.95

Whlsl T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.42	1.16	5.15
t-4	0.09	1.20	3.85
t-3	-0.07	1.04	3.80
t-2	-0.03	0.94	4.36
t-1	0.35	0.69	8.32
t	-1.00	1.44	0.00
t+1	0.31	1.40	3.96
t+2	-0.76	1.27	0.77
t+3	-0.03	1.10	3.70
t+4	0.41	1.01	5.87
t+5	0.04	1.31	3.36

Rtail T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.54	1.22	6.24
t-4	0.11	1.07	5.42
t-3	-0.17	1.11	4.13
t-2	0.16	1.21	4.95
t-1	0.07	1.06	5.30
t	-1.26	1.76	0.00
t+1	0.28	1.12	5.81
t+2	-0.41	1.54	2.32
t+3	-0.03	1.41	3.68
t+4	0.17	0.92	6.58
t+5	0.09	1.78	3.20

Meals T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.67	1.26	7.31
t-4	0.34	1.23	6.32
t-3	-0.41	1.16	3.99
t-2	0.24	1.49	4.93
t-1	0.11	1.48	4.59
t	-1.49	1.68	0.00
t+1	0.15	1.14	6.08
t+2	-0.57	1.51	2.59
t+3	0.06	1.52	4.33
t+4	0.61	1.07	8.32
t+5	0.18	1.41	5.04

Fin T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.34	1.19	6.22
t-4	-0.13	1.76	3.05
t-3	-0.37	0.87	5.00
t-2	0.17	1.19	5.58
t-1	0.31	0.89	8.18
t	-1.40	2.20	0.00
t+1	0.27	1.51	4.68
t+2	-0.73	1.98	1.42
t+3	0.43	2.68	2.90
t+4	0.78	2.35	3.93
t+5	-0.27	2.36	2.02

Other T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.46	0.95	8.16
t-4	0.13	1.26	5.07
t-3	-0.34	0.93	4.70
t-2	0.04	1.05	5.70
t-1	0.15	0.97	6.66
t	-1.37	2.27	0.00
t+1	0.01	1.47	3.98
t+2	-0.77	1.44	1.76
t+3	0.27	2.18	3.18
t+4	0.74	1.86	4.82
t+5	0.55	2.83	2.89

Event Average Abnormal Return T-Test Results

Event 1 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	-0.59	0.54	23.59
t-4	-0.69	0.51	23.77
t-3	-0.10	0.45	33.94
t-2	0.09	1.03	15.87
t-1	-1.22	0.67	13.79
t	-2.90	1.20	0.00
t+1	3.46	1.51	23.13
t+2	-0.12	0.36	42.21
t+3	1.42	0.78	30.43
t+4	0.26	0.62	28.12
t+5	-0.06	0.59	26.51

Event 2 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.72	0.59	11.23
t-4	2.12	1.06	13.40
t-3	0.22	0.78	4.95
t-2	0.80	0.91	7.80
t-1	0.47	0.96	5.43
t	-0.49	0.54	0.00
t+1	1.64	0.83	14.06
t+2	0.76	0.77	8.90
t+3	1.09	0.67	12.83
t+4	0.28	0.66	6.31
t+5	0.54	0.87	6.49

Event 3 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	2.39	0.92	16.78
t-4	0.84	0.69	10.12
t-3	-1.63	0.72	-9.03
t-2	0.72	0.80	7.94
t-1	0.34	0.53	8.07
t	-0.44	0.52	0.00
t+1	-0.01	0.65	3.64
t+2	-1.58	0.97	-6.47
t+3	-1.59	0.67	-9.49
t+4	-0.35	0.78	0.63
t+5	-0.08	0.45	4.30

Event 4 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	-0.50	0.52	1.96
t-4	-0.93	0.47	-2.85
t-3	0.18	0.61	7.79
t-2	1.76	0.81	16.61
t-1	2.37	0.79	21.20
t	-0.69	0.71	0.00
t+1	-0.19	0.63	4.31
t+2	1.13	0.51	19.64
t+3	-0.19	0.68	4.07
t+4	0.40	0.75	7.88
t+5	-1.08	0.57	-3.75

Event 5 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.75	0.59	9.54
t-4	0.52	0.40	10.91
t-3	0.14	0.40	5.69
t-2	-0.49	0.52	-2.22
t-1	1.30	0.86	10.10
t	-0.28	0.40	0.00
t+1	0.04	0.53	3.33
t+2	-0.22	1.09	0.30
t+3	-0.82	0.47	-6.39
t+4	1.21	0.89	9.18
t+5	0.31	0.51	6.27

Event 6 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.07	0.46	9.95
t-4	1.59	0.60	21.35
t-3	-0.62	0.75	1.02
t-2	0.62	0.58	12.99
t-1	0.14	0.35	13.94
t	-0.76	0.42	0.00
t+1	-0.64	0.31	2.17
t+2	-1.27	0.41	-6.67
t+3	0.55	0.58	12.42
t+4	1.23	0.37	29.71
t+5	1.42	0.79	15.07

Event 7 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.60	0.87	5.28
t-4	-0.39	0.80	-1.00
t-3	1.35	0.60	14.40
t-2	-0.42	0.58	-1.70
t-1	-0.89	0.53	-6.76
t	-0.24	0.41	0.00
t+1	1.18	0.62	12.47
t+2	0.23	0.84	3.08
t+3	0.00	0.64	2.05
t+4	-0.30	0.50	-0.70
t+5	-1.04	0.44	-10.10

Event 8 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	-0.65	0.59	-12.52
t-4	-0.84	0.51	-16.59
t-3	0.11	0.45	-7.25
t-2	0.97	0.53	2.75
t-1	0.35	0.54	-3.59
t	0.70	0.68	0.00
t+1	0.18	0.66	-4.39
t+2	-0.25	0.41	-12.83
t+3	0.93	0.50	2.43
t+4	0.84	0.84	0.89
t+5	-0.16	0.88	-5.39

Event 9 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.23	0.41	20.29
t-4	0.11	0.41	18.37
t-3	-0.65	0.60	5.78
t-2	-0.16	0.52	11.77
t-1	-0.79	0.76	3.52
t	-1.28	0.82	0.00
t+1	-0.11	0.51	12.61
t+2	0.41	0.57	16.11
t+3	0.47	0.56	17.09
t+4	0.33	0.68	12.99
t+5	0.02	0.62	11.41

Event 10 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.14	0.69	7.33
t-4	1.39	0.86	13.85
t-3	0.14	0.58	8.67
t-2	0.22	0.80	6.87
t-1	-0.24	0.64	4.61
t	-0.78	0.57	0.00
t+1	0.41	0.56	11.64
t+2	-0.18	0.79	4.15
t+3	-0.76	0.69	0.17
t+4	0.67	0.69	11.64
t+5	-0.41	0.60	3.40

Event 11 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.83	0.52	11.12
t-4	-0.24	0.43	-0.07
t-3	-0.02	0.53	2.15
t-2	-0.21	0.40	0.34
t-1	0.45	0.56	6.67
t	-0.23	0.58	0.00
t+1	0.02	0.76	1.82
t+2	0.08	0.75	2.29
t+3	0.11	0.55	3.35
t+4	0.00	0.50	2.54
t+5	-0.29	0.76	-0.43

Event 12 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.10	0.65	-1.35
t-4	-0.05	0.78	-2.21
t-3	0.13	0.46	-1.59
t-2	0.68	0.60	3.84
t-1	0.55	0.55	2.93
t	0.26	0.43	0.00
t+1	-0.14	0.67	-3.25
t+2	-0.60	0.54	-8.64
t+3	-0.46	0.75	-5.22
t+4	-0.11	0.66	-3.06
t+5	0.12	0.49	-1.59

Event 13 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.84	0.82	14.81
t-4	0.11	0.92	8.81
t-3	-0.73	0.59	5.94
t-2	-0.22	0.78	8.05
t-1	0.23	0.64	13.64
t	-1.37	1.16	0.00
t+1	-1.61	0.94	-1.42
t+2	0.47	0.92	10.95
t+3	-0.27	0.60	10.06
t+4	-0.50	0.89	5.39
t+5	0.53	0.76	13.64

Event 14 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	0.41	1.15	29.63
t-4	-0.21	1.10	27.98
t-3	-1.67	0.97	23.54
t-2	-2.00	1.16	18.01
t-1	-0.31	1.25	24.12
t	-5.83	4.36	0.00
t+1	-1.04	1.36	19.35
t+2	-2.18	1.51	13.22
t+3	-3.51	2.06	6.14
t+4	-1.70	1.83	12.32
t+5	3.58	2.99	17.22

Event 15 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	1.08	0.99	10.62
t-4	0.29	1.29	4.78
t-3	-1.82	1.79	-3.03
t-2	1.12	1.32	8.10
t-1	0.31	0.61	10.36
t	-0.83	1.12	0.00
t+1	-0.57	0.77	1.87
t+2	-0.68	0.61	1.38
t+3	-1.03	0.61	-1.72
t+4	0.79	0.99	8.95
t+5	-0.63	0.96	1.16

Event 16 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	-0.44	0.57	-1.19
t-4	-0.66	0.68	-2.74
t-3	0.29	0.38	8.91
t-2	-0.58	0.25	-5.76
t-1	0.67	0.69	7.92
t	-0.32	0.96	0.00
t+1	1.24	0.87	9.78
t+2	-0.02	1.04	1.56
t+3	-0.40	0.55	-0.77
t+4	1.09	0.56	13.68
t+5	0.39	0.61	6.36

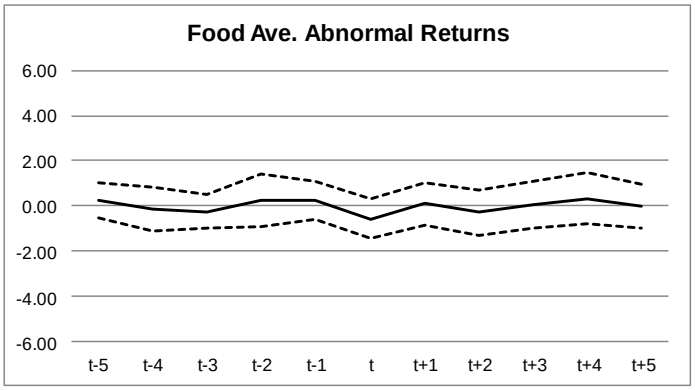
Event 17 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	1.28	2.60	11.66
t-4	-3.63	2.54	1.36
t-3	1.04	1.87	15.53
t-2	1.26	0.89	34.11
t-1	0.86	2.07	13.57
t	-4.26	2.67	0.00
t+1	1.38	1.26	24.45
t+2	-4.18	1.64	0.25
t+3	3.80	1.97	22.44
t+4	3.96	2.96	15.22
t+5	-3.58	1.93	1.93

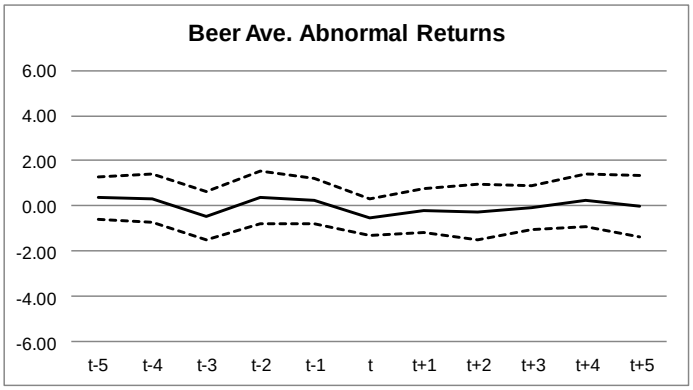
Event 18 T-Test Results			
Time	Ave. Return	Std. Dev.	T-Value
t-5	-1.13	0.74	-3.58
t-4	1.05	0.77	12.09
t-3	-0.20	1.01	2.43
t-2	-1.92	1.15	-6.10
t-1	0.72	0.73	10.32
t	-0.64	0.82	0.00
t+1	-0.81	0.73	-1.29
t+2	-1.59	0.72	-7.15
t+3	1.05	0.89	10.44
t+4	0.34	1.02	5.27
t+5	1.77	0.66	19.91

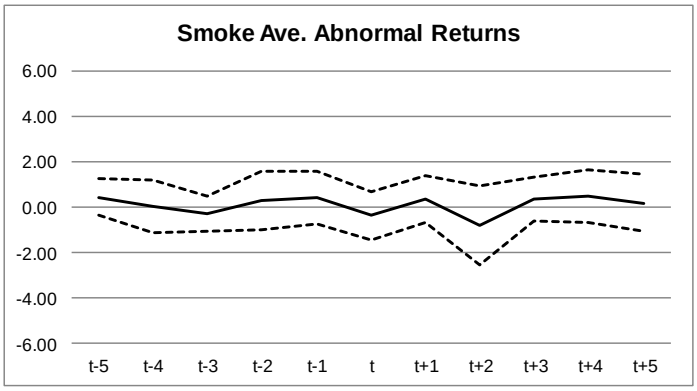
Average Abnormal Return Graphs Results

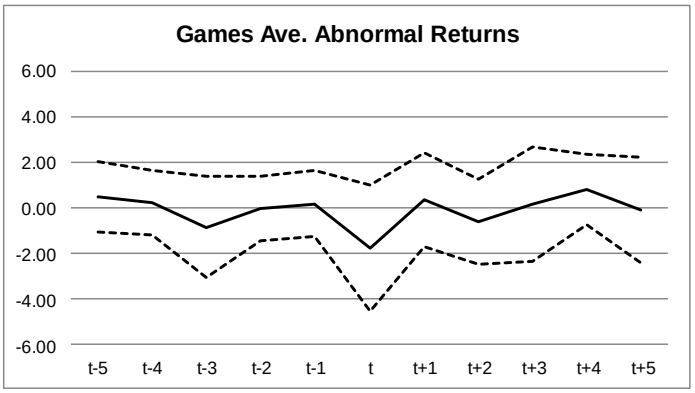
The graphs of the average abnormal returns for the 30 industry portfolios and the black swan events did not provide significant evidence from which to draw conclusions. I keep the scale of the graphs consistent throughout to allow for a better interpretation of the results. The graphs depict the volatility of the abnormal returns over the 10-day window and track how the black swan event impacts the volatility. Overall the standard deviation appears to be consistent throughout the time window. There are only a few instances in which the standard deviation changes drastically as a result of volatility surrounding the black swan event. In the case of the Txtls, Fin, and Other industry portfolios, volatility increases slightly following each black swan event. While the September 11th Terrorist Attacks (Event 14) and Hurricane Katrina (Event 17) are among the black swan events that create the most volatility. Due to the nature of each event, the depicted volatility differs. Hurricane Katrina, an event with some extent of warning, shows volatility in abnormal returns preceding and succeeding the actual event date. Conversely, the September 11th Terrorist Attacks completely blind sighted U.S. investors and shows significant volatility on the date of the event. It is important to note that in both the industry graphs and the event graphs that even the comparatively least volatile instances are more volatile than asset price movements on a "normal" trading day.

