THE PENNSYLVANIA STATE UNIVERSITY
SCHREYER HONORS COLLEGE

DEPARTMENT OF FINANCE

AN ANALYSIS OF SHORT SELLING'S ROLE IN THE RECENT FINANCIAL
CRISIS AND THE EFFECTIVENESS OF SHORT SELLING RESTRICTIONS

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Spring 2010

A thesis
submitted in partial fulfillment
of the requirements
for baccalaureate degrees
in Finance and Economics
with honors in Finance

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Abstract

This paper goes into depth regarding short selling, short selling restrictions and the most recent financial crisis. Through statistical tests and analyses, I set out to illustrate how short selling impacted the market during the crisis, as well as, the effect of short selling restrictions on financial stock characteristics like return, volume and volatility. The paper will begin with an explanation of short selling and some background to the financial crisis. It will be followed by data selection and analysis and will end with conclusions brought about by the statistical tests. I will tailor my report for those who have a minimal finance background, hoping to educate the average investor, so they, too, will be able to form a well-versed opinion of short selling.

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1. INTRODUCTION

Short Selling has been among the hottest topics in the financial news recently, especially after the Sub-prime Financial Crisis. Short selling was said to play a large role in the downfall of banks like Bear Stearns and Lehman Brothers. There are, however, conflicting opinions regarding short selling. There are those who believe it is outright unethical and that it should be completely banned. Then there are those who think it is absolutely necessary for efficient price discovery. And, of course, there are those who represent the middle ground who think that measures need to be taken only in emergency type situations or that there should be minor measures taken to curb short selling such as increased disclosure (Gruenewald). In this paper I will go into detail on each opinion and elaborate on the role that short selling should take, as well as, how it is enacted and what can prevent it from occurring.

Once the reader is well versed in short selling, I will go into some background info about the recent financial crisis. I feel this information will a beneficial primer to the report and it will help the reader understand my motivations for performing the tests and analyses that I have completed. Next, I will introduce my data and analysis methods. Finally, I will elaborate on how short selling has affected the volatility, market sensitivity and abnormal returns of financial firms throughout the crisis and test to see if the restrictions on the financial sector were effective. For this study I have chosen 25 financial firms from the financial sector to get a broad smattering of companies affected by the crisis. I collected daily volume and price data from each company using Bloomberg, as well as bi-monthly short interest and short interest ratio data. Using graphs

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and statistical analysis throughout this event study, I hope to illustrate to the reader the ins and outs of short selling and its effect on the securities, so that they, too, can make an educated decision as to whether or not short selling is a positive input into the market.

The Basics of Short Selling

The concept of short selling is not as complicated as most would think (although actually executing it can be quite difficult). Essentially, it is the opposite of buying a stock. For comparison reasons, I will first review how to make money when purchasing a stock. Buying a stock is known as going "long" and it is a "bullish" bet meaning you hope that the price of the stock increases. The following scenarios will ignore taxes and transaction costs. Say I liked the prospects of the firm Apple and that it is trading at $100 dollars. I would purchase the stock for $100 dollars hoping that it would go up in price. Now we'll assume I was right (an unlikely scenario) and that Apple beat earnings, increasing their price to $110. I could then sell the stock for $110 dollars making a profit of $10 or 10%; not bad.

If you thought that was relatively straight forward you are ready for short selling. Selling a stock short is known as a "bearish" bet because you believe the price of the stock will fall. Say, once again, Apple is trading at $100. However, you think the new and awkwardly sized I-Pad will be a flop. To short Apple you contact your broker, asking him to borrow one share of Apple. Your broker in turn will contact a lending institution and borrow the stock. Remember, your debt to the institution is not the $100; it is one share of stock. Once you obtain the share you immediately sell it for $100 and pocket the

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money. Luckily, your prediction is right and Apple's shares fall to $90. You then buy one share on the market for $90 dollars. You give this share to your broker and your debt is settled. You now keep the difference of $10, once again making a 10% return assuming no taxes and transaction costs. . Now if it was only this easy (Gruenewald).

Of course shorting stocks is not that simple, there are certain restrictions, lending inefficiencies, margin requirements and so on, but the principle is the same. You are borrowing stocks, selling them immediately and hoping they fall in price, so you can buy them back cheaper. Naked short selling is when one shorts a stock, but does not intend or have the means to deliver it back to the lender. For the purposes of this paper, I will not go into anymore technical detail about short selling.

Obviously, short selling is done because one is pessimistic about the prospects of a firm. Delving deeper into the mind of a short seller, you find that they are motivated by two separate emotions; greed and fear. This was brought to my attention by Harlan D. Platt's paper, A Fuller Theory of Short Selling. Greed based short selling is the most intuitive and well known. It is done when an investor feels a stock is priced too high, and predicts it will come down. Greed based short selling follows an upward sloping demand curve. The higher the stock price, the greater the chances it is overpriced, the more investors will sell it short. Conversely, the less known driver of short selling is fear based. It occurs when a company is in financial distress or approaching bankruptcy. As the company's stock price decreases, its prospects for failure increase and, in turn, so does short selling. This gives fear based short selling a downward sloping demand curve. The lower the company's stock price, the more distress it is in, the higher the short interest on that security. It is the combination of these two demand curves that creates the total

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demand for short selling a security. Thus, the lower the price target for a firm, the higher the total short demand is for that firm. I mention these two types of demand, because the more unconventional type of short selling, fear based, is a larger contributing factor to the type of short selling I will be evaluating; predatory short selling. Predatory trading is known as trading that induces and/or exploits the need of other investors to reduce their positions (Shkilko). It is this type of trading that may have played a role in bringing down companies like Lehman Brothers.

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2. OPINIONS OF SHORT SELLING

After investigating multiple reports, I came across varying opinions and insights about short selling. Academics have opinions ranging from staunchly against to strongly advocating the practice of short selling. They also produce some useful anecdotes about the impact of short selling and how it may relate to the financial crisis. I will explore these ideas and draw some conclusions of my own hoping to guide the reader to their own informed opinion of short selling.

Overpricing

First and foremost, I would like to discuss short selling's impact on pricing. By far, the most popular opinion among investors and politicians is that short selling is "morally wrong" and negatively manipulates the price of a company. Many of these pleas, however, are based more on emotion than factual evidence. Another party sometimes bitter towards short selling is the firms themselves. More times than not, their complaints are to preserve their own stock price. Due to these public outcries, the uneducated mass of investors and citizens have built up in their minds that short selling is "bad". Combating these general beliefs, the paper Short Selling Constraints and Overpricing by Owen A. Lamont, goes into great detail attempting to disprove these negative stigmas. In fact, it states that short selling is not only a beneficial but necessary for proper price discovery. The overpricing theory states that the more short selling restrictions on a stock, the more overpriced the security will be. The author states, "By

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identifying stocks with particularly high short sale constraints, one can identify stocks with particularly low future returns." In other words, he found that stocks that can not reflect immediate negative information through short selling will be forced to have lower returns over time to reflect that pessimism. It is also noted that short selling is not as prevalent as most would think. It is typically done by larger accredited institutions as opposed to retail investors. There are many barriers in the way of short selling other than outright restrictions. The paper even mentions that, "(the) SEC, the Federal Reserve, the various stock exchanges, underwriters and individual brokerage firms can mechanically impede short selling." Another interesting point discussed is that firms who lobby to eliminate shorting of their company usually do so because they have something to hide. It is mentioned that firms who protest a great deal about short selling typically have low returns in subsequent periods; many times because these firms have been involved in some type of scandal. So, in the end, the short seller is not the bad guy, but actually the one who exposes the deviant firm. In the past, short sellers have discovered such scandals as Enron and Tyco International (Barr). Some of these firms may have never been uncovered, if it was not for short sellers.

I, too, feel that the many cries against short selling are simply done so, because it is a politically hot topic. A recent article in the Star Ledger divulged that commissioners, who voted for the circuit breaker up-tick rule that came into effect this February, did so without proof that it would improve markets. The title of the article was powerful enough on its own stating, "SEC short-seller limits said to be 'political'" (Mehta). I also agree that short selling is necessary for price discovery, barring it is not done in excess. Without

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allowing negative sentiment to be computed in the price of a stock, it will undoubtedly be biased towards the opinions of the optimists.

Predatory Short Selling and Price Reversals

So, if short selling is technically a positive input to the market, then why have there been restrictions in the past and debates concerning more restrictions in the future? For one, to reiterate, it is a political subject where politicians who label short sellers as the bad guy can then look like the good guy. But there are also more concrete reasons. There are indeed harmful instances of short selling. These crisis type scenarios are the situations that need to be controlled. One example would be when short sellers swarm to beat down an ailing company, also known as predatory short selling. There has also been another type of harmful short selling that has been identified by Andriy Shkilko, Bonnie Van Ness and Robert Van Ness in their paper Aggressive Short Selling and Price Reversals. A price reversal is a situation where on a no news day a firm's price will fall significantly followed by a quick recovery. It is said to occur when an institution needs to sell off a large holding in a company. Aggressive investors will identify this situation and after the initial price drop will continue to short sell leading to a sharp decline in the stock price; a strategy known as momentum trading. Once shorting activity subsides, the stock will typically recover to its initial price range. The author proposes this is an unrecognized type of shorting and can be potentially dangerous, because it eats up liquidity and increases intraday volatility. It was also noted that, "As prices fall, short sellers actively consume liquidity and tend to route their orders to venues that do not

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restrict short selling (e.g., do not comply with the bid test) or sufficiently expedite it. In addition, we show that the bid test is partly circumvented by frequent submission of small fleeting up-bid quotes." This is interesting because it proposes that, even if restrictions are in place for hazardous trading, they can be circumvented if desired, thus rendering them ineffective. If the uptick rule is indeed ineffective and there are instances of harmful or predatory short selling, what should be done about regulation?

