THE PENNSYLVANIA STATE UNIVERSITY
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DEPARTMENT OF FINANCE

AN ANALYSIS OF SINGLE STOCK FUTURES, DIVIDEND PREDICTIONS, AND SHORT-SALE BAN EFFECTS ON MARKET PRICING

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Abstract

This paper focuses on the analysis of the U.S. single stock futures market. First, the study finds that average mispricing in futures contracts can be explained by categorical variables including security type, contract type, and an interaction between the two variables. Furthermore, evidence is also found that the market is efficient in predicting dividend changes from one hundred days prior to the declaration date. Moreover, it is found that along with substantially higher volume during the three weeks of the no short sale ban in 2008, there is evidence of greater mispricing among financial securities in the futures market when comparing the post three week ban period to the ban interval itself. However, I detect no evidence of greater mispricing for the pre-interval period against the ban interval.

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Chapter 1

Single Stock Futures

With origins in seventeenth century Japan, futures contracts have successfully proliferated in financial markets. Futures are most commonly associated with commodity-based products and serve a vital purpose to a business: to ensure that future supply is met with future demand. A futures contract is simply an agreement to buy or sell an asset at a specified price at some future point in time. Clearly, such an agreement can provide flexibility to a supplier, who can adjust his supply for any inundation or scarcity of demand. Interestingly, the product was born of less noble intentions. As Nison (1994) reports, when first introduced, futures on rice were sold by Japanese feudal lords, the daimyo, in order to finance lifestyles that were unsustainable with current income. These futures were named “empty rice” contracts because the rice had not actually existed at contract formation.

Despite a questionable genesis, futures have developed to serve two practical purposes. The instruments can be used for either hedging or speculating (Hull, 2000). When applied to equity, futures can be used to hedge against a current exposure. For example, if an investor owns stock in Exxon Mobil, but is concerned about a short-term decline in price, he can hedge his downside exposure by selling a future. This locks in a desired price for the futures seller, as gains from the future offset losses on the stock. In this example, selling a future oftentimes serves as a better alternative to enduring the costs associated with selling an entire position.

Whereas hedgers strive to mitigate risk, speculators attempt to profit. Upon entering the futures contract, the hedger has an initial exposure. The speculator, on the other hand, does not, but desires to profit from anticipated growth or decline in price. For this reason, the term “speculator” is a misnomer. Little separates the “investor” and the “speculator,” who in the case of being long, both agree that the price of the underlying security will rise. The only difference between buying the spot versus the future is the time at which you agree to hand over cash in exchange for shares. For example, an investor may purchase a single stock futures contract on XYZ because although he wishes to own stock in XYZ, at the time of contract origination, he does not have the cash to purchase the spot. Understanding the impact of time is crucial to realizing the usefulness of the single stock futures product—this concept will be elaborated upon further in Chapter 2 on pricing.

Product Advantages

Aside from the ability to hedge a long position, single stock futures provide two unique benefits. First, market participants are able to benefit from the leverage associated with futures, which have only 20% margin requirement. When compared to the securities market, which requires 50%, this is indeed an appealing rate. An investor can use this reduced margin requirement to form an ‘interpolated hedge’ (Young and Sidey, 2003). This hedge allows a potential investor, who is in the process of receiving cash flows, to gain full market exposure through reduced capital requirements—consider it like buying ahead of time. When the cash flow is received in full, the investor sells the future, and buys the spot to shed basis risk (Young and Sidey, 2003).

The second major advantage of the product is its availability for trading. If a seller is trying to short equity, the seller must borrow shares from a broker in order to sell the stock. In times of short supply, this can be problematic, as sellers are not able to exercise their pessimism because brokers lack stock to lend. However, when using single stock futures, shares do not have to be borrowed because there is constant supply, which is a function of open interest (Young & Sidey, 2003). This allows a potential-seller to obtain the desired short exposure. Additionally, single stock futures are exempt from the "uptick" rule, which governed the equity markets until recently in 2007. The uptick rule required that the market could not be sold short unless the last trade had been at least the same price as the previous trade (Young & Sidey, 2003). However, regulators are currently considering reinstatement of the rule. Regardless, the futures market is not subject to this pesky constraint and therefore can allow for a greater degree of price discovery.

History of Single Stock Futures

The most well-known futures contracts are those traded on commodities and on stock indexes. Such products are long-standing staples of the financial markets, while single stock futures are still within their infancy in the U.S., having only been traded since 2003. The late birth of the product can be attributed to bureaucratic bickering, as debates whether to classify single stock futures as equity or futures raged between two governing entities in the 1970s. As a result, the Commodity Futures Trading Commission and Securities Exchange Commission agreed to sign the Shad-Johnson Accord in the early 1980s. The Shad-Johnson Accord effectively outlawed trading of single stock futures and narrow-based indices, and (in a way) resolved the problem.

Although the United States banned their trading, single stock futures began appearing on various international exchanges. Hong Kong, Stockholm, and Sydney were all hosts to the product, and in 2000, London joined the mix. On September 20th, 2000, LIFFE (London International Financial Futures and Options Exchange) announced the release of a product called the Universal Stock Futures, which offered futures on American companies (Mitchell, 2003). Although the Shad-Johnson Accord still prohibited a U.S. investor from purchasing futures through the international capital markets, such progress in terms of product development only evidenced the rising demand for futures at the time. Mitchell emphasizes this demand spurt by citing a two-fold increase in trading volume from 1999-2000. This activity did not go unnoticed in the U.S. as lobbyists plead for the settlement of the jurisdictional dispute, which was finally addressed in the Commodities Futures Modernization Act of 2000.

The Commodities Futures Modernization Act of 2000 (CFMA) removed the ban on trading of single stock futures and narrow-based indices. Under the CFMA, joint jurisdiction was provided to the CFTC and SEC. The CFTC was the primary regulator over the futures, but exchanges and brokerages must file registration with the opposite regulator, which in this case, is the SEC (Young and Sidey, 2003). Originally, trading was restricted to investors with a minimum $5 million in assets, but the accommodation for retail trading was soon incorporated.

OneChicago Exchange

From the first day of trading on November 8 2002, there were two major exchanges in the U.S. offering the stock futures product. The first was a joint-venture between LIFFE and the NASDAQ, NQLX, and the other was a venture between CME and CBOE, OneChicago. The NQLX was a unique venture, hoping to merge the NASDAQ's presence in the U.S. equity market with LIFFE's Connect trading platform and expertise in the USF product (Young and Sidey, 2003). Shortly after the announcement of NQLX, CME and CBOE announced the formation of their own exchange, aptly titled OneChicago—Chicago Board of Trade rushed to join the venture and was given 10% ownership stake. Regardless, both exchanges had the advantage of offering electronic trading platforms and seemed poised to tackle the promising market with vigor.