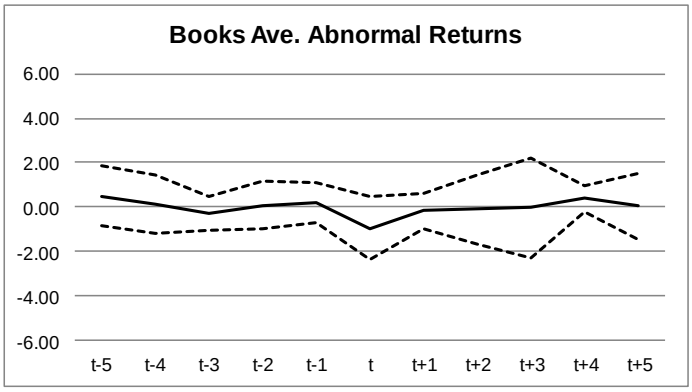
Industry Average Abnormal Return Graphs

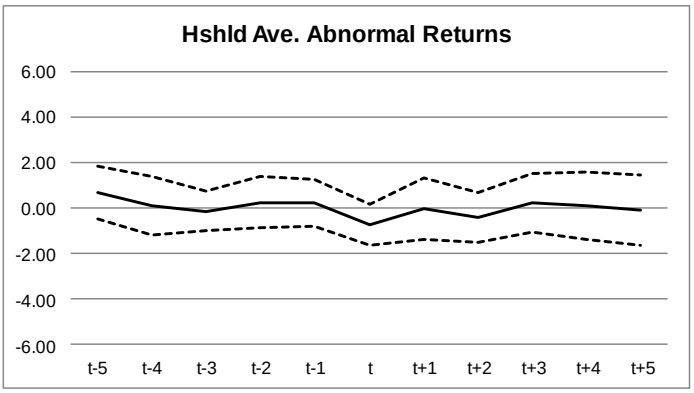


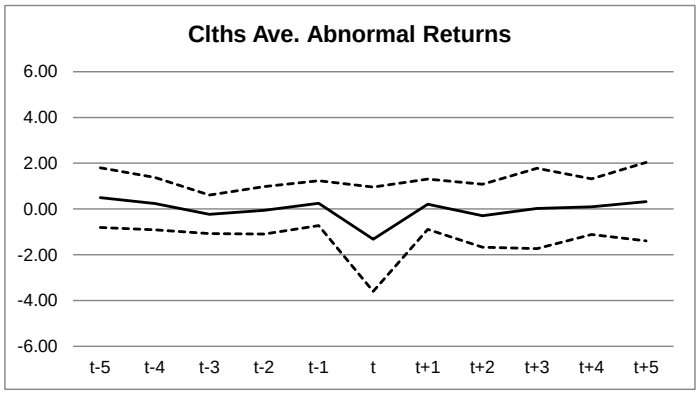


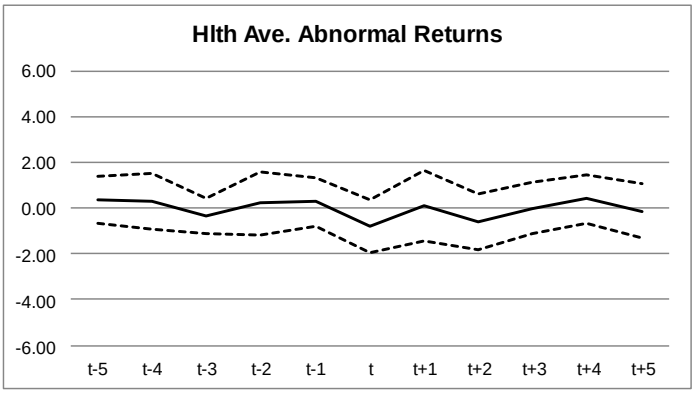









Clths Ave. Abnormal Returns
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Hlth Ave. Abnormal Returns
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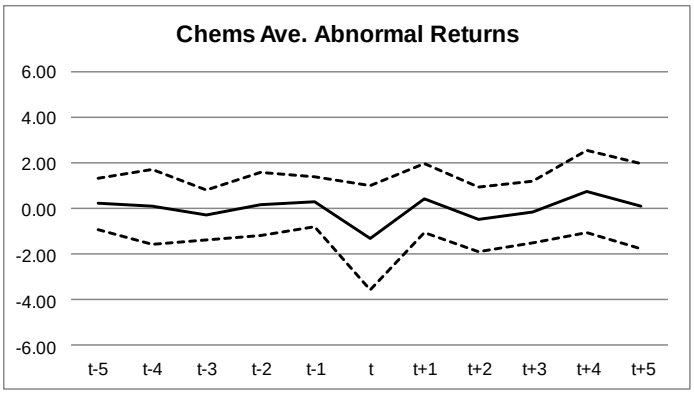
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Chems Ave. Abnormal Returns
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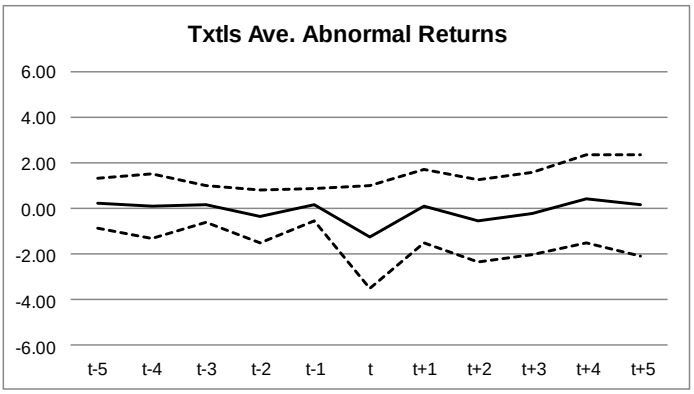
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Txtls Ave. Abnormal Returns
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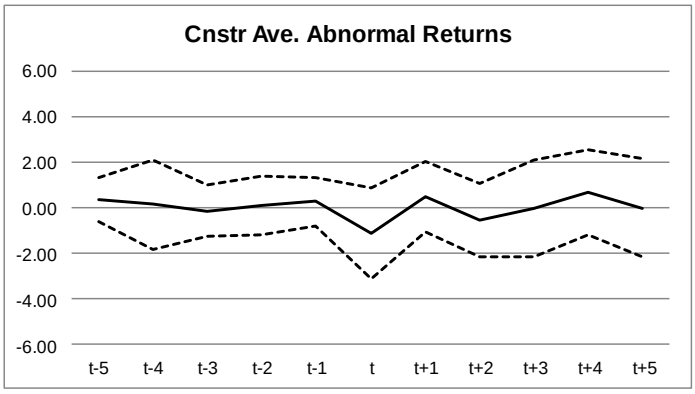
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Cnstr Ave. Abnormal Returns
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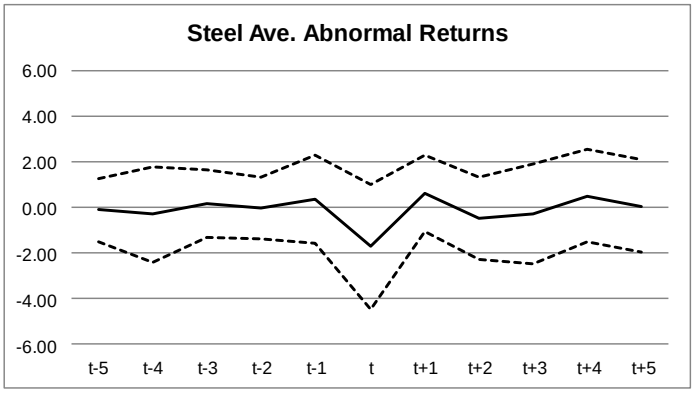
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Steel Ave. Abnormal Returns
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-6.00
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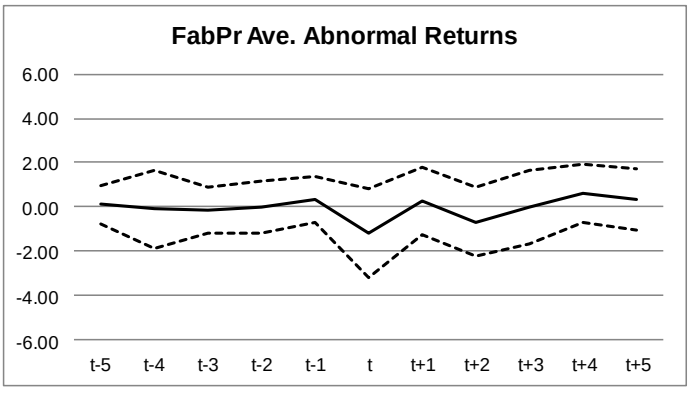
FabPr Ave. Abnormal Returns
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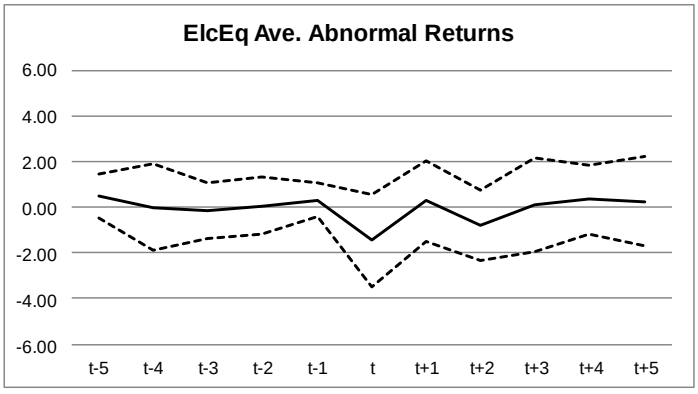
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