Proposed Restrictions

Seraina Gruenewald, Alexander F. Wagner, and Rolf H. Weber's paper Short Selling Regulation after the Financial Crisis elaborates on the current options being debated for future short selling restrictions. They are as follows; (i) make a permanent price test rule, either bringing back the up-tick rule or creating a new modified up-tick rule, or (ii) create circuit breaker type restrictions that will only be enacted during a severe market decline of a security (a crisis situation). The emergency restrictions will consist of either an emergency price test rule (like the up-tick rules above) or a temporary halt of short selling in that particular company. The author contests that price tests like the proposed up-tick rules were not that effective in the past and actually created more price inefficiencies than they eliminated. It was stated that, "Financial markets regulation is generally considered justified if (i) it aims to correct market failures, (ii) it is effective in doing so and (iii) its benefits exceed the costs caused by it." Because, in the author's opinion, the up-tick rule's benefits did not exceed its costs, due to mispricing and inefficiencies, it should not be used now or in the future. They argued that because

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predatory trading happens only in emergency situations, that preventions should also only be enacted in emergency situations. Hence, circuit breaker restrictions would be more appropriate. In their words, "To eliminate short selling for the purpose of market abuse, regulators need not eliminate short selling per se, but rather enforce existing market abuse regulation." I agree with his outlook and think that emergency restrictions would only be appropriate for emergency situations of abuse. I will go one step further and say that it would be more fitting to instate a temporary halt on short selling, as opposed to a modified up-tick rule (when considering the circuit breaker options). It has been shown in the past that the up-tick rule does not always serve its purpose and, as was mentioned before, can be circumvented through fleeting up-bid trades. A true halt is the only way to directly address predatory short selling. Unfortunately, as I touched upon above, regulation was finally decided upon in February 2010. A circuit breaker up-tick rule will be instated that becomes active when a stock has lost 10% of its value in a day. After this threshold is broken, the new modified uptick rule will not be removed until after the following day. This regulation was more about politics and doesn't seem to aid the crisis. Critics said the policy has "no teeth" and disliked the fact that a short seller could still potentially make 10% before any restrictions. Not a bad profit for a day's work (Jaffe).

To summarize, these authors have provided many interesting views on short selling. Ultimately, I feel that short selling is essential in the market and is not a "bad" thing. It rarely is predatory, and when it is, it should be regulated on an emergency basis.

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3. THE FINANCIAL CRISIS

Before I get into meat of the statistics, I thought it would be worthwhile to talk a little about the recent financial crisis. A general background of what happened will make it easier to understand why I am looking specifically at the financial sector.

Sub-prime Mortgages

The financial crisis started in the summer of 2007 and was initially brought on by sub-prime mortgages. The crisis brought volatility to the returns of companies, especially in the financial sector. As you can see in Figure 1 below, late July 2007 is about the time when blips of volatility are depicted. They appear right after the yellow line in the graph.
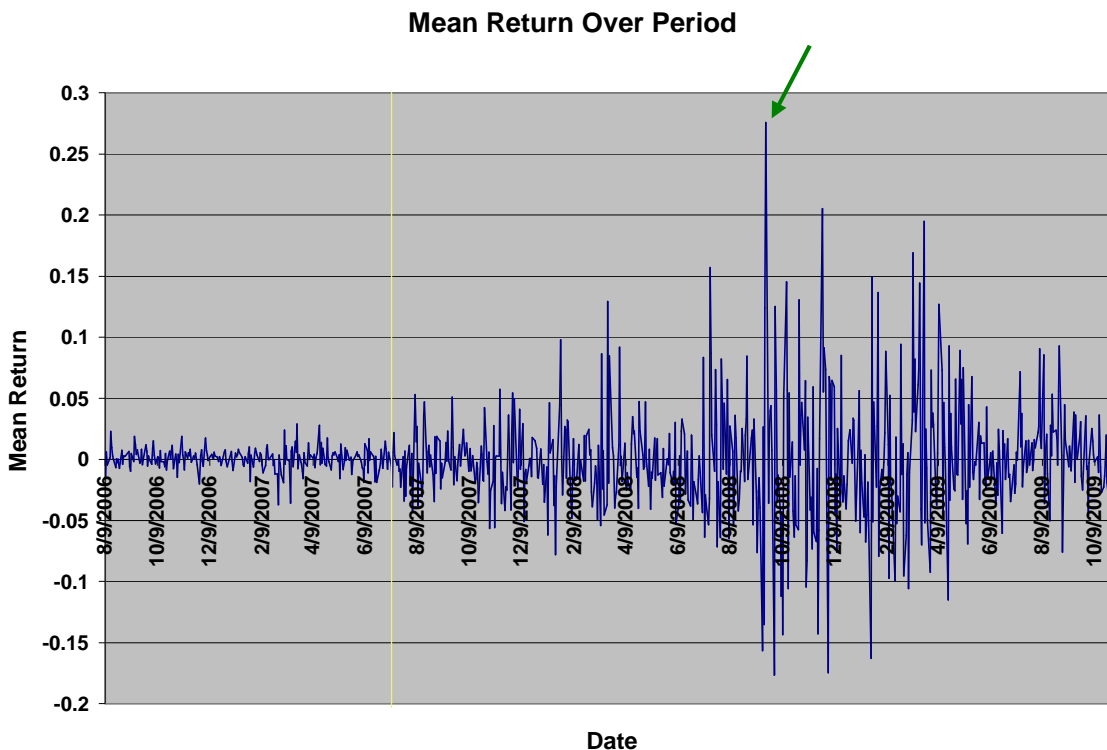
Mean Return Over Period

Figure 1. Mean return of 25 financial firms over the most recent financial crisis. Dates range from 8/9/06 - 10/30/09

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This figure also shows that the height of volatility is centered on September 2008

(indicated by the green arrow); right around the time short selling restrictions were placed

on financial firms (this will be discussed in greater detail later). But, I digress, a sub-

prime mortgage is a mortgage given to someone of high risk. They have low or

undocumented income and usually a bad credit history. Furthermore, after the purchase,

the receivers of the sub-prime mortgages usually chooses to have minimal equity in their

homes and will pay the lowest possible down payment (they have a high Loan to Value

or LTV. LTV is simply the loan value divided by the value of the home). This down

payment could be as low as 5% (LTV = .95). These mortgages typically have low initial

rates or teaser rates, which are followed up in a year or two by much higher rates, making

them increasingly harder to pay back. Nevertheless, sub-prime mortgage clients were

able to keep up with the loans as long as the price of their homes continued to rise. When

their homes appreciated in value, they could borrow against the equity of their homes and

use it like income. And with low rates at the time they could always refinance to decrease

their monthly payments. LTV's would remain high because sub-prime clients typically

only make the minimum loan payments, never reducing their principle. Once again, this

was fine as long as housing prices consistently climbed higher and higher. Unfortunately,

there is never a constant in the world of finance, so just as the Tech Bubble of the nineties

popped, so did the Housing Bubble. As prices of homes started to fall, these sub-prime

borrowers who lived on the fringe of an LTV equaling one, began to lose equity in their

homes (LTV rose) and many of them reached negative equity (LTV > 1); a scenario

where the value of the loan actually exceeds the value of the home. If this was the case, it

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would not even be worthwhile to sell your home, because you wouldn't have enough to pay off the loan. Instead, people just foreclosed and walked away.

Impact on Financial Institutions

Where does this fit in with all the banks? Well, the only reason lending agencies like Countrywide were able to grant these sub-prime mortgages is because they were able to take the risk created by them off their books through securitization. They would do this by passing through the mortgage to bigger companies like Freddie Mac where they would then be securitized and made into an asset (Mortgage Backed Security or MBS). These assets would receive a return equal to that of the loan repayment of whoever took out the mortgage. Contrary to popular belief, most MBS's were fairly safe. There were many good mortgages out there that people were paying back. The problem arose when these mortgage backed securities were put into bundles, known as traunches, and then resold as collaterized debt obligations or CDO's. It is here where healthy mortgages began to get mixed in with the sub-prime. Because these mortgages were packaged and re-packaged so many times, investors began to lose track of where payments were coming from. Even worse, these securities were sold to almost all financial firms and investment banks exposing the entire financial sector to these potentially toxic assets. Once sub-prime mortgages started to default, investors shunned CDO's making their value plummet. Companies like Freddie Mac and Fannie Mae got crushed, because they were creating these securities. Investment banks and other financial institutions incurred monstrous losses, because they had invested in these assets. Then the financial insurance companies

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like AIG, Ambac and MBIA had their businesses almost collapse, because they insured

so many CDO's they could not cover the losses. Numerous companies required a bail out

and investors lost all confidence in financial firms. There was mass contagion, and one of

the symptoms was widespread short selling attacks. It was these attacks that brought

companies like Bear Stearns and Lehman Brothers to their knees. Figure 2 below

illustrates how the 25 financial firms were affected throughout the time period of my

sample.

