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Trading Ahead of Bad News: Evidence From Short-Sales of Stocks and the Options Market

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Abstract:

Throughout the past ten years, the United States Environmental Protection Agency (EPA) has issued hundreds of enforcement actions in the electric, natural gas, and petroleum industries. The vast majority of these citations have been violations of environmental statutes, notably the Clean Air Act (CAA) and the Clean Water Act (CWA). My research evaluates the timing of informed investors' actions pertaining to the public release of these EPA announcements. Since informed traders have much more leverage in the options market, there seems likely to be a concentration of abnormal put option activity shortly before the time in which the announcements reach the public. My sample includes energy companies that were cited by the EPA from 2008 to 2014. In particular, I test whether there is a heightened level of abnormal short-sale and options trading activity prior to these announcements. I find moderate evidence of informed trading in the options market, but no such evidence in the equity market.

Introduction

Insider trading allows a number of investors to benefit from privileged information before it reaches the market. Tracking such behavior is important because the trustworthiness of the marketplace is of paramount concern to lawmakers. Additionally, it is difficult to quantitatively trace this type of behavior. Since this activity is illegal in the United States, methods of tracking such trading tendencies can be useful to SEC regulators in order to level the playing field. The key to measuring insider trading is to determine when the announcement was released to the public and then observe trading activity before, during, and after disclosure of information. Thus, I am able to determine whether there is an abnormal level of trading activity in the electric, natural gas, and petroleum industries from 2008 to 2014. As such, I incorporate event studies utilized by researchers in studies of other industries to determine such a relationship.

In the energy industry, all firms are regulated by the EPA. Therefore, I use citations published by the EPA for the violation of federal environmental statutes in order to standardize my results. In about a third of the cases, the pertinent information in the EPA announcement is released prior to such date via an alternative news publication. I create one model for equity market activity and another one for options market trading activity. My models take into account the earlier leakages of information in the press in order to determine when insider trading was to occur, if any. As a result, I use the initial release of material information to test whether a certain group of individuals having access to such information has an effect on prior short interest and put option activity.

In the options market model, there is modest evidence of insider trading prior to EPA or related news announcements. However, most of the individual terms in the model prove to be statistically insignificant. In the equity market model, there is no evidence of insider trading

prior to the announcements and most independent variables tested for are statistically insignificant. The low R-squares for each model suggests that the independent variables chosen below do not accurately depict evidence of insider trading prior to such announcements.

Insider Trading

In the United States, insider trading is defined as having privileged access to material, nonpublic information about a corporation and acting based upon such knowledge in the market (Bodie, Kane, and Marcus 2010). Since insider trading is illegal in the United States, its presence in the financial markets is problematic for the government. Many authors have performed event studies in the past that tried to predict and measure patterns of insider trading. However, this type of illegal investment activity does not occur haphazardly throughout the equity and options markets. Many authors contend that there is a strong presence in the trading patterns of stocks and options prior to major events that indicate insider trading. We believe this pattern can be applied to EPA citations involving energy companies. The viewpoints of insider trading in different industries and scenarios will be illustrated in more detail below.

Informed vs. Insider Trading

First, it is necessary to distinguish between insider trading and informed trading. The former is easier to describe as it is a product of conventional wisdom: acting upon privileged access to information before the market has it. This activity is primarily conducted in either the equity market or the options market, to be described in detail in the paragraphs below. Additionally, insider trading could occur with certain commodities and future contracts as well, but for the purpose of my analysis, I will be focused on the equity and options markets. Holders of this private, insider information can exercise these transactions on their own or provide tips to other individuals/institutions. In response to technological improvements on a nation-wide scale,

the SEC has created a number of algorithms in an attempt to detect these illicit activities in real-time to try to uncover such investors (SEC).

