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THE EFFECT OF CYBERCRIME NEWS ANNOUNCEMENTS ON STOCK PRICES

KYLE WANG

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Reviewed and approved* by the following:

Chris Muscarella
Professor of Finance
Thesis Supervisor

James Miles
Professor of Finance
Honors Adviser

* Signatures are on file in the Schreyer Honors College.

ABSTRACT

In the 21st century, cybercrime continues to be a prevalent and rapidly evolving threat to businesses. Companies must address this key issue in order to maintain the security of their intellectual property and to stay competitive. However, due to the complexity and wide variety of cyber attacks employed, it is difficult to quantify the damage these attacks inflict on publicly-traded corporations. Based on a prior event study, observing the significance of stock price movements during the announcement of each attack may prove the best indicator of loss assessment. This thesis expands upon this prior research by examining whether shareholder attitudes toward cybercrime have changed over the past decade. The underlying hypothesis is that shareholders have become desensitized after cybercrime has lost its novelty, and that stock price movements due to cybercrime news announcements are no longer statistically significant compared to those studied in the early 2000s. After analyzing an expanded sample size of over thirty mid- and large-cap firms, I find that cyber attacks continue to cause substantial concern among investors, thus incentivizing businesses to underreport or marginalize the effects of these events to preserve shareholder value. As a whole, the data suggests that the market closely observes instances of cybercrime, thus adding another level of urgency to stakeholders such as the SEC to more clearly define the rules in the comparatively nascent world of cybercrime response and reporting protocol.

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In addition, I would like to express my gratitude to Dr. L. Murphy Smith, whose research at Texas A&M University served as the inspiration for this topic. As the field of cybercrime research continues to grow, it is researchers like Dr. Smith who are responsible for developing its foundation.

Chapter 1

Introduction

As the internet continues to take a greater and more prevalent role in every aspect of e-commerce, companies have become increasingly dependent on websites and electronic databases to conduct their communication and marketing activities as well as day-to-day transactions. Unfortunately, all e-business is susceptible to cybercrime, which can not only severely disrupt company operations but also result in theft of valuable company intangible assets and loss of consumer confidence. The wide range of cybercrime activities ultimately result in direct losses to the United States economy of over $100 billion per year, a figure that is massively understated when considering the importance of the damage to less quantifiable assets, such as consumer loyalty and lost business (Mello, 2007). If a company consistently handles consumer data poorly or cannot protect its website from malicious activity, it will not be profitable for long.

While the phenomenon of cybercrime is still relatively new compared to the long history of financial markets, these threats to the now ubiquitous online infrastructure of businesses and governments regularly appear on headlines today. Since the advent of the Morris Worm, one of the first recognized attacks in 1988 on the world's cyber infrastructure in its infancy ("The history of," n.d.), cyber criminals have grown ever more cunning and specialized. Today, the only limiting factor to permutation of criminal activity online appears to be the imagination – today's hackers can perpetrate a seemingly endless array of attacks against businesses, including but far from limited to phishing,

botnet infections, computer viruses, netspionage, e-theft, and distributed denial of service (DDOS) attacks against online assets. Moreover, no industry or subsector is safe; while banks and tech companies are obvious targets, companies in the less visible utilities or consumer staples sector are just as likely to experience a bevy of electronic intrusions designed to cripple operations, plunder corporate secrets, or appropriate consumer data. As nations and corporations continue the trend toward globalization and online resource implementation, it is evident that cybercrime has and will only continue to increase in volume and menace as hackers' methods and motives grow ever more sophisticated and refined.

As the complexity and scope of cybercrime against companies continue to rise, these threats will surely be significant causes for concern among creditors, investors, financial analysts, and other relevant stakeholders. Unfortunately, it is very difficult for stakeholders and oftentimes even the firms themselves to accurately quantify the damage done in any given attack. A variety of factors, from the difficulty of valuing affected intangibles such as branding and customer goodwill to the unwillingness of companies to report security shortfalls, work together to obfuscate the actual damage done to a company. As such, as suggested by L. Murphy Smith, an accounting professor at Texas A&M University, the best indicator of the damage a firm has suffered due to a recent cyber-attack may best be reflected in changes in its stock price (Smith et al., 2010). In his event study of ten companies from 2000-2005, he was able to identify statistically significant negative impacts on company stock prices on the days following the announcement date. However, almost a decade later, it is possible that investor perception of cybercrime differs significantly from that of those during Smith's research

period. Today, there is a significant divide over the true impact of cybercrime, with some federal officials claiming in 2013 that "billions of dollars in corporate secrets are being stolen" every year. On the other hand, according to data compiled by Bloomberg, twenty-seven of the largest U.S. companies that have reported cyber attacks maintain that they have actually sustained no major financial losses and that all incidents have been immaterial in effect on company operations (Strohm, Michaels & Engleman, 2013).

Given the pace of technological advancement and inevitably increasing savviness of investors, I hypothesize that market participants have become increasingly desensitized and rationally ignorant due to the sheer volume and elevated sophistication of cyber-attacks inundating the news over the past decade. As such, I raise the question, has the impact of cybercrime announcements on stock prices declined over time as investors have become accustomed to the actions of cyber criminals? As a corollary, could the statistically significant results of Smith's event study in the early 2000s be attributed to the novelty of e-crime at the time in lieu of an accurate representation of company losses?

Ultimately, my expanding and building on Smith's experiment, I aim to elucidate the market's attitude toward the perceived danger firms face in cyberspace today as well as introduce a comparison of the effect of cybercrime on stock prices today compared to that of a decade ago. I intend to collect data on domestic mid-cap and large-cap companies across a variety of industries to give a well-rounded depiction of market reaction. If the stock price movement after these companies' cybercrime news announcement is not significant, I would be able to draw the conclusion that the either the market overstated the impact of cybercrime a decade ago or that the market no longer

attaches as much importance to cybercrime events today. This insight may prove useful to companies skittish about reporting cybercrime events due to fears about negative stock price movement or to the investor seeking to understand the impact of such an attack on one of his or her holdings.

In the following chapter, I will discuss more detailed background information on the subject of cybercrime research on which my event study is based. In Chapter 3, I lay out my research methodology used to perform my event study as well as the criterion used in my analysis. My results appear in Chapter 4, followed by an in-depth examination and discussion of these outcomes in Chapter 5. Lastly in Chapter 6, I address my hypothesis and offer a conclusion to my fundamental question.

Chapter 2

Literature Review

While there has not been much research in the area of cybercrime with specific regard to its effect on stock prices, studies abound concerning its increasing complexity and threat to domestic businesses. In today's Information Age, the new electronic marketplace of "cyberspace" offers not only new opportunities to connect with consumers and conduct business but also the possibility to commit crime and evade the law. Zombori's "A Report on Cyber-Crime and Money Laundering" (2001) notes that moral and legal structures tend to fall apart in the hyper-anonymous world of cyberspace, while the best efforts of legislators and regulators always inexorably tend to lag behind the newest criminal innovation. This report seems to reject the notion that companies today are any better at fighting the evolving nature of cybercrime than firms of yesterday. This conclusion is concerning considering the steep rise in volume and maliciousness of these attacks in recent years.

An independent study sponsored by HP Enterprise Security, examining 64 domestic companies and 235 companies in total, found that "cyber attacks have become common occurrences", with the number of successful attacks increasing 18 percent from 2012 to 2013. Furthermore, the average annualized cost to businesses from attacks was $11.6 million in 2013, representing an increase in cost of 26 percent compared with the year prior. As shown below in Figure 2-1, companies in the United States are much more likely to attract the most costly cyber attacks, such as denial of service and malicious

code infections, and sustain the highest amount of damage overall among the countries surveyed (Ponemon, n.d.).

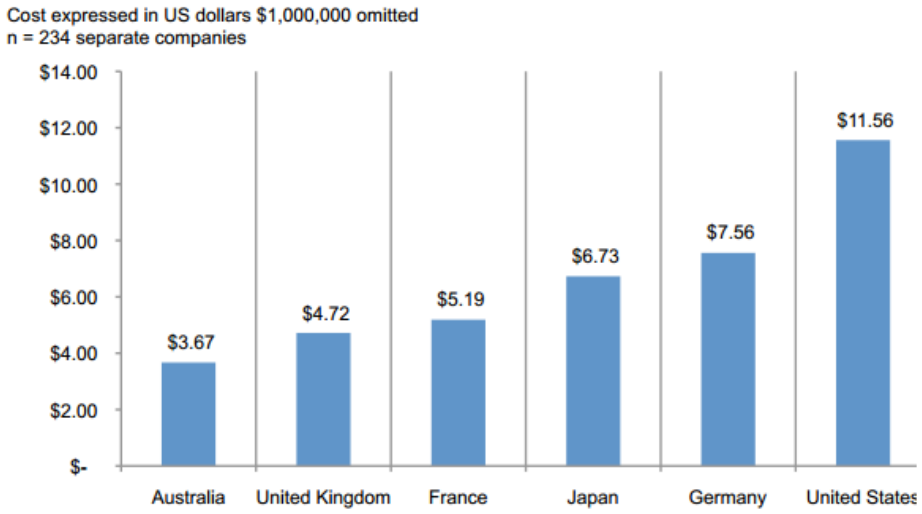

Figure 2-1: Total cost of cyber crime in six countries (Ponemon, n.d.).