ElcEq Ave. Abnormal Returns
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-2.00
-4.00
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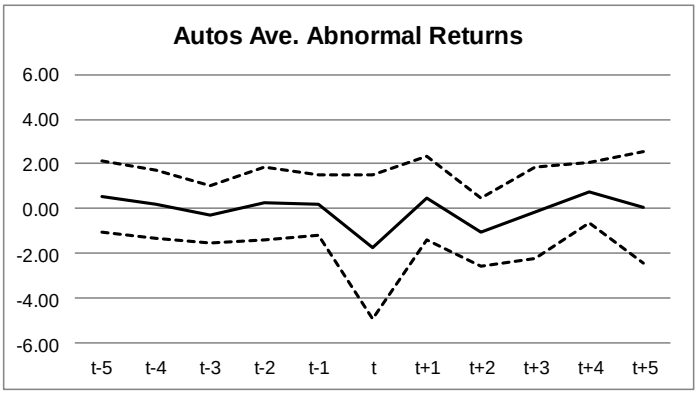
Autos Ave. Abnormal Returns
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-4.00
-6.00
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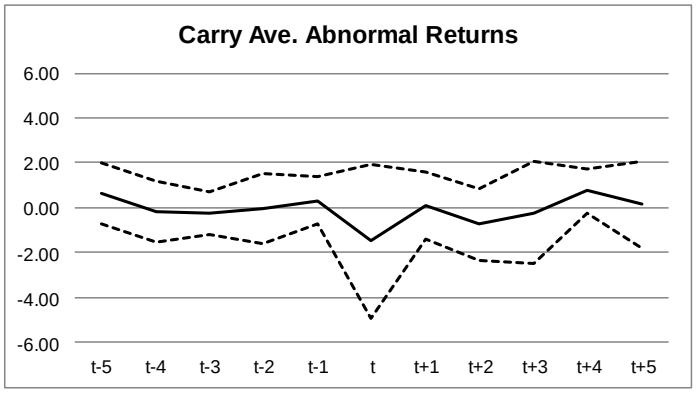
Carry Ave. Abnormal Returns
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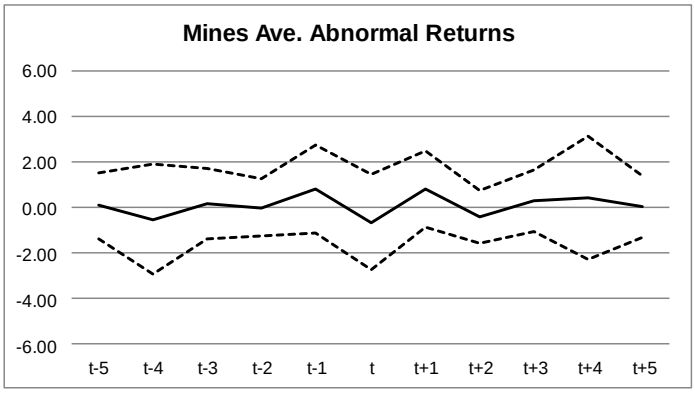
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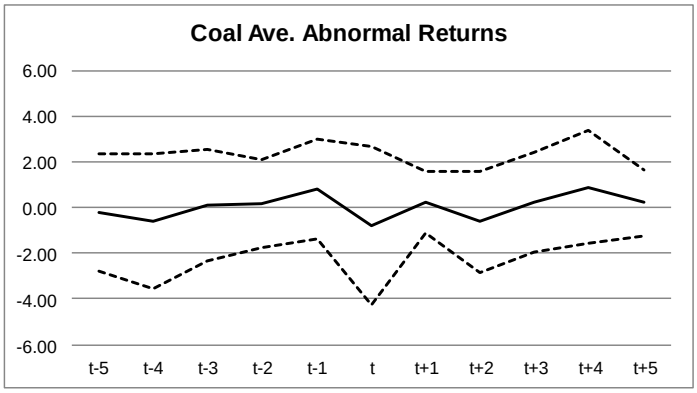
Coal Ave. Abnormal Returns
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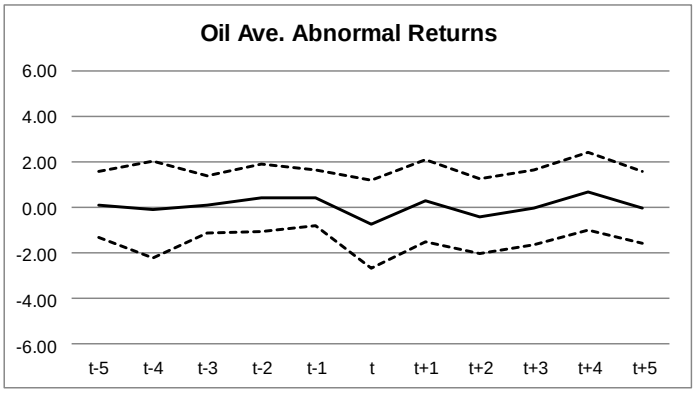
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Oil Ave. Abnormal Returns
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-4.00
-6.00
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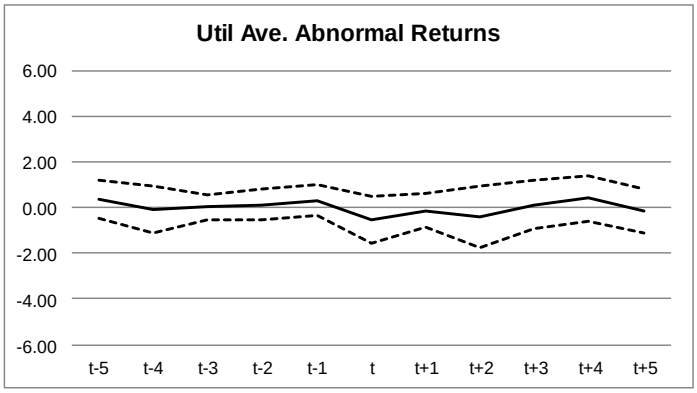
Util Ave. Abnormal Returns
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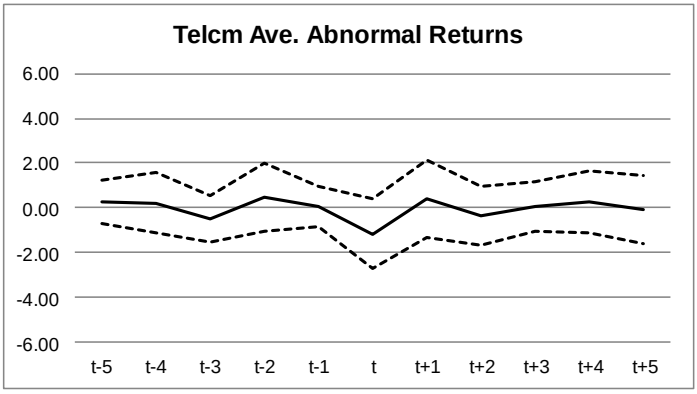
Telcm Ave. Abnormal Returns
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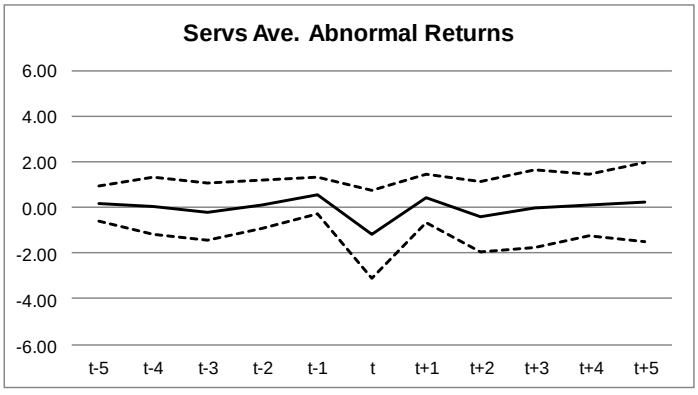
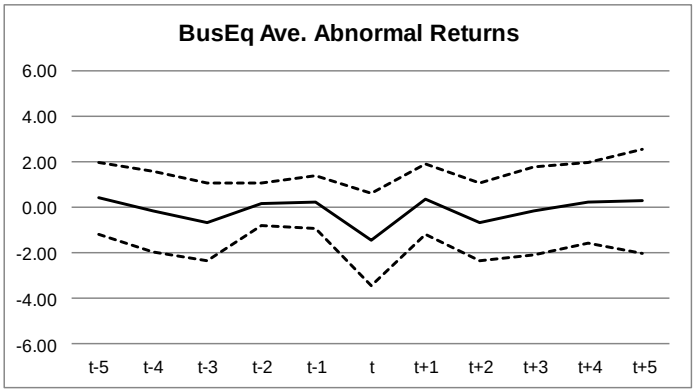
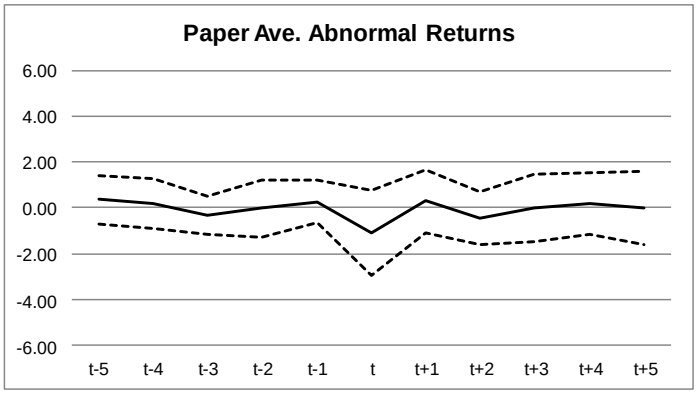
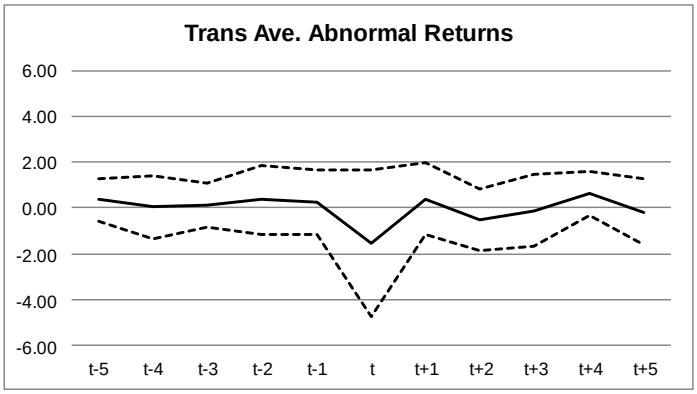
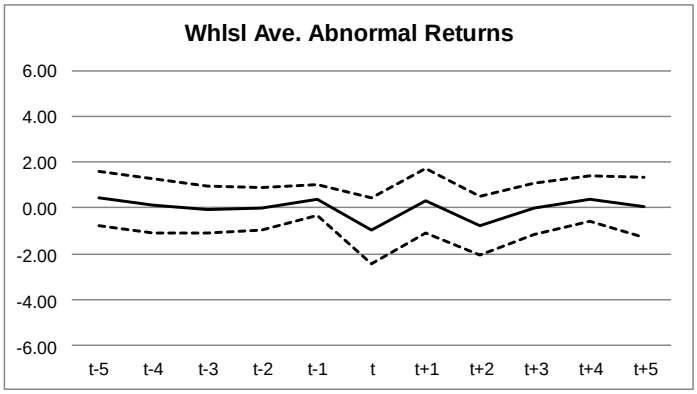
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

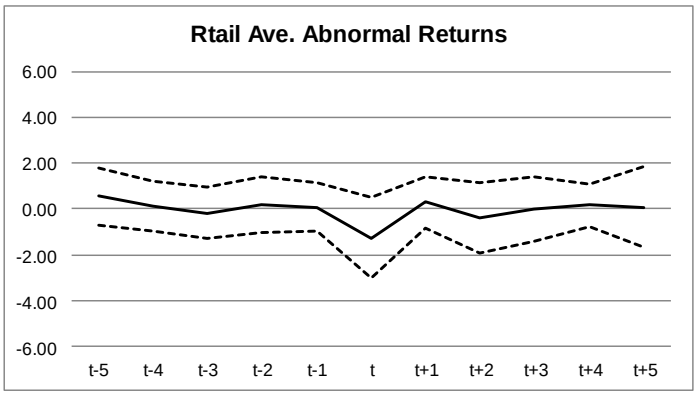

Servs Ave. Abnormal Returns
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

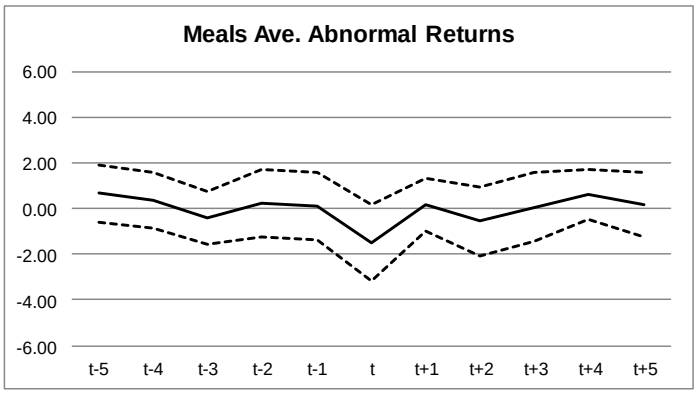

BusEq Ave. Abnormal Returns
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

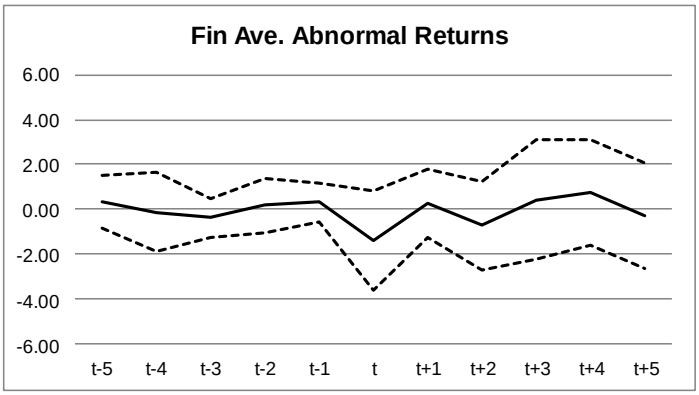

Paper Ave. Abnormal Returns
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

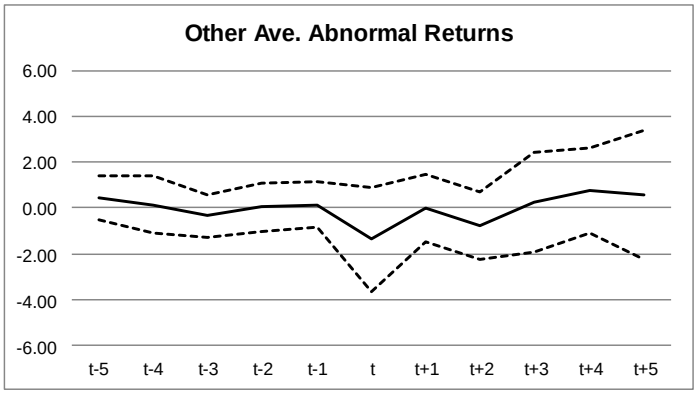

Trans Ave. Abnormal Returns
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Whlsl Ave. Abnormal Returns
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

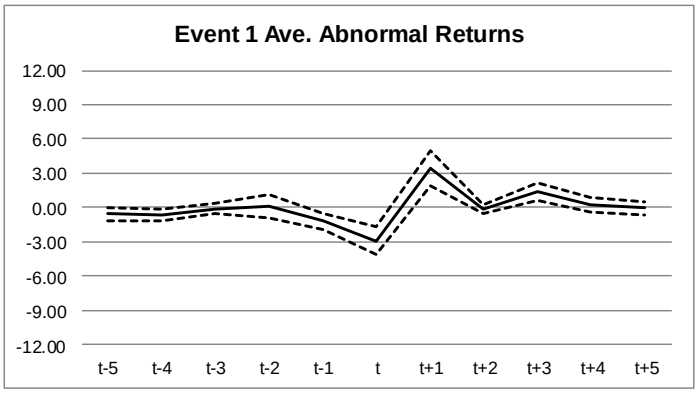

Rtail Ave. Abnormal Returns
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