Informed trading involves actors making decisions based on the best available information. This strategy is best described through an analogy contrasting an average individual investor to a division within a large mutual fund. After doing a minimal amount of internet surfing and glancing at a few graphs, the former decides to purchase 200 shares of Coca-Cola based upon barely more than a few positive news articles. On the other hand, the large mutual fund has thousands of employees that have been gathering information about the beverage industry for decades, even since before Coca-Cola was made public. Furthermore, this mutual fund has access to nearly every financial news publication, and has dozens of analysts who follow Coca-Cola religiously since the company is a part of their individual portfolios. In other words, the mutual fund has a cheaper average cost of information than the individual investor and thus is able to make much more informed investment decisions. In addition, since the fund has access to a higher level of capital, the mutual fund can spread out its funds more efficiently in well diversified portfolios. The mutual fund 'knows' whether to invest in Coca-Cola at this time, to short the company's stock, or simply to abstain from purchasing shares of Coca-Cola. This is a prime example of how a sub-sect of the mutual fund is the much more informed party when compared to an average individual investor as the latter has neither the time nor resources to evaluate all of the fundamental/technical information available to the public. Yet, in the above example, the mutual fund is using informed – not insider – trading to its advantage and naturally exploiting those who are less informed.

Risk Assessment

Upon discovering and trading upon privileged information before it becomes public, this action affects the risk aversion of other investors through the change in market expectations. Access to privileged information – whether as an informed or insider investor – allows this entity to seek relatively riskier investment choices because the corresponding risk-reward relationship is better than that of a less risky investment. As such, asymmetric levels of information via informed or insider trading can lead to high abnormal returns utilizing various trading strategies: short-sales and put options (Easley *et al.* 1998). If informational imbalances prior to EPA announcements cause abnormal levels of trading to occur during this time period, high abnormal returns will be realized after the information is released.

On a rudimentary level, Miller (1977) argues that risk-averse investors would take the short position less frequently than the long one because of the inherent risk of the former. The long position allows for potentially unlimited returns with potential losses amounting to zero if the company went bankrupt. However, Miller claims that taking the short position enables potentially unlimited losses if the stock price continues to increase while gaining only the then-current share price if the company were to become completely insolvent. Finally, he concludes that investors holding privileged information make up a much greater proportion of the short-sale market since from their perspectives, there isn't as much relative risk in the investment when compared to others. As such, this is the primary reason why the short side of the equity market generally attracts more informed traders who may have greater access to information. In relation to EPA announcements, the informational imbalances described above distort the market efficiency for both the equity and options markets. As such, the level of risk aversion by

uninformed investors is affected by informed investors assuming that the actions taken by the latter cause an artificial shift in the market price before the information become public.

Additionally, there is the question of whether traders engaging in transactions prior to announcements are informed or simply speculating on future returns. Referring specifically to unexpected analyst recommendations (to be discussed in more detail below), Blau and Wade (2012) finds that a nearly symmetric relationship exists between call and put option activity prior to an analyst upgrade or downgrade. As such, Blau and Wade shows that during the pre-recommendation period, short-sellers are not unusually informed about the direction of the upcoming recommendation changes. Therefore, determining net changes in call and put option volume are vital for a holistic analysis on option market operations and subsequent reactions to EPA citations, even though it only publish negative information in my analysis.

Since options and derivatives are relatively new in the marketplace, short-sales were the only mechanism widely available to predict a decrease in a firm's market value until the late 1970's. Oversight over the short side of the equity market changed significantly after the 2008 financial crisis. In years preceding the housing crash, Dong and Sinha (2012) claim that a few investors speculated that a negative downturn was imminent. They contend that this is reflective of the large proportion of short to long positions of the 30 firms within the DJIA from 2003-2008. As such, Dong and Sinha note that after the SEC regulations were authorized, there was a notable shift of informed investors from the equity to options market[1]. The 2008 U.S. housing crisis caused the SEC to keep a closer eye on the stock market, which subsequently caused

[1] In 2008, the SEC further prohibited the practice of naked short-selling, which is to short a stock without having a certain level of the long position of such shares (Tanenbaum *et. al.*). Prior to 2008, it was customary for investors to deliberately misrepresent to broker dealers about their intentions to sell short as well as possessing the proper ratio of short to long shares in the first place.

severe restrictions on the daily volume of short-sales. This change caused a higher percentage of informed investors to shift from the equity to the options market.