Cybercrime itself poses a significant threat to the companies since it can attack the very medium and lifeline of twenty-first century business: the internet. Since the internet has accelerated and made globalization inevitable and unavoidable, no service, not communications, military, energy, nor transportation – to name a few – is safe. Moreover, the development of increasingly sophisticated methods of cybercrime have made it ever more difficult and costly to detect and prevent. Zombori also finds that, interestingly enough, a clear definition of cybercrime still does not exist due to the sheer variability and ingenuity of these attacks. Ultimately, trust in e-business is paramount; it is confidence in the new technology or commerce platforms that a firm adopts that is most important. If consumers lose trust in a particular business' online infrastructure,

businesses cannot fully realize the benefits of their e-investment, and will likely suffer as a result.

Furthermore, Blazovich & Smith (2008) finds that the nature of a firm's corporate governance and ethical corporate citizenship translate into positive brand equity, while Smith et al. (2010) asserts that a good corporate reputation leads to a significant correlation with superior financial performance and a comparatively lower firm cost of capital. As such, since cybercrimes strike at the heart of company brand image, it follows that these attacks most certainly contribute to a reflection in the market's assessment of shareholder value.

However, a significant obstacle obscures a wholly accurate observation of the effects on shareholder value. The primary and overriding concern lies in companies' reluctance to even report these occurrences. For instance, in March 2009, Coca-Cola Co. (KO) was on the receiving end of significant e-theft when hackers acquired sensitive documents regarding a $2.4 billion acquisition. This acquisition, which would have been the largest foreign takeover of a Chinese company, completely collapsed three days after the intrusion. However, the world's largest soft-drink company never publicly disclosed the loss of this information despite its obvious connection to the deal. Company executives simply filed it along with the rest of the day-to-day attacks it refuses to report to shareholders, employees, and even some senior management. Chesapeake Energy Corp. (CHK) was a similar story, where hackers gained access to files regarding its natural gas leases by breaking into the computer system of its investment bank, Jefferies Group, in 2011. Neither company reported the event to shareholders (Elgin, Lawrence & Riley, 2012).

These revelations were extraordinarily troubling to investors; while the effects of particular cybercrimes were already difficult to quantify, the fact that companies often refused to report them meant that any attempt at valuation was pointless. The Securities and Exchange Commission (SEC) attempted to remedy this situation by enacting more specific requirements for companies in October 2011. By issuing new guidelines, the SEC made it clear that it expected publicly traded companies to not only report significant cyber attacks, but even if these companies were at material risk of such an event. The chairman of the Senate commerce committee who urged the SEC to take these actions, Sen. John D. Rockefeller IV, remarked that "investors have been kept completely in the dark" and that "this guidance changes everything. It will allow the market to evaluate companies in part based on their ability to keep their networks secure".

However, critics were quick to point out the issues of this implementation. While the SEC's actions were definitely the mark of significant progress toward addressing the nebulous and still nascent area of corporate cyber security, Larry Ponemon, chairman of the Poneman Institute, stated that requiring companies to report on potential risk was a meaningless endeavor since "virtually every firm is at risk" or has already suffered a breach, and predicted that companies will still continue to disclose frugally if at all. Furthermore, security consultant and former SEC official John Reed Stark noted that "some companies may want to disclose a hacking incident but do not have the expertise to assess the damage". He urged some leniency when it comes to these guidelines lest the world of corporate cyber security fall into "chaos and confusion" (Nakashima, 2011).

In 2012, a year later, a report from CNBC seemed to support these concerns. While the United States intelligence community asserts that "cyberattacks are causing so much damage to American companies that they threaten U.S. economic competitiveness around the world", it is difficult to find evidence of this dramatic statement by sifting through SEC filings. CNBC found that "only a limited number of companies disclosed cyberattacks in 2012", despite the SEC decree specifically instructing them to reveal all significantly damaging attacks. As the report points out, the volume of disclosures simply does not add up; it continues to be obvious that cyber attacks afflicting public companies are underreported. Evidently, companies are clearly not incentivized enough to reveal these attacks, instead fearing loss of business, damaging share value, or incurring legal liabilities. A House aide interviewed by CNBC put it most bluntly, "They're going to find every reason not to report it. Unless we create an environment where it's not suicidal for these guys to come clean, they're not going to do it" (Javers, 2013).

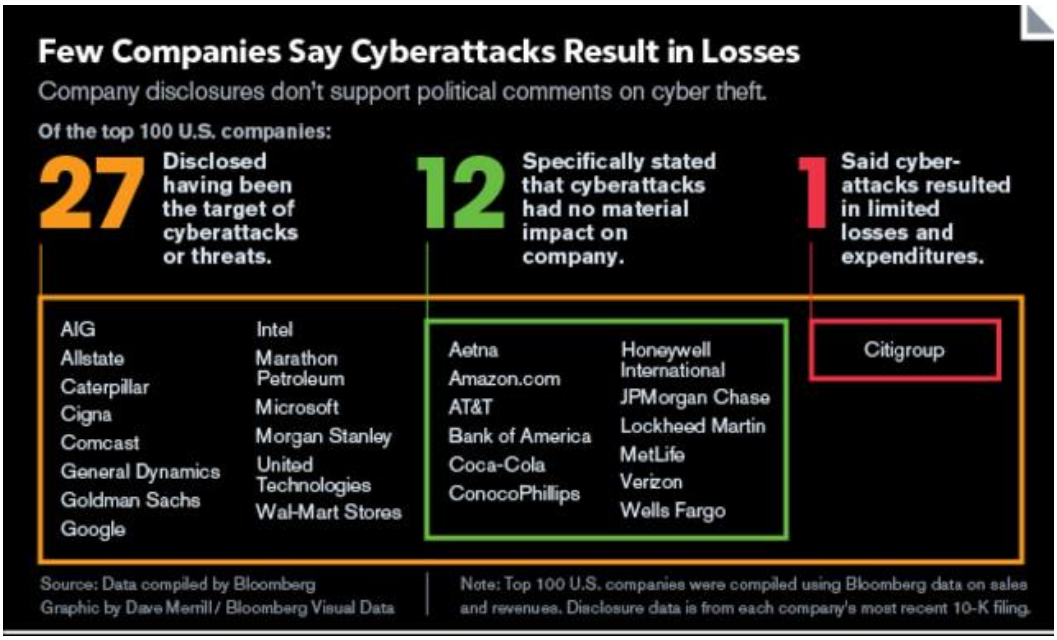

Figure 2-2: Bloomberg survey data does not support Willis Report findings (Strohm, Michaels & Engleman, 2013).

The disparity between the findings of independent research agencies reports and the actual costs enumerated in company filings is the direct result of the reluctance of companies to be more forthcoming. While the 2013 Willis Fortune 500 Cyber Disclosure Report indicated that cyber attacks could cause "serious harm or adversely impact" the majority of public companies (Willis Group Holdings 2013) , twenty-seven of the largest United States companies were quick to point out that they have sustained no major financial losses from their cyber attacks (Strohm, Michaels & Engleman, 2013) as noted in Figure 2-2 above. These mixed messages have sparked concern that companies are telling different stories to politicians and investors. In addition, while regulatory agencies want as much information as possible, businesses are understandably reluctant to provide proprietary information that may compromise their networks. Despite these issues, it is

undeniable that companies who fail to disclose may be subject to dire consequences. These companies may face expensive shareholder lawsuits or SEC enforcement actions.

Since the SEC disclosure rule is still relatively recent and observed sparingly at best, every notable cyber attack reported is exceptionally valuable. Even so, the reticence of businesses when it comes to reporting cybercrime definitely adds yet another layer of complexity on the already difficult task of quantifying the effects of these criminal activities. Given the tricky nature of intangible property, Cashell et al. (2004) finds that "most estimates of the cost to companies of cyber-attacks are based on surveys". However, since these survey responses include "considerable subjectivity and thus… may be of limited use", the authors suggest that a discounted cash flow analysis of the expected future cash flows from these intangible properties would be the best measure. By extension, using a DCF model would lead us to the intrinsic value of the company, which should be reflected by the firm's stock price. However, since cyber attacks appear in many different incarnations and affect a wide variety of intellectual property, introducing DCF analysis may oftentimes create more even more complexity. Currently, until there are more concrete developments in the realm of cyber security and reporting, it would appear that the reaction of stock prices surrounding the event announcement is the best measure.