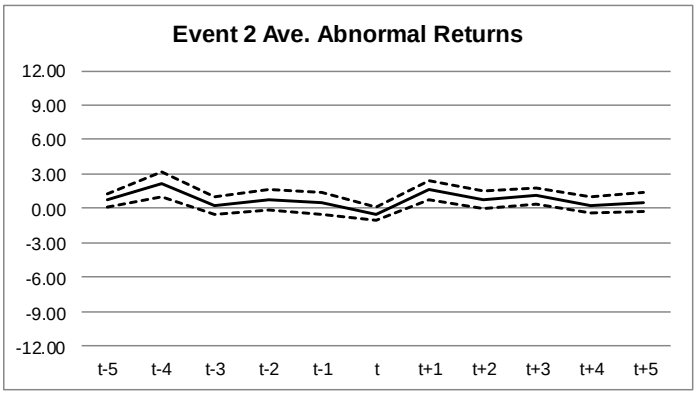

Meals Ave. Abnormal Returns
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

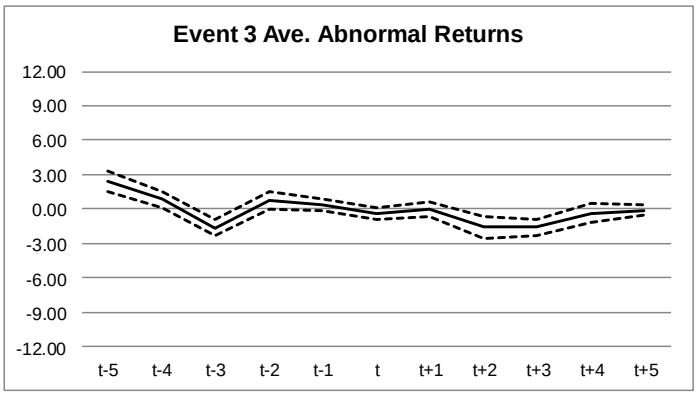

Fin Ave. Abnormal Returns
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

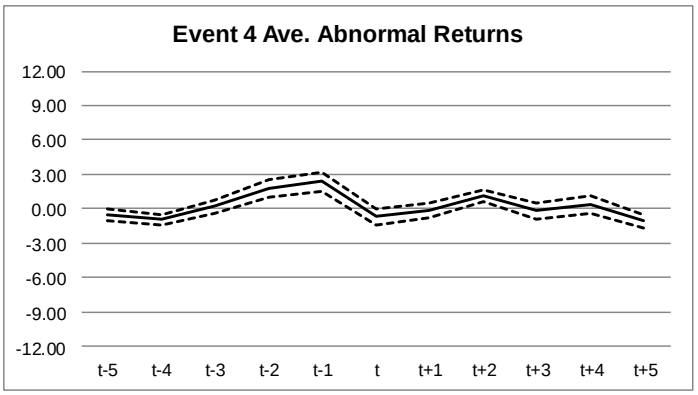

Other Ave. Abnormal Returns
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