Because of such regulations, Easley *et. al.* (1998) claim that transactions in the derivatives market represent the most important predictor of security price movement. Furthermore, they also contend that short-term puts best represent the actions of informed trading ahead of negative news in order to capitalize on a higher likelihood of future negative returns. In comparison to shorting stocks, purchasing options is significantly more practical to traders relying upon instantaneous market reactions in order to maximize profits. This is due to the nature of how options are purchased and exercised, which will be discussed in the theory section below.

Family vs. Non-Family Owned Firms

Insider trading has many reasons for execution in the market. Anderson *et. al.* (2012) argue that the degree of family ownership plays a vital role in abnormal levels of trading prior to earnings announcements. Thus, Anderson *et. al.* empirically test whether family-controlled firms show heightened evidence of insider trading than those owned by multiple families or by the public at large. They utilize data for 2,000 firms in 2004, which is important to note because the increased level of regulation on the short-sales does not occur until 2008. Therefore, most of the potential insider trading occurs in the equity market in his data set, which is reflected in Anderson *et. al.'s* results. Their analysis portrays that family-controlled firms have 17 times the amount of abnormal short-sale transactions prior to negative press releases compared to that of non-family-owned firms. Additionally, their examination revealed that family-owned firms were six times more likely to exhibit future negative returns from abnormal short-sale activity versus

those of nonfamily firms. As such, Anderson *et. al.* assert that family-owned firms seem to have sizeable issues with information leakages by one or more family members.

The Modeling of Announcements

By nature, some type of announcements are expected, an example of which being earnings announcements which are released on a quarterly basis. Accordingly, investors know approximately when these announcements will be made public. Christophe *et. al.* (2004) claims that while investors may not know the direction of the news – positive or negative – they do in fact know that it will be published and released. Furthermore, Balasubramanian and Palvia (2013) provide empirical evidence showing abnormal short interest around regulatory announcements. Finally, Diether, Lee, and Werner (2009) link abnormal short selling activity to lower stock returns (Diether, Lee, and Werner 2009).

Unexpected announcements include mergers and acquisitions, analyst upgrades/downgrades, the syndicated loan market, and most importantly EPA press releases. Since these announcements are quintessentially unpredictable, it becomes easier to track the ebbs and flows of insider activities by measuring the volume of investments before the announcement and a potential corresponding change in price afterwards.

Mergers and Acquisitions

Cao *et. al.* (2005) study large merger deals to pinpoint potential signals of the presence of individuals capitalizing on privileged, insider information. They find that an increase in the call-volume imbalance of a merging firm signals that a merge and acquisition has a greater chance of succeeding. These authors calculate and quantify a call-volume imbalance by taking the call volume the day of the merging announcement and divide by the same day total call option open interest. Consequently, they determine that there is an abnormal spike of short-term call options

prior to takeovers, suggesting that investors prematurely expect a significant price movement[2]. Finally, these authors empirically reinforce through multiple regressions that investors are more likely to engage in the options market while possessing insider information than shorting firms in the stock market. All of these conclusions emphasize the pattern that investors privy to insider, unexpected information will initiate transactions before they become public.

Analyst Recommendations

Christophe *et. al.* (2004) study short-selling activity for 913 large firms listed on the Nasdaq that analysts follow very closely. Despite having partially skewed results by only observing the larger, more established firms in the Nasdaq, they discovers a strong link between abnormal short-selling prior to analyst downgrades utilizing a window three days before the respective downgrade. Taking his event study one step further, Christophe *et. al.* and Desai *et. al.* (2002) are both able to find another correlation between high levels of short interest and subsequent negative returns for the ensuing year. Combining the above two conclusions show that investors contributing towards the abnormal short-sales have a much higher chance of profiting from such transactions.