Average Price of all Firms Over Period
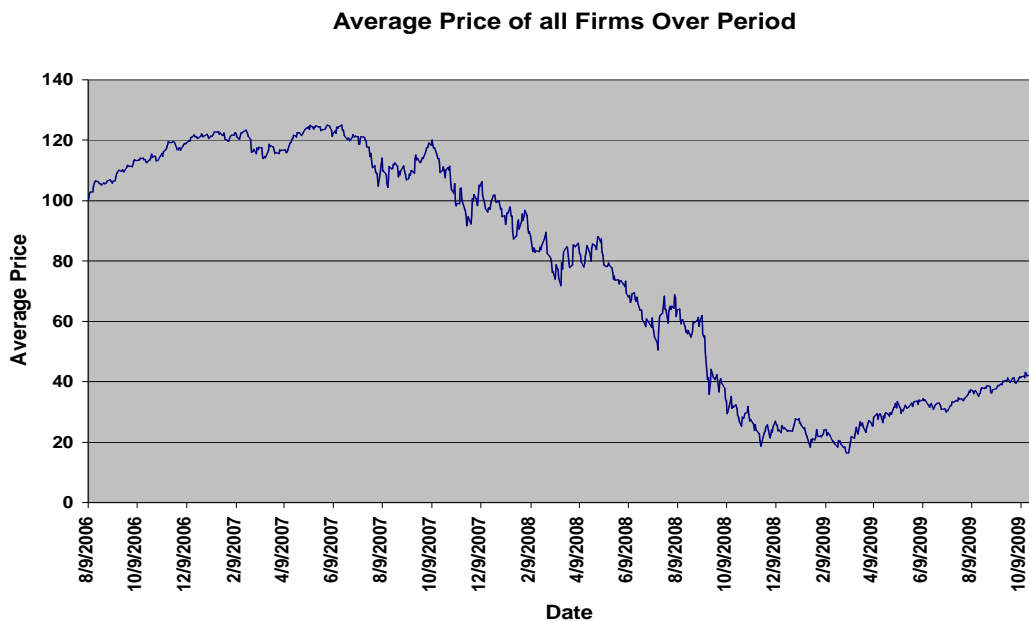
Figure 2. Average price of 25 financial firms over the duration of my time selection

The financial sector appears to reach a bottom in March of 2009.

Short selling restrictions by the SEC to prohibit all short selling of firms in the

financial sector were instated on 9/17/08, because momentum short selling attacks like

these could be very hazardous to the health of companies (The Financial Crisis).

Although necessary at the time, there were still those who disagreed with the restrictions.

Some say that the financial firms deserved it. The fact that they were so highly leveraged

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and incurred such high losses was more than enough reason for low stock prices. Erik Sirri, a former SEC official said, "It's not exactly the case that short sellers were wrong" to bet against banks in 2008. "Short sellers were making those prices more efficient. They were right." (Mehta) These divergent views are the reason that I decided to focus my paper on short selling and its restrictions (Information for this chapter was primarily obtained from an interview with a former mortgage broker and current a financial advisor; Richard J. Scialabba)

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4. DATA COLLECTION

To conduct this event study, I collected daily data from Bloomberg for 25 financial firms. The firms for which I collected data include: Bank of America (BAC), Citigroup (C), JPMorgan (JPM), Morgan Stanley (MS), Wells Fargo Company (WFC), Goldman Sachs (GS), Lehman Brothers (LEHMQ), PNC Bank (PNC), BlackRock (BLK), US Bancorp (USB), The Bank of NY Mellon (BK), UBS (UBS), Deutsch Bank (DB), Credit Suisse (CS), Lazard (LAZ), Charles Schwab (SCHW), TD Ameritrade (AMTD), Ameriprise Financial (AMP), American International Group (AIG) Freddie Mac (FRE), Fannie Mae (FNM), Wachovia Bank (WB), Merrill Lynch (MER), Ambac Financial (ABK), MBIA Inc. (MBI). I chose to use Bloomberg because of its accuracy, credibility and its abundance of data. From Bloomberg I was able to obtain daily volume and stock price data. I was also able to obtain bi-monthly data on short interest, and short interest ratios (short interest/average daily volume). I chose these data categories because they are all characteristics that short selling restrictions could affect. I decided to select data from 8/9/06 to 10/30/09. I chose the start date because it is about six months before the start of the crisis, and the end date because it is about six months after the worst of the crisis. This time period also encompass important events that are contained in Table A-1 (Appendix A, Table A-1, The Financial Crisis).

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5. DATA ANALYSIS

Summary Statistics

My first step was tabulating summary statistics for the whole time period and organizing the data so it was more palatable. To do this, I made matrices with the 25 firms across the top, and the dates listed down the left hand side of the spread sheet. See Table A-2, in Appendix A for an example. From there, I inserted daily data for each company. I then took daily means and standard deviations across each row for each date. With these statistics, I was able to create line graphs illustrating the mean daily volume of the 25 firms over time, as well as, mean price, mean return, mean short interest and mean short interest ratio. I also created standard deviations graphs for all of the above scenarios (See Appendix C for graphs not used in paper: Figures C-1 to C-4). I used these graphs to gauge how these companies were doing/trading over the entire period of my event study. They were great visuals to see how poorly the financial sector was performing at a certain time, or how much trading was taking place. For instance in Figure 3 you can see how mean trading volume rose dramatically throughout the crisis.
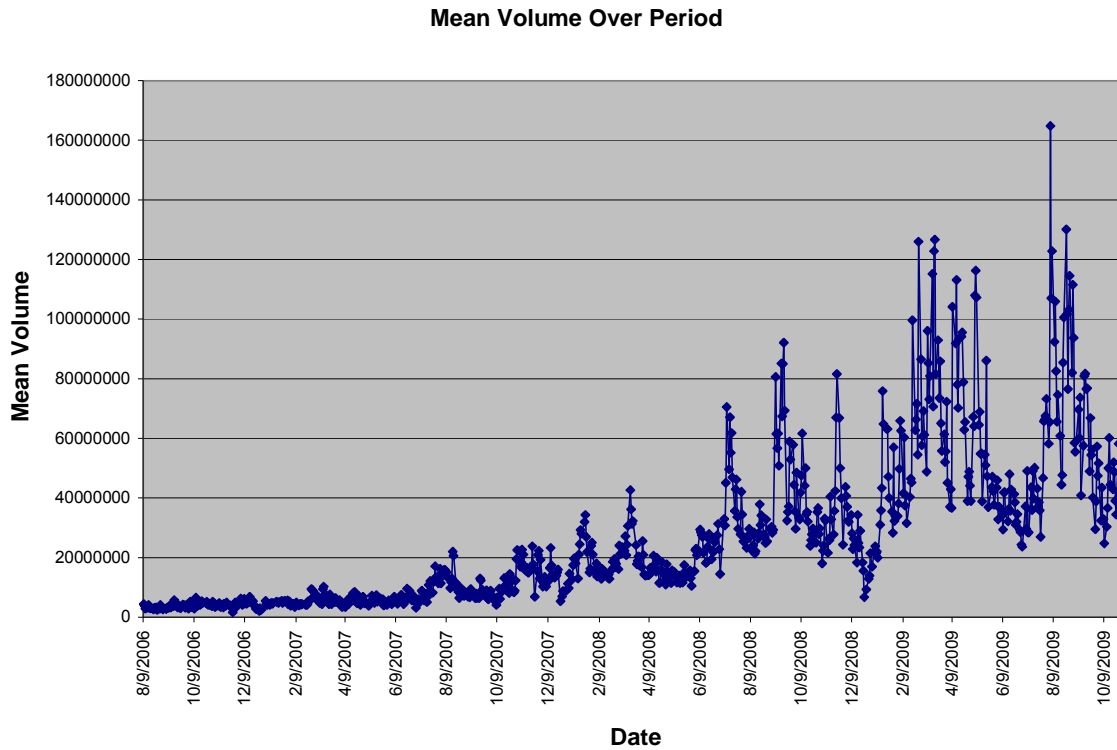
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Figure 3. Mean volume of 25 financial firms throughout the financial crisis

This increased volume is indicative of increased volatility, panic trading and day trading brought about by the crisis. Figure 4 shows the mean short interest over the period. There is a noticeable dip in short interest right around the date restrictions began, 9/17/08, indicated by the yellow line.
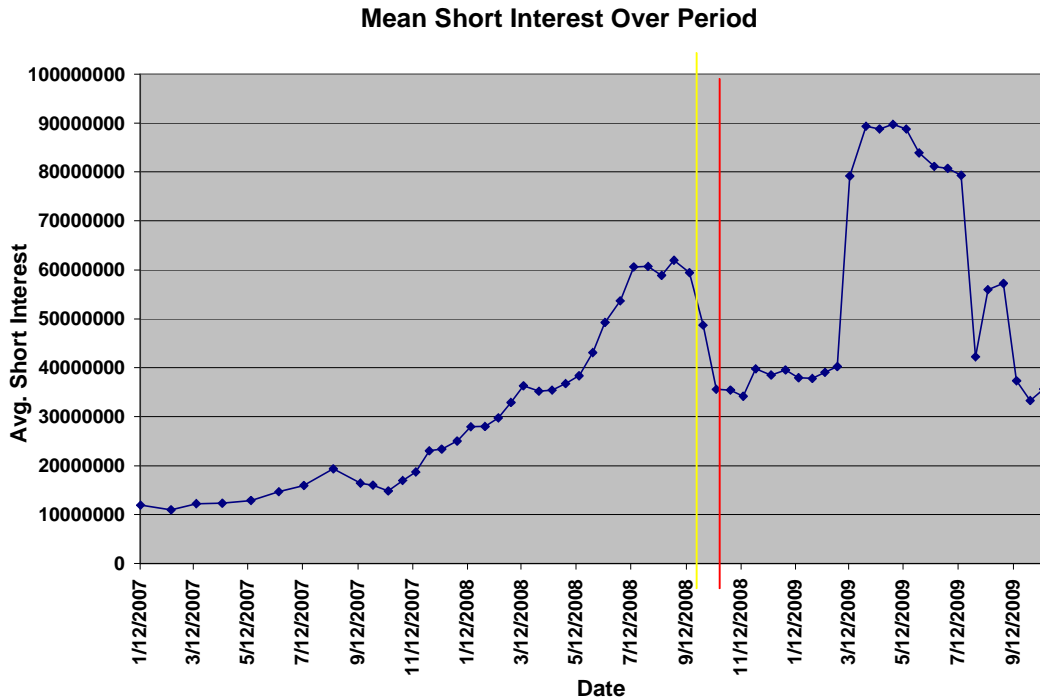
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Mean Short Interest Over Period

Figure 4. Mean short interest of 25 financial firms throughout the financial crisis

Unexpectedly, short interest does jump back up significantly later in the graph falling between the dates of 2/27/09 and 3/13/09.