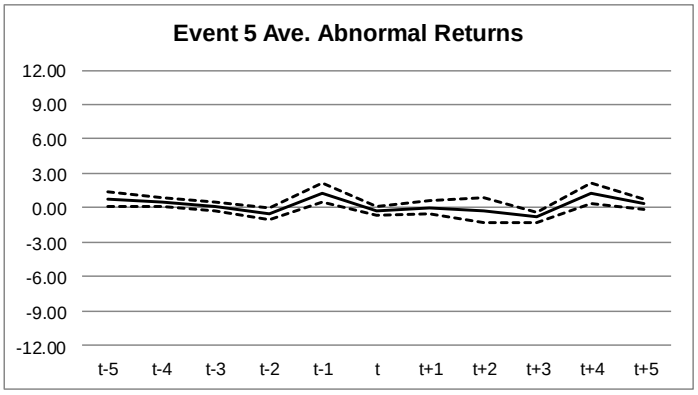
Event Average Abnormal Return Graphs

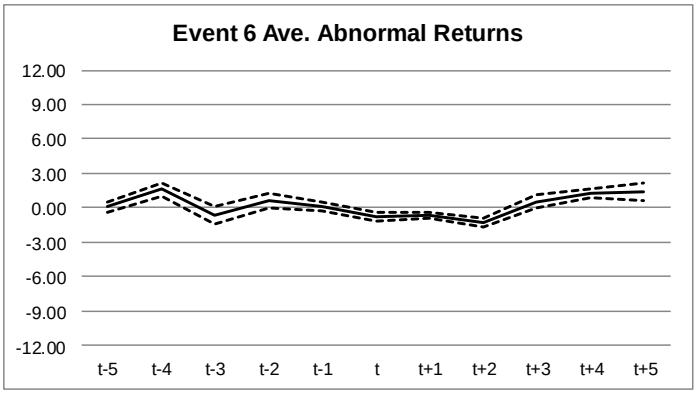


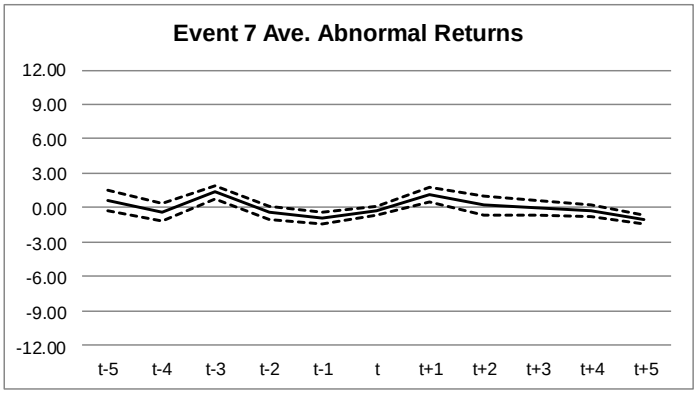


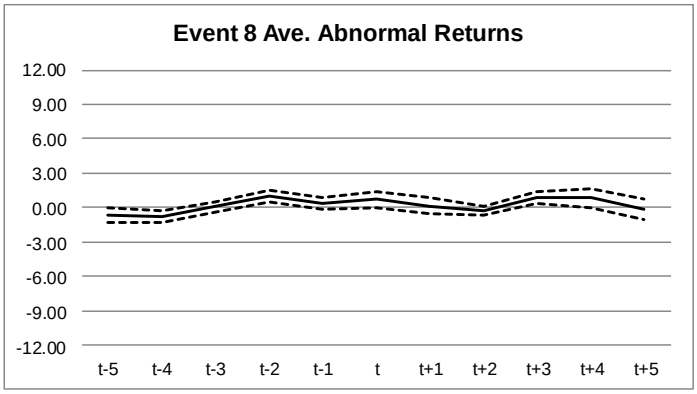


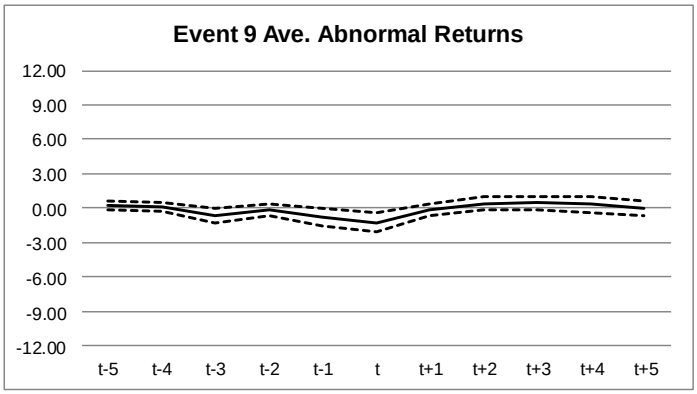


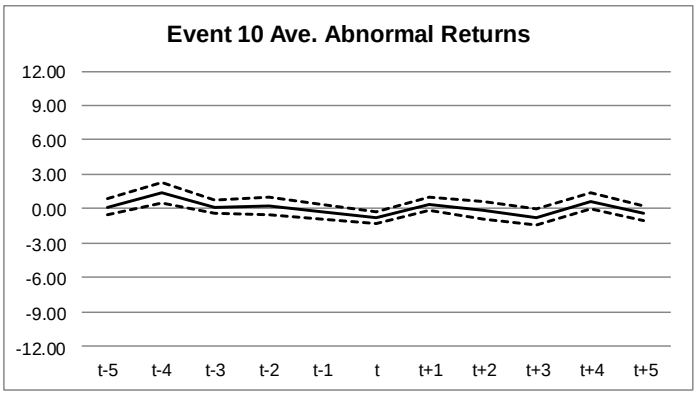


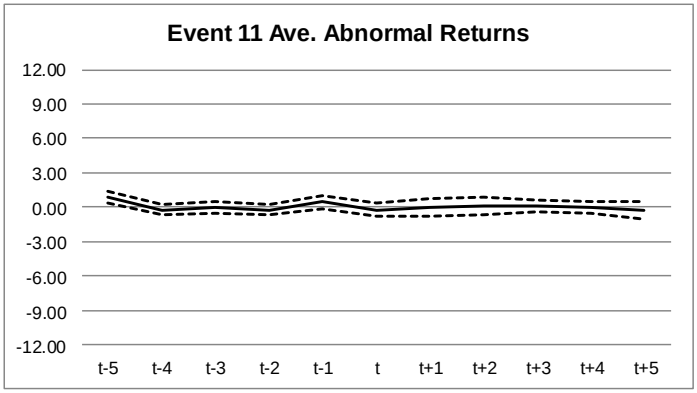


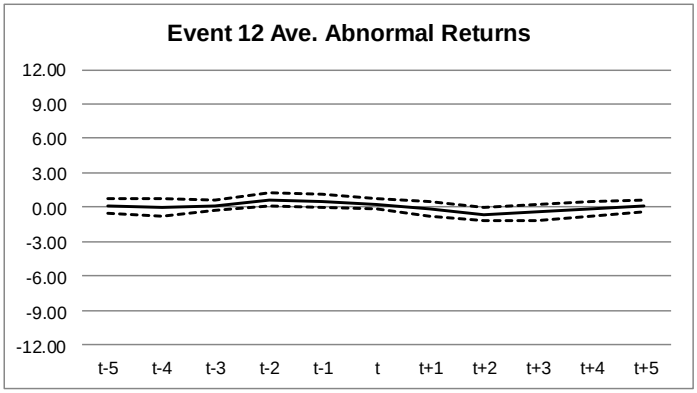

Event 7 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

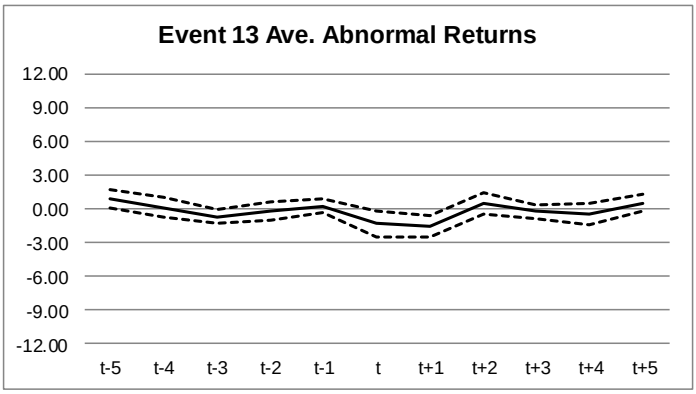

Event 8 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

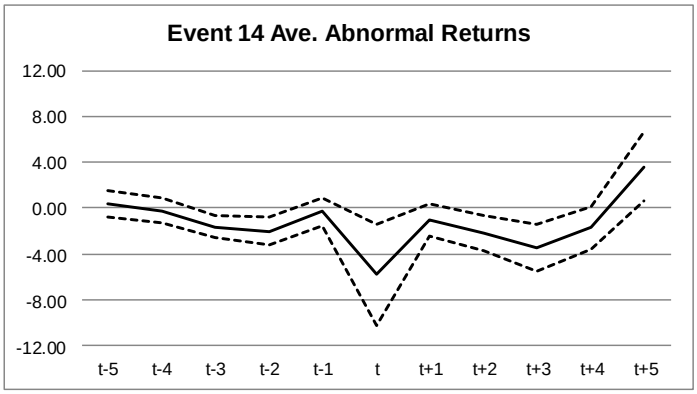

Event 9 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

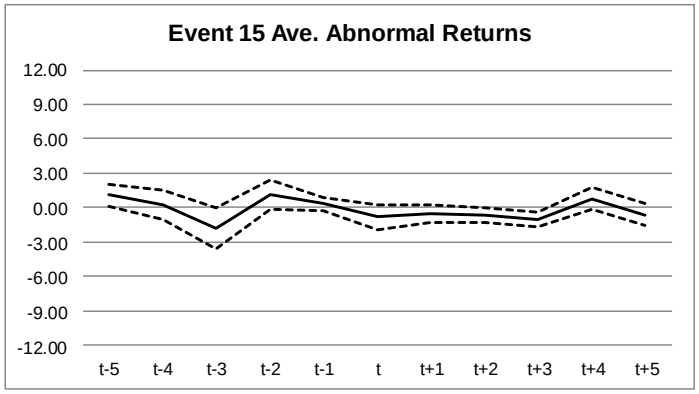

Event 10 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

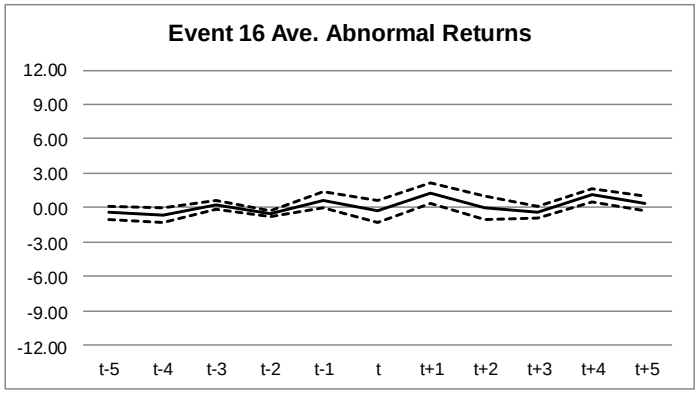

Event 11 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

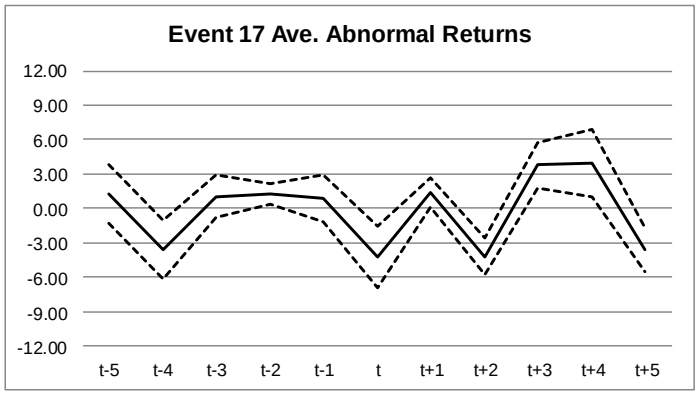

Event 12 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

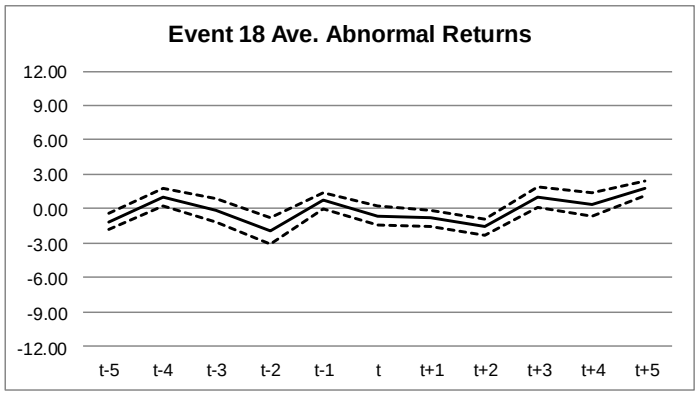

Event 13 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Event 14 Ave. Abnormal Returns
12.00
8.00
4.00
0.00
-4.00
-8.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Event 15 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Event 16 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Event 17 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5


Event 18 Ave. Abnormal Returns
12.00
9.00
6.00
3.00
0.00
-3.00
-6.00
-9.00
-12.00
t-5 t-4 t-3 t-2 t-1 t t+1 t+2 t+3 t+4 t+5

Change in Beta Test Results

The purpose of the change in beta test is to determine if the industry portfolio returns on the date of each black swan event impacted the calculation of each industry portfolio's market beta. The results for each event, across the 30 industry portfolios examined provide a mixed picture. In most cases, the returns of the black swan event have very little to no effect on the beta calculation incorporating daily returns over the 60 months immediately preceding the event.

I perform a two-tail t-test to analyze the results of the change in beta test. I average the changes in beta between the periods of 60 months before the event and 60 months after the event for the 18 black swan events. I also take the average of the changes in beta between the periods of 60 days before the event and 60 days after the event for the 18 black swan events. To test for the significance of these average changes, I adopt the following hypothesis. In words, if the average change in beta for each event equals zero, with a 95% confidence interval and 29 degrees of freedom, then the null hypothesis is accepted.

Null Hypothesis:

H_0: $\mu = 0$ and H_1: $\mu \neq 0$ in

I once again use Equation 5 to calculate the t-values for each event. If the t-value is greater than 2.045, then the null hypothesis rejected. Table 4-2 summarizes the results of my analysis.

Based on my analysis, it is clear that each black swan event has a very marginal impact on the calculation of beta. The null hypothesis was accepted for 17 of 18 events for the 60 month beta calculation, and it was also accepted for 17 of 18 events for the 60 day beta calculation. The September 11, 2001 Terrorist Attacks is the only event to demonstrate a significant impact on each industry

portfolio's 60 month market beta. While the John F. Kennedy Assassination is the only event to demonstrate a significant impact on each industry portfolio's 60 day market beta. It is also worthy to note

Table 4-2. Change in Beta T-Test Results

Change in Beta T-Test Results

t-60m to tm				t-60d to td			
Event #	**Ave. Change**	**Std. Dev.**	**T-Value**	**Event #**	**Ave. Change**	**Std. Dev.**	**T-Value**
Event 1	0.00	0.01	1.05	Event 1	0.09	0.21	2.27
Event 2	0.00	0.00	0.33	Event 2	0.00	0.01	-1.79
Event 3	0.00	0.00	-1.51	Event 3	0.00	0.01	-1.92
Event 4	0.00	0.00	-0.02	Event 4	0.00	0.01	-1.55
Event 5	0.00	0.02	1.00	Event 5	0.00	0.01	-0.75
Event 6	0.00	0.02	1.60	Event 6	0.00	0.00	1.10
Event 7	0.00	0.00	-1.29	Event 7	0.00	0.01	-1.16
Event 8	0.00	0.00	-0.10	Event 8	-0.01	0.02	-1.86
Event 9	0.00	0.00	0.31	Event 9	0.01	0.08	0.80
Event 10	0.00	0.00	-0.73	Event 10	0.01	0.03	1.58
Event 11	0.00	0.00	-0.62	Event 11	0.00	0.02	-1.23
Event 12	0.00	0.00	-1.16	Event 12	0.00	0.02	-0.57
Event 13	0.00	0.03	0.73	Event 13	0.00	0.08	-0.32
Event 14	0.01	0.02	2.48	Event 14	0.10	0.32	1.67
Event 15	0.00	0.00	-0.92	Event 15	-0.01	0.04	-1.92
Event 16	0.00	0.00	-0.37	Event 16	0.00	0.02	1.53
Event 17	0.00	0.01	-2.22	Event 17	-0.01	0.09	-0.67
Event 18	0.00	0.00	1.25	Event 18	0.00	0.02	1.43

that the market betas calculated over the 12 months after each event and the 60 days after each event change dramatically from the betas calculated with returns before the event. Indicating, other factors and events caused impactful changes in beta over these time horizons.

It is clear that the black swan events, in most cases, only have a small impact on the calculation of the market betas for each industry portfolio. This observation suggests that the calculation of beta as a measure of the market risk of an asset is effective and valuable. The following tables summarize the changes in beta over both time windows.

Change in Beta Test

Event 1: JFK Assasination						
Industry	t-60m	tm	t+12m	t-60d	td	t+60d
Food	0.83	0.83	0.59	0.55	0.60	0.34
Beer	0.70	0.70	0.41	0.41	0.36	0.12
Smoke	0.84	0.83	0.77	0.59	0.43	0.37
Games	1.54	1.54	1.55	1.52	1.45	0.99
Books	0.85	0.85	0.70	0.53	0.65	0.32
Hshld	0.98	0.98	1.12	1.13	0.98	0.76
Clths	0.70	0.71	0.64	0.55	0.70	0.43
Hlth	1.11	1.12	1.08	1.31	1.32	0.82
Chems	1.00	1.00	1.10	0.76	0.87	0.77
Txtls	0.79	0.79	0.79	0.53	0.79	0.51
Cnstr	0.93	0.93	0.75	0.57	0.72	0.46
Steel	1.18	1.18	1.50	1.32	1.27	0.95
FabPr	0.95	0.95	0.96	0.84	0.88	0.49
ElcEq	1.34	1.35	1.27	1.11	1.40	0.83
Autos	1.19	1.19	1.57	1.91	1.67	1.00
Carry	1.19	1.19	1.00	0.69	0.92	0.74
Mines	0.54	0.55	1.07	0.74	0.97	0.62
Coal	0.65	0.64	0.75	0.76	0.57	0.47
Oil	0.93	0.92	0.94	1.02	0.97	0.58
Util	0.63	0.63	0.33	0.34	0.35	0.19
Telcm	1.07	1.08	1.13	1.31	1.43	0.92
Servs	0.87	0.87	1.04	0.74	0.70	0.56
BusEq	1.34	1.34	1.36	1.41	1.20	0.84
Paper	1.00	1.01	1.05	0.85	1.09	0.76
Trans	0.88	0.88	1.26	0.96	1.02	0.71
Whlsl	0.93	0.94	0.91	0.60	0.98	0.62
Rtail	0.82	0.83	0.86	0.74	0.83	0.54
Meals	0.87	0.87	0.54	0.50	0.56	0.28
Fin	0.84	0.84	0.69	0.59	0.63	0.44
Other	0.65	0.66	0.94	0.81	0.82	0.55

Event 2: MLK Jr. Assasination						
Industry	t-60m	tm	t+12m	t-60d	td	t+60d
Food	0.69	0.69	0.87	0.68	0.68	0.83
Beer	0.69	0.69	0.87	0.68	0.68	0.83
Smoke	0.60	0.60	0.77	0.47	0.47	0.61
Games	1.89	1.89	1.53	2.00	2.00	1.61
Books	0.79	0.79	0.74	0.94	0.93	0.81
Hshld	1.28	1.28	1.12	1.18	1.19	1.22
Clths	0.91	0.90	0.96	1.07	1.07	0.70
Hlth	1.01	1.01	0.92	1.05	1.04	0.91
Chems	0.94	0.94	1.01	0.77	0.77	1.13
Txtls	0.97	0.97	1.00	0.83	0.83	0.97
Cnstr	0.92	0.92	1.13	1.08	1.07	1.23
Steel	1.17	1.17	1.07	0.76	0.76	0.86
FabPr	1.01	1.01	0.93	1.05	1.05	0.78
ElcEq	1.43	1.43	1.14	1.59	1.59	1.08
Autos	1.26	1.26	1.06	1.09	1.09	1.02
Carry	1.36	1.36	1.15	1.21	1.20	1.07
Mines	1.18	1.18	0.98	0.62	0.62	0.76
Coal	0.72	0.72	0.83	0.72	0.73	0.68
Oil	0.89	0.89	0.89	0.83	0.84	0.82
Util	0.43	0.43	0.44	0.44	0.43	0.33
Telcm	0.82	0.82	0.49	0.55	0.54	0.39
Servs	1.27	1.27	1.52	1.93	1.92	1.62
BusEq	1.52	1.52	1.38	1.70	1.71	1.69
Paper	0.95	0.95	1.01	0.70	0.70	0.95
Trans	1.38	1.38	1.29	1.03	1.02	1.18
Whlsl	1.32	1.32	1.55	1.75	1.75	1.16
Rtail	0.79	0.79	0.99	0.87	0.88	0.90
Meals	1.07	1.07	1.50	1.79	1.79	1.29
Fin	0.74	0.74	1.23	1.00	1.01	1.08
Other	1.11	1.11	1.35	1.16	1.16	1.30

Event 3: Ford Assasination Attempt 1						
Industry	t-60m	tm	t+12m	t-60d	td	t+60d
Food	0.86	0.86	0.90	0.82	0.81	0.99
Beer	0.92	0.92	1.06	1.01	1.01	1.24
Smoke	1.06	1.06	1.06	1.02	1.03	1.01
Games	1.41	1.41	1.47	1.66	1.66	1.46
Books	0.83	0.83	0.84	0.89	0.88	0.82
Hshld	1.28	1.28	1.29	1.33	1.34	1.33
Clths	0.90	0.89	1.17	1.21	1.21	1.07
Hlth	1.10	1.10	1.09	0.97	0.97	1.16
Chems	1.12	1.12	1.16	1.13	1.13	1.05
Txtls	0.83	0.83	0.84	0.83	0.82	0.59
Cnstr	1.01	1.01	1.03	1.05	1.05	0.91
Steel	1.03	1.03	1.04	0.88	0.87	0.79
FabPr	1.07	1.07	1.05	1.04	1.04	0.98
ElcEq	1.10	1.10	0.96	1.00	0.99	0.86
Autos	1.06	1.06	1.21	1.18	1.17	1.28
Carry	1.10	1.10	1.12	1.24	1.22	1.06
Mines	0.69	0.69	0.67	0.82	0.81	0.79
Coal	1.31	1.30	1.22	1.56	1.56	1.46
Oil	0.96	0.96	0.88	0.91	0.91	0.77
Util	0.57	0.57	0.53	0.74	0.73	0.50
Telcm	0.61	0.61	0.63	0.60	0.60	0.57
Servs	1.11	1.11	0.99	1.12	1.11	0.92
BusEq	1.24	1.24	1.34	1.27	1.29	1.43
Paper	0.96	0.96	1.08	0.94	0.94	1.17
Trans	1.22	1.22	1.07	0.99	0.99	0.99
Whlsl	0.94	0.94	0.90	1.01	1.01	0.86
Rtail	1.03	1.03	1.04	0.95	0.95	1.05
Meals	1.57	1.57	1.42	1.57	1.57	1.68
Fin	0.97	0.97	1.00	0.91	0.91	1.06
Other	0.90	0.90	0.81	0.85	0.84	0.86