Hedge Funds and the Syndicated Loan Market

Massoud *et. al.* (2011) examine whether there is evidence of abnormal short selling by hedge funds prior to loan originations and loan amendments in the banking industry. They utilizes data from 2005-2007, once again before the heightened regulation in the equity market starting at the end of 2008. Massoud *et. al.* duly note that some hedge funds are quasi-insiders as they have access to private information about the performance of borrowing firms around the

[2] Selling/writing call options is not discussed here because in order to do so, the insider must possess the corresponding number of shares of stock in his/her portfolio or be approved by having a certain level of capital in reserve. Additionally, while Cao makes no reference to put options in his study about mergers, investigating both calls and puts will be fleshed out in further detail upon the analysis of my data.

time in which a loan can be accepted or denied by the hedge fund. Prior to 1995, the acceptance or denial of a loan was entirely controlled by commercial banks. Massoud *et. al.* explain that when a hedge fund either grants or denies the loan enactment or continuation, this same firm can short the firm with a comparatively higher level of knowledge than other investors in the equity market. As a result, it is unsurprising that hedge funds take advantage of this conflict of interest to boost profits. Specifically, Massoud *et. al.* determine that the market reacts positively to new bank loan announcements with a 1.52% abnormal return, versus the negative market reaction to new hedge fund loan announcements via a -1.29% abnormal return. One possibility for the positive/negative difference in abnormal returns for bank loan and hedge fund loan announcements, respectively, is that the quasi-insiders of the latter perform actions in the market before it is publicly release.

Concluding Remarks

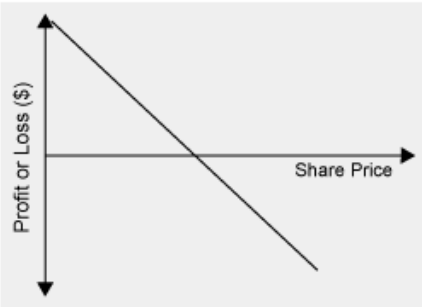
Drawing from the above event studies, they all show evidence of some degree of informed or insider trading. Whether present in the equity market or options market, information asymmetries will cause the privileged few to profit at other people's expense. In the case of unexpected EPA announcements being published, this paper aims to find evidence that insider trading may exist in the energy industry. Consequently, my empirical results will support the above evidence that informed options activity is much greater than evidence of short selling activity ahead of EPA announcements.

Theory

In order for us to determine insider investor expectations and how that affects subsequent short-sale and option pricing, we must first discuss the mechanisms behind each relevant market action or derivative. When an investor initiates a short-sale, that individual sells borrowed securities while simultaneously agreeing to buy back an equal number of shares at some point in the future. As a result, the short-sale investor is anticipating a decline in the price of such shares in the near or long-term future. The investor's goal is to buy and return the securities at the lower price, while receiving the difference in profit as demonstrated in Figure 1 below[3].

Figure 1

Short Sale



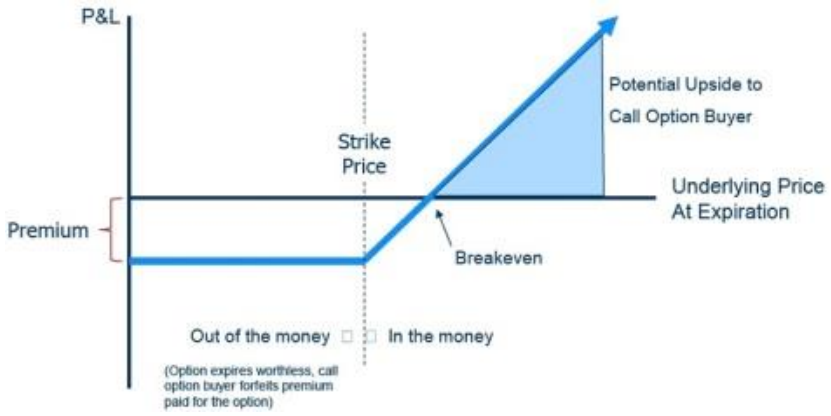
http://www.investopedia.com/ask/answers/05/shortvsput.asp

[3] Depending on the brokerage firm, amount borrowed, and type of institution executing a short-sale will determine whether there is an associated interest charge. Most brokers do not charge interest, and for extremely large amounts, the brokers sometime pay interest to the borrower since when the brokerage firm already puts the money gained from the transaction into an interest-bearing account. Accordingly, it wouldn't make sense for the brokerage firm to charge the customer an additional interest charge.