As mentioned earlier, L. Murphy Smith, an accounting professor at Texas A&M University, focused on utilizing stock market prices to gauge the effect of cyber crime. In addition, he conducted a cursory study of cybercrime and market response. Smith et al. (2010) described some of the major types of cybercrime that publicly traded firms most commonly face, including cyber-terrorism, netspionage, e-theft, and online credit

card fraud. Cyber-terrorism generally involves defacement and vandalism of company websites and online operating channels through malicious alteration of programming code or exploitation of backdoors or poor programming. Netspionage is usually perpetrated by a marketplace competitor and results in the loss of confidential information, while e-theft results in the loss of online currency.

Smith et al. also had a significant discussion on e-risk. Hackers exploit the risks of doing online business by seeking systems to infiltrate and misuse. Such actions can stem from political motives, simple greed, or even just for leisure. Once these intruders in cyberspace gain access to a company's online infrastructure, they can cause debilitating damage to a company by crippling these systems by altering of erasing data. Companies who manage e-risk poorly often find their profitability and even existence severely threatened.

The authors then examined ten case studies from 2000-2005 of publicly traded firms who were the victims of cybercrime to determine the event's impact on the firm's shareholder value. Using this limited sample of cybercrime news stories, Smith et al. found statistically significant changes in company stock prices and the S&P 500 index one to three days following the attack. Thus, for this sample of ten companies, the authors concluded that cybercrime news results in a significant, negative decline in the average' firm's market value in the short term. However, the small sample size notwithstanding, the sample was biased more toward so-called "Internet companies, such as Yahoo, Ebay, and Amazon, which are affected more deeply by these attacks. Smith et al. recommend further research by extending the study to a larger sample of publicly traded companies and including more industries. Moreover, a longitudinal study would

be interesting to determine if "investors may be less alarmed by news stories about cybercrime if such crimes become more commonplace". In my study, I seek to replicate Smith's results with a larger sample size to address this particular question.

Chapter 3

Methodology

Necessary data collection was performed over three stages: 1) identifying the sample set of companies to be observed; 2) obtaining relevant return data three days before and after the announcement date of the cyber attack; 3) utilize a difference of means t-test and a difference of proportions test to test for significant stock price movements across the companies as a whole. The results will be used to answer the question of whether stock price fluctuations around the announcement dates of cyber attacks in the past five years can be explained by the variation in the greater market, represented by the S&P 500 index. In order to collect the required data, I utilized ProQuest, reputable news sources such as the Wall Street Journal and BBC News, the Wharton Research Data Services (WRDS) Database, and the Bloomberg Professional software platform. The Bloomberg software system contains an extensive, up-to-date database of corporation data, which I utilized to fill in returns too recent to be found in the WRDS database.

Identifying the Sample Set

Since the objective of this event study is to replicate Smith et al. (2010)'s research, I utilized many of the same parameters. In particular, companies must be publicly traded and mid-to-large in terms of market capitalization. Companies are

generally domestic, but those with international operations are included if they have significant domestic business. Since Smith et al. had only used ten large cyber attacks, focused on the information technology and banking sectors, over the period of 2000-2005 in their study, I wanted to expand the sample size to be include more than thirty instances over 2009-2013, the past five years. As mentioned before, I sought to identify if attitudes toward the cybercrime landscape had changed enough that today's stock prices do not respond as dramatically to cyber crime news announcements. In addition, I wanted to contribute more recent data to the cybercrime research community as these attacks have grown ever more frequent and sophisticated. With a larger sample size, I hoped to capture a larger snapshot of the effect of cyber attacks over many different industries.

Utilizing ProQuest as a starting point, I sifted through large announcement headlines over the past five years to identify major occurrences fitting the criteria described above. The following keywords were used to search for this data: "cyber attack, "cybercrime", "hacked", "hacking", and "breach". Where possible, I also limited the search interval to between the years 2009 to 2013. In some cases, several companies were the victim of more than one massive cybercrime event, and each instance was included and treated separately. Listed below in Table 3-1 are the selected cybercrime events with company information, announcement date, and a brief description of the nature of the attack. While information technology and financial sector companies continue to be popular targets, I also attempted to identify instances in the consumer discretionary, industrials, consumer staples, and telecommunications sectors.

Table 3-1: Sample of Companies

Event No.	Company	Ticker	Date	Description
1	Apple Inc	AAPL	2/19/2013	Malware focused on employee Macintosh computers
2	Baidu Inc	BIDU	1/13/2010	Website disabled
3	BB&T Corporation	BB&T	10/17/2012	Intrusion by Iranian hackers
4	Betfair Group Ltd	BET	9/30/2011	Lost millions of credit card details
5	Capital One Financial Corporation	COF	10/17/2012	Intrusion by Iranian hackers
6	CH Energy Group Inc	CHG	2/20/2013	Massive cyberattack, lost customer data
7	Charles Schwab Corporation	SCHW	4/23/2013	Website denial of service attack
8	Citigroup Inc	C	12/22/2009	E-theft from Citibank
9	Citigroup Inc	C	6/9/2011	Hacking incident
10	CME Group Inc.	CME	11/20/2013	Customer information compromised
11	Dun & Bradstreet Corp	DNB	9/25/2013	Customer database breach
12	Electronic Arts Inc	EA	6/27/2011	User information stolen
13	EMC Corporation	EMC	3/18/2011	Info theft
14	EMC Corporation	EMC	6/9/2011	Hacking incident
15	Google Inc	GOOG	12/4/2013	70,000 Gmail, Google+, YouTube accounts compromised
16	Intel Corporation	INTC	2/23/2010	Sophisticated cyberattack
17	JPMorgan Chase & Co.	JPM	3/14/2013	Consumer banking site denial of service
18	LinkedIn Corporation	LNKD	6/6/2012	Millions of passwords stolen
19	Lockheed Martin Corporation	LMT	5/30/2011	Hackers gained access to company network
20	Morgan Stanley	MS	4/1/2011	Sensitive information stolen from databanks

21	New York Times	NYT	8/27/2013	Site taken down
22	PNC Financial Services Group Inc	PNC	10/27/2012	Denial of service attack
23	Sony Corporation	SNE	4/20/2011	PlayStation Network taken down
24	Symantec Corporation	SYMC	11/05/12	User & employee accounts dumped
25	Target Corporation	TGT	12/19/2013	Data breach
26	The Coca-Cola Company	KO	11/4/2012	Loss of sensitive acquisition information, not disclosed
27	Toronto-Dominion Bank	TD	3/21/2013	Mobile and online banking systems offline
28	Toyota Motor Corporation	TM	6/14/2013	Server hacked
29	Vodafone Group Plc	VOD	7/15/2011	Mobile phones targeted
30	Wells Fargo & Co	WFC	9/25/2012	Websites disrupted
31	Yahoo! Inc	YHOO	7/12/2012	Theft of 450,000 email addresses/passwords

Obtaining Company Return Data

After identifying the event study sample, I utilized the WRDS database to harvest the raw return data for each company three days before and after the announcement event for analysis. In addition, I was careful to identify if any cyber attack announcement dates coincided with dividend announcements or any such confounding events. However, the WRDS database was not sufficient for several cybercrime instances because it only contained return data up to the year 2012. As such, I exported 2013 data from Bloomberg and utilized Yahoo! Finance to fill in any remaining missing returns.

The fact that some cybercrime news announcements occur on weekends should not be ignored. In these instances, I used the business day immediately preceding and following the announcement date. I went through a similar process to cull out the relevant S&P 500 data on and surrounding each announcement date for each instance.

These particular returns, paired with respective S&P 500 data, are provided in Appendix A.

Testing for Significance

To determine the statistical significance of stock price movements around these announcement dates, I utilized a difference of means t-test. First, I adjusted returns by subtracting out the corresponding S&P 500 return for each day surrounding each event (Appendix B). Then I performed two separate trials to determine significance, one being over the three day interval preceding the event and the other only being one day preceding it. I will refer to these intervals with the notation (-x, 0), where "x" is the days preceding and "0" indicating the date of announcement. For instance, the time interval of 3 days leading up to the actual event would be denoted by (-3, 0).

These two trials capture the variation in stock prices preceding the date of announcement and address the issue of pre-announcement trading. By the time the news item is actually printed or posted on, for instance, the Wall Street Journal, the stock price is likely to have already responded. By taking the mean change in returns in the days or day leading up to the event, we can glean a more accurate picture of how the event affected the market.

In both trials, the mean return over the specified period of days was calculated for every company to produce a list of means. These grand mean of these means was then calculated for use in the difference of means t-test, whose primary statistic is given by:

$$t = \frac{\bar{x}}{\sigma\sqrt{\frac{1}{n-1}}}$$

where $\bar{x}$ is the grand mean of announcement period interval means, σ is the standard deviation of this sample of means, and n is the number of observations. I then compared the resultant t-factor with the appropriate critical t value at n-1 degrees of freedom and at a 95% confidence interval.

Next, I examined the proportion of negative outcomes in both samples. If the cyber attacks did not affect these companies' stock prices, we would expect half of all observed events to be negative. The z-statistic computation for this difference of proportions test is given by:

$$z = \frac{(p - P)}{\sqrt{P * (1 - P)/n}}$$

where P is the hypothesized population proportion in our null hypothesis, or 0.5, p is the sample proportion of negative outcomes, and n is the sample size. I determined z-scores for both trials and assessed their significance.