Event 4: Ford Assasination Attempt 2						
Industry	t-60m	tm	t+12m	t-60d	td	t+60d
Food	0.87	0.87	0.88	0.88	0.88	1.00
Beer	0.93	0.93	1.03	1.05	1.07	1.20
Smoke	1.06	1.07	1.07	1.05	1.06	1.01
Games	1.41	1.41	1.46	1.68	1.67	1.41
Books	0.83	0.83	0.82	0.89	0.88	0.82
Hshld	1.28	1.28	1.29	1.33	1.33	1.30
Clths	0.90	0.90	1.18	1.22	1.20	1.14
Hlth	1.10	1.10	1.07	1.05	1.05	1.10
Chems	1.12	1.12	1.17	1.06	1.06	1.07
Txtls	0.83	0.83	0.88	0.72	0.70	0.66
Cnstr	1.01	1.01	1.04	1.06	1.06	0.92
Steel	1.03	1.03	1.05	0.86	0.87	0.76
FabPr	1.07	1.07	1.04	1.05	1.04	0.97
ElcEq	1.10	1.10	0.95	1.00	0.99	0.80
Autos	1.06	1.06	1.22	1.21	1.21	1.31
Carry	1.10	1.10	1.12	1.24	1.26	1.01
Mines	0.69	0.69	0.64	0.89	0.88	0.67
Coal	1.31	1.31	1.20	1.35	1.35	1.46
Oil	0.95	0.95	0.90	0.83	0.83	0.81
Util	0.57	0.57	0.53	0.64	0.63	0.54
Telcm	0.61	0.61	0.64	0.58	0.57	0.56
Servs	1.11	1.11	0.99	1.10	1.08	0.95
BusEq	1.24	1.24	1.34	1.29	1.29	1.40
Paper	0.96	0.96	1.07	1.02	1.02	1.15
Trans	0.94	0.94	0.91	1.02	1.01	0.89
Whlsl	1.03	1.03	1.03	1.04	1.04	1.02
Rtail	1.56	1.56	1.38	1.67	1.66	1.64
Meals	0.97	0.97	0.99	0.93	0.93	1.09
Fin	0.97	0.97	0.99	0.93	0.93	1.09
Other	0.90	0.90	0.79	0.85	0.85	0.87

Event 5:Three Mile Island						
Industry	**t-60m**	**tm**	**t+12m**	**t-60d**	**td**	**t+60d**
Food	0.00	0.00	0.03	-0.26	-0.25	0.04
Beer	0.98	0.98	1.04	1.03	1.02	0.90
Smoke	1.04	1.04	0.86	0.80	0.79	0.86
Games	1.35	1.34	1.14	1.45	1.46	1.38
Books	0.79	0.79	0.68	0.79	0.79	0.64
Hshld	1.32	1.32	0.83	1.30	1.30	1.00
Clths	0.88	0.88	0.81	0.75	0.77	0.72
Hlth	1.19	1.19	0.91	1.08	1.08	1.00
Chems	1.17	1.17	1.11	1.28	1.28	1.19
Txtls	0.79	0.79	0.76	0.90	0.89	0.89
Cnstr	0.98	0.98	0.92	0.95	0.96	0.95
Steel	1.00	1.00	1.13	1.19	1.19	1.00
FabPr	1.06	1.06	0.92	1.05	1.06	1.03
ElcEq	1.11	1.11	0.78	1.25	1.25	1.01
Autos	1.04	1.04	0.77	1.03	1.02	0.91
Carry	1.13	1.13	1.42	1.79	1.78	1.51
Mines	0.64	0.64	1.01	0.52	0.52	0.66
Coal	1.30	1.30	1.32	1.49	1.48	1.06
Oil	0.96	0.96	1.50	1.00	1.01	1.40
Util	0.58	0.58	0.62	0.45	0.45	0.60
Telcm	0.60	0.60	0.45	0.54	0.54	0.47
Servs	1.07	1.07	1.00	1.09	1.09	0.98
BusEq	1.24	1.24	1.11	1.25	1.25	1.20
Paper	1.01	1.01	0.82	1.10	1.10	1.08
Trans	1.12	1.12	1.04	1.34	1.33	1.09
Whlsl	0.85	0.85	1.02	0.92	0.92	0.88
Rtail	1.07	1.07	0.71	0.90	0.90	0.82
Meals	1.53	1.53	1.15	1.78	1.79	1.84
Fin	0.97	0.97	0.81	0.86	0.86	0.79
Other	0.88	0.88	0.98	0.96	0.96	0.92

Event 6: Iran Hostage Crisis						
Industry	**t-60m**	**tm**	**t+12m**	**t-60d**	**td**	**t+60d**
Food	0.85	0.85	0.73	0.70	0.70	0.67
Beer	1.01	1.01	1.01	1.18	1.17	1.23
Smoke	1.00	1.00	0.89	0.86	0.87	0.99
Games	1.42	1.42	1.07	1.22	1.22	1.28
Books	0.83	0.83	0.63	0.83	0.83	0.62
Hshld	1.28	1.27	0.88	0.79	0.79	1.08
Clths	0.99	0.99	0.71	0.95	0.95	0.75
Hlth	1.15	1.15	0.87	0.97	0.97	1.13
Chems	1.20	1.20	1.02	1.14	1.14	1.15
Txtls	0.85	0.85	0.64	0.92	0.91	0.69
Cnstr	1.02	1.02	0.87	1.05	1.06	0.82
Steel	1.04	1.04	1.04	1.17	1.18	0.86
FabPr	1.08	1.08	0.90	0.99	0.99	0.91
ElcEq	1.08	1.08	0.89	0.72	0.72	0.70
Autos	1.09	1.09	0.90	0.79	0.79	0.87
Carry	1.26	1.26	1.27	1.37	1.36	1.49
Mines	0.66	0.66	1.14	0.98	0.99	0.42
Coal	1.27	1.27	1.23	1.39	1.39	1.14
Oil	1.01	1.01	1.48	1.37	1.37	1.40
Util	0.55	0.55	0.60	0.60	0.60	0.54
Telcm	0.58	0.58	0.52	0.46	0.46	0.44
Servs	1.08	1.08	0.93	1.22	1.22	0.88
BusEq	1.25	1.25	1.15	0.96	0.96	1.43
Paper	1.02	1.02	0.77	0.84	0.84	0.74
Trans	1.14	1.14	1.01	1.10	1.10	0.93
Whlsl	0.90	0.90	1.03	1.10	1.11	0.78
Rtail	1.04	1.04	0.68	0.80	0.80	0.60
Meals	1.49	1.49	0.99	1.28	1.29	1.16
Fin	0.93	0.93	0.74	0.94	0.94	0.72
Other	0.90	0.90	0.84	0.77	0.78	0.91

Event 7: Regan Assasination Attempt						
Industry	**t-60m**	**tm**	**t+12m**	**t-60d**	**td**	**t+60d**
Food	0.74	0.74	0.68	0.67	0.66	0.68
Beer	0.92	0.92	0.75	0.64	0.63	0.76
Smoke	0.94	0.94	0.75	0.97	0.97	0.78
Games	1.25	1.25	1.12	1.08	1.07	1.04
Books	0.71	0.71	0.68	0.51	0.51	0.52
Hshld	1.06	1.06	0.91	0.90	0.90	1.02
Clths	0.81	0.81	0.72	0.63	0.63	0.56
Hlth	1.04	1.04	0.98	0.72	0.71	0.73
Chems	1.13	1.13	1.06	1.05	1.05	1.12
Txtls	0.74	0.74	0.64	0.50	0.49	0.78
Cnstr	0.95	0.95	0.84	0.78	0.77	0.78
Steel	1.07	1.07	0.92	0.92	0.93	0.78
FabPr	1.01	1.01	0.97	0.89	0.88	0.87
ElcEq	0.97	0.97	0.89	1.05	1.05	0.86
Autos	0.98	0.98	0.96	1.09	1.09	0.98
Carry	1.33	1.33	1.07	1.16	1.15	1.07
Mines	0.88	0.88	1.43	1.14	1.15	1.04
Coal	1.24	1.24	1.41	1.22	1.22	0.93
Oil	1.29	1.29	1.38	1.52	1.52	1.39
Util	0.55	0.55	0.61	0.57	0.57	0.65
Telcm	0.53	0.53	0.59	0.43	0.44	0.66
Servs	0.99	0.99	0.98	0.73	0.73	0.87
BusEq	1.20	1.20	1.23	1.19	1.19	1.23
Paper	0.90	0.90	0.76	0.80	0.80	0.74
Trans	1.14	1.14	1.18	1.11	1.11	1.25
Whlsl	0.98	0.98	0.91	0.96	0.96	0.78
Rtail	0.87	0.87	0.87	0.75	0.74	0.87
Meals	1.23	1.23	1.07	0.77	0.76	1.03
Fin	0.84	0.84	0.77	0.70	0.69	0.81
Other	0.93	0.93	0.88	1.08	1.07	0.94

Event 8: Challenger Explosion						
Industry	**t-60m**	**tm**	**t+12m**	**t-60d**	**td**	**t+60d**
Food	0.74	0.74	1.29	1.04	1.05	1.22
Beer	0.72	0.72	1.02	0.68	0.65	0.82
Smoke	0.88	0.88	1.34	1.02	1.02	1.73
Games	1.15	1.15	1.27	1.00	1.00	1.14
Books	0.82	0.82	1.14	1.09	1.07	1.19
Hshld	1.00	1.00	1.16	1.25	1.24	1.29
Clths	0.76	0.76	1.07	0.83	0.83	0.95
Hlth	1.01	1.01	1.19	1.12	1.12	1.11
Chems	1.05	1.05	1.10	0.90	0.90	1.37
Txtls	0.64	0.64	0.76	0.58	0.56	0.63
Cnstr	0.95	0.95	1.07	0.89	0.88	0.90
Steel	0.99	0.99	0.77	0.97	0.99	0.85
FabPr	0.96	0.96	0.85	0.86	0.85	0.90
ElcEq	1.11	1.10	1.16	1.04	1.02	1.23
Autos	1.20	1.20	1.08	1.06	1.10	1.14
Carry	1.13	1.12	0.96	1.01	0.98	0.86
Mines	1.33	1.33	0.46	0.58	0.56	0.18
Coal	1.00	1.00	0.72	0.81	0.80	0.61
Oil	1.14	1.14	0.89	1.03	1.00	0.70
Util	0.55	0.55	0.75	0.74	0.75	0.76
Telcm	0.81	0.81	0.96	1.00	1.00	1.05
Servs	1.01	1.01	1.08	0.97	0.96	1.02
BusEq	1.34	1.34	1.03	1.24	1.23	0.94
Paper	0.86	0.86	1.05	0.91	0.92	1.06
Trans	1.18	1.18	0.85	1.04	1.02	0.95
Whlsl	1.08	1.08	0.98	1.01	1.00	0.98
Rtail	1.04	1.04	1.14	1.01	1.02	1.13
Meals	1.02	1.02	0.99	0.90	0.91	0.90
Fin	0.86	0.86	0.97	0.98	0.99	1.03
Other	0.87	0.87	1.03	0.98	0.96	0.93

Event 9: Hurricane Andrew						
Industry	**t-60m**	**tm**	**t+12m**	**t-60d**	**td**	**t+60d**
Food	1.05	1.05	1.11	0.93	0.85	0.89
Beer	1.13	1.13	1.11	1.27	1.20	1.27
Smoke	1.03	1.03	1.39	1.16	1.09	0.71
Games	1.25	1.25	1.22	1.13	1.14	1.00
Books	1.03	1.03	0.90	0.92	0.95	0.87
Hshld	1.15	1.15	1.00	1.12	1.12	1.08
Clths	1.14	1.14	1.16	1.34	1.40	0.72
Hlth	1.14	1.14	1.42	1.46	1.34	1.42
Chems	1.08	1.08	0.84	1.09	1.09	1.11
Txtls	0.98	0.98	0.90	1.15	1.16	0.82
Cnstr	1.05	1.05	0.91	1.12	1.06	1.13
Steel	1.14	1.14	1.00	1.20	1.24	1.36
FabPr	1.04	1.04	0.84	1.15	1.18	1.07
ElcEq	1.23	1.23	0.87	0.88	0.86	1.15
Autos	1.13	1.13	1.41	1.50	1.63	1.76
Carry	0.97	0.97	0.81	0.67	0.68	0.90
Mines	0.48	0.48	-0.35	0.50	0.45	-0.10
Coal	0.69	0.69	0.63	0.67	0.85	0.92
Oil	0.94	0.94	0.64	0.66	0.59	0.67
Util	0.60	0.60	0.46	0.35	0.38	0.38
Telcm	1.01	1.01	0.85	0.60	0.71	0.83
Servs	1.12	1.12	1.37	1.47	1.46	1.31
BusEq	1.16	1.16	1.35	1.34	1.35	1.23
Paper	1.08	1.08	0.95	1.01	1.00	1.25
Trans	1.02	1.02	1.14	1.30	1.37	1.29
Whlsl	0.86	0.86	0.89	0.94	0.94	0.92
Rtail	1.23	1.23	1.33	1.32	1.29	1.16
Meals	1.05	1.05	1.18	1.28	1.23	1.20
Fin	0.92	0.92	1.09	0.87	0.93	0.86
Other	1.10	1.10	1.01	0.81	0.84	1.16