Short Selling Restrictions and Change in Beta

The first and focal event I investigated was the day the SEC put a temporary ban on short selling firms in the financial sector; 9/17/08. To do so, I evaluated how short interest changed before and after the date, as well as how returns changed. As you can see above in Figure 4, short interest dropped significantly after the restrictions had set in. This is what I expected to find, assuming that the halt in short selling was effective. These restrictions were lifted on 10/8/08, indicated by the red line. There was no noticeable jump in short selling. About a half a year later, they took a large leap starting

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around 2/27/09. This is most likely because this was the worst part of the crisis. March 9th was when the mean price of the 25 firms was the lowest. Two pivotal events occurring at this time were the heavy bailout of AIG and the realizing of crippling losses for companies like Freddie Mac. These financial troubles, along with a lack of confidence in the proposed bailout program, the Toxic Asset Relief Program or TARP, most likely provoked investors to short sell heavily. Next I evaluated returns. I chose a period of 70 days before and after the event. I did not want to just look at daily returns however; I wanted daily abnormal returns, or the firm's daily alpha. This is defined as the return above or below what is predicted by Capital Asset Pricing Model or CAPM. CAPM is a formula that uses the product of the market return and a firm's beta to determine the expected returns for that firm (Appendix B, Formula B-1). In order to create CAPM estimates for daily returns, I used daily returns from the S&P 500 as the market proxy. I then calculated a beta for the firm before and after the date or restrictions, using the data from the 70 day periods. A firm's beta is how sensitive it is to market returns. The market, the S&P 500 in this case, always has a beta of 1. So, a stock with a beta of 2 will have movements double the magnitude of market movements and a stock with a beta of ½ will have movements half the magnitude of the market. Any other price movements the firm makes not related to the market (firm specific) would be reflected in the firm's alpha or returns over what is expected by the market and the CAPM formula. To obtain the beta of the firm for the 70 days before the date of short selling restrictions, I created a scatter plot of the S&P daily returns vs. the firm's daily returns. I then ran a regression line through the scatter plot. Figure 5 below is an example for Bank of America (BAC).

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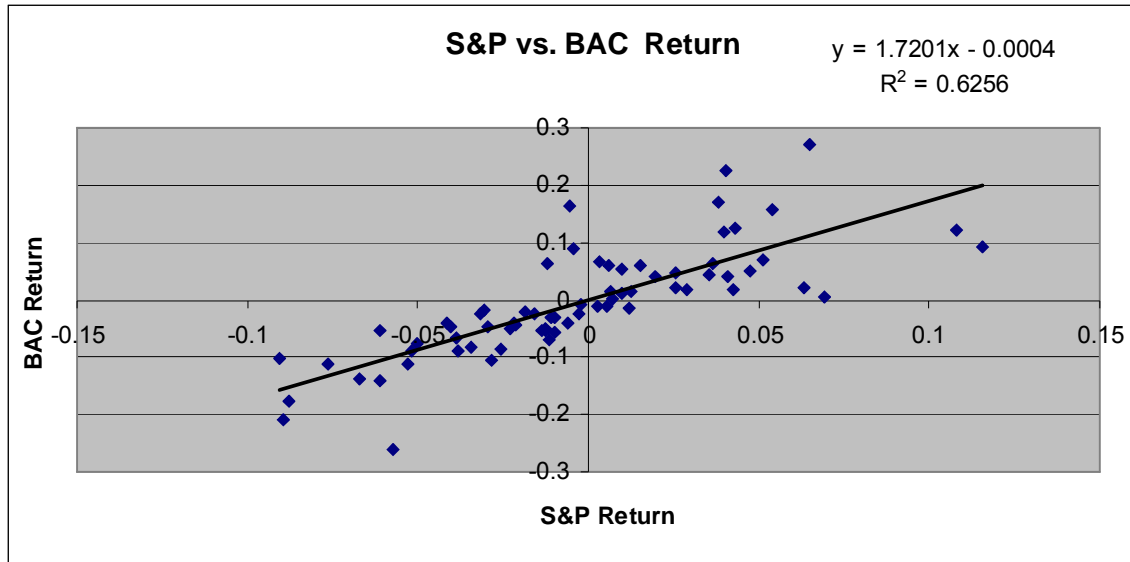**S&P vs. BAC Return**

y = 1.7201x - 0.0004

$R^2 = 0.6256$

Figure 5. Regression line determining the beta of Bank of America

The slope of this line is the firm's beta, in this case 1.7201. So, once again, if Bank of America has a slope of 1.7201, for every 1% return the market has, Bank of America has a 1.7201% return, and vice versa for losses. I also calculated a beta in the same way for the 70 days after short selling restrictions. Using these betas I calculated the CAPM expected daily returns for each firm (For example, CAPM expected return for BAC = Return of the S&P that day*Beta of BAC). I then compared them to the actual daily returns of each company over this time period. The actual return minus the CAPM predicted return is the firm's alpha, or abnormal return. I will come back to this in the next section. Last, I created bar graphs, Figure 5 and 6 below, to depict the change in the beta before and after the date for each firm.
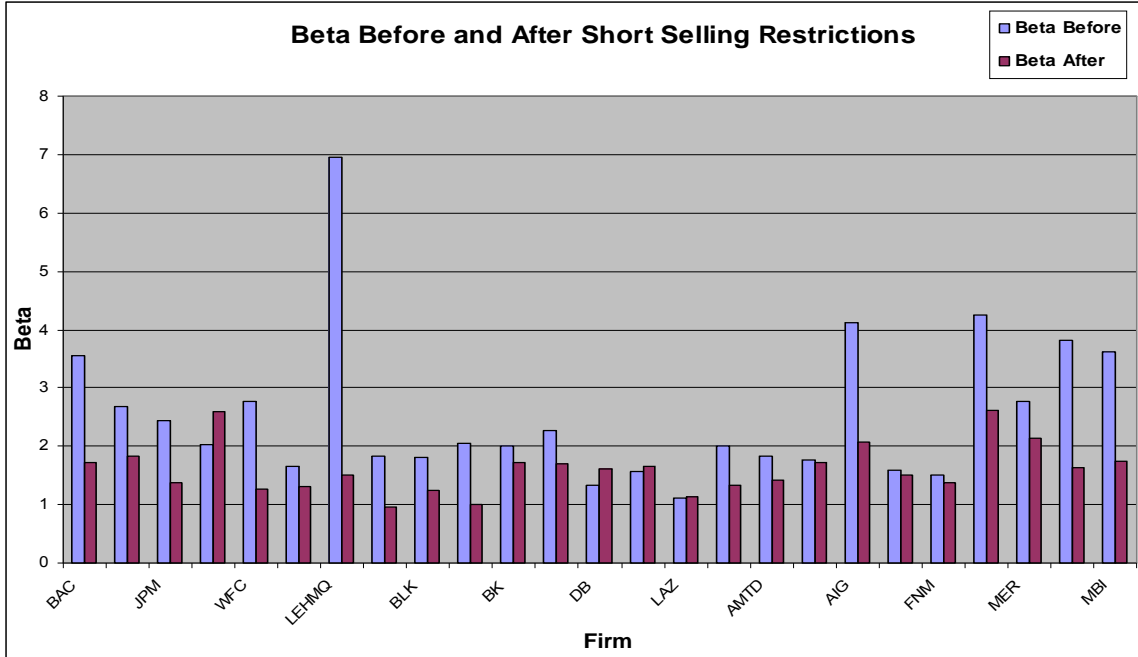
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Figure 6. Change in beta before and after short selling restrictions on 9/17/08
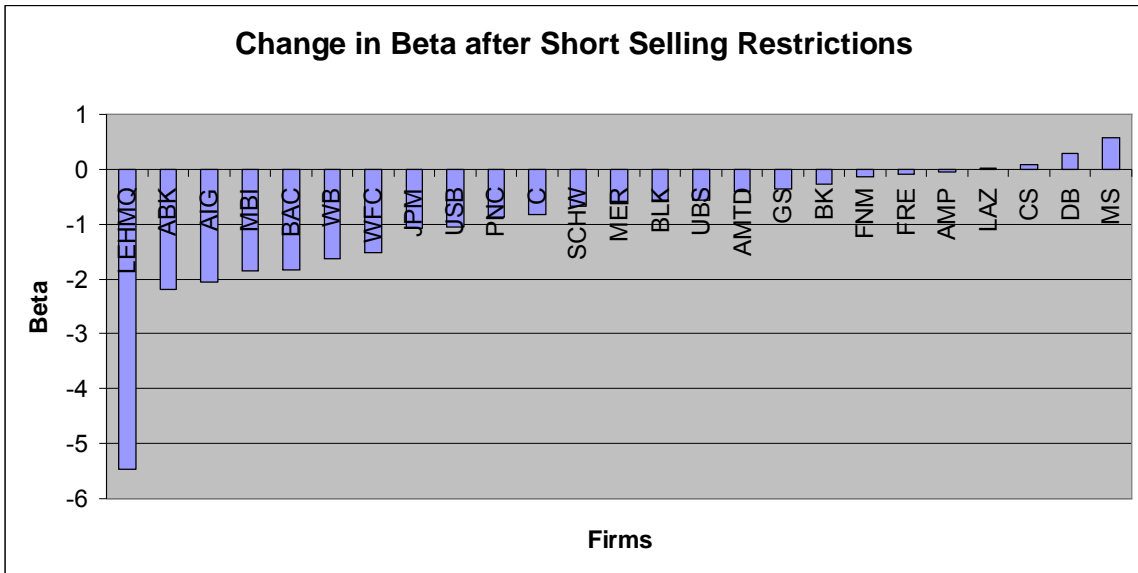

Figure 7. Change in beta after short selling restrictions. Ordered from most negative to most positive changes

As you can see the betas dropped pretty consistently after short selling restrictions were put in place. This could be due to that fact that the firms were not as sensitive to market movements anymore because they could not reflect any negative sentiment which would

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usually be enacted via short selling. I will test this idea in the following chapter.