Returns in the Options Market

Depending upon future expectations alongside informational imbalances, an investor attracted to the derivatives market has a few choices. If the investor believes a stock will increase in the near or far term, he or she can purchase call options for that particular stock. A call option constitutes an agreement in which the seller – or writer – of an option agrees sell a company's stock at a predetermined price to the buyer of the option for a particular period of time if the buyer chooses. The aforementioned price and date are called a "strike price" and "expiration date", respectively. The seller expects the market price to remain below the strike price and, if correct, the buyer has no incentive to exercise the option to buy the stock.

Figure 2

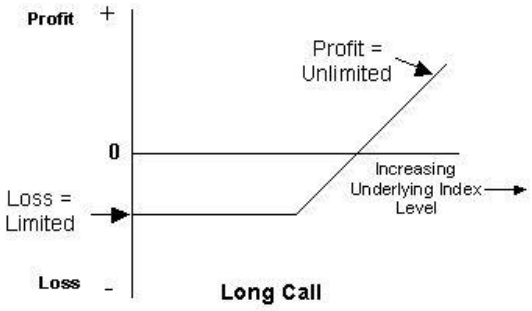


https://www.sec.gov/Archives/edgar/data/1053092/000089109213004721/e53788fwp.htm

As shown graphically in Figure 2 above, the buyer of the option receives a profit equal to the current price of the stock minus the strike price threshold and the option buyer pays a "premium" originally paid by the buyer. Upon the market price staying below the strike price, the seller will profit equal to the original options price. The amount of options one purchases needs to be 'exercised' by the appropriated date if the underlying stock price rises above the strike price, or else the initial up-front investment is lost by the buyer and transferred to the seller. The buyer of a call option is betting that the stock price will increase to a certain

threshold before the expiration date. Thus, a trader would buy a call option if the person expected the market value to rise above the strike price by a certain date.

Figure 3



http://www.cboe.com/learncenter/concepts/basics/index.aspx

Alternatively, a put option incorporates the same mechanism described above simply in the opposite direction. Put options can only be exercised – and thus be "in the money" – when the underlying stock price falls below the agreed-upon strike price before the options expire. In contrast with the intentions of call option buyers, the holders of put options are wagering that the underlying stock price will fall below the strike price during a certain time period. The seller of the put option is expecting that the market price remains above the strike price, in which case the seller would profit equal to the up-front investment of the buyer upon expiration. As shown graphically in Figure 3 above, the buyer of the put option expects the market price to fall much below the strike price in order to make a subsequent profit equal to market price minus the strike price and original price paid for the options. In the case of EPA announcements conveying imminent negative information, insiders holding this information prematurely would likely either choose to purchase put options or sell call options if they expected the market to react in accordance with the news.

Options possess several innate characteristics that make them more attractive for insider traders than purchasing shares of stock. As outlined by Dong and Sinha (2012), options have a

higher degree of leverage over taking the long or short position on a stock. This occurs because investors pay lower prices for options relative to those for stocks, but the corresponding payoffs are much larger than the payoffs from equity market purchases, ceteris paribus. Christophe *et. al.* (2004) illustrate that since purchasing options constitutes an all-or-nothing transaction that matures at a future date, informed investors have been continually exploiting these benefits, especially in the most recent decade. Additionally, Dong and Sinha argue that options have a lower transaction costs than analogous transactions in the equity market. Since options contracts are normally bundled by the hundreds and the initial up-front investment is lower, the commission fees are comparably lower for both high volume and frequency traders in the options market. Finally, Donoho (2004) asserts that for the purposes of trying to measure insider trading, options with the shortest expiration periods are more attractive than those with longer expiration periods. This is because investors holding asymmetric information aim to maximize profitability by making such transactions with a comparatively lower threshold to enter into the money. Shorter times to expiration can be better for insider trading because option prices increase with time to expiration as there is more time for the option to go into the money.