Afterward, I took note of any specific outliers among the means. Since cyber attacks are generally a negative event, an extreme positive movement in the stock price is most likely indicative of another confounding variable unrelated to the attack itself, and only serves to skew the data. If cyber attacks indeed have a less potent effect on companies today compared to those in Smith et al.'s study more than a decade ago, we

would expect that the stock price would hardly move at all. As such, I removed any mean changes in returns over the announcement interval that were beyond +100 basis points and ran the analysis again using the updated sample. The results and data are provided in the next chapter.

Chapter 4

Data Results

Provided below are the mean changes in stock prices for the sample of 31 companies for the interval before the announcement date. The return data used to derive these means can be found in Appendix B. Outliers, or mean stock price changes that are greater than +100 bps, have been highlighted.

Table 4-1: Mean 3-day returns before cyber attack announcement (-3,0)

Company	Mean % Change	Company	Mean % Change
AAPL	-0.61%	JPM	0.20%
BIDU	2.21%	LNKD	-0.87%
BBT	-1.18%	LMT	-0.34%
BET	0.40%	MS	-0.35%
COF	-0.85%	NYT	-0.08%
CHG	0.11%	PNC	-0.18%
SCHW	-0.25%	SNE	0.08%
C	-0.89%	SYMC	0.35%
C	-1.09%	TGT	-0.55%
CME	0.94%	KO	-0.28%
DNB	-0.46%	TD	-0.28%
EA	-0.79%	TM	-0.53%
EMC	-0.22%	VOD	-0.34%
EMC	4.05%	WFC	-0.04%
GOOG	0.08%	YHOO	0.23%
INTC	-0.21%		

Table 4-2: Mean 1-day returns before cyber attack announcement date (-1,0)

Company	Mean % Change	Company	Mean % Change
AAPL	-1.02%	**JPM**	0.37%
BIDU	5.15%	**LNKD**	-0.35%
BBT	-0.89%	**LMT**	-0.90%
BET	1.03%	**MS**	-0.10%
COF	-0.35%	**NYT**	-0.51%
CHG	0.15%	**PNC**	-0.32%
SCHW	-0.14%	**SNE**	0.55%
C	-1.58%	**SYMC**	0.36%
C	0.12%	**TGT**	-0.36%
CME	1.31%	**KO**	-0.39%
DNB	0.01%	**TD**	-0.25%
EA	-0.31%	**TM**	-1.15%
EMC	-0.25%	**VOD**	-0.46%
EMC	-0.44%	**WFC**	0.28%
GOOG	0.40%	**YHOO**	-0.16%
INTC	-0.38%		

After collecting these means, I calculated a grand mean and sample standard deviation for each trial. I then applied the difference of means test to compute the t-statistic and measure it against the critical t-factor, calculated at a 95% confidence interval and 30 degrees of freedom.

Table 4-3: T-test for 3 days before announcement date (-3,0)

Grand Mean	-0.06%
Standard Deviation	0.997%
Degrees of Freedom	30
T-stat	0.307
T-critical at 30 *df*	2.042

Table 4-4: T-test for 1 day before announcement date (-1,0)

Grand Mean	-0.02%
Standard Deviation	1.13%
Degrees of Freedom	30
T-stat	0.092
T-critical at 30 *df*	2.042

I then repeated this t-test after discarding the highlighted outliers in tables 4-1 and 4-2. The sample size and corresponding degrees of freedom were adjusted appropriately.

Table 4-5: (-3,0) T-test, adjusted for outliers

Grand Mean	-0.28%
Standard Deviation	0.479%
Degrees of Freedom	28
T-stat	3.045
T-critical at 28 *df*	2.024

Table 4-6: (-1,0) T-test, adjusted for outliers

Grand Mean	-0.29%
Standard Deviation	0.50%
Degrees of Freedom	27
T-stat	3.008
T-critical at 27 *df*	2.052

Table 4-7: Difference of Proportions Test

Trial (-3,0)	
Negative Mean Returns	**21**
Sample Size	31
Adjusted Sample Size	29
Expected Proportion	0.5
Full Sample	
Sample Proportion	0.677
Standard Deviation	0.090
Z-score	1.976
P-value	0.024
*Adjusted Values**	
Adj. Sample Proportion	0.724
Adj. Standard Deviation	0.093
Adj. Z-score	2.414
Adj. P-value	0.008

Trial (-1,0)	
Negative Mean Returns	**20**
Sample Size	31
Adjusted Sample Size	28
Expected Proportion	0.5
Sample Proportion	0.645
Standard Deviation	0.090
Z-score	1.616
P-value	0.053
Adj. Sample Proportion	0.714
Adj. Standard Deviation	0.094
Adj. Z-score	2.268
Adj. P-value	0.012

*Adjusted values remove outliers listed in tables 4-1 and 4-2

Chapter 5

Discussion of Results

From even a cursory glance at these results, it is evident that there is a significant disparity between the original t-test and that with outliers excluded. Without removing outliers, neither scenario even approaches statistical significance, with each calculated *t* falling far short of its respective critical t-factor. However, by excluding these outliers, we see a colossal shift to significance for both three day and one day trials. A closer examination of these outliers revealed positive, company-specific events that most likely masked the effect of the cyber attack.

The largest outlier Baidu Inc. (BIDU), exhibited a +2.21 percent mean change for trial (-3,0) and +5.51 percent for trial (-1,0). However, on the date of announcement of a severe denial of service attack against its website, the news that its chief competitor in the Chinese market, Google Inc., was withdrawing from China caused the company's stock price to soar (Barboza, 2010). Similarly, shareholders rewarded Betfair Group Ltd (BET)., a casino company that revealed its loss of millions of credit card details, for its considerable upheaval of senior executives due to a history of company mismanagement (Osborne, 2011).

Despite suffering a significant breach of customer data in November of 2013, CME Group Inc., one of the largest options and futures exchanges, also enjoyed a positive mean percent change due to the introduction of a new pricing structure that analysts projected would push its revenues and margins higher (Trefis Team, 2013).

Finally, a hacking incident at the information security company EMC Corp.(EMC) in mid-2011 was overlooked due to news of the company's desire to "double down" on acquisitions over the next year (Ricadela, 2011).

As indicated in tables 4-5 and 4-6, after outliers were removed I found a t-statistic of 3.045 compared to its corresponding critical t-factor of 2.024 at 28 degrees of freedom for $t(-3,0)$, and for $t(-1,0)$, I received similar results with a t-statistic of 3.008 compared to a critical t of 2.052 at 27 degrees of freedom. Since both t-statistics easily surpass each respective critical t-factor, we can be 95 percent confident that the variation in stock prices around the announcement date of a cybercrime event cannot simply be explained away by the general movements of the market.

The difference of proportions test further supports this conclusion. As shown in table 4-7, the p-values related to the 21 negative outcomes in trial (-3,0) were found to be less than 5 percent for both the full sample and adjusted sample, indicating that the prevalence of negative mean returns is statistically significantly. For trial (-1,0), the full sample test narrowly failed to disprove the null hypothesis, but the adjusted sample p-value is significant at p=0.012. As such, the adjusted sample test results lend further credence to the conclusion that cybercrime events are having a greater negative impact than usual on companies.

However, there are certainly several factors to consider when evaluating these results. Since this study is limited to domestic, established mid-to-large market capitalization companies, we cannot be certain that these results hold true outside these parameters. Furthermore, because the area of cybercrime is still a relatively nascent area of research, it was and continues to be difficult to identify these events that fit all of L.

Murphy Smith's criteria. As discussed earlier, the reticent nature of companies to disclose cyber attacks compounded with general ignorance in identifying a "material" attack also hampers data collection. While it would appear that reports on cyber attacks flood the news everyday, many of these events are difficult to research for one of the following reasons: 1) the company is privately held and lacks transparency; 2) the company, especially within the sector of information technology, is too new or has undergone a significant period of change such that it is difficult to pinpoint the effect of the cybercrime news event versus the variety of miscellaneous factors that could contribute to the volatility of the stock; 3) the frequency of cyber attacks has increased dramatically, and, coupled with the fact that the guidelines of cybercrime disclosure are still in their infancy, many companies are woefully uninformed about when and what to report; 4) specific industries, such as information technology, endure far greater interest from hackers and other cyber criminals, and as such results will invariably be skewed toward these sectors; 5) efforts to stratify attacks by industry or marketing activities such as supply chain or website user interfaces for research purposes are difficult due to the wide variety and constant, evolving nature of cybercrime; 6) studies of past events, including those in this analysis, are always subject to the fact that companies have reported these events sporadically in the past, often providing different stories to investors and government researchers. As discussed prior, in many situations the official announcement dates may differ significantly, in weeks to entire quarters, from the actual event dates, meaning news of these events may have filtered into the markets prior to the companies' acknowledgement of them.