Restriction's Impact on Abnormal Returns

My next step was to build a time varying alpha graph for the entire 140 day period. To create this graph I constructed a matrix with the 25 firms and their daily alphas (abnormal returns) which I calculated in the previous section. From there, I made a daily mean and standard error (SE) for every date as can be seen in Figure 8.
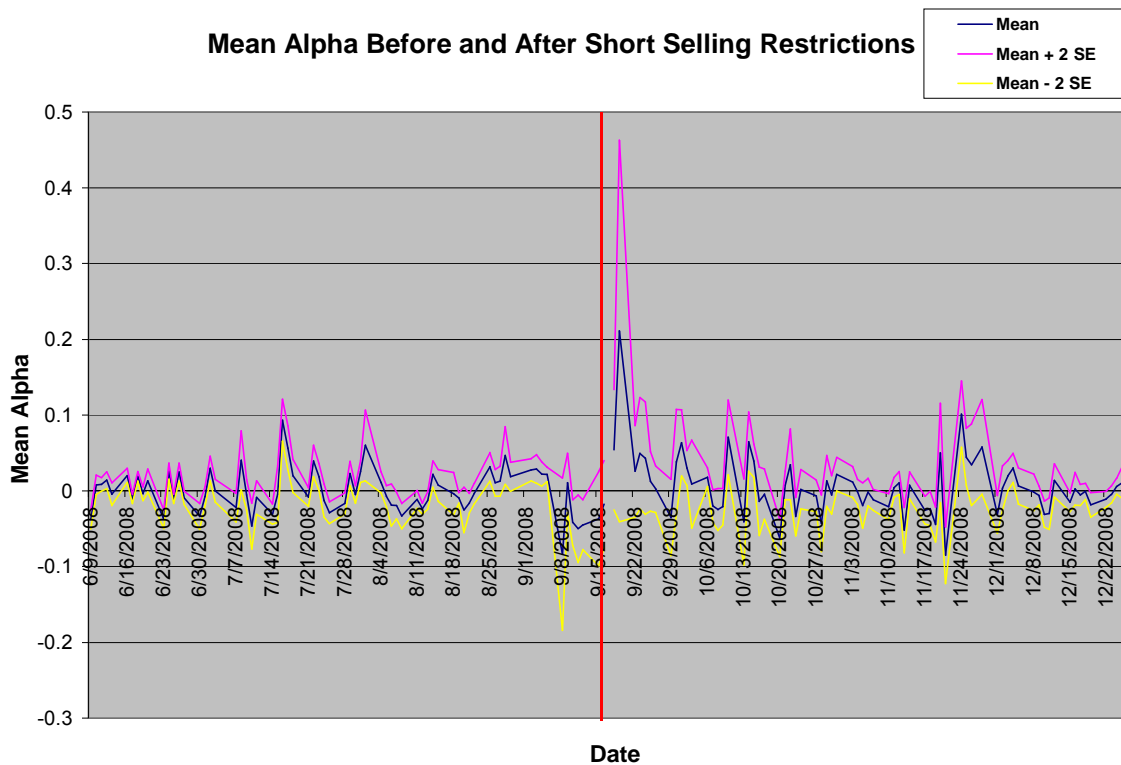

Figure 8. Mean Alpha (abnormal return) of firms before and after restrictions. Also +/ - 2 standard error bands added

It shows that the day after short selling restrictions were instated; there was a significant jump in mean alphas, as well as, standard error. This jump in abnormal returns depicts that short selling restrictions were effective. However, after this time period the alphas

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seem to revert back to the same trend as before. This could be the result of traders transferring their pessimism to the derivative market, or learning ways how to circumvent the restrictions. Furthermore, there is no noticeable dip in prices when the restrictions were removed on 10/08/08, indicating that short selling does not necessarily mean lower prices. To get an idea of abnormal returns over the entire period of my sample, the following graph, Figure 9, shows alphas throughout the time span I used for my data.
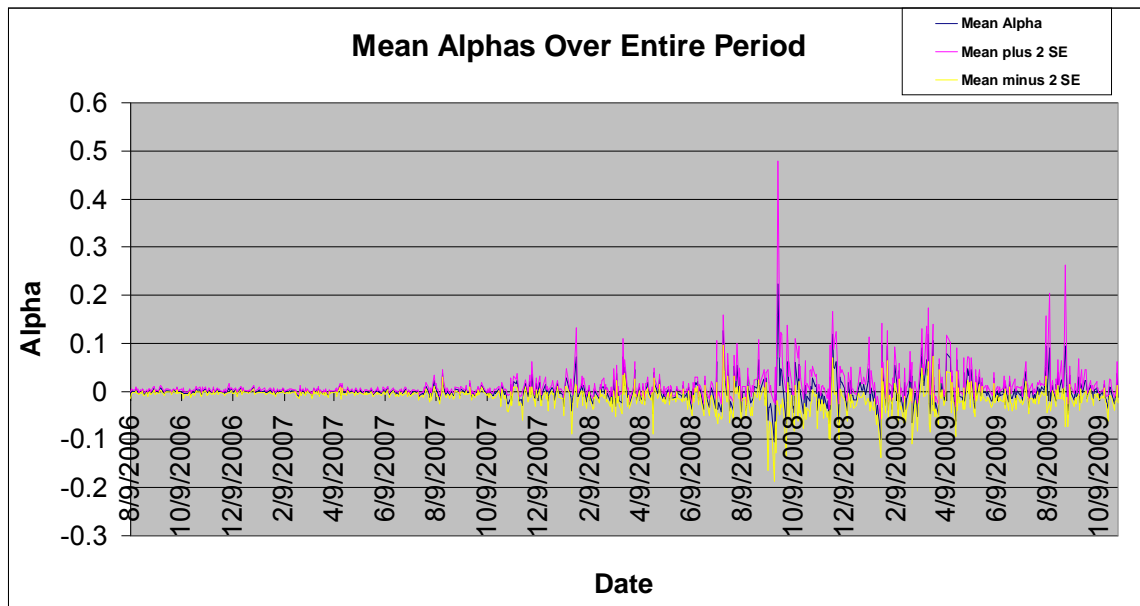

Figure 9. Mean Alpha from 8/9/06 - 10/30/09

Signs of increasing alphas do not seem to appear until late summer of 2007, about the time the financial crisis began. The beta for this graph was calculated using the first six months of data. The equation I used to calculate beta was covariance of the firm and the market divided by the variance of the market, an alternative to the regression method I used initially, because of its ease and relative quickness (Appendix B, Formula B-2).

It would make sense that many bearish bets would transfer to the derivative market, when they could not be enacted in the cash market. This was the topic of Joakim Westerholm and Mostala Ahmed's paper, The Impact of Actual Market Wide Short

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Selling Restrictions and Liquidity Constraints during the Financial Crisis of 2008. To their surprise, not only did short selling interests not transfer to the derivative market, but the derivative market actually saw even less trading when short selling restrictions were introduced. In fact, the cash market saw *more* trading when the restrictions were introduced, indicating that a greater amount of price discovery was occurring in the cash market. Volume actually increased for the cash market, which can be seen in the average volume graph in Figure 3. Their proposed reason for the decrease in activity in the derivative market is because, "It appears that the absence of sophisticated market participants active in short selling has a spill-over effect on the derivatives markets as a result of lower incentives for hedging and arbitrage between cash and derivatives."

If the disappearance of higher returns the day after restrictions were imposed was not because of a transfer of trading to the derivative market, traders either learned to circumvent short selling restrictions or prices were never really deflated by short selling in the first place (people continued to trade in the cash market as usual). And don't forget just because investors were not allowed to short sell, does not mean that normal selling of stocks could not take place. Normal selling depresses the price of an asset in the same manor.

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6. DATA TESTS AND RESULTS

Welch's t-test

The first test that I conducted was a t-test of the average change in beta after restrictions for the 25 financial firms. More specifically it was a two sample t-test assuming unequal variances; also known as Welch's t-test (Appendix B, Formula B-3). A t-test is when one tests to see if two separate means are equal, assuming a normal distribution. In this case, I am testing to determine whether the average change in beta of the 25 financial firms, after short selling restrictions were instated, is the same as the average change in beta of all firms in the market. As a market proxy, I used 25 portfolios constructed by and downloaded from Ken French's website vs. the S&P 500 (Kenneth). These portfolios are organized by the firms' size and Book-to-Market ratios and are well representative of the entire market. To calculate betas for these portfolios, I used the same formula I used previously, covariance of the portfolio and the market divided by the variance of the market. Once again, I used 70 days of returns before and after the date short selling was restricted for each security, as well as, the market. I used the 70 days of data before (after) to calculate the beta before (after). My hopes were to discover that the average change in the portfolios' betas was statistically different from the average change in the financial firms' betas, as I'm assuming financial firms are acting differently due to short selling restrictions. I found that most financial firms' betas decreased drastically, an average decrease of .926608 after short selling restrictions were implemented. Using Ken French's portfolios, I found that betas on average decreased only slightly; an average

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decrease of .0789889. My proposition is that less information is now being processed in financial firms' stock prices; specifically negative information. Additionally, financial stocks were more volatile and sporadic at this time reacting not to market sentiment but panic. Because of these two factors, financial equities became less sensitive to market movements. After running the t-test, I arrived at a t-stat of -3.4737038. This is extremely large in magnitude, much larger than the needed 1.95. The two-tailed p value in this case equaled .001886, meaning that there is a .1886% chance that a difference in means like this could happen by chance alone. This confirmed my assumptions that the financial firms were acting statistically differently than the market, most likely due to short selling restrictions.