Figure 4

Put Option Data

Stock Ticker	Data Date	Expiration Date	Underlying Price	Strike Price	Bid	Ask	Bid/Ask Spread	Volume	Open Interest
APC	7/1/2013	7/5/2013	86.79	87.5	1.36	1.43	0.07	22	23
APC	7/2/2013	7/5/2013	86.77	87.5	1.19	1.27	0.08	58	45
APC	7/3/2013	7/5/2013	86.93	87.5	0.95	1.05	0.1	10	94
APC	7/5/2013	7/5/2013	88.38	87.5	0.01	0.03	0.02	162	104
APC	7/1/2013	7/20/2013	86.79	87.5	2.6	2.65	0.05	987	2167
APC	7/2/2013	7/20/2013	86.77	87.5	2.67	2.73	0.06	179	2139
APC	7/3/2013	7/20/2013	86.93	87.5	2.48	2.54	0.06	114	2131
APC	7/5/2013	7/20/2013	88.38	87.5	1.62	1.65	0.03	315	2135

The return potential of several different put options for the same exercise dates and strike prices can be illustrated in a simpler example. As shown in Figure 4, the bid and ask prices outline how the cost of options is delivered to investors. The bid price represents the latest price offered by the market to purchase options for a firm. Whereas the ask price constitutes the latest price offered by that same market to sell options of a stock. The bid-ask spread signifies how much commission is generated by the market-making intermediary involved in each transaction. Volume is simply quantifies how many options contracts were executed on a given trading day. Observing previous market trends demonstrates the fact that options which demonstrate a large amount of daily activity will have a narrower bid-ask spread than that of less frequently-traded firms. Open interest portrays the number of options that have been purchased but not yet exercised; the open interest will return to 0 once the regimented expiration date set by the marketplace ensues.

The data in Figure 4 illustrate relevant options data for Anadarko Petroleum Corporation (APC) in July of 2013. Let us assume that an investor has access to material, nonpublic, and negative information on July 1st that will become public sometime in the near future, but before

July 20th, 2013. The current price for Anadarko on July 1st is $86.79 per share. What choices does this investor have? The first choice would be whether to invest in the equity or options market. Both choices will be discussed, but let us initially select the latter. Because of uncertainty concerns of when the information will be released, the investor will likely purchase the put option with the expiration date of July 20th. For example, since options are typically bought and sold in hundreds of options, the investor buys 2 bundles of 100 options at a bid price of $2.60 on July 1st for the July 20th expiration date. The total cost for this individual is $520 up-front. The investor expects with great certainty that the underlying price of $86.79 will plummet quickly once the news is announced. On July 16th, Anadarko's stock price drops to $79.79 per share. At this point, the insider has the ability to exercise the 200 options purchased on July 1st. Upon exercising the options at this juncture, the price differential between the initial underlying price and the current stock price is $86.79 – 79.79 = $7.00 per option. In other words, if both bundles of options are exercise at this time, the profit from such a transaction is (200*$7.00) – 520 = $880 relative to a $520 initial investment. Alternatively, the corresponding ask price at this time would have increased exponentially, allowing the options to flow to another holder expecting the price to decrease even further by the July 20th exercise date if the insider chooses this route.