Despite these shortcomings, continued collection of these cyber crime news events over the years will eventually allow for the more insightful longitudinal studies that Smith et al. suggested. While the data gathered from this event study seems to indicate that investors are no less alarmed by cybercrime news stories today than ten years ago despite them being more commonplace, we can draw no conclusion that this will not change over the next decade, or even the decade after.

Chapter 6

Conclusion

From these results, it is very convincing to draw the conclusion that cyber attacks continue to adversely affect the stock prices of these domestic companies significantly, indicating that investors are just as concerned as ten years ago about the ability of today's companies to defend themselves in cyber space successfully. While I shared Smith et al.'s hypothesis that the commonality of cyber attacks today has desensitized the market to their dangers, it appears that the growing exposure of firms to cyber attacks as well as their increasing sophistication continue to play a key role in investor psychology and decision-making. For better or worse, the market punishes companies that have reported cybercrime events irrespective of industry or nature of the crime.

Continuing to monitor the attitudes of investors toward cyber attacks over the years will provide more insights. Since the area of cyber security and incident reporting is evolving just as rapidly as the variety of the attacks themselves, there will be many opportunities over the next decade to gauge investor sentiment and identify its impact on companies. Currently the market's negative reaction to these disclosures has disincentivized companies to report cybercrime, despite vigorous SEC actions to the contrary. In the future, as more cybercrime events arise, we may be able to construct a more comprehensive study to analyze how these criminal activities in cyberspace affect specific industries as well as identify any changes in how businesses and investors view cybercrime and its impact. In the meanwhile, it will definitely be interesting to keep a

vigilant eye on current events, on developments in the ever-changing realm of cyberspace, and on the complex interplay between businesses, the SEC, and investors as all three seek to puzzle out the cost of these unconventional yet deadly criminal activities and their true effect on operations and stakeholders.

Chapter 7

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Appendix A

Return Data

The following tables contain return data collected three days prior and three days following each news announcement. The date of announcement is highlighted, and each series of returns is matched with its corresponding S&P 500 data below.

Table 7-1: Return Data for AAPL, BIDU, BBT

AAPL			*BIDU*			*BBT*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
2/22/2013	442.33	1.07%	1/19/2010	440.84	-5.74%	10/22/2012	29.37	-1.38%
2/21/2013	437.66	-0.62%	1/15/2010	467.68	0.74%	10/19/2012	29.78	-0.67%
2/20/2013	440.40	-2.42%	1/14/2010	464.23	5.63%	10/18/2012	29.98	-7.10%
2/19/2013	451.33	-0.04%	1/13/2010	439.48	13.71%	10/17/2012	32.27	1.45%
2/15/2013	451.50	-1.38%	1/12/2010	386.49	-3.51%	10/16/2012	31.81	-1.79%
2/14/2013	457.81	-0.09%	1/11/2010	400.57	-0.92%	10/15/2012	32.39	0.15%
2/13/2013	458.22	-0.19%	1/8/2010	404.27	-0.09%	10/12/2012	32.34	-2.59%
2/12/2013	459.09		1/7/2010	404.63		10/11/2012	33.20	
S&P 500			*S&P 500*			*S&P 500*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
2/22/2013	1515.60	0.88%	1/19/2010	1150.23	1.25%	10/22/2012	1433.82	0.04%
2/21/2013	1502.42	-0.63%	1/15/2010	1136.03	-1.08%	10/19/2012	1433.19	-1.66%
2/20/2013	1511.95	-1.24%	1/14/2010	1148.46	0.24%	10/18/2012	1457.34	-0.24%
2/19/2013	1530.94	0.73%	1/13/2010	1145.68	0.83%	10/17/2012	1460.91	0.41%
2/15/2013	1519.79	-0.10%	1/12/2010	1136.22	-0.94%	10/16/2012	1454.92	1.03%
2/14/2013	1521.38	0.07%	1/11/2010	1146.98	0.17%	10/15/2012	1440.13	0.81%
2/13/2013	1520.33	0.06%	1/8/2010	1144.98	0.29%	10/12/2012	1428.59	-0.30%
2/12/2013	1519.43		1/7/2010	1141.69		10/11/2012	1432.84	

Table 7-1 Continued: Return Data for BET, COF, CHG

BET			*COF*			*CHG*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
10/5/2011	705.50	6.81%	10/22/2012	60.00	-1.23%	2/25/2013	65.12	-0.15%
10/4/2011	660.50	-8.33%	10/19/2012	60.75	6.02%	2/22/2013	65.22	-0.03%
10/3/2011	720.50	-3.26%	10/18/2012	57.30	-1.26%	2/21/2013	65.24	0.14%
9/30/2011	744.78	0.78%	10/17/2012	58.03	0.03%	2/20/2013	65.15	-0.12%
9/29/2011	739.00	-0.41%	10/16/2012	58.01	0.71%	2/19/2013	65.23	-0.09%
9/28/2011	742.05	-2.10%	10/15/2012	57.60	-1.05%	2/15/2013	65.29	0.20%
9/27/2011	758.00	0.66%	10/12/2012	58.21	-1.15%	2/14/2013	65.16	-0.08%
9/26/2011	753.00		10/11/2012	58.89		2/13/2013	65.21	
S&P 500			*S&P 500*			*S&P 500*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
10/5/2011	1144.03	1.79%	10/22/2012	1433.82	0.04%	2/25/2013	1487.85	-1.83%
10/4/2011	1123.95	2.25%	10/19/2012	1433.19	-1.66%	2/22/2013	1515.60	0.88%
10/3/2011	1099.23	-2.85%	10/18/2012	1457.34	-0.24%	2/21/2013	1502.42	-0.63%
9/30/2011	1131.42	-2.50%	10/17/2012	1460.91	0.41%	2/20/2013	1511.95	-1.24%
9/29/2011	1160.40	0.81%	10/16/2012	1454.92	1.03%	2/19/2013	1530.94	0.73%
9/28/2011	1151.06	-2.07%	10/15/2012	1440.13	0.81%	2/15/2013	1519.79	-0.10%
9/27/2011	1175.38	1.07%	10/12/2012	1428.59	-0.30%	2/14/2013	1521.38	0.07%
9/26/2011	1162.95		10/11/2012	1432.84		2/13/2013	1520.33	

Table 7-1 Continued: Return Data for SCHW, C

SCHW			*C*			*C*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
4/26/2013	16.58	-0.12%	12/28/2009	3.39	1.19%	06/14/2011	38.78	-1.00%
4/25/2013	16.60	0.61%	12/24/2009	3.35	1.82%	06/13/2011	39.17	3.30%
4/24/2013	16.50	0.30%	12/23/2009	3.29	-1.50%	06/10/2011	37.92	0.40%
4/23/2013	16.45	1.04%	12/22/2009	3.34	-2.34%	06/09/2011	37.77	2.61%
4/22/2013	16.28	0.18%	12/21/2009	3.42	0.59%	06/08/2011	36.81	-2.05%
4/19/2013	16.25	0.00%	12/18/2009	3.40	6.25%	06/07/2011	37.58	-1.29%
4/18/2013	16.25	-0.49%	12/17/2009	3.20	-7.25%	06/06/2011	38.07	-4.47%
4/17/2013	16.33		12/16/2009	3.45		06/03/2011	39.85	
S&P 500			*S&P 500*			*S&P 500*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
4/26/2013	1582.24	-0.18%	12/28/2009	1127.78	0.12%	06/14/2011	1287.87	1.26%
4/25/2013	1585.16	0.40%	12/24/2009	1126.48	0.53%	06/13/2011	1271.83	0.07%
4/24/2013	1578.79	0.00%	12/23/2009	1120.59	0.23%	06/10/2011	1270.98	-1.40%
4/23/2013	1578.78	1.04%	12/22/2009	1118.02	0.36%	06/09/2011	1289.00	0.74%
4/22/2013	1562.50	0.47%	12/21/2009	1114.05	1.05%	06/08/2011	1279.56	-0.42%
4/19/2013	1555.25	0.88%	12/18/2009	1102.47	0.58%	06/07/2011	1284.94	-0.10%
4/18/2013	1541.61	-0.67%	12/17/2009	1096.08	-1.18%	06/06/2011	1286.17	-1.08%
4/17/2013	1552.01		12/16/2009	1109.18		06/03/2011	1300.16	