NQLX and OneChicago emerged strongly from the gates, but on September 1 2004, NQLX announced it would be stepping out of the single stock futures race. Despite a promising start, NQLX struggled in its early years with low product volume and heavy turnover of upper management. NASDAQ exited the venture in 2003, as its priorities drifted away from the single stock futures product. When NQLX disclosed its exit from the market, former NQLX CEO Bob Fitzsimmons cited systemic problems with the product itself as the root of the business's troubles. In a 2004 article from *All Business*, Fitzsimmons reflects that the 20% margin while attractive on the surface, when compared to the 50% margin rate required on securities, is still too high on the basis that institutional traders trade with 15% or better.

Once NQLX stepped aside, OneChicago became the powerhouse of the single stock futures market. OneChicago also gained an additional investment from Interactive Brokers in March 2006, which represented the most recent addition to the ownership of the exchange. Futures are in their eighth year of trading, and OneChicago currently offers 1200 single stock future products.

Chapter 2

Pricing Explanation

To understand the pricing of a single stock future, suppose an investor desires to purchase equity in three months. From a pricing perspective, he should be willing to purchase a futures contract at a price reflective of an investment *S* grown at some rate *r* for time three months, or more generally, the duration of time remaining between the contract formation date and the contract's expiration, represented by *T*. The following equation can be used to price a futures contract *F*,

$$F = Se^{r*T}$$

where *e* represents the base of the natural log. Should this equilibrium not hold, a pure arbitrage opportunity exists. If the futures is overpriced, where $F > S*e^{(r*T)}$, an arbitrageur can first short the pricey futures contract, and then borrow an amount S to purchase one share of the underlying (Hull, 2000). Upon contract expiration, the investor transfers his one share to the futures contract buyer and pockets a profit of $F – S*e^{(r*T)}$. A cashflow summary is provided below:

Payoff	$+F$
Cost, owed to the bank at *T*	$\underline{-Se^{r*T}}$
Profit	$F - Se^{r*T}$

Conversely, should the futures contract be underpriced, where $F< S*e^{(r*T)}$, an arbitrageur can go long the futures price and short the underlying spot S. With this initial cash flow, the arbitrageur can invest S, and at expiration, cover his short position with the acquired share from the futures contract. This results in an excess cashflow of $S*e^{(r*T)} – F$, as defined below:

Payoff	$+Se^{r*T}$
Cost, owed to buyer	$\underline{-F}$
Profit	$Se^{r*T} - F$

This pricing formula applies to an investment S that provides no interim income. However, to properly accommodate dividend payments, F requires an adjustment of d,

$$F = (S - d)e^{r*T},$$

where d is the present value of the expected dividend. While minor, this tweak is necessary to correctly price the futures contract. Let's say, for instance, the futures is overpriced. Similar to our initial example, an arbitrageur first shorts the futures, and then borrows from the bank to purchase one share of the underlying, an amount equal to S. However, in the case of a dividend-paying stock, the arbitrageur finances his purchase of S through two loans: one equal to the present value of the dividend, and the other equal to the difference, S – d. Upon the dividend payment date, the arbitrageur pays off the smaller loan with the received dividend, and therefore has one outstanding loan equal to $(S – d) * e^{(r*T)}$ payable at the futures contract expiration date.

The concept of two loan payments is critical to valuing the single stock futures instruments and can shed light on pricing discrepancies. For example, if only one loan were issued by the bank, the arbitrageur would owe an amount

$$(Se^{r*t_i} - S) + [Se^{r*t_i} - D]e^{r*(T-t_i)}$$
$$interest + ending\ principal$$

to the bank by expiration, where t_i is an interim time and D is the nominal cash flow. This amount is greater because the larger initial principal raises the cost of borrowing via compounding. Thus, in order to reduce financing costs, the arbitrageur takes out two loans, and does so at two different rates, one presumably lower than the other given the shorter borrowing interval.

While ideal, such a financing method may be unrealistic given a minimal amount of dividend distribution. For instance, Goldman Sachs typically pays a dividend of $.35 per share, requiring an arbitrageur to take out a separate loan of $35 per one hundred shares for every futures contract shorted. Clearly, such a loan amount may be regarded negligible, but may also help to explain pricing inefficiencies.

When considering dividend payments, an additional item of importance is chronology. The futures pricing model for a dividend paying stock assumes receipt of the dividend if the underlying were purchased instead of the future at contract formation. This raises several accounting issues, which will distinguish the use of the pricing formulas. Our equation that prices the receipt of a dividend assumes *entitlement* to that dividend. While the ex-dividend date has no cash flow impact, the payable amount of the dividend has no relevance unless the trade date of the futures occurs before the ex-dividend date. This is because the ex-dividend date denotes the day upon which named owners of the company (stock-holders) are entitled to the declared dividend[1]. Further, the contract expiration date must also occur after the payable date. This holds true because even if you purchase a future prior to the ex-dividend date, there is no dividend sacrificed unless you receipt of the payment is forgone. If these two conditions are not met, use of the dividend pricing equation is inappropriate. A timeline below shows the necessary sequence required to use the dividend-inclusive formula.

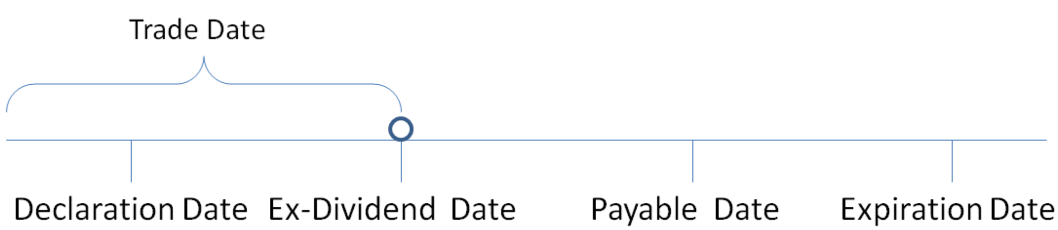

Figure 2.1

[1] The specific amount of the dividend is announced on the Declaration Date. The dividend-inclusive formula can be still used if the trade date occurs after this date—so long as the trade is before the ex-dividend date, which denotes entitlement. The declaration date will have more significance in the analysis of the 'Predicting Dividends' section in Chapter 3.

These basic pricing principles regarding time value and dividends work well to frame the analysis of the paper. In the following section, I will use the futures pricing theory described above as the basis for the sampling process, which will be used to arrive at a "mispricing." This mispricing will serve as the backbone of the studies conducted in Chapter 3.