Event 10: Storm of the Century						
Industry	**t-60m**	**tm**	**t+12m**	**t-60d**	**td**	**t+60d**
Food	1.07	1.07	1.15	0.90	0.91	1.46
Beer	1.35	1.35	1.03	1.03	1.06	0.96
Smoke	1.10	1.10	1.43	1.61	1.58	1.86
Games	1.14	1.13	1.22	1.28	1.25	1.29
Books	1.01	1.01	0.87	0.78	0.79	0.96
Hshld	1.07	1.07	1.03	0.85	0.85	0.88
Clths	1.20	1.20	0.99	1.55	1.53	0.91
Hlth	1.20	1.20	1.15	1.42	1.40	1.40
Chems	1.06	1.06	0.68	0.89	0.90	0.49
Txtls	0.91	0.91	0.85	0.83	0.85	0.93
Cnstr	1.03	1.03	0.82	0.87	0.87	0.69
Steel	1.01	1.01	0.79	0.96	0.99	0.74
FabPr	1.02	1.02	0.86	0.90	0.91	0.62
ElcEq	1.26	1.26	0.75	0.98	0.99	0.54
Autos	1.22	1.22	1.22	1.37	1.38	1.02
Carry	1.06	1.06	0.78	0.81	0.80	0.79
Mines	0.07	0.07	-0.34	-0.31	-0.33	-0.83
Coal	0.60	0.60	0.48	0.67	0.71	0.34
Oil	0.77	0.77	0.52	0.64	0.66	0.42
Util	0.54	0.55	0.75	0.42	0.44	0.59
Telcm	1.05	1.05	1.07	0.75	0.76	0.96
Servs	1.13	1.13	1.39	1.30	1.25	1.40
BusEq	1.17	1.17	1.49	1.25	1.22	1.45
Paper	1.00	1.00	0.80	0.92	0.94	0.68
Trans	1.09	1.09	0.92	1.18	1.17	1.02
Whlsl	0.88	0.88	0.81	0.96	0.97	0.79
Rtail	1.30	1.30	1.18	1.39	1.38	1.46
Meals	1.12	1.12	1.21	1.14	1.14	1.25
Fin	1.02	1.02	1.16	1.09	1.09	1.33
Other	1.12	1.12	1.01	0.99	0.99	0.98

Event 11: Northridge Earthquake						
Industry	**t-60m**	**tm**	**t+12m**	**t-60d**	**td**	**t+60d**
Food	1.06	1.06	0.74	0.82	0.82	0.65
Beer	1.35	1.35	0.80	0.84	0.87	0.61
Smoke	1.14	1.14	0.90	0.93	0.93	1.05
Games	1.16	1.16	1.13	1.09	1.09	1.22
Books	0.99	0.99	0.86	0.58	0.58	0.90
Hshld	1.05	1.05	0.94	1.02	1.03	0.89
Clths	1.23	1.23	0.74	0.76	0.75	0.79
Hlth	1.22	1.22	0.93	0.87	0.87	0.90
Chems	1.01	1.01	1.00	0.57	0.57	1.00
Txtls	0.93	0.93	0.77	0.76	0.76	0.92
Cnstr	1.01	1.01	1.03	0.72	0.71	1.06
Steel	0.97	0.97	1.21	0.75	0.73	1.19
FabPr	1.02	1.02	1.21	0.96	0.94	1.24
ElcEq	1.20	1.20	1.09	0.74	0.73	0.98
Autos	1.23	1.23	1.43	1.54	1.53	1.25
Carry	1.03	1.03	0.91	0.57	0.56	0.91
Mines	0.55	0.55	0.70	0.65	0.65	0.68
Coal	1.03	1.03	0.91	0.57	0.56	0.91
Oil	0.69	0.69	0.69	0.23	0.22	0.78
Util	0.54	0.54	0.86	1.07	1.07	0.87
Telcm	1.05	1.05	0.95	1.05	1.07	0.86
Servs	1.19	1.19	1.32	1.65	1.65	1.29
BusEq	1.20	1.20	1.44	1.73	1.74	1.24
Paper	0.95	0.95	0.94	0.87	0.87	0.81
Trans	1.09	1.09	1.06	0.83	0.83	0.96
Whlsl	0.87	0.87	0.82	0.90	0.89	0.94
Rtail	1.33	1.33	1.17	0.88	0.90	1.15
Meals	1.16	1.16	1.15	1.38	1.38	1.07
Fin	1.07	1.07	0.97	1.20	1.21	0.97
Other	1.13	1.13	1.04	1.12	1.07	1.02

Event 12:Kobe Earthquake						
Industry	**t-60m**	**tm**	**t+12m**	**t-60d**	**td**	**t+60d**
Food	1.02	1.02	0.74	0.72	0.71	1.01
Beer	1.26	1.26	0.63	0.73	0.73	0.91
Smoke	1.05	1.05	0.59	0.89	0.89	0.29
Games	1.18	1.18	1.00	0.88	0.88	0.98
Books	0.95	0.95	0.70	0.85	0.86	0.73
Hshld	1.04	1.04	0.77	1.01	1.01	0.92
Clths	1.22	1.22	0.72	0.78	0.78	0.76
Hlth	1.18	1.18	0.70	0.96	0.96	0.73
Chems	1.01	1.01	0.85	1.07	1.09	0.98
Txtls	0.93	0.93	0.68	0.72	0.71	0.90
Cnstr	1.03	1.03	0.90	0.97	0.98	0.80
Steel	1.00	1.00	1.02	1.12	1.11	1.07
FabPr	1.05	1.05	1.24	1.21	1.21	1.11
ElcEq	1.15	1.15	1.05	1.36	1.35	1.48
Autos	1.27	1.27	1.09	1.42	1.41	1.29
Carry	1.01	1.01	1.01	0.93	0.94	1.02
Mines	-0.05	-0.05	0.12	0.11	0.10	-1.01
Coal	0.54	0.54	0.32	0.65	0.67	-0.13
Oil	0.61	0.61	0.63	0.59	0.61	0.43
Util	0.58	0.58	0.50	0.55	0.56	0.82
Telcm	0.98	0.98	0.94	0.83	0.83	1.40
Servs	1.27	1.27	1.73	1.31	1.31	1.19
BusEq	1.27	1.27	2.11	1.53	1.51	1.23
Paper	0.95	0.95	0.90	1.11	1.13	0.93
Trans	1.11	1.11	1.09	1.01	1.02	1.33
Whlsl	0.87	0.87	0.81	0.66	0.66	0.81
Rtail	1.35	1.35	0.95	1.09	1.09	0.87
Meals	1.18	1.18	0.89	1.08	1.08	1.03
Fin	1.08	1.08	1.03	1.15	1.15	1.26
Other	1.12	1.12	0.82	1.01	1.01	0.83

Event 13: North American Blizzard						
Industry	t-60m	tm	t+12m	t-60d	td	t+60d
Food	0.94	0.93	0.77	0.71	0.64	0.92
Beer	1.08	1.07	1.16	0.70	0.73	1.18
Smoke	1.02	1.01	0.84	0.71	0.76	0.69
Games	1.09	1.09	1.07	0.93	0.92	0.87
Books	0.88	0.87	0.83	0.76	0.71	0.84
Hshld	0.96	0.95	0.93	0.77	0.73	0.90
Clths	1.08	1.08	0.88	0.72	0.73	0.75
Hlth	1.11	1.11	1.12	0.58	0.60	1.08
Chems	0.96	0.95	0.77	0.69	0.62	0.89
Txtls	0.89	0.89	0.61	0.38	0.45	0.60
Cnstr	1.00	1.00	0.85	0.81	0.74	0.92
Steel	1.01	1.01	0.78	0.80	0.87	0.99
FabPr	1.08	1.08	0.98	1.28	1.29	1.00
ElcEq	1.09	1.09	1.27	0.90	0.96	1.29
Autos	1.32	1.32	0.89	0.78	0.80	0.98
Carry	0.94	0.94	0.91	0.79	0.80	0.94
Mines	-0.03	-0.03	0.11	0.50	0.43	-0.06
Coal	0.57	0.57	0.58	0.76	0.65	0.59
Oil	0.63	0.63	0.78	0.75	0.78	0.97
Util	0.57	0.57	0.62	0.34	0.29	0.70
Telcm	0.92	0.92	0.96	0.83	0.83	1.21
Servs	1.38	1.39	1.40	1.89	1.93	1.16
BusEq	1.42	1.43	1.52	2.27	2.37	1.29
Paper	0.96	0.96	0.68	0.61	0.64	0.72
Trans	1.14	1.13	0.86	0.83	0.79	0.91
Whlsl	0.86	0.86	0.73	0.76	0.75	0.66
Rtail	1.29	1.28	1.09	1.00	0.98	1.05
Meals	1.11	1.11	1.02	0.84	0.91	1.25
Fin	1.05	1.05	1.05	1.09	1.05	1.03
Other	1.00	1.00	0.79	0.66	0.65	0.70

Event 14: September 11 Terrorist Attacks						
Industry	t-60m	tm	t+12m	t-60d	td	t+60d
Food	0.38	0.38	0.49	0.32	0.28	0.39
Beer	0.46	0.46	0.45	0.36	0.22	0.42
Smoke	0.43	0.41	0.22	0.47	0.16	0.36
Games	0.90	0.92	1.04	0.85	1.22	1.15
Books	0.71	0.71	0.73	0.60	0.67	0.82
Hshld	0.55	0.55	0.59	0.46	0.47	0.77
Clths	0.74	0.76	0.88	0.82	1.12	1.13
Hlth	0.79	0.78	0.86	0.63	0.54	0.46
Chems	0.54	0.56	0.94	0.74	1.02	1.04
Txtls	0.48	0.50	1.11	0.81	1.09	1.56
Cnstr	0.65	0.66	0.78	0.72	0.84	1.12
Steel	1.03	1.04	1.13	1.43	1.48	1.42
FabPr	0.99	1.00	1.21	1.17	1.22	1.42
ElcEq	1.12	1.12	1.00	0.86	0.98	1.32
Autos	0.75	0.78	1.02	0.97	1.45	1.34
Carry	0.74	0.77	0.99	0.79	1.33	1.29
Mines	0.24	0.24	0.29	0.16	0.15	0.08
Coal	1.05	1.04	0.79	0.67	0.35	0.29
Oil	0.39	0.40	0.86	0.39	0.42	0.59
Util	0.22	0.23	0.67	0.41	0.35	0.50
Telcm	0.92	0.91	1.15	1.00	0.92	0.69
Servs	1.47	1.47	1.34	1.59	1.50	1.36
BusEq	1.76	1.75	1.74	2.29	1.98	2.01
Paper	0.55	0.56	0.78	0.71	0.88	1.01
Trans	0.69	0.72	0.84	0.80	1.35	1.00
Whlsl	0.59	0.60	0.77	0.60	0.63	0.79
Rtail	0.92	0.93	0.98	1.15	1.25	1.16
Meals	0.54	0.55	0.67	0.50	0.76	0.87
Fin	0.97	0.97	0.99	0.75	0.81	0.96
Other	0.72	0.73	1.30	1.09	1.37	1.45

Event 15: Columbia Space Shuttle Explosion						
Industry	t-60m	tm	t+12m	t-60d	td	t+60d
Food	0.35	0.35	0.65	0.35	0.34	0.76
Beer	0.37	0.37	0.53	0.47	0.45	0.77
Smoke	0.29	0.29	0.65	0.04	0.03	0.75
Games	0.97	0.97	1.09	1.41	1.42	1.15
Books	0.73	0.73	0.84	0.76	0.77	1.05
Hshld	0.50	0.50	0.61	0.55	0.53	0.69
Clths	0.82	0.82	1.04	1.06	1.07	1.00
Hlth	0.74	0.74	0.91	0.72	0.72	0.87
Chems	0.67	0.67	1.02	1.09	1.08	1.09
Txtls	0.69	0.69	1.00	1.08	1.10	1.02
Cnstr	0.69	0.69	0.98	0.88	0.88	0.95
Steel	1.13	1.13	1.33	1.50	1.52	1.12
FabPr	1.08	1.08	1.19	1.34	1.33	1.12
ElcEq	1.07	1.07	1.16	0.95	0.93	1.16
Autos	0.88	0.88	1.26	1.34	1.33	1.31
Carry	0.81	0.81	1.12	0.99	0.96	1.09
Mines	0.23	0.23	0.41	0.29	0.26	0.23
Coal	1.09	1.08	0.63	0.70	0.71	0.46
Oil	0.48	0.47	0.54	0.80	0.77	0.47
Util	0.36	0.36	0.58	0.64	0.65	0.57
Telcm	1.01	1.01	1.24	1.38	1.37	1.43
Servs	1.45	1.45	1.25	1.26	1.27	1.17
BusEq	1.77	1.77	1.53	1.75	1.75	1.30
Paper	0.62	0.62	0.84	0.87	0.86	0.91
Trans	0.75	0.75	0.98	0.82	0.82	0.97
Whlsl	0.64	0.64	0.93	0.66	0.66	0.93
Rtail	0.96	0.96	1.12	1.00	1.00	1.19
Meals	0.58	0.58	0.97	0.68	0.69	1.04
Fin	0.97	0.97	1.03	0.99	1.00	1.07
Other	0.91	0.91	1.07	1.15	1.15	1.12

Event 16: Hurricane Katrina						
Industry	t-60m	tm	t+12m	t-60d	td	t+60d
Food	0.37	0.37	0.62	0.73	0.72	0.60
Beer	0.36	0.36	0.43	0.85	0.84	0.38
Smoke	0.30	0.30	0.63	0.64	0.63	0.87
Games	1.10	1.10	0.94	0.93	0.95	1.22
Books	0.67	0.67	0.71	0.96	0.98	0.92
Hshld	0.48	0.48	0.69	0.68	0.67	0.84
Clths	0.90	0.90	0.95	1.23	1.26	0.98
Hlth	0.70	0.70	0.77	0.98	0.97	0.75
Chems	0.89	0.89	1.10	1.39	1.41	0.90
Txtls	0.91	0.91	0.79	1.05	1.08	0.84
Cnstr	0.81	0.81	1.75	1.42	1.41	2.02
Steel	1.40	1.40	1.93	2.01	2.02	1.53
FabPr	1.20	1.20	1.45	1.34	1.34	1.18
ElcEq	1.11	1.11	1.16	1.35	1.34	1.07
Autos	1.04	1.04	1.19	1.26	1.24	1.33
Carry	0.97	0.97	1.01	1.04	1.06	0.78
Mines	0.39	0.39	1.89	1.03	1.08	1.33
Coal	0.76	0.76	2.18	1.69	1.71	2.10
Oil	0.59	0.59	1.36	1.21	1.21	1.63
Util	0.50	0.50	0.86	0.98	1.00	1.30
Telcm	1.07	1.07	0.79	0.70	0.71	0.79
Servs	1.42	1.42	0.94	0.95	0.92	0.83
BusEq	1.86	1.86	1.28	1.20	1.18	0.96
Paper	0.74	0.74	0.95	1.13	1.15	0.78
Trans	0.87	0.87	1.22	1.21	1.23	0.98
Whlsl	0.74	0.74	0.99	1.03	1.03	0.93
Rtail	0.95	0.95	0.99	1.30	1.31	1.19
Meals	0.66	0.66	1.07	0.96	0.99	1.25
Fin	0.96	0.96	0.94	0.87	0.88	0.91
Other	1.13	1.13	0.61	0.76	0.77	0.60