Another strategy I used to analyze the change in betas of the financial firms was to see how betas changed during other significant events throughout the financial crisis. The four other events I investigated were the collapse of Bear Stearns (3/14/08), the collapse of Lehman Brothers (9/15/08), the day emergency temporary naked short selling restrictions were instated on firms like Fannie Mae and Freddie Mac (6/15/08) and the day short selling restrictions were officially lifted (10/8/08). Unfortunately, my results were mixed and thus inconclusive. After the Bear Stearns collapse and emergency naked short selling restrictions were instituted, betas increased. Betas decreased, after the collapse of Lehman and after short selling restrictions were lifted; the same pattern found when short selling restrictions were instated. My hypothesis was that betas would drop during emergency naked restrictions just as they did after short selling restrictions were instated and that betas would act similarly after the failures of Bear and Lehman. I also predicted betas would reverse when restrictions were lifted. This was not the case. I also

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created histograms for the betas before and after each event to get a better idea of how they were distributed (see Appendix C for change in beta figures and histograms: Figures C-5 to C-16). To determine if these events had significant impacts on returns, I created mean alpha graphs for each event. Unlike the mean abnormal return during short selling restrictions graph, Figure 8, none of these events proved to have any significant impact on abnormal returns (See Appendix B for alpha graphs: Figures C-17 to C-19).

Although my beta comparisons before and after important events turned out to be unfruitful, my t-test confirmed that financial firms' change in betas after short selling restrictions behaved statistically different than that of the market. The fact that other influential events did not have the same impact on abnormal returns and standard error as short selling restrictions did also speaks volumes.

Event Study and CAR's

I employed an event study to test whether short selling restrictions had an effect on stock price. To accomplish this I utilized the same 140 day period around the date short selling restrictions were enacted, but broke up the time intervals differently than I did to create my time varying mean alpha graph in a previous section (Figure 8). I used the first 30 days of the period, known as the estimation period, to calculate the parameters I would need to calculate abnormal returns: alpha and beta. The five days before and after the event is known as the event window and the thirty days after the event window are known as the post event period. Because I used an estimation period, the calculation for abnormal returns is slightly different than before. The daily abnormal return of a stock is

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equal to the return of the stock that day, minus the stock's alpha, minus the product of the

stock's beta and the market return for that day (Appendix B, Formula B-4). Once again, I

used daily returns of the S&P 500 as the market proxy. To compute beta I calculated the

variance of the market's returns over the 30 day period, as well as, the covariance of each

firm's returns with that of the market. I then divided the covariance of each firm with the

market, by the variance of the market, to obtain the firm's beta. To calculate the average

alpha for each firm, I took the average return of the firm over the 30 day period and

subtracted the product of the firm's beta and the average return of the market over the 30

day period from it (Appendix B, Formula B-4). This differs from my calculation of alpha

previously in this paper; before I calculated alpha for each day and equated it to the

abnormal return, where as here I am using a 30 day average. Once I calculated all of the

firms' alphas and betas, I was able to determine any daily abnormal return for each stock.

Following with the rules of my event study, I calculated abnormal returns for each day in

the 11 day event window for each firm. Next, I created cumulative abnormal returns or

CAR's for the 11 day event window for each firm (I summed all eleven abnormal

returns). If the event was not significant, the CAR's should sum to zero. I then created

summary statistics for all 25 firms' 11 day CAR's as can be seen in Table 1 below.

11 Day CAR Summary Statistics	
Mean	0.117055994
Standard Error	0.106776733
Median	0.044849357
Mode	-
Standard Deviation	0.533883663
Sample Variance	0.285031765
Kurtosis	3.089148444
Skewness	1.299766928
Range	2.539877611
Minimum	-0.85798517

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Maximum	1.681892441
Sum	2.92639985
Count	25

Table 1. 11 day CAR summary statistics

There are several interesting points in this table. For one, the mean CAR over this 11 day period is about 11.7%. This is extremely large. The mean 11 day cumulative return of the S&P calculated in this same 140 period is about -2.2%; a huge contrast. Comparing the two means using Welch's t-test, resulted in a t value of -1.278 which is fairly large. The corresponding two-tailed p value is .2124. In other words, there is a 21.24% chance the difference in means is by chance. With almost 80% confidence we can say these means are statistically different. Even after accounting for any outliers, the median CAR for the financial firms is still about 4.5%. The high skewness further suggests large returns. These higher abnormal returns are most likely due to short selling restrictions. Figure 10 shows the median abnormal returns for the 25 firms over the 11 day event window.
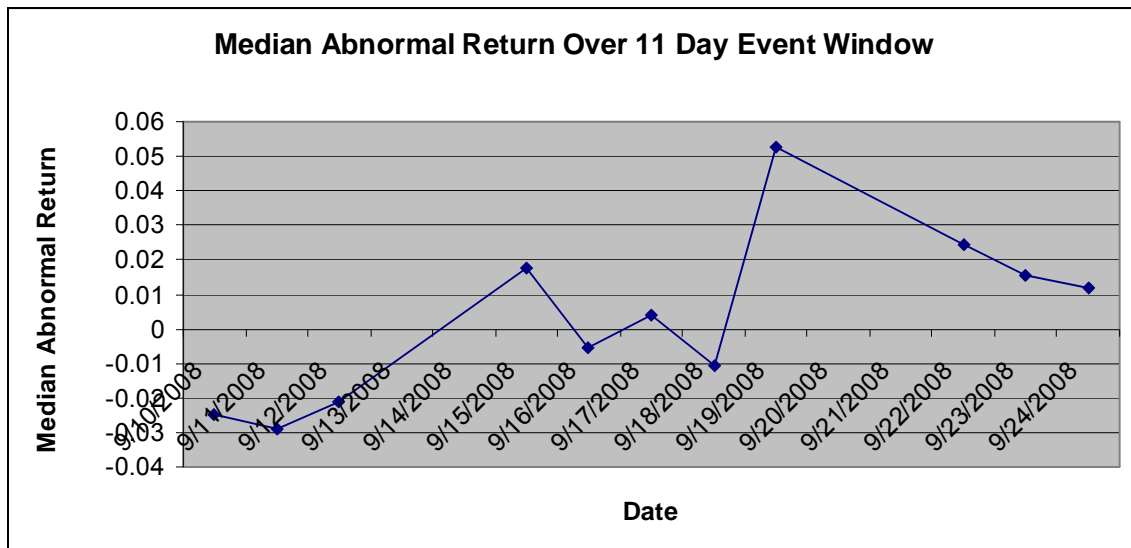
Figure 10. Median abnormal returns of 25 financial firms over 11 day event window

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As you can see, there may have been some leakage of news that short selling restrictions were to come, because abnormal returns are mostly positive a few days before restrictions were instated on 9/17/08. The restrictions seem to be effective, although not immediately, with high abnormal returns realized on 9/20. It seems that short selling restrictions absolutely have an effect on abnormal returns. One explanation is that without short selling there is more uncertainty about a security's price. With uncertainty, comes volatility and with volatility, comes the possibility of higher returns, especially when bearish bets are restricted.

I repeated the same process for a three day event window (the day before the event and the day after) to see if anything peculiar was occurring right around the date of restrictions. The three day CAR summary statistics can be seen below in Table 2.

Three Day CAR Summary Statistics	
Mean	-0.038207021
Standard Error	0.047826549
Median	0.01024055
Mode	-
Standard Deviation	0.239132743
Sample Variance	0.057184469
Kurtosis	3.193680433
Skewness	-1.288325811
Range	1.196499977
Minimum	-0.792001328
Maximum	0.404498649
Sum	-0.955175514
Count	25

Table 2. Three day CAR summary statistics

The mean CAR in this case is -3.8% but is not reliable because the standard error is larger in magnitude. I also graphed the median abnormal returns of the 25 financial firms in Figure 11.
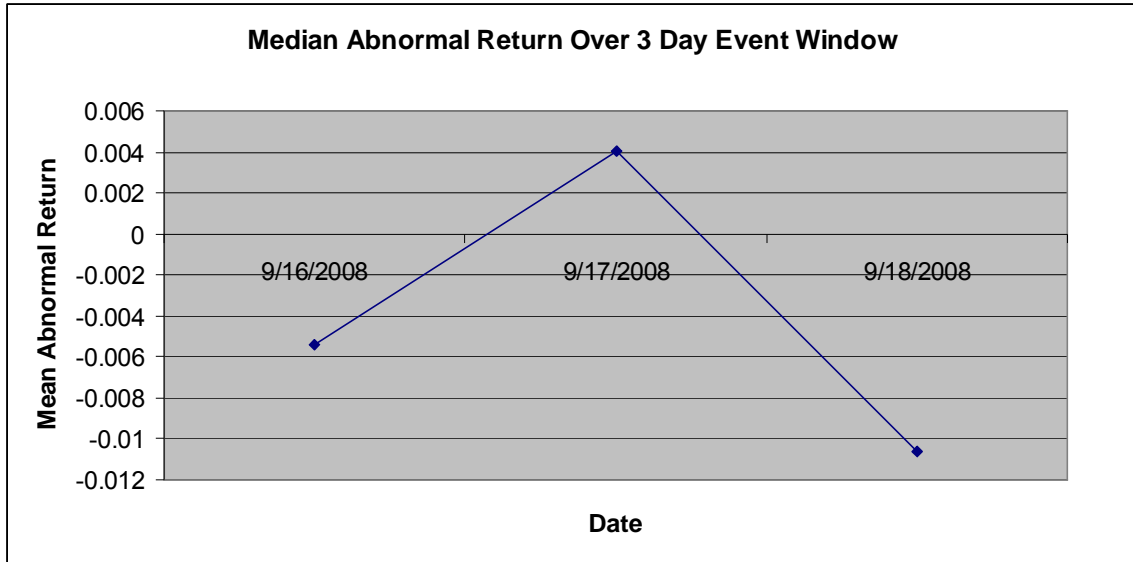
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Figure 11. Median abnormal returns of the 25 financial firms over the three day event window