Sample Walkthrough

The following walkthrough demonstrates the methodology for pricing the single-stock futures. I will use the JPM1CH09[2] security, the March futures on JP Morgan for 2009, traded on August 11, 2008 as a sample. The March 2009 contracts expire March 20, 2009, or 221 days from contract formation. This gives a *T* value of 221/365, or .606, and 1 year Treasury yield of 2.5408%. First, I find that the contract was priced at $42.58 at 1:40 PM. Next, I obtain the corresponding minute price for the JPM underlying, which traded at $42.72.

Given the use of continuous pricing, I convert the Treasury to a continuous rate, R_c, using

$$R_c = m * \ln\left(1 + \frac{R_m}{m}\right),$$

where *m* denotes a compounding frequency, R_m a quoted annual Treasury rate, and ln as the natural log. With a frequency *m* of 1 and R_m of 2.5408%, this yields a continuous rate of 2.227%. Then, by multiplying R_c by *T*, the discount factor becomes $e^{(.0135)}$. With this information, the only unknown variable in the pricing formula is the dividend, which can be implied. In this example, I find the Implied Dividend (ID) of $.71, defined by

$$ID = S - \frac{F}{e^{r*T}}$$

The next step is to compare the value of the Implied Dividend to the Realized. Given that the contract was formed on August 11, 2008 and expires March 20, 2009, the purchaser of the future forgoes two dividend cash flows. There are two ex-dividend dates that fall within the interval of *T*, which are payable on 10/31/2008 and 1/31/2009 for an amount equal to $.38 each, totaling an aggregate cash flow of $.76. However, the Realized Dividend (RD) is not the nominal total, but rather the sum of the present value of *n* payments. This value equals $.7549.

$$RD = \sum_{i=1}^{n} D_i \, e^{-r*t_i}$$

The analysis concludes with the comparison of discrepancy between the Implied and Realized dividend. I define "mispricing" as the absolute value of the difference between the Implied Dividend and the Realized Dividend.

[2] JPM1CH09 is the TradeStation symbol for the single stock future. TradeStation quotes follow the format: "Ticker"+1C+"Expiration Month"+"Two-digit Year".

$$Mispricing = |Implied\ Div. - Realized\ Div.|$$

Therefore, the mispricing of the JPMorgan March 2009 future is equal to $.0492. If I remove the absolute value, mispricing is equal to $-.0492. The negative value indicates an overpriced contract, while a positive value represents underpricing. The following relationship justifies this logic: As *F* decreases, the Implied Dividend increases, which in turn increases mispricing. Throughout Chapter 3, there will be two instances in which I remove the absolute value for purposes of examining of directional mispricing.

Chapter 3

With a definition for "mispricing," several questions are ready to be addressed. First, can differences in variables like security and contract type explain variance in mispricing—do the company and trade month have any influence on pricing? Second, given the pricing formula, how well can the market predict dividend payments? Finally, did the futures market for financial securities reflect any abnormality in pricing given the No Short Sale Ban of September 2008? The following sections of Chapter 3 are devoted to exploring these questions and finding meaning in their answers

Study Overview

The analysis of the futures is conducted across eight securities on twelve contracts, one for each month. The security types include Goldman Sachs, Citigroup, JPMorgan Chase, Bank of America, PepsiCo, Exxon Mobil, General Electric, and Johnson & Johnson. OneChicago provided me with a list of the 30 most actively traded products over the last three months as of January 27, 2010. Companies are randomly selected from this list, aside from the deliberate overweight of financial securities, which was done with the intent to test mispricing during the No Short Sale interval. A table of summary statistics by security type is provided below in Figure 3.1.

With regards to information sources, my inputs are obtained mainly through TradeStation Securities and Bloomberg. Transaction prices on the single-stock futures are obtained through TradeStation, which is also used to acquire the corresponding minute closing price of the underlying stock. I gathered discount rates from Bloomberg's daily closing yields on Treasuries as of the trade date.

Security	Median	Mean	StDev	Minimum	Maximum	Count
Bank of America	0.0411	0.1374	1.0466	-34.8472	2.0325	2383
Citigroup	-0.00515	-0.00424	0.3393	-14.3098	0.8438	2262
General Electric	0.02658	0.04489	0.15895	-1.91243	2.44182	1564
Goldman Sachs	0.044	0.0389	1.401	-5.983	104.182	5925
Johnson & Johnson	-0.02572	-0.00908	0.21243	-0.65315	1.10206	2104
JPMorgan Chase	0.01044	0.02611	0.13724	-0.88284	0.88329	2236
PepsiCo	0.07204	0.12709	0.18723	-0.65784	1.35836	889
Exxon Mobil	0.0211	0.0691	0.4354	-16.189	1.0057	2858

Figure 3.1

The table in Figure 3.1 distinguishes samples by the eight security types. For the purpose of illustrating which securities are overpriced as compared to underpriced, I remove the absolute values from mispricing: positive mispricing indicates an underpriced futures because the discounted futures price slips below the spot, while negative mispricing denotes an overpriced futures. As an example, the table shows there have been 889 trades (located from the Count column) on futures for PepsiCo. These trades are on average underpriced by $.127, meaning it would be advantageous for an arbitrageur to buy the futures on PepsiCo and short the spot to obtain a risk-free (aside from dividend risk and the bid-ask spread) profit of $.127. There were a total of 20,221 trades analyzed.

Explaining Mispricing

The first question considers if mispricing can be predicted by categorical variables like security and contract type. In other words, I am trying to see if a future is any more likely to be mispriced if the underlying security is Bank of America, Goldman Sachs, or Citigroup etc. Also, I want to know if mispricing is any more likely to occur if I trade a future for the month of January, as compared to trading that future for the February expiration. Finally, I want to know if mispricing is also due to a combination of security and contract month type. In application, this would be analogous to asking the question: Is the February future on Bank of America more likely to be mispriced than the February contract on Goldman Sachs?

To answer this, I begin by assuming that mean mispricing is equal between security and contract types. The idea is to be conservative, assuming no dependence exists between mispricing and the variables. I perform a two-way ANOVA (analysis of variance) using "treatments," or categories, contract and security. I started by building a full model—this includes an interaction term, which is used to show the combined effect of both variable types on mispricing. The results show that treatment security and the interaction term are statistically significant at the 5% and 1% levels, while treatment contract is significant at 5%. Thus, the findings indicate that on average mispricing will be affected by the security selected and the contract month for delivery specified, as well as the contract month chosen for a particular security type[3]. For more information, the output of this test can be viewed in Appendix A.