Event 17: Hurricane Ike						
Industry	**t-60m**	**tm**	**t+12m**	**t-60d**	**td**	**t+60d**
Food	0.71	0.70	0.66	0.60	0.59	0.71
Beer	0.49	0.48	0.53	0.25	0.24	0.58
Smoke	0.56	0.56	0.56	0.41	0.40	0.74
Games	1.07	1.07	1.17	1.53	1.42	1.06
Books	0.86	0.87	1.18	1.25	1.20	1.08
Hshld	0.64	0.63	0.65	0.70	0.64	0.66
Clths	1.13	1.12	1.00	1.20	1.10	0.71
Hlth	0.71	0.70	0.63	0.53	0.52	0.70
Chems	1.15	1.15	1.16	0.99	0.99	1.12
TxtIs	1.05	1.04	1.18	1.34	1.21	0.88
Cnstr	1.41	1.41	1.30	1.57	1.54	1.17
Steel	1.61	1.61	1.68	1.18	1.28	1.64
FabPr	1.25	1.24	1.27	1.11	1.11	1.18
ElcEq	1.17	1.16	1.18	1.19	1.15	1.10
Autos	1.36	1.35	1.29	1.71	1.59	1.17
Carry	0.97	0.96	0.95	1.12	1.03	0.91
Mines	1.37	1.38	1.38	0.92	1.03	1.48
Coal	1.55	1.58	1.97	1.00	1.32	1.99
Oil	1.03	1.04	1.21	0.69	0.81	1.33
Util	0.73	0.73	0.80	0.49	0.54	0.91
Telcm	0.88	0.88	1.00	0.89	0.89	1.03
Servs	1.00	0.99	0.89	0.88	0.85	0.90
BusEq	1.21	1.21	0.95	0.91	0.91	0.93
Paper	0.97	0.97	0.89	1.08	1.02	0.81
Trans	1.16	1.15	0.97	1.35	1.24	0.83
Whlsl	0.94	0.93	0.84	0.86	0.81	0.81
Rtail	1.02	1.00	0.76	1.08	0.99	0.78
Meals	0.95	0.94	0.76	1.11	1.00	0.74
Fin	1.26	1.27	1.48	2.01	1.99	1.29
Other	0.79	0.79	0.88	0.90	0.91	0.79

Event 18: Tohoku Earthquake and Tsunami						
Industry	**t-60m**	**tm**	**t+12m**	**t-60d**	**td**	**t+60d**
Food	0.67	0.67	0.67	0.56	0.57	0.58
Beer	0.51	0.51	0.52	0.35	0.37	0.54
Smoke	0.56	0.56	0.54	0.35	0.36	0.58
Games	1.18	1.18	1.21	1.26	1.27	1.03
Books	1.14	1.14	1.13	1.10	1.11	0.96
Hshld	0.63	0.63	0.60	0.38	0.38	0.55
Clths	1.06	1.06	1.08	0.94	0.96	0.93
Hlth	0.64	0.64	0.77	0.71	0.71	0.72
Chems	1.17	1.17	1.26	1.39	1.37	1.27
TxtIs	1.19	1.19	1.29	1.21	1.21	1.08
Cnstr	1.35	1.35	1.38	1.60	1.60	1.21
Steel	1.64	1.64	1.63	1.77	1.75	1.48
FabPr	1.29	1.29	1.40	1.41	1.39	1.44
ElcEq	1.18	1.18	1.31	1.36	1.36	1.32
Autos	1.33	1.33	1.34	1.52	1.51	1.33
Carry	0.98	0.98	1.06	1.04	1.05	1.10
Mines	1.42	1.42	1.25	1.45	1.44	1.38
Coal	1.87	1.87	1.79	1.57	1.50	1.33
Oil	1.16	1.16	1.17	0.94	0.92	1.34
Util	0.77	0.77	0.65	0.53	0.55	0.75
Telcm	0.96	0.96	0.85	0.84	0.85	0.90
Servs	0.91	0.91	0.97	1.05	1.06	1.02
BusEq	1.00	1.00	1.01	1.13	1.12	1.05
Paper	0.92	0.92	1.03	1.02	1.03	1.07
Trans	1.03	1.03	1.02	1.14	1.15	0.93
Whlsl	0.87	0.87	1.01	1.07	1.07	1.00
Rtail	0.81	0.81	0.76	0.75	0.76	0.67
Meals	0.81	0.81	0.75	0.64	0.65	0.61
Fin	1.43	1.43	1.30	1.27	1.27	0.95
Other	0.87	0.88	1.01	1.06	1.07	1.04

Chapter 5

Conclusion

Through my preliminary research, I discovered that there was a lack of exploration on the topic of the effectiveness market beta as a measure of risk in the context of a negative black swan event. In an event study, I analyze and reveal if market beta is an effective measure of an asset's market risk in the case of a negative black swan event. My analysis consists of two main processes. The first, I test the underlying prediction of CAPM that abnormal returns of an asset, calculated using beta and the average market return, should theoretically equal zero. I perform a single sample t-test to test if the abnormal returns for 30 industry portfolios on the date of the black swan event are statistically different than the abnormal returns of the five days preceding and following the event. The second analytical process I perform tests the impact of each black swan event on the calculation of an industry portfolio's market beta.

My analysis delivers mixed evidence supporting beta as a measure of an asset's market risk. Through my study, I discover that the abnormal returns of an asset are statistically different on the date of the black swan event from the five days preceding and following the event. This discovery implies that the underlying prediction of abnormal returns in the Capital Asset Pricing Model does not hold in the context of a black swan event. Meaning, an asset's market beta is not an effective tool for the measurement of abnormal returns in the case of a black swan event. However, my analysis also finds that the excess return on the date of the black swan event does not generally impact the value of an asset's market beta using time windows of 60 months and 60 days. There is a lack of evidence to suggest that each black swan event in my study has a significant impact on the calculation of market beta. This supports my conclusion that an asset's

market beta can be a useful tool to measure market risk in the context of a black swan event. Although my analysis delivers mixed evidence, it is clear that CAPM does not hold, but beta can still be a useful measurement of an asset's market risk.

The results of my study are of particular importance to portfolio managers. With downside risk management being an important objective of a portfolio manager, it is useful for managers to know that market beta can be useful tool in the measurement of market risk when a negative black swan event impacts the market. The relative performance of a money manager's portfolio will be reflected in the portfolio's beta, even in the event of a negative black swan. Furthermore, although beta should not be used to measure abnormal returns in this context, an asset's market beta can still be useful to evaluate how an asset will react relative to the market as a result of a negative black swan event.

Appendix

Summary Statistics

Summary Statistics (5 Yrs Pre Event)																		
Event No.	**Event 1**	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Event 6**	**Event 7**	**Event 8**	**Event 9**	**Event 10**	**Event 11**	**Event 12**	**Event 13**	**Event 14**	**Event 15**	**Event 16**	**Event 17**	**Event 18**
Mean	0.03	0.03	-0.01	-0.01	0.01	0.03	0.02	0.02	0.01	0.03	0.03	0.02	0.05	0.03	-0.01	-0.01	0.02	0.02
Median	0.05	0.06	0.01	0.01	0.00	0.03	0.05	-0.01	0.06	0.06	0.06	0.04	0.05	0.07	0.01	0.03	0.08	0.09
S.D.	0.68	0.53	0.91	0.91	0.86	0.74	0.75	0.79	1.05	0.75	0.71	0.68	0.59	1.22	1.37	1.18	0.87	1.59
Skewness	-0.77	-0.12	0.20	0.21	0.29	-0.04	-0.20	0.32	-3.68	-0.50	-0.54	-0.20	-0.10	-0.21	0.05	0.24	-0.23	-0.09
Kurtosis	13.38	5.39	1.85	1.81	2.23	1.84	2.17	1.87	63.41	4.12	4.73	2.75	3.02	2.95	1.62	2.07	1.76	7.76
Min	-6.99	-2.87	-3.53	-3.53	-3.53	-3.53	-3.47	-3.61	-17.16	-5.37	-5.37	-3.43	-3.43	-6.65	-6.65	-5.09	-3.51	-9.00
Max	4.94	3.88	4.24	4.24	4.24	4.09	4.09	4.07	8.63	3.28	3.28	3.28	3.28	5.27	5.31	5.31	3.97	11.52

Summary Statistics (1 Yr Post Event)																		
Event No.	**Event 1**	**Event 2**	**Event 3**	**Event 4**	**Event 5**	**Event 6**	**Event 7**	**Event 8**	**Event 9**	**Event 10**	**Event 11**	**Event 12**	**Event 13**	**Event 14**	**Event 15**	**Event 16**	**Event 17**	**Event 18**
Mean	0.08	0.03	0.07	0.09	-0.02	0.09	-0.10	0.08	0.05	0.02	-0.01	0.08	0.07	-0.03	0.14	0.03	0.00	0.04
Median	0.08	0.09	0.07	0.08	0.06	0.14	-0.07	0.11	0.06	0.05	0.02	0.11	0.07	-0.03	0.17	0.05	0.13	0.12
S.D.	0.39	0.52	0.72	0.70	0.82	0.97	0.84	0.81	0.52	0.48	0.58	0.50	0.68	1.43	0.93	0.72	2.84	1.51
Skewness	3.49	-0.42	0.11	0.00	-0.84	-0.28	-0.18	-0.91	-0.57	-0.83	-0.40	-0.55	-0.65	0.36	0.05	0.20	-0.01	-0.43
Kurtosis	35.81	0.85	0.18	0.13	2.61	0.96	0.88	4.01	2.96	2.82	2.22	1.49	2.07	1.15	0.93	0.72	1.91	2.95
Min	-1.12	-1.50	-2.05	-2.05	-3.47	-3.25	-3.00	-4.37	-2.60	-2.29	-2.29	-1.74	-2.86	-3.83	-3.29	-1.91	-9.00	-6.99
Max	3.88	1.71	2.33	2.33	2.14	3.39	2.59	2.42	1.52	1.35	2.36	1.38	1.80	5.31	3.26	2.37	11.52	5.21

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EDUCATION:

The Pennsylvania State University, University Park, PA **Anticipated May 2013**
The Schreyer Honors College, The Smeal College of Business

- Bachelor of Science in Finance — Dean's List: Fall 2009-Spring 2011, Spring 2012
- Minors in Economics, International Business — Cumulative GPA: 3.8/4.0

The Maastricht University, Maastricht, The Netherlands **June 2011-July 2011**
The School of Business and Economics

- Explored the economics of European integration to understand the history of the European Union, and its relation to the current financial environment

RELEVANT EXPERIENCE:

The Vanguard Group, Malvern, PA **May 2012-August 2012**
College to Corporate Intern in Portfolio Review Department

- Assisted with management oversight and search duties of Vanguard's $300 billion of sub-advisor mandates
- Wrote market and investment commentaries, performed ad-hoc analysis studies, answered database questions and project requests, and recommended fund performance evaluation adjustments
- Developed analytical, writing, communication, and presentation skills within a professional setting

Nittany Lion Fund, LLC, University Park, PA
Associate Analyst of the Consumer Staples Sector **January 2012-August 2012**
Associate Analyst of the Information Technology Sector **January 2011-December 2011**

- Managed $500,000-$650,000 investment portfolio of the $4 million student-run mutual fund
- Utilized Bloomberg, Factset, and Excel to create comparable, ratio, CAGR, and DCF models
- Pitched companies to buy, hold, or sell before 40 fellow Fund Managers and the 250 member Penn State Investment Association (PSIA) to further develop public speaking skills

Smeal Traders Association, University Park, PA **August 2012-Present**
Vice President

- Co-lead organization of approximately 100 students dedicated to learning about equity and fixed income trading
- Participate in trading competitions throughout the country against teams from other top universities

The Smeal Trading Room, University Park, PA **August 2011-Present**
TradeStation and Rotman Interactive Trader Group Intern

- Specialize in TradeStation Pro and Rotman Interactive Trader software programs
- Teach bi-weekly classes in the trading room to Smeal students about how to effectively use software platforms

Rotman International Trading Competition, Toronto, Canada **February 2012**
Competitor

- Competed on a team of four against 42 other top undergraduate and graduate teams in a series of cases that simulate real-world trading situations involving stocks, fixed income, and commodity future securities
- Dedicated 50 practice hours to prepare for the three day competition to receive 21st place overall

ACTIVITIES/EMPLOYMENT:

Club Cross Country, University Park, PA **August 2009-Present**
Team Member

- Dedicate 8 hours a week in daily practices and meets against other club teams and DIII schools with teammates
- Fundraise for the Penn State Dance Marathon (THON) to contribute over $36,000 to pediatric cancer in 2012

The Center of Mergers & Acquisitions, University Park, PA **August 2011-May 2012**
Office Assistant to Professor of Law Samuel Thompson

- Committed 10-15 hours a week performing various tasks around the office according to priority