Table 7-1 Continued: Return Data for CME, DNB, EA

CME			*DNB*			*EA*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
11/25/2013	79.26	-1.87%	9/30/2013	103.49	-0.31%	6/30/2011	23.60	-0.04%
11/22/2013	80.77	0.32%	9/27/2013	103.81	-0.19%	6/29/2011	23.61	4.70%
11/21/2013	80.51	2.67%	9/26/2013	104.01	0.36%	6/28/2011	22.55	3.87%
11/20/2013	78.42	0.35%	9/25/2013	103.64	0.02%	6/27/2011	21.71	-0.28%
11/19/2013	78.15	1.70%	9/24/2013	103.62	-0.53%	6/24/2011	21.77	-0.59%
11/18/2013	76.84	0.27%	9/23/2013	104.17	0.64%	6/23/2011	21.90	-2.84%
11/15/2013	76.63	0.91%	9/20/2013	103.51	-3.70%	6/22/2011	22.54	-0.62%
11/14/2013	75.94		9/19/2013	107.49		6/21/2011	22.68	
S&P 500			*S&P 500*			*S&P 500*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
11/25/2013	1802.48	-0.13%	9/30/2013	1681.55	-0.60%	6/30/2011	1320.64	1.01%
11/22/2013	1804.76	0.50%	9/27/2013	1691.75	-0.41%	6/29/2011	1307.41	0.83%
11/21/2013	1795.85	0.81%	9/26/2013	1698.67	0.35%	6/28/2011	1296.67	1.29%
11/20/2013	1781.37	-0.36%	9/25/2013	1692.77	-0.27%	6/27/2011	1280.10	0.92%
11/19/2013	1787.87	-0.20%	9/24/2013	1697.42	-0.26%	6/24/2011	1268.45	-1.17%
11/18/2013	1791.53	-0.37%	9/23/2013	1701.84	-0.47%	6/23/2011	1283.50	-0.28%
11/15/2013	1798.18	0.42%	9/20/2013	1709.91	-0.72%	6/22/2011	1287.14	-0.65%
11/14/2013	1790.62		9/19/2013	1722.34		6/21/2011	1295.52	

Table 7-1 Continued: Return Data for EMC, GOOG

EMC			*EMC*			*GOOG*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
03/23/2011	26.48	0.46%	06/14/2011	27.09	3.16%	12/9/2013	1078.14	0.77%
03/22/2011	26.36	-0.83%	06/13/2011	26.26	-0.23%	12/6/2013	1069.87	1.19%
03/21/2011	26.58	3.71%	06/10/2011	26.32	-2.19%	12/5/2013	1057.34	-0.08%
03/18/2011	25.63	0.27%	06/09/2011	26.91	-0.30%	12/4/2013	1058.18	0.47%
03/17/2011	25.56	0.99%	06/08/2011	26.99	-0.26%	12/3/2013	1053.26	-0.12%
03/16/2011	25.31	-2.62%	06/07/2011	27.06	-0.95%	12/2/2013	1054.48	-0.48%
03/15/2011	25.99	-0.84%	06/06/2011	27.32	16.85%	11/29/2013	1059.59	-0.33%
03/14/2011	26.21		06/05/2012	23.38		11/27/2013	1063.11	
S&P 500			*S&P 500*			*S&P 500*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
03/23/2011	1297.54	0.29%	06/14/2011	1287.87	1.26%	12/9/2013	1808.37	0.18%
03/22/2011	1293.77	-0.36%	06/13/2011	1271.83	0.07%	12/6/2013	1805.09	1.12%
03/21/2011	1298.38	1.50%	06/10/2011	1270.98	-1.40%	12/5/2013	1785.03	-0.43%
03/18/2011	1279.21	0.43%	06/09/2011	1289.00	0.74%	12/4/2013	1792.81	-0.13%
03/17/2011	1273.72	1.34%	06/08/2011	1279.56	-0.42%	12/3/2013	1795.15	-0.32%
03/16/2011	1256.88	-1.95%	06/07/2011	1284.94	-0.10%	12/2/2013	1800.90	-0.27%
03/15/2011	1281.87	-1.12%	06/06/2011	1286.17	-1.08%	11/29/2013	1805.81	-0.08%
03/14/2011	1296.39		06/05/2012	1300.16		11/27/2013	1807.23	

Table 7-1 Continued: Return Data for INTC, JPM, KO

INTC			*JPM*			*KO*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
02/26/2010	20.53	-0.48%	3/19/2013	47.87	-0.62%	11/08/2012	36.36	-0.98%
02/25/2010	20.63	-0.34%	3/18/2013	48.17	-1.03%	11/07/2012	36.72	-1.87%
02/24/2010	20.70	1.53%	3/15/2013	48.67	-1.91%	11/06/2012	37.42	1.77%
02/23/2010	20.39	-2.31%	3/14/2013	49.62	1.66%	11/05/2012	36.77	-0.84%
02/22/2010	20.87	0.24%	3/13/2013	48.81	-0.22%	11/02/2012	37.08	-0.67%
02/19/2010	20.82	-0.10%	3/12/2013	48.92	-0.41%	11/01/2012	37.33	0.40%
02/18/2010	20.84	0.87%	3/11/2013	49.12	0.55%	10/31/2012	37.18	0.38%
02/17/2010	20.66		3/8/2013	48.85		10/26/2012	37.04	
S&P 500			*S&P 500*			*S&P 500*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
02/26/2010	1104.49	0.14%	3/19/2013	1548.34	-0.24%	11/08/2012	1377.51	-1.22%
02/25/2010	1102.94	-0.21%	3/18/2013	1552.10	-0.55%	11/07/2012	1394.53	-2.37%
02/24/2010	1105.24	0.97%	3/15/2013	1560.70	-0.16%	11/06/2012	1428.39	0.79%
02/23/2010	1094.60	-1.21%	3/14/2013	1563.23	0.56%	11/05/2012	1417.26	0.22%
02/22/2010	1108.01	-0.10%	3/13/2013	1554.52	0.13%	11/02/2012	1414.20	-0.94%
02/19/2010	1109.17	0.22%	3/12/2013	1552.48	-0.24%	11/01/2012	1427.59	1.09%
02/18/2010	1106.75	0.66%	3/11/2013	1556.22	0.32%	10/31/2012	1412.16	0.02%
02/17/2010	1099.51		3/8/2013	1551.18		10/26/2012	1411.94	

Table 7-1 Continued: Return Data for LNKD, LMT, MS

LNKD			*LMT*			*MS*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
06/11/2012	94.29	-2.05%	06/03/2010	79.71	-0.11%	04/06/2011	27.76	2.13%
06/08/2012	96.26	2.26%	06/02/2010	79.80	0.80%	04/05/2011	27.18	0.30%
06/07/2012	94.13	1.13%	06/01/2010	79.17	-0.94%	04/04/2011	27.10	-0.59%
06/06/2012	93.08	0.09%	05/28/2010	79.92	-0.79%	04/01/2011	27.26	-0.22%
06/05/2012	93.00	2.10%	05/27/2010	80.56	1.04%	03/31/2011	27.32	0.33%
06/04/2012	91.09	-0.46%	05/26/2010	79.73	-0.83%	03/30/2011	27.23	0.00%
06/01/2012	91.51	-4.78%	05/25/2010	80.40	0.75%	03/29/2011	27.23	0.18%
05/31/2012	96.10		05/24/2010	79.80		03/28/2011	27.18	
S&P 500			*S&P 500*			*S&P 500*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
06/11/2012	1308.93	-1.26%	06/03/2010	1102.83	0.41%	04/06/2011	1335.54	0.22%
06/08/2012	1325.66	0.81%	06/02/2010	1098.38	2.58%	04/05/2011	1332.63	-0.02%
06/07/2012	1314.99	-0.01%	06/01/2010	1070.71	-1.72%	04/04/2011	1332.87	0.03%
06/06/2012	1315.13	2.30%	05/28/2010	1089.41	-1.24%	04/01/2011	1332.41	0.50%
06/05/2012	1285.50	0.57%	05/27/2010	1103.06	3.29%	03/31/2011	1325.83	-0.18%
06/04/2012	1278.18	0.01%	05/26/2010	1067.95	-0.57%	03/30/2011	1328.26	0.67%
06/01/2012	1278.04	-2.46%	05/25/2010	1074.03	0.04%	03/29/2011	1319.44	0.71%
05/31/2012	1310.33		05/24/2010	1073.65		03/28/2011	1310.19	

Table 7-1 Continued: Return Data for NYT, PNC, SNE

NYT			*PNC*			*SNE*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
8/30/2013	11.15	-3.13%	11/02/2012	59.19	-0.10%	04/26/2011	29.79	-1.00%
8/29/2013	11.51	1.32%	11/01/2012	59.25	1.80%	04/25/2011	30.09	-1.34%
8/28/2013	11.36	-1.90%	10/31/2012	58.20	0.76%	04/21/2011	30.50	1.19%
8/27/2013	11.58	-2.93%	10/26/2012	57.76	-1.16%	04/20/2011	30.14	1.45%
8/26/2013	11.93	-0.08%	10/25/2012	58.44	0.76%	04/19/2011	29.71	1.57%
8/23/2013	11.94	-0.42%	10/24/2012	58.00	-1.09%	04/18/2011	29.25	-1.48%
8/22/2013	11.99	2.39%	10/23/2012	58.64	-0.76%	04/15/2011	29.69	0.00%
8/21/2013	11.71		10/22/2012	59.09		04/14/2011	29.69	
S&P 500			*S&P 500*			*S&P 500*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
8/30/2013	1632.97	-0.32%	11/02/2012	1414.20	-0.94%	04/26/2011	1347.24	0.90%
8/29/2013	1638.17	0.20%	11/01/2012	1427.59	1.09%	04/25/2011	1335.25	-0.16%
8/28/2013	1634.96	0.27%	10/31/2012	1412.16	0.02%	04/21/2011	1337.38	0.53%
8/27/2013	1630.48	-1.59%	10/26/2012	1411.94	-0.07%	04/20/2011	1330.36	1.35%
8/26/2013	1656.78	-0.40%	10/25/2012	1412.97	0.30%	04/19/2011	1312.62	0.57%
8/23/2013	1663.50	0.39%	10/24/2012	1408.75	-0.31%	04/18/2011	1305.14	-1.10%
8/22/2013	1656.96	0.86%	10/23/2012	1413.11	-1.44%	04/15/2011	1319.68	0.39%
8/21/2013	1642.80		10/22/2012	1433.82		04/14/2011	1314.52	