My next objective is to determine whether mispricing is greater among contracts including dividends as compared to those which do not. I conduct a two-sample t-test on the data, separating dividend from non-dividend inclusive contracts. The results show statistical significance to mean mispricing, defined by the absolute value, between the groups and can be further reviewed in Appendix D. Similar to the interpretation of the ANOVA, this suggests that mispricing can also be explained by whether the company pays a dividend.

Predicting Dividends

Aside from application, the single stock future also proves itself a unique financial barometer of forecasted dividends. Given that the dividend is the only unknown variable[4] in the futures pricing equation, we can interpret 'mispricing' as the market's incorrect estimate for a hypothesized change in future dividends. Essentially, through the single stock future product we

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[3] Additionally, I use a multiple range test, Fisher's least significant difference (LSD), to identify differences based on security and contract. The Fisher Test compares confidence intervals to distinguish groups that are significantly different from each other. Here, I noted 12 out of 28 significant differences on security and 42 out of 66 significant differences on contract. The output for the Fisher tests on security and contract is located in Appendix B and C.

[4] Interest rates, while known at contract formation, can fluctuate throughout *T*, but this risk can be hedged

can examine the market's ability to forecast and trade beliefs in changes of dividend distribution. Thus, our question becomes: How well does the market anticipate changes in dividends?

To answer this question, I first identify declaration dates associated with changes in dividends. Next, I find dividend-inclusive, futures contracts traded prior to the declaration date, but also those with expiration dates greater than the payable date. Additionally, I incorporate contracts that were traded up to the ex-dividend date. These two sets of contracts are used to compare mispricing pre- and post- declaration date: the day upon which the company announces the dividend amount. The next step is to plot mispricing as a function of time, with reference to the declaration date, in order to show the progression of market realization from speculation to certainty. Because my interest is the accuracy of pricing rather than direction, I use absolute values.

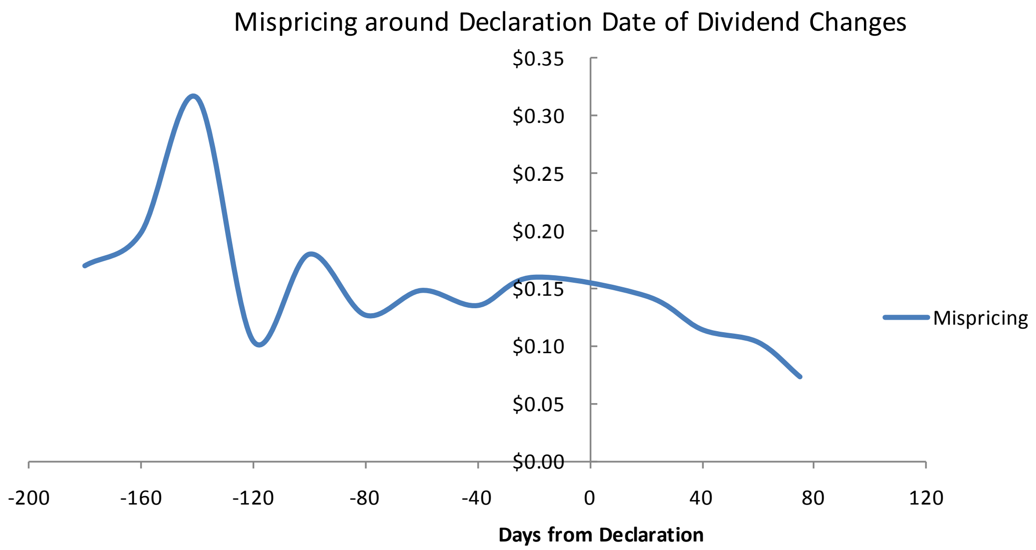

Figure 3.2

Figure 3.2, shown above, is a plot of the average absolute value of mispricing around declaration date. Individual observations include all dividend changes from 2003 to the present associated with the eight securities analyzed. The observations were bucketed in sets of twenty days and plotted as a single, averaged data point. As illustrated by the chart, there are both more observations and a greater period of time pre-declaration date than post-declaration; this is due to the considerably shorter length of time between the declaration and ex-dividend dates.

Although mispricing appears to be decreasing as T increases, confirmation must be provided through a two-sample t-test. Surprisingly, the t-test does not validate a change in pricing, as there is not enough (nowhere near enough) evidence to provide statistical significance to a difference in pricing pre- and post-declaration. However, this t-test is quite broad because it only divides groups between pre- and post- declaration—the pre-declaration date encompasses a full 180 days, while the post-declaration period spans only 80 days. Given the discrepancy in time periods, I compare the furthest 80 days from declaration date to the 80 days post-declaration. This t-test provides statistical significance to a difference in means between the two periods.

Also, it helps justify the apparent decrease in mispricing and also validates basic intuition about the nature of prediction: as more information becomes available through time and the declaration date approaches, the market becomes better able to predict dividend changes. The output for both t-tests is summarized in the table below.

Summary Table

	Count	Mean	StDev	Standard Error	P Value
180 Days Pre-Declaration Date	1275	0.153	0.126	0.0035	0.741
Post-Declaration Date	505	0.143	0.651	0.029	
180 - 100 Days Pre-Declaration Date	286	0.205	0.167	0.0099	0.045
Post-Declaration Date	505	0.143	0.651	0.029	

Figure 3.3

The table in Figure 3.3 shows that when comparing the '180-100 Days Pre-Declaration Date' to the Post-Declaration Date period, there is a significant difference in mispricing. This statistic, coupled with the chart in Figure 3.2, shows that the '180-100 Days Pre-Declaration Date' experienced more absolute mispricing because the market is still speculating about the dividend amount.

Analysis of No-Short Sale Interval

As the market witnessed the purchase of Merrill Lynch and the bailout of AIG in the same week of mid September 2008, the value of financial stocks quickly plummeted. In response, the SEC issued a surprise directive on September 19th banning the short sale of 797 financial stocks. The ban lasted through October 8th, and thus created a unique three-week window for single stock futures. Despite this ban, a legal, synthetic short position could still be made through the sale of the future. One would expect that given this characteristic of stock futures, the mispricing between the futures and spot would be greater than usual, as higher demand to sell forces down the futures price.

Using the futures data for Citigroup, Goldman Sachs, Bank of America, and JPMorgan, I test to see if there is significant difference in pricing during the no short sale ban. I compare mispricing during the September 18-October 8 interval to the three weeks pre- and post- ban. However, given that I am curious about the directional mispricing of the futures, I have removed the absolute value effect from the mispricing.