If an investor were to short Anadarko utilizing the same $520 up-front cost, the insider would have been able to borrow and sell approximately six shares of the company on July 1st. Assuming that the investor purchases and returns the shares at the same time as the one did with options at $79.79, the corresponding profit would be $7.00*6 = $32.00 relative to a $520 initial

investment[4]. Both examples do not include commission as the corresponding amounts would likely cancel each other out. This is a paltry profit when compared to the options investor who is walking away with nearly $900.00. A few factors explain this large difference in profit. First, there is significantly higher risk with purchasing options: the $520 options investment could have been lost completely if the price remained above the strike price. Whereas the short seller would still have had most of his/her investment and may have been able to capitalize at a later point in the future if the underlying share price subsequently decreased. Second, there is less risk for an insider to be caught[2] (Christophe *et al.* 2004).

EPA-Specific Details

Returning to the original premise of predicting insider trading activity within the energy industry, it is important to closely observe the intricacies surrounding the EPA citations themselves. Since nearly all options for publicly-traded U.S. firms expire on the same date, the timing of the EPA press release in relation to this date is important for insiders. Furthermore, the EPA statement may not be the first time the information concerning the environmental law breach is released to the public. In nearly a third of the firms analyzed, other news sources published the information before the EPA statement. Furthermore, most firms have several options available with different expiration dates. Similarly, another factor that helps isolate insider traders exclusively is the timing of the discovery of information. Since the expiration dates for options are the same across the board, the timing influences when the insider would execute a transaction. For example, if an individual found material information eight days prior to its scheduled release, yet the expiration date in the options marketplace was going to occur in two days, he or she would likely wait until after the two-day mark and sometime before eight

[4] The investor could earn interest on the cash in a separate account during the same period. If the interest earned equals the borrowing cost, the transaction would be a wash.

days to make the transaction. Alternatively, an investor could purchase an option with a later expiration date depending upon when the information is received by the investor.

Visibility

Another consideration for insider traders is how high can options volume reach before a red flag is generated by the SEC? This question brings us back to the relationship between the equity and options market. Specifically referring to option transactions after 2008, there is a comparatively lesser chance of being caught in this time period than in the past because of the relative increase in aggregate options activity[5]. Dong and Sinha (2012) asset that this shift is caused by heightened regulatory involvement in the equity market – including restricting the proportion of short to long positions on a firm – that makes the options market a more attractive substitute in the wake of the financial crisis. Currently, there is still a much higher number of daily transactions in the stock market versus transactions in the options market. Therefore, an insider holding onto invaluable information would be able to better hide his or her actions in the equity market since there is more volume on both sides, which causes a greater level of investor uncertainty and divergence of opinion (Miller 1977). Dong and Sinha note that when certain events occur, options activity is highly focused primarily around expected earnings announcements as well as unannounced incidents that subsequently affect a firm's corresponding market value.

Let us assume that an insider investor receives material, nonpublic information a month before it is scheduled to be released to hands of the public. Additionally, such information in an EPA press release or equivalent news source will decrease the value of the underlying stock. The investor has several choices for how to best take advantage of such information. As other

[5] After 2008, the comparative risk has increased. However, in comparison to the equity market, the risk is still greater in the options market despite new regulations.

authors such as Christophe *et. al.* (2004) have stated in the past, one choice would be to purchase put options with the shortest expiration dates and closest strike prices to their underlying share prices that day. Ceteris paribus, these put options will have the cheapest price when compared to puts with longer expiration dates. Another choice would be to purchase put options with longer expiration dates and/or ones that have a strike price farther away from the share price. This medium-risk investor is assuming that after the EPA press release is distributed to the public, the corresponding market price will respond more acutely. As such, the higher the level of risk, the greater the potential returns. Similarly, an alternative investment would be to execute a short-sale transaction. Compared to options, short-sales represent the most costly investment up-front, but have a long-term value and are more balanced. There is no one best choice for an insider, which is why some investors may choose to blend these investments to balance the associated risk and reward for each individual choice.