Table 7-1 Continued: Return Data for SYMC, TGT, TD

SYMC			*TGT*			*TD*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
11/08/2012	17.95	-1.43%	12/24/2013	61.71	-0.27%	3/26/2013	80.73	0.64%
11/07/2012	18.21	-3.40%	12/23/2013	61.88	-0.98%	3/25/2013	80.22	0.55%
11/06/2012	18.85	0.75%	12/20/2013	62.49	0.55%	3/22/2013	79.78	0.47%
11/05/2012	18.71	-0.48%	12/19/2013	62.15	-2.20%	3/21/2013	79.41	-0.49%
11/02/2012	18.80	0.48%	12/18/2013	63.55	3.08%	3/20/2013	79.80	-0.18%
11/01/2012	18.71	2.86%	12/17/2013	61.65	-0.84%	3/19/2013	79.94	-0.37%
10/31/2012	18.19	-1.09%	12/16/2013	62.17	-0.30%	3/18/2013	80.24	-1.02%
10/26/2012	18.39		12/13/2013	62.36		3/15/2013	81.07	
S&P 500			*S&P 500*			*S&P 500*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
11/08/2012	1377.51	-1.22%	12/24/2013	1833.32	0.29%	3/26/2013	1563.77	0.78%
11/07/2012	1394.53	-2.37%	12/23/2013	1827.99	0.53%	3/25/2013	1551.69	-0.33%
11/06/2012	1428.39	0.79%	12/20/2013	1818.32	0.48%	3/22/2013	1556.89	0.72%
11/05/2012	1417.26	0.22%	12/19/2013	1809.60	-0.06%	3/21/2013	1545.80	-0.83%
11/02/2012	1414.20	-0.94%	12/18/2013	1810.65	1.66%	3/20/2013	1558.71	0.67%
11/01/2012	1427.59	1.09%	12/17/2013	1781.00	-0.31%	3/19/2013	1548.34	-0.24%
10/31/2012	1412.16	0.02%	12/16/2013	1786.54	0.63%	3/18/2013	1552.10	-0.55%
10/26/2012	1411.94		12/13/2013	1775.32		3/15/2013	1560.70	

Table 7-1 Continued: Return Data for TM, VOD, WFC

TM			*VOD*			*WFC*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
6/19/2013	120.78	-1.23%	07/20/2011	26.04	0.70%	09/28/2012	34.53	-0.66%
6/18/2013	122.29	1.59%	07/19/2011	25.86	1.61%	09/27/2012	34.76	0.99%
6/17/2013	120.38	2.56%	07/18/2011	25.45	-1.24%	09/26/2012	34.42	-0.86%
6/14/2013	117.38	-3.23%	07/15/2011	25.77	-0.04%	09/25/2012	34.72	-1.07%
6/13/2013	121.30	1.82%	07/14/2011	25.78	-1.00%	09/24/2012	35.10	0.36%
6/12/2013	119.13	-0.66%	07/13/2011	26.04	0.54%	09/21/2012	34.97	-0.65%
6/11/2013	119.92	-1.02%	07/12/2011	25.90	-1.11%	09/20/2012	35.20	-0.14%
6/10/2013	121.15		07/11/2011	26.19		09/19/2012	35.25	
S&P 500			*S&P 500*			*S&P 500*		
Date	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**	**Date**	**Adj Close**	**% Chg**
6/19/2013	1628.93	-1.39%	07/20/2011	1325.84	-0.07%	09/28/2012	1440.67	-0.45%
6/18/2013	1651.81	0.78%	07/19/2011	1326.73	1.63%	09/27/2012	1447.15	0.96%
6/17/2013	1639.04	0.76%	07/18/2011	1305.44	-0.81%	09/26/2012	1433.32	-0.57%
6/14/2013	1626.73	-0.59%	07/15/2011	1316.14	0.56%	09/25/2012	1441.59	-1.05%
6/13/2013	1636.36	1.48%	07/14/2011	1308.87	-0.67%	09/24/2012	1456.89	-0.22%
6/12/2013	1612.52	-0.84%	07/13/2011	1317.72	0.31%	09/21/2012	1460.15	-0.01%
6/11/2013	1626.13	-1.02%	07/12/2011	1313.64	-0.44%	09/20/2012	1460.26	-0.05%
6/10/2013	1642.81		07/11/2011	1319.49		09/19/2012	1461.05	

Table 7-1 Continued: Return Data for YHOO

YHOO		
Date	**Adj Close**	**% Chg**
07/17/2012	15.60	-0.29%
07/16/2012	15.65	-0.60%
07/13/2012	15.74	0.32%
07/12/2012	15.69	-0.70%
07/11/2012	15.80	-0.13%
07/10/2012	15.82	0.44%
07/09/2012	15.75	-0.19%
07/06/2012	15.78	
S&P 500		
Date	**Adj Close**	**% Chg**
07/17/2012	1363.67	0.74%
07/16/2012	1353.64	-0.23%
07/13/2012	1356.78	1.65%
07/12/2012	1334.76	-0.50%
07/11/2012	1341.45	0.00%
07/10/2012	1341.47	-0.81%
07/09/2012	1352.46	-0.16%
07/06/2012	1354.68	

Appendix B

Adjusted Return Data

The following tables contain adjusted return data for the sample size of companies under study. By subtracting out the relevant S&P 500 data for each case presented in Appendix A, the effects of the general market are isolated from the raw return data.

Table 7-2: Adjusted Return Data Part I

AAPL		BIDU		BBT		BET	
Date	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**
2/22/2013	0.19%	1/19/2010	-6.99%	10/22/2012	-1.42%	10/5/2011	5.03%
2/21/2013	0.01%	1/15/2010	1.83%	10/19/2012	0.99%	10/4/2011	-10.58%
2/20/2013	-1.18%	1/14/2010	5.39%	10/18/2012	-6.85%	10/3/2011	-0.41%
2/19/2013	-0.77%	1/13/2010	12.88%	10/17/2012	1.03%	9/30/2011	3.28%
2/15/2013	-1.27%	1/12/2010	-2.58%	10/16/2012	-2.82%	9/29/2011	-1.22%
2/14/2013	-0.16%	1/11/2010	-1.09%	10/15/2012	-0.65%	9/28/2011	-0.04%
2/13/2013	-0.25%	1/8/2010	-0.38%	10/12/2012	-2.29%	9/27/2011	-0.40%
COF		CHG		SCHW		C	
Date	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**
10/22/2012	-1.28%	2/25/2013	1.68%	4/26/2013	0.06%	12/28/2009	1.08%
10/19/2012	7.68%	2/22/2013	-0.91%	4/25/2013	0.20%	12/24/2009	1.30%
10/18/2012	-1.01%	2/21/2013	0.77%	4/24/2013	0.30%	12/23/2009	-1.73%
10/17/2012	-0.38%	2/20/2013	1.12%	4/23/2013	0.00%	12/22/2009	-2.70%
10/16/2012	-0.32%	2/19/2013	-0.83%	4/22/2013	-0.28%	12/21/2009	-0.46%
10/15/2012	-1.86%	2/15/2013	0.30%	4/19/2013	-0.88%	12/18/2009	5.67%
10/12/2012	-0.86%	2/14/2013	-0.15%	4/18/2013	0.18%	12/17/2009	-6.07%
C		CME		DNB		EA	
Date	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**
06/14/2011	-2.26%	11/25/2013	-1.74%	9/30/2013	0.29%	6/30/2011	-1.05%
06/13/2011	3.23%	11/22/2013	-0.17%	9/27/2013	0.22%	6/29/2011	3.87%
06/10/2011	1.80%	11/21/2013	1.85%	9/26/2013	0.01%	6/28/2011	2.57%
06/09/2011	1.87%	11/20/2013	0.71%	9/25/2013	0.29%	6/27/2011	-1.19%
06/08/2011	-1.63%	11/19/2013	1.91%	9/24/2013	-0.27%	6/24/2011	0.58%
06/07/2011	-1.19%	11/18/2013	0.64%	9/23/2013	1.11%	6/23/2011	-2.56%
06/06/2011	-3.39%	11/15/2013	0.49%	9/20/2013	-2.98%	6/22/2011	0.03%