The three weeks of interest experienced increased volume of nearly 59% and 47% compared to the pre- and post- period, respectively. Interestingly, the period in which the ban was in place witnessed a mean mispricing greater than zero. In other words, the spot price appears overpriced relative to that of the futures. This observation aligns with my initial assumption, which states that given an inability to short stock, there is heavier shorting of the futures. This results in a reduced futures price, and therefore a positive mispricing. The average mispricing for the period is positive $.03. T-tests against the pre- and post- interval periods show that the mispricing before and during the interval are not significantly different; however, the mispricing during the interval of interest and the three weeks post are significantly different. These observations show that along with higher volume, the futures market for financial stocks did experience the positive mispricing that one would expect. However, the mispricing was only significantly different from the post-interval period. A graph is provided below that plots mispricing around the No Short Sale Interval in Figure 3.4. Also, the output for the two-sample t-test is located in Appendix F and is summarized below in Figure 3.5.

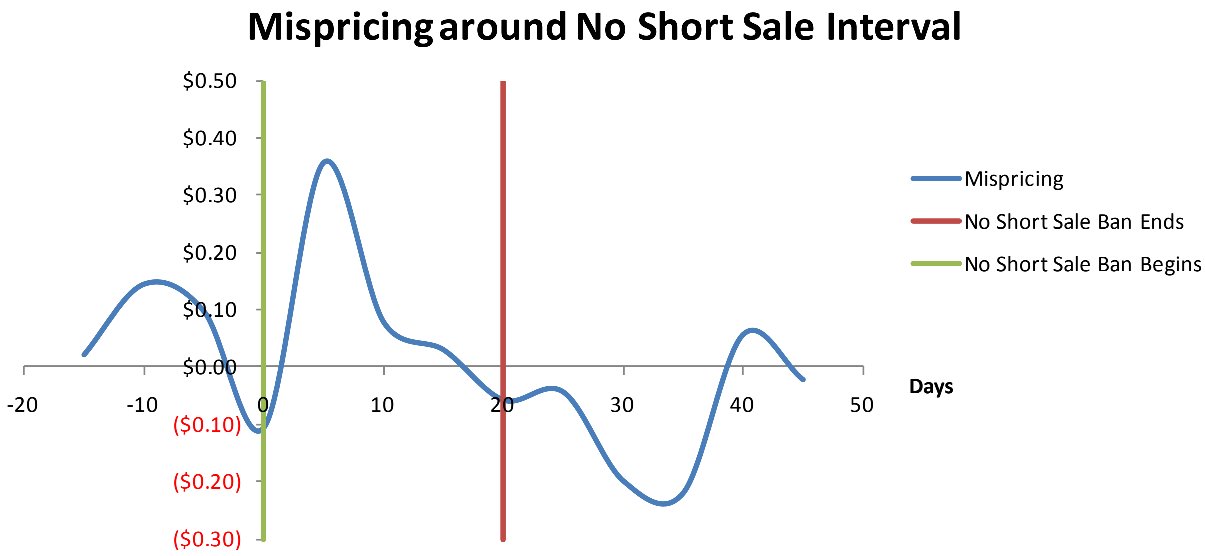

Figure 3.4

Summary Table

	Count	Mean	StDev	Standard Error	P Value
Pre-No Short Sale	133	-0.011	0.559	0.049	0.561
No Short Sale	212	0.03	0.748	0.051	
Post-No Short Sale	144	-0.11	0.485	0.04	0.033
No Short Sale	212	0.03	0.748	0.051	

Figure 3.5

Whereas the single stock futures market saw higher volume, the equity option market experienced the reverse effect. Battalio and Schultz (2009) found that the short sale ban did not cause a migration to the options market to either buy puts or sell calls. By computing the changes in short exposure on banned and control stocks, Battalio and Schultz discover little evidence to confirm a growing aggregate short position on banned equity during the time in which the ban was in place. However, they do cite greater trading costs and wider spreads as a potential cause for this, which resulted in an estimated additional $505 million dollars in transaction costs for investors trading options on banned stocks.

Chapter 4

Further Research

Although my research is thorough across the eight securities analyzed, the sample size is rather concentrated. There is opportunity to discover unique findings in the analysis of a wider array of futures. OneChicago currently lists 1200 single stock future products; my analysis is done across eight of the thirty most heavily traded securities. The purpose of selecting from such a list is to see how well the futures market prices the exchange's most liquid securities. As such, there is plenty of opportunity for exploration of pricing inefficiencies in the less frequently traded products. For example, this can be accomplished by either focusing on a small sample size of the 30 most illiquid stocks—30 only because there will be fewer samples—or by spreading the playing field and gathering data on 15 futures that witness average volume.

Additionally, I believe that a more robust statistical analysis can be conducted on the data. My tests do not incorporate the fact that the gathered data is essentially a time series, where each data point exercises some influence upon the next. For instance, a regression of contract mispricing for observation n against the independent mispricing of $n-1$ shows statistical significance of $\beta \neq 0$. The presence of this time series effect complicates the ANOVA and t-tests, which assume independent observations. Thus, further statistical analysis is required.

Conclusions

This study provides an examination of mispricing in the single stock futures market. The first objective of the analysis is to determine if mispricing could be explained by categorical variables. I identify two treatments of interest, security and contract month, and test the interaction effect. Using a two-way analysis of variance, I find statistical significance that these factors contribute to the mispricing of the futures contract. Peripherally, I also find that there are significant differences in mispricing between futures contracts that are dividend-inclusive and those that are not dividend-inclusive.

An additional goal of the study is to test the market's ability to predict and correctly price changes in dividend payments. This is done by first identifying declaration dates associated with a change in dividend distribution, and then by obtaining the appropriate dividend-inclusive contracts that were traded prior to a declaration date. Figure 3.2 shows the plotted results of the average mispricing as a function of time around the declaration date. The first test reveals that mispricing pre-declaration date is not significantly different than mispricing post-declaration date. However, a refinement in time intervals reveals that there is significant difference between group '180 -100 days prior to declaration date' and group post-declaration date.

The final analysis is done to test the effects of the no short sale time period on the futures market. I separate the data based on weeks that satisfy the short sale ban interval, along with pre- and post- periods. These outside interval periods are used to compare the theoretical differences in mispricing during the short sale ban. Given the inability to short the equity market, I anticipated seeing greater mispricing during the three week ban, as bearish market participants migrated to the futures market to gain short exposure. I find that futures did experience a sizable increase in volume during the three weeks as compared to the outside intervals, and that futures traded during the ban are significantly different from those traded through the post-interval period.