Figure 11 also depicts an increase in abnormal returns approaching the date of restrictions. This once, again, could be an indication of news leakage. However, abnormal returns appear to take a dive after restrictions are in place. This contradicts the above graph, but it is not as reliable, considering it is a 3 day period. Still this drop in abnormal returns could be the result of investors viewing restrictions and increased volatility as negative news, lowering the prices of stocks.

7. CONCLUSION

Overall, I was pleased with the results of my event study. After interpreting the multiple reports, I came to the conclusion that short selling is rarely harmful and is quite beneficial to price discovery. As you can see in Figures 1 and 9, when short selling restrictions were put in place, the market actually became more volatile and trading became more violent. Without short selling, there was less information being put into stock prices. Because of this, I believe investors were less confident about the true price of securities. Whenever prices of an asset are unknown, volatility and volume tend to increase, which we saw in Figures 1 and 3. One theory for the increased volatility in the financial sector would be mass day trading. The initial price jump that followed restrictions was quickly lost, because investors could have sold off on these high daily returns. After huge price dips, investors could buy back in hopes of generating, again, large daily returns. It was this type of back and forth day trading, what I like to call "jump and dump" trading, that could have led to the incredible amounts of volatility. If short selling had been allowed during this time of volatility, prices for financial securities could have been discovered faster, quelling the panic of investors. In regard to restrictions, I feel that the only appropriate remedy would be an emergency halt of short selling, if a security depreciates by a certain percentage. The up-tick and modified up-tick rules have been proven to be ineffective and inefficient, and can be circumvented, if necessary. In the end, short sellers are intelligent informed investors who need to be a part of the market.

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As for my tests, I discovered that there was indeed an intitial impact of short selling restrictions on abnormal returns, in addition to, the changes in beta around the event. The abnormal return jump can be seen in Figure 8. The event study illustrated that there was sufficient positive drift, Figures 10 and 11, before the event date alluding to the effectiveness of the restrictions and news leakage. The mean CAR of my 25 financial firms over the 11 day event window was noticeably larger than the mean 11 day cumulative return of the S&P and was strengthened by a t-test. Welch's t-test also proved that the drop in beta was significant for my 25 financial firms, as compared to the market represented by Ken French's 25 portfolios. It is likely that betas dropped after restrictions, because less information was able to be input into stock prices, making those stocks less prone to market movements.

Although restrictions did make a significant impact on my financial firms and increased abnormal returns during the event window, they did not complete their goal of price stability. Prices became much more hectic with restrictions and trading actually increased in the cash market. This further proves that short selling is an integral input to stock prices. Moreover, the negative effects on volatility imply restrictions were around for too long. Hence, short selling is not the bad guy that everyone deems it to be with the only exceptions coming on rare, extreme occasions. I would like statements such as, "those who are in the business of "building" don't like this (short selling) destructive component of the financial market." to be seen as political banter (Mitra). There is nothing destructive about short selling; it is just an opinion of a company's prospects. I hope my thesis has given some valuable insights into the effects of short selling, and can direct the average investor to an intelligent judgment of short selling for themselves.

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Appendix A

Table A-1. Important events throughout the financial crisis

Date	Event
12/12/2007	Term Auction Facility announced
1/11/2008	Bank of America announces it will buy Countrywide Financial
1/18/2008	Fitch Downgrades Ambac from AAA to AA
3/14/2008	The Fed Reserve Board approves the financing arrangement announced by JPMorgan Chase and Bear Stearns
6/15/2008	The SEC issues an emergency order temporarily prohibiting naked short selling in the securities of Fannie Mae, Freddie Mac and primary dealers at commercial and investment banks
9/7/2008	The Federal Housing Finance Agency places Fannie Mae and Freddie Mac in government conservatorship.
9/15/2008	Bank of America announces its intent to purchase Merrill Lynch and Co. for $50 billion Lehman Brothers Holdings Incorporates files for Chapter 11 Bankruptcy protections
9/16/2008	The Federal Reserve Board authorizes the Fed Reserve Bank of NY to lend up to $85 billion to AIG
9/17/2008	The SEC announces a temporary emergency ban on short selling in the stocks of all companies in the financial sector.
9/25/2008	The Office of Thrift Supervision closes Washington Mutual Bank.
9/29/2008	The FDIC announces that Citigroup will purchase the banking operation of Wachovia Corporation
10/3/2008	Wells Fargo announces a competing proposal to purchase Wachovia Corporation that does not require assistance from the FDIC Congress passes and Bush signs into law the Emergency Economic Stabilization Act of 2008, which establishes the $700 billion Troubled Asset Relief Program. TARP
10/8/2008	Ban on short selling financial companies is lifted

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10/12/2008	The Federal Reserve Board announces its approval of an application by Wells Fargo & Co to acquire Wachovia Corporation.
11/23/2008	The US Treasury Department, FED Reserve Board and FDIC jointly announce an agreement with Citigroup to provide a package of guarantees, liquidity access, and capital. Citi will issue preferred shares to the Treasury and FDIC in exchange for protection against losses on 306 billion pool of commercial and residential securities held by Citi.
11/25/2008	The Fed Reserve Board announces a new program to purchase direct obligation of housing related government sponsored enterprises - FNM, FRE and Fed Home Loan Banks.
11/26/2008	The Federal Reserve Board announces approval of the notice of Bank of America Corp to acquire Merrill Lynch and Co.
2/18/2008	President Obama announces the Homeowner Affordability and Stability Plan.
5/13/2009	The US treasury dept proposes amendment to the commodity exchange act and securities law as to enhance government regulation of OTZC derivatives markets.
1/5/2009	The U.K. Financial Services Authority (FSA) was not proposing to renew its ban on short selling of the stocks of U.K. financial sector companies

Table A-2. Sample of Volume Matrix

Date	Bank of America (BAC)	Citigroup (C)	JPMorgan (JPM)	Morgan Stanley (MS)
10/30/2009	307675008	535832736	58854000	21658760
10/29/2009	202946608	440740000	35898512	17559084
10/28/2009	213262336	645073152	45679484	25573380
10/27/2009	270972096	333795872	38086396	16451750
10/26/2009	376382912	640385728	42085476	23859758
10/23/2009	181905552	335230624	27639458	27244116
10/22/2009	235015344	306798752	32398752	29312702
10/21/2009	219343968	392402656	32991512	48862072
10/20/2009	169353664	524593024	30618892	15467713
10/19/2009	155876032	304623904	30415394	17683594
10/16/2009	336814496	410990016	37458936	28620020
10/15/2009	212270128	834050880	36105928	16684360
10/14/2009	229813760	585271936	70368648	23646816

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Appendix B

Formula B-1. How to calculate CAPM

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f)$$

Where E(Ri) equals the expected return of a security, Rf equals the risk free rate, which in my study is zero because I am only looking at raw returns, Bi is the beta of that security and Rm is equal to the return of the market.

Formula B-2. How to calculate beta

$$\beta_a = \frac{\text{Cov}(r_a, r_p)}{\text{Var}(r_p)}$$

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Where rp is the return of the market, and ra is the return of an equity or portfolio.

Formula B-3. Welch's t-test

$$t = \frac{\overline{X}_1 - \overline{X}_2}{s_{\overline{X}_1 - \overline{X}_2}}$$

and,

$$s_{\overline{X}_1 - \overline{X}_2} = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}.$$

Where X equals the average return, s2 equals the variance and n equals the number of samples or firms.