Table 7-2 Continued: Adjusted Return Data Part II

EMC		EMC		GOOG		INTC	
Date	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**
03/23/2011	0.16%	06/14/2011	1.90%	12/9/2013	0.59%	02/26/2010	-0.63%
03/22/2011	-0.47%	06/13/2011	-0.29%	12/6/2013	0.06%	02/25/2010	-0.13%
03/21/2011	2.21%	06/10/2011	-0.79%	12/5/2013	0.35%	02/24/2010	0.56%
03/18/2011	-0.16%	06/09/2011	-1.03%	12/4/2013	0.60%	02/23/2010	-1.10%
03/17/2011	-0.35%	06/08/2011	0.16%	12/3/2013	0.20%	02/22/2010	0.34%
03/16/2011	-0.67%	06/07/2011	-0.86%	12/2/2013	-0.21%	02/19/2010	-0.31%
03/15/2011	0.28%	06/06/2011	17.93%	11/29/2013	-0.25%	02/18/2010	0.21%
JPM		LNKD		LMT		MS	
Date	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**
3/19/2013	-0.38%	06/11/2012	-0.78%	06/03/2010	-0.52%	04/06/2011	1.92%
3/18/2013	-0.48%	06/08/2012	1.45%	06/02/2010	-1.79%	04/05/2011	0.31%
3/15/2013	-1.75%	06/07/2012	1.14%	06/01/2010	0.78%	04/04/2011	-0.62%
3/14/2013	1.10%	06/06/2012	-2.22%	05/28/2010	0.44%	04/01/2011	-0.72%
3/13/2013	-0.36%	06/05/2012	1.52%	05/27/2010	-2.25%	03/31/2011	0.51%
3/12/2013	-0.17%	06/04/2012	-0.47%	05/26/2010	-0.27%	03/30/2011	-0.67%
3/11/2013	0.23%	06/01/2012	-2.31%	05/25/2010	0.72%	03/29/2011	-0.52%
NYT		PNC		SNE		SYMC	
Date	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**
8/30/2013	-2.81%	11/02/2012	0.84%	04/26/2011	-1.89%	11/08/2012	-0.21%
8/29/2013	1.12%	11/01/2012	0.71%	04/25/2011	-1.18%	11/07/2012	-1.02%
8/28/2013	-2.17%	10/31/2012	0.75%	04/21/2011	0.67%	11/06/2012	-0.04%
8/27/2013	-1.35%	10/26/2012	-1.09%	04/20/2011	0.10%	11/05/2012	-0.70%
8/26/2013	0.32%	10/25/2012	0.46%	04/19/2011	1.00%	11/02/2012	1.42%
8/23/2013	-0.81%	10/24/2012	-0.78%	04/18/2011	-0.38%	11/01/2012	1.77%
8/22/2013	1.53%	10/23/2012	0.68%	04/15/2011	-0.39%	10/31/2012	-1.10%
TGT		KO		TD		TM	
Date	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**
12/24/2013	-0.57%	11/08/2012	0.24%	3/26/2013	-0.14%	6/19/2013	0.15%
12/23/2013	-1.51%	11/07/2012	0.50%	3/25/2013	0.89%	6/18/2013	0.81%
12/20/2013	0.07%	11/06/2012	0.98%	3/22/2013	-0.25%	6/17/2013	1.80%
12/19/2013	-2.14%	11/05/2012	-1.05%	3/21/2013	0.34%	6/14/2013	-2.64%
12/18/2013	1.42%	11/02/2012	0.27%	3/20/2013	-0.84%	6/13/2013	0.34%
12/17/2013	-0.53%	11/01/2012	-0.69%	3/19/2013	-0.13%	6/12/2013	0.18%
12/16/2013	-0.94%	10/31/2012	0.36%	3/18/2013	-0.47%	6/11/2013	0.00%

Table 7-2 Continued: Adjusted Return Data Part III

VOD		WFC		YHOO	
Date	**Adj Ret**	**Date**	**Adj Ret**	**Date**	**Adj Ret**
07/20/2011	0.76%	09/28/2012	-0.21%	07/17/2012	-1.03%
07/19/2011	-0.02%	09/27/2012	0.02%	07/16/2012	-0.37%
07/18/2011	-0.43%	09/26/2012	-0.29%	07/13/2012	-1.33%
07/15/2011	-0.59%	09/25/2012	-0.02%	07/12/2012	-0.20%
07/14/2011	-0.33%	09/24/2012	0.58%	07/11/2012	-0.12%
07/13/2011	0.23%	09/21/2012	-0.65%	07/10/2012	1.26%
07/12/2011	-0.66%	09/20/2012	-0.09%	07/09/2012	-0.03%

CURRENT ADDRESS:
520 E Calder Way, Apt 403
State College, PA 16801

Academic Vita

PERMANENT ADDRESS:
1112 DONOVAN WAY
CHESTER SPRINGS, PA 19425

Mobile: (484)-252-1759 **Email:** ktw5064@psu.edu

EDUCATION

The Pennsylvania State University **University Park, PA**
The Schreyer Honors College *Class of 2014*
Bachelor of Science in Finance, Minor in Chinese

- Honors: National Merit Scholarship, Beta Gamma Sigma, President's Freshman Award, Dean's List (6/6), Altria Sophomore Leadership Development Program, Johnson & Johnson's Future Leaders Program, Wall Street Boot Camp Certified

RELEVANT EXPERIENCE

The Retirement Group, LLC. **New York, NY**
Financial Analyst Intern *Summer 2013*

- Conducted research on ETFs and mutual funds that follow Graham & Dodd-style value investing
- Provided recommendations on fund managers and analyzed past trading decisions based on Tweedy & Browne investment criteria, value metrics, and fund investment philosophy
- Prepared presentations on the Buffet "Super-Investor" Index and studied Dreman and Klarman's investment processes

Verizon Communications, Inc. **Malvern, PA**
Consumer & Mass Business Markets Intern *Summer 2012*

- Led copper-to-fiber Network Evolution efforts in Eastern South region as the pilot intern of PA/DE territory
- Contacted and visited over 400 customers, with successful migrations leading to cost savings of approximately $110K yearly
- Supported marketing events and sales efforts, resulting in 30+ consumer upgrades and gross adds-to-bill in 3 communities

Nittany Lion Fund, LLC. **University Park, PA**
Utilities Sector Associate Analyst *January 2012-August 2012*

- Managed over $215K in equities for the Nittany Lion Fund's Utilities sector and determined buy/sell decisions based on financial statements, public comparables, and discounted cash flow analysis utilizing Bloomberg and Excel
- Returned 5.39% relative to the S&P Utilities benchmark YTD as of August 2012
- Created stock pitches to express and defend investment theses, analyses, and valuations to a 300+ student general body
- Constructed weekly reports detailing key sector trends and conducted education sessions on Utilities and Power industries

Fund Administrator / Alumni Relations *January 2011-December 2011*

- Compiled weekly updates, monthly newsletters, and an annual report for fund members and ~70 alumni investors
- Updated latest transactions, resumé books, and social media to provide timely updates for managers and student body

LEADERSHIP / ACTIVITIES

The Sapphire Leadership Program **University Park, PA**
President *January 2013-December 2013*

- Collaborate with six Vice Presidents to drive strategic and operational planning for the program
- Implement and oversee program transition to a fully university-backed entity through partnership with the Schreyer Honors College, support from corporate sponsors, and relationships with Smeal faculty and alumni
- Developed a series of soft skill workshops involving body language awareness and conflict resolution skills to increase the competitive edge of the Sapphire community
- Lead a symposium steering committee to restructure and expand the annual leadership symposium to Big 10 schools

VP of Marketing *January 2012-December 2012*

- Devised and oversaw pilot Junior Gate application process and improved outreach to potential freshmen applicants
- Partnered with distinguished alumni and Smeal faculty to organize the Second Annual Sapphire Leadership Symposium

VP of Leadership Development *January 2011-December 2011*

- Selected from the top 8% of the business school and served as the first freshman on the Executive Board
- Established distinguished alumni advisor involvement and oversaw leadership project development

Smeal Trading Room Internship Program **University Park, PA**
Market Analysis Group *August 2011-May 2013*

- Collaborate with a group of analysts to develop new Market Analysis curriculum
- Create and deliver presentations on current market trends, financial crises, and investing theory

Pink Zone Foundation Student Involvement Committee **University Park, PA**
Treasurer *August 2011-June 2012*

- Established and expanded first WBCA Pink Zone charity sub-account and developed budgeting and transaction processes
- Raised over $203K in contributions since 2010 and attracted 11,000+ fans per game day through committee initiatives

Case Competitions

- *PwC 2011 xAct Case Competition, 1st Place*
- *PwC 2012 xTax Case Competition, Finalist*
- *Ingersoll Rand 2012 Case Competition, 3rd Place*
- *KPMG 2012 Case Competition, 2nd Place*