The results of the study have implications for market participants, academics, and regulators. From the first analysis of categorical variables, I conclude that mispricing can be explained by underlying security, contract, and interaction. This finding suggests that some months are more prone to mispricing, after also considering security type. This serves as a precaution to investors looking to minimize mispricing, as an unfortunate choice of trading months can result in a higher cost basis. The second study proves useful to academics, showing that the market is efficient in its efforts to price dividend changes. Evidence for this is found through the comparison of average mispricing before and after the declaration date, which is the same for both periods, implying accurate prediction before the announcement of defined payment. The final study of the No Short Sale Ban shows that there were more participants in the futures market based off volume, and that the period averaged positive mispricing, as futures prices were more depressed relative to the spot. The mispricing is found to be significantly different from that of the 20 days post-ban period, but no evidence is found to declare a difference in mispricing between the ban period and the twenty days preceding it.

Appendix A

Two-way ANOVA

General Linear Model: Mispricing versus Security, Contract

Factor	Type	Levels	Values
Security	fixed	8	BAC, C, GE, GS, JNJ, JPM, PEP, XOM
Contract	fixed	12	F, G, H, J, K, M, N, Q, U, V, X, Z

Analysis of Variance for Mispricing, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Security	7	69.3089	40.8350	5.8336	8.10	0.000
Contract	11	35.6248	20.9887	1.9081	2.65	0.002
Security*Contract	77	133.7328	133.7328	1.7368	2.41	0.000
Error	20125	14489.4787	14489.4787	0.7200		
Total	20220	14728.1452				

S = 0.848513   R-Sq = 1.62%   R-Sq(adj) = 1.16%

*Two-way ANOVA full model testing differences in mean mispricing between treatments security, contract, and interaction (Security*Contract).

Appendix B

One-way ANOVA: Mispricing versus Security

```
Source       DF        SS    MS      F      P
Security      7     69.31  9.90  13.65  0.000
Error     20213  14658.84  0.73
Total     20220  14728.15

S = 0.8516   R-Sq = 0.47%   R-Sq(adj) = 0.44%


                             Individual 95% CIs For Mean Based on
                             Pooled StDev
Level     N    Mean   StDev  --+---------+---------+---------+-------
BAC    2383  0.2284  1.0306                          (-----*-----)
C      2262  0.0996  0.3244     (-----*----)
GE     1564  0.1005  0.1311    (------*------)
GS     5925  0.2340  1.3818                             (---*---)
JNJ    2104  0.1450  0.1555            (-----*-----)
JPM    2236  0.0860  0.1101  (-----*-----)
PEP     889  0.1613  0.1587            (--------*--------)
XOM    2858  0.1899  0.3978                    (-----*----)
                             --+---------+---------+---------+-------
                             0.060     0.120     0.180     0.240

Pooled StDev = 0.8516


Fisher 95% Individual Confidence Intervals
All Pairwise Comparisons among Levels of Security

Simultaneous confidence level = 49.08%


Security = BAC subtracted from:

Security    Lower   Center    Upper  ---------+---------+---------+---------+
C         -0.1778  -0.1288  -0.0798   (----*----)
GE        -0.1822  -0.1279  -0.0736   (----*-----)
GS        -0.0349   0.0056   0.0461                  (---*---)
JNJ       -0.1334  -0.0835  -0.0335        (----*----)
JPM       -0.1915  -0.1424  -0.0932  (----*----)
PEP       -0.1327  -0.0671  -0.0015        (-----*------)
XOM       -0.0848  -0.0385   0.0078             (---*----)
                                     ---------+---------+---------+---------+
                                          -0.10      0.00      0.10      0.20


Security = C subtracted from:

Security    Lower   Center   Upper  ---------+---------+---------+---------+
GE        -0.0540   0.0009  0.0558              (----*-----)
GS         0.0932   0.1345  0.1757                            (---*----)
JNJ       -0.0052   0.0454  0.0959                  (-----*----)
JPM       -0.0633  -0.0135  0.0363             (----*----)
PEP       -0.0044   0.0617  0.1278                   (-----*------)
XOM        0.0434   0.0903  0.1373                       (----*----)
                                    ---------+---------+---------+---------+
                                         -0.10      0.00      0.10      0.20
```

```
Security = GE subtracted from:

Security    Lower   Center   Upper  ---------+---------+---------+---------+
GS         0.0861   0.1335  0.1810                              (---*----)
JNJ       -0.0113   0.0445  0.1002                    (----*-----)
JPM       -0.0695  -0.0144  0.0406              (-----*----)
PEP       -0.0093   0.0608  0.1309                    (------*------)
XOM        0.0369   0.0894  0.1419                         (----*----)
                                    ---------+---------+---------+---------+
                                          -0.10      0.00      0.10      0.20


Security = GS subtracted from:

Security    Lower   Center    Upper  ---------+---------+---------+---------+
JNJ       -0.1314  -0.0891  -0.0467        (---*---)
JPM       -0.1894  -0.1480  -0.1066  (---*---)
PEP       -0.1328  -0.0728  -0.0127        (-----*-----)
XOM       -0.0821  -0.0441  -0.0061             (---*--)
                                     ---------+---------+---------+---------+
                                           -0.10      0.00      0.10      0.20


Security = JNJ subtracted from:

Security    Lower   Center    Upper  ---------+---------+---------+---------+
JPM       -0.1096  -0.0589  -0.0082          (----*----)
PEP       -0.0505   0.0163   0.0831                (------*-----)
XOM       -0.0030   0.0449   0.0929                     (---*----)
                                     ---------+---------+---------+---------+
                                           -0.10      0.00      0.10      0.20


Security = JPM subtracted from:

Security   Lower  Center   Upper  ---------+---------+---------+---------+
PEP       0.0090  0.0752  0.1414                      (------*-----)
XOM       0.0567  0.1039  0.1510                           (---*----)
                                  ---------+---------+---------+---------+
                                        -0.10      0.00      0.10      0.20


Security = PEP subtracted from:

Security    Lower  Center   Upper  ---------+---------+---------+---------+
XOM       -0.0355  0.0286  0.0927                 (------*-----)
                                   ---------+---------+---------+---------+
                                         -0.10      0.00      0.10      0.20
```

*One-way ANOVA and Fisher Test for differences in means between security types. There are 12 of 28 significant differences