Hypotheses:

Based on the literature concerning informed and insider trading in the stock and options markets, my results will presumably show some evidence of privileged access to material information industry-wide. As such, my first hypothesis is that if there is an EPA violation for an energy company, then there can be evidence of informed or insider trading traced by heightened levels of short-sale volume or put option activity one or several days prior to the EPA press release or the news breaking from another source beforehand. The intercept value for each regression will show whether the model shows evidence of heightened levels of trading in the short sale and options market, respectively. There are many factors that affect the free market price of a stock, some of which are both unmeasurable and unquantifiable. However, a significant factor for measuring trading activity for each press release is the magnitude of the

penalty for companies of varying market capitalizations. Thus, my second hypothesis is that the relative strength of the EPA monetary penalty has a positive relationship with the level of short-sale and put option volume. More specifically, companies that receive larger penalties as a percentage of total revenue or total assets will experience greater trading volume around such announcements in accordance with the theory behind the Black-Scholes model. Finally, why informed and insider traders act upon such information in the first place is to secure greater profits in the future. My third hypothesis is that companies that exhibit abnormally-high levels of short interest and put option activity prior to a negative EPA press release will experience abnormally-negative returns in the short term.

Empirical Analysis

In this analysis I determine whether there is evidence of informed or insider trading in the energy market before EPA press releases become public. I utilize two series of regressions: one using put option data and the other utilizing short-sale data. Both of my models measure whether heightened levels of trading occur prior to EPA announcements or the news breaking into the media. Before each EPA announcement, I searched Lexis Nexis to see if the information contained in each announcement was reported in the news media was released by the EPA. If so, the date the news is reported in the media becomes the new announcement date. Additionally, these models measure whether the size of the penalty to the firm's revenue abnormally enhances trading prior to the announcement. Finally, I determine whether prior trading activity causes abnormal stock returns the day after the announcement.

Options Model

In my subsequent analysis, I use the following population regression function:

$$ABPUT_i = \beta_0 + \beta_1 LNPENTR_i + \beta_2 NMPES_i + \beta_3 OI_i + \beta_4 CPI_i + \beta_5 ABRETSP_i$$

(1)

The primary dependent variable I use to capture trading activity prior to EPA announcements called abnormal put option activity (ABPUT). ABPUT is calculated by taking the average put option volume five days prior to the announcement and dividing by the previous 14-day put option volume average. This value measures if there is an increase in put option volume for each firm directly before the announcement and seeing whether the number changes relative to two weeks beforehand.

ABPUT is regressed on five independent variables to determine whether these factors have an influence on prior put option activity[6]. PENTR is the total EPA monetary penalty divided by the firm's total revenue that year. The total monetary cost is comprised of four parts: 1) state and federal civil penalties, 2) monetarily-quantified injunctive relief, 3) leak detection and repair (LDAR) projects, and 4) environmental mitigation projects. The civil penalties are lump sums that are mandated payments to the EPA, the corresponding state government, or both. The injunctive relief comprises the greatest expense to the firm: it demonstrates how much capital each firm needs to pay to fix its facilities. Since the amendments to the CAA and the CWA constitute relatively severe changes in emission and wastewater management, the injunctive relief is quite expensive. LDAR systems are similar to injunctive relief; however, they focus on preventative measures that facilities need to install to prevent future environmental

[6] I tried including a sixth dummy variable to account for sanction news reaching the media before the EPA released the news. However, the variable didn't prove to be significant and was omitted from the final model.

infractions. Finally, the environmental mitigation projects require the firm to remedy any damage it caused to the atmosphere, nearby water supplies, or anything else.

The natural logarithm of the ratio of total monetary penalty divided by the firm's total revenue (LNPENTR) measures the size of the penalty compared to the firm's total revenue. Since the range of values of PENTR is quite high and skewed right as shown statistically in Table 8, the natural logarithm of these values were computed in order compress this range. Since the mean value of PENTR – 9.258 – is significantly larger than its median value of 0.0371, the PENTR values are skewed right. As such, the natural logarithm values for the 35 firms are captured in the LNPENTR variable, and this variable is used in the subsequent analysis. Consequently, I expect the coefficient to have