Formula B-4. How to calculate abnormal returns

ARjt = Rjt – (α + βRmt)

Where ARjt = abnormal return of stock j on day t, Rjt = actual return on the jth stock on day t, Rmt = return on the market index, value-weighted return, α = Alpha and β = Beta

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Appendix C

Figure C-1

Volume Standard Deviation Over Period

Figure C-2

Short Interest Standard Deviation Over Period

Figure C-3

Figure C-4

Figure C-5

Change in Betas after Collapse of Bear Stearns

Figure C-6

Betas Before Collapse of Bear Stearns

Figure C-7

Betas After the Collapse of Bear Stearns

Figure C-8

Change in Beta After the Collapse of Lehman

Figure C-9

Betas Before the Collapse of Lehman

Figure C-10

Betas After the Collapse of Lehman

41

Figure C-11

Change in Beta after Naked Short Selling Restrictions

Figure C-12

Betas Before Emergency Naked Short Selling

42

Figure C-13

Betas After Emergency Short Selling Restrictions

Figure C-14

Change in Beta AFter Short Selling Restrictions Lifted

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Figure C-15

Betas Before the End of Short Selling Restrictions

Figure C-16

Betas Before the End of Short Selling Restrictions

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Figure C-17

Mean Alphas Before and after Bear Stearns Collapse

Figure C-18

Mean Alphas Before and After the Collapse of Lehman

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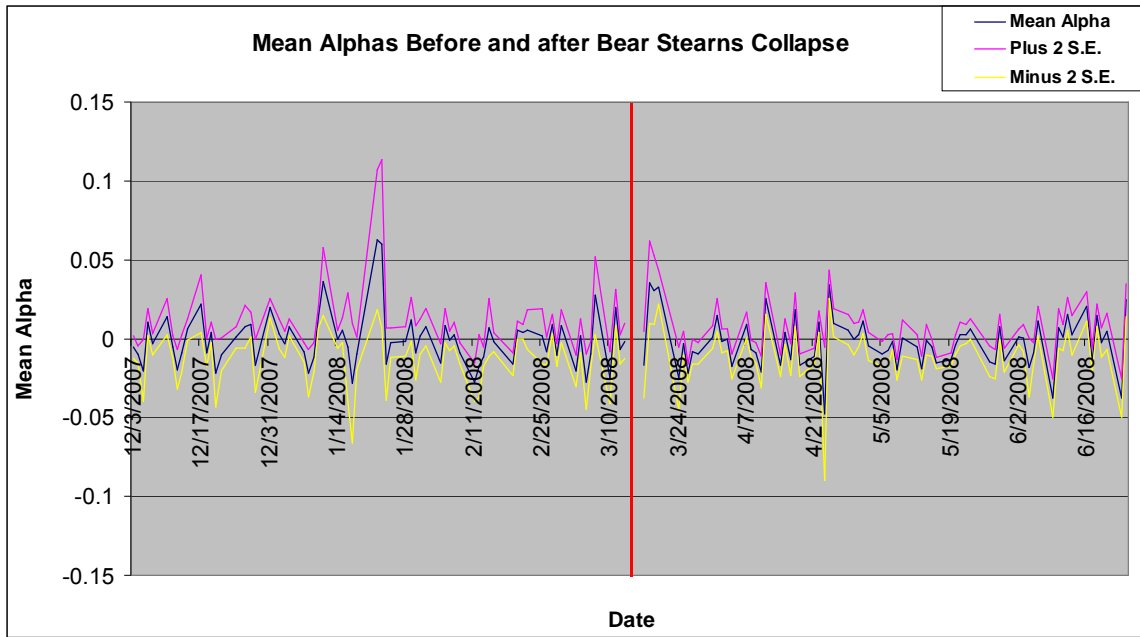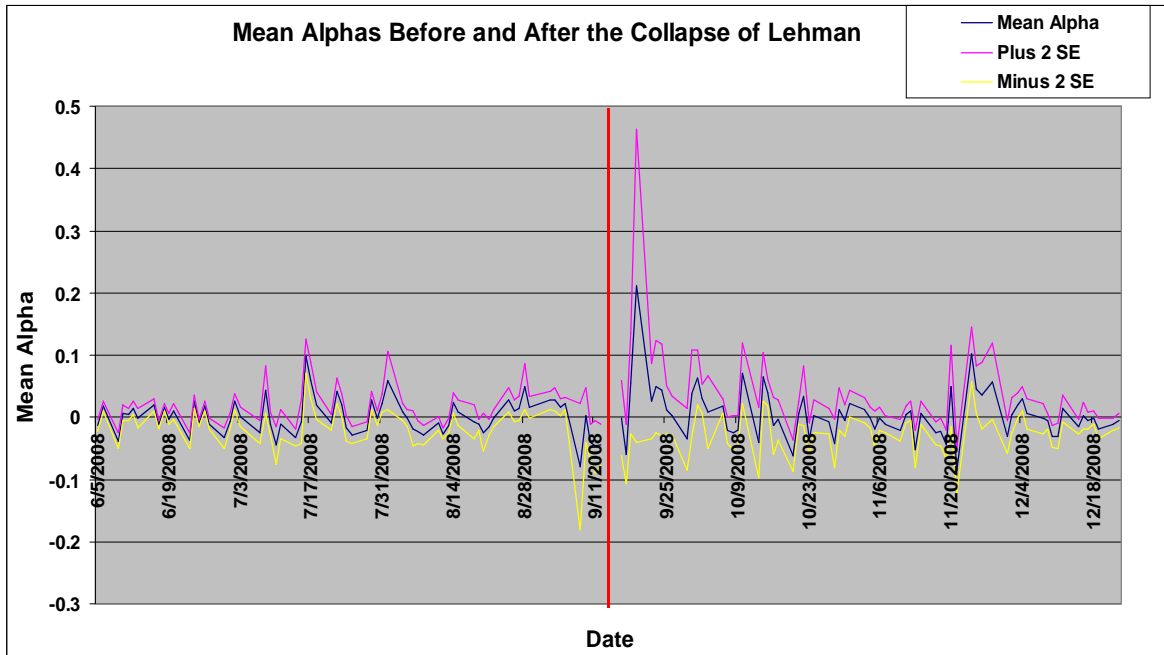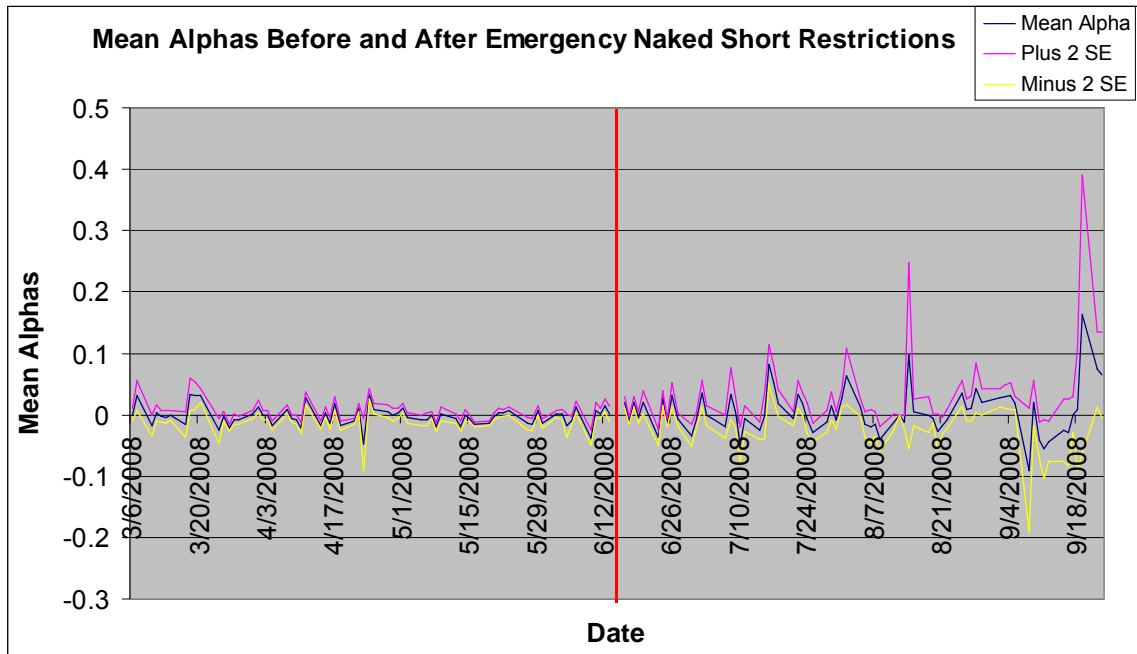**Figure C-19**

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Education

The Pennsylvania State University, *Schreyer Honors College*   University Park, PA
The Smeal College of Business, B.S., Finance, I.B. Minor   Expected Graduation Date: May 2010
The College of the Liberal Arts, B.A., Economics
Sapphire Accelerated Business Program

University of Maastricht   Maastricht, Netherlands
Economic Integration of the European Union   *Summer 2008*

Honors and Awards

- Finance Department Student Marshal
- Student Leader Scholarship
- Smeal Sheeler Scholarship

Activities/Leadership

Smeal Student Mentors, *President*   *Spring 2009 - Fall 2009*
- Lead an organization of 100 mentors dedicated to aiding Smeal's 1,000 freshman into college
- Hold weekly meetings with the club's B.O.D. and advisor to guide the future of the organization
- Present in 1st year seminar classes on scheduling, the career fair, and major alternatives

The Penn State Investment Association, *IT, Telecom, & Energy Sector*   *Spring 2007 - Spring 2009*
- Aided in creating stock pitches composed of fundamental analysis which led to stock purchasing decisions for the Nittany Lion Fund; a student managed fund with $5 million in investor assets
- Gained DCF model preparation skills for the energy sector of the Nittany Lion Fund

Shaver's Creek Outdoor School, *Volunteer Counselor/Teacher*   *Summer 2008, 2009*
- Taught outdoor classes dealing with nature, the water/sediment cycle, tree identification, etc.
- Honed public speaking skills through dance, song, cheers and announcements

Work Experience

General Electric, *Financial Management Program (FMP) Intern*   *Summer 2009*
- Created a mapping system to improve the allocation and efficiency of Field Service Engineers
- Analyzed physical assets per GAAP rules, logging all assets into a comprehensive catalogue
- Worked with managers around the world to formulate a global obsolescence policy

Wachovia Securities, *Shadow*   *Summer 2008*
- Created mutual fund portfolios based on a client's needs, risk tolerance, age, etc.
- Learned how securities are purchased and sold on Wachovia's computer system; Smart Station

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- Bloomberg, Power Point, Word, Excel, Smart Station, Siebel, GE OneStop
- Former track and field long jumper who enjoys skateboarding, surfing, skiing and fishing