Appendix C

One-way ANOVA: Mispricing versus Contract

```
Source       DF        SS    MS     F      P
Contract     11     36.01  3.27  4.50  0.000
Error     20209  14692.13  0.73
Total     20220  14728.15

S = 0.8526   R-Sq = 0.24%   R-Sq(adj) = 0.19%


                             Individual 95% CIs For Mean Based on
                             Pooled StDev
Level     N    Mean   StDev  ------+---------+---------+---------+---
F       671  0.1469  0.1566          (--------*--------)
G       804  0.1790  0.1725               (--------*-------)
H      3053  0.2195  1.8982                         (---*----)
J      1052  0.1201  0.1462        (------*-------)
K       884  0.1585  0.1564             (-------*-------)
M      3050  0.1865  0.9412                    (----*---)
N      1389  0.0736  0.0968  (------*-----)
Q      1230  0.1813  0.1953                 (------*------)
U      2761  0.1568  0.2291                (---*----)
V      1126  0.1178  0.1758        (------*------)
X      1047  0.2521  0.5646                           (------*------)
Z      3154  0.1883  0.3270                     (---*---)
                             ------+---------+---------+---------+---
                                 0.070     0.140     0.210     0.280

Pooled StDev = 0.8526


Fisher 95% Individual Confidence Intervals
All Pairwise Comparisons among Levels of Contract

Simultaneous confidence level = 27.93%


Contract = F subtracted from:

Contract    Lower   Center   Upper  ------+---------+---------+---------+---
G         -0.0553   0.0321  0.1195              (-----*-----)
H          0.0013   0.0725  0.1438                  (----*----)
J         -0.1094  -0.0268  0.0558           (----*-----)
K         -0.0740   0.0115  0.0971             (-----*----)
M         -0.0317   0.0395  0.1108                (----*---)
N         -0.1519  -0.0733  0.0052        (----*----)
Q         -0.0458   0.0344  0.1146               (----*-----)
U         -0.0620   0.0099  0.0818              (----*---)
V         -0.1106  -0.0291  0.0524           (----*----)
X          0.0225   0.1052  0.1878                    (----*-----)
Z         -0.0297   0.0414  0.1124                (----*---)
                                    ------+---------+---------+---------+---
                                       -0.15       0.00      0.15      0.30


Contract = G subtracted from:

Contract    Lower   Center    Upper  ------+---------+---------+---------+---
H         -0.0258   0.0405   0.1067                (----*---)
```

```
J          -0.1372  -0.0589   0.0194         (----*----)
K          -0.1020  -0.0205   0.0609           (-----*----)
M          -0.0588   0.0074   0.0737              (---*----)
N          -0.1795  -0.1054  -0.0314      (----*----)
Q          -0.0735   0.0023   0.0781             (----*----)
U          -0.0892  -0.0222   0.0448            (----*---)
V          -0.1384  -0.0612   0.0160         (----*----)
X          -0.0053   0.0731   0.1515                  (----*----)
Z          -0.0567   0.0093   0.0753              (----*---)
                                       ------+---------+---------+---------+---
                                          -0.15      0.00      0.15      0.30


Contract = H subtracted from:

Contract    Lower   Center    Upper   ------+---------+---------+---------+---
J          -0.1591  -0.0993  -0.0396       (---*---)
K          -0.1248  -0.0610   0.0028          (---*---)
M          -0.0758  -0.0330   0.0098             (--*--)
N          -0.2000  -0.1459  -0.0918     (--*---)
Q          -0.0946  -0.0382   0.0183            (--*---)
U          -0.1065  -0.0626  -0.0187           (--*--)
V          -0.1599  -0.1017  -0.0434       (---*---)
X          -0.0272   0.0327   0.0925                (---*---)
Z          -0.0736  -0.0312   0.0113             (--*--)
                                       ------+---------+---------+---------+---
                                          -0.15      0.00      0.15      0.30


Contract = J subtracted from:

Contract    Lower   Center   Upper   ------+---------+---------+---------+---
K          -0.0379   0.0384  0.1146              (-----*----)
M           0.0066   0.0663  0.1261                 (---*---)
N          -0.1148  -0.0465  0.0218        (----*---)
Q          -0.0090   0.0612  0.1314                (----*----)
U          -0.0238   0.0367  0.0973               (---*---)
V          -0.0740  -0.0023  0.0694            (----*----)
X           0.0590   0.1320  0.2050                      (----*----)
Z           0.0087   0.0682  0.1277                  (---*---)
                                      ------+---------+---------+---------+---
                                         -0.15      0.00      0.15      0.30


Contract = K subtracted from:

Contract    Lower   Center    Upper   ------+---------+---------+---------+---
M          -0.0359   0.0280   0.0918                (---*---)
N          -0.1568  -0.0849  -0.0130        (---*----)
Q          -0.0509   0.0228   0.0965               (----*---)
U          -0.0662  -0.0016   0.0629              (---*---)
V          -0.1158  -0.0407   0.0344          (----*----)
X           0.0173   0.0936   0.1700                   (----*----)
Z          -0.0338   0.0298   0.0934                (---*---)
                                       ------+---------+---------+---------+---
                                          -0.15      0.00      0.15      0.30


Contract = M subtracted from:

Contract    Lower   Center    Upper   ------+---------+---------+---------+---
N          -0.1669  -0.1129  -0.0588       (--*---)
Q          -0.0616  -0.0052   0.0513              (---*--)
```

```
U          -0.0735  -0.0296   0.0143              (--*--)
V          -0.1269  -0.0686  -0.0104           (--*---)
X           0.0058   0.0657   0.1255                   (---*---)
Z          -0.0406   0.0019   0.0443                (--*--)
                                        ------+---------+---------+---------+---
                                           -0.15      0.00      0.15      0.30


Contract = N subtracted from:

Contract    Lower  Center   Upper  ------+---------+---------+---------+---
Q           0.0423  0.1077  0.1731                   (---*----)
U           0.0283  0.0832  0.1382                  (---*--)
V          -0.0228  0.0442  0.1112              (----*---)
X           0.1101  0.1785  0.2469                       (----*---)
Z           0.0609  0.1147  0.1685                    (---*--)
                                      ------+---------+---------+---------+---
                                         -0.15      0.00      0.15      0.30


Contract = Q subtracted from:

Contract    Lower   Center   Upper  ------+---------+---------+---------+---
U          -0.0818  -0.0245  0.0328            (--*---)
V          -0.1324  -0.0635  0.0055        (----*---)
X           0.0006   0.0708  0.1411                 (----*---)
Z          -0.0492   0.0070  0.0632              (--*---)
                                    ------+---------+---------+---------+---
                                       -0.15      0.00      0.15      0.30


Contract = U subtracted from:

Contract    Lower   Center   Upper  ------+---------+---------+---------+---
V          -0.0981  -0.0390  0.0201          (---*---)
X           0.0346   0.0953  0.1559                   (---*---)
Z          -0.0121   0.0315  0.0750                (--*--)
                                    ------+---------+---------+---------+---
                                       -0.15      0.00      0.15      0.30


Contract = V subtracted from:

Contract   Lower  Center   Upper  ------+---------+---------+---------+---
X          0.0626  0.1343  0.2061                   (----*----)
Z          0.0125  0.0705  0.1285                (---*---)
                                  ------+---------+---------+---------+---
                                     -0.15      0.00      0.15      0.30


Contract = X subtracted from:

Contract    Lower   Center    Upper  ------+---------+---------+---------+---
Z          -0.1234  -0.0638  -0.0042         (---*---)
                                     ------+---------+---------+---------+---
                                        -0.15      0.00      0.15      0.30
```

Expiration Months

January	F
February	G
March	H
April	J
May	K
June	M
July	N
August	Q
September	U
October	V
November	X
December	Z

*One-way ANOVA and Fisher Test for differences in means between contract types. There are 42 out of 66 significant differences

**Calendar of expiration months and symbols

Appendix D

Two-Sample T-Test and CI: C1, C2

```
Two-sample T for C1 vs C2

        N   Mean  StDev  SE Mean
C1   5440  0.221  0.749    0.010
C2  14781  0.155  0.888   0.0073


Difference = mu (C1) - mu (C2)
Estimate for difference:  0.0653
95% CI for difference:  (0.0408, 0.0898)
T-Test of difference = 0 (vs not =): T-Value = 5.22  P-Value = 0.000  DF =
     11399
```

*Two-sample t-test between groups of contracts that include dividends and those that do not

Appendix E

Two-Sample T-Test and CI: Pre-Declaration Date, Post-Declaration Date

Two-sample T for Pre-Declaration Date vs Post-Declaration Date

	N	Mean	StDev	SE Mean
Pre-Declaration Date	1275	0.153	0.126	0.0035
Post-Declaration Date	505	0.143	0.651	0.029

Difference = mu (Pre-Declaration Date) - mu (Post-Declaration Date)
Estimate for difference: 0.0097
95% CI for difference: (-0.0477, 0.0670)
T-Test of difference = 0 (vs not =): T-Value = 0.33 P-Value = 0.741 DF = 518

Two-Sample T-Test and CI: Pre-Declaration Date, Post Declaration

Two-sample T for Pre-Declaration Date vs Post Declaration

	N	Mean	StDev	SE Mean
Pre-Declaration Date	286	0.205	0.167	0.0099
Post Declaration	505	0.143	0.651	0.029

Difference = mu (Pre-Declaration Date) - mu (Post Declaration)
Estimate for difference: 0.0614
95% CI for difference: (0.0013, 0.1216)
T-Test of difference = 0 (vs not =): T-Value = 2.01 P-Value = 0.045 DF = 613

Appendix F

Two-Sample T-Test and CI: Pre No Short Sale Ban, No Short Sale Ban

```
Two-sample T for Pre No Short Sale Ban vs No Short Sale Ban

                         N    Mean  StDev  SE Mean
Pre No Short Sale Ban  133  -0.011  0.559    0.049
No Short Sale Ban      212   0.030  0.748    0.051


Difference = mu (Pre No Short Sale Ban) - mu (No Short Sale Ban)
Estimate for difference:  -0.0411
95% CI for difference:  (-0.1801, 0.0978)
T-Test of difference = 0 (vs not =): T-Value = -0.58  P-Value = 0.561  DF = 332
```

Two-Sample T-Test and CI: Post No Short Sale Ban, No Short Sale Ban

```
Two-sample T for Post No Short Sale Ban vs No Short Sale Ban

                          N    Mean  StDev  SE Mean
Post No Short Sale Ban  144  -0.110  0.485    0.040
No Short Sale Ban       212   0.030  0.748    0.051


Difference = mu (Post No Short Sale Ban) - mu (No Short Sale Ban)
Estimate for difference:  -0.1399
95% CI for difference:  (-0.2684, -0.0114)
T-Test of difference = 0 (vs not =): T-Value = -2.14  P-Value = 0.033  DF = 353
```

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EDUCATION

The Pennsylvania State University **University Park, PA**
The Schreyer Honors College *Class of 2010*
The Smeal College of Business
Bachelor of Science, Finance
Honors: Recipient of The Ralph H. Wherry Award, The President's Freshman Award, Dean's List

RELEVANT EXPIERNECE

Ernst & Young **McLean, VA**
Advisory – Intern *June 2009 - August 2009*

- Reviewed the design and operating effectiveness of manual and automated controls
- Updated walkthrough control matrices for both public (Department of Education) and private (energy & technology) sector clients
- Validated SOX compliance across the different instances of SAP for a global utility company

Lord Abbett & Co. LLC **Jersey City, NJ**
Reporting/Analytics - Intern *May 2008 - August 2008*

- Performed regression analyses using Quadstone software for predictive modeling to enhance the effectiveness of marketing strategy
- Contributed to the development of a segmentation model used to evaluate current and prospective clients
- Compared fund performance relative to competitors

LEADERSHIP EXPERIENCE

Nittany Lion Fund, LLC **University Park, PA**
Director of Portfolio Analytics Group *January 2009 - Present*

- Monitor and asses portfolio performance and risk within the individual sectors of a $4.0 million equity investment fund
- Developed a model to track momentum and highlight other technical indicators of stock price movement
- Publish weekly reports of key portfolio returns and statistics that are distributed to fund investors

Fund Manager, Utilities Sector *December 2007 – December 2008*

- Managed equity sales and purchases in the Nittany Lion Fund's $200,000 utilities sector
- Selected to deliver a 5-minute stock pitch to CNBC's Jim Cramer, who later pitched the same stock on Mad Money
- Prepared reports of comparables, discounted cash flows, and financial ratios
- Led stock valuation sessions for a team of 25 analysts using Bloomberg software

Penn State Trading Room **University Park, PA**
Trading Systems Intern *January 2008 - Present*

- Conduct educational seminars on technical analysis using TradeStation and Rotman Trader
- Assist in running trading room programs and events, including trade competitions
- Develop and back-test technical strategies using TradeStation

Holy Ghost Preparatory Speech and Debate **Bensalem, PA**
Speech Coach *September 2006 - Present*

- Coach student performances and speeches for Holy Ghost Preparatory forensics, which successfully competes on both state and national levels

Speech Accolades

- 2006 National Catholic Forensics League: 5th Place in Dramatic Acting **Chicago, IL**
- 2005 Pennsylvania Speech League: State Champion in Prose Reading **Susquehanna, PA**

SKILLS/INTERESTS

- Soccer, speech and debate, writing
- *Software:* Bloomberg, TradeStation, ThinkorSwim, Microsoft Office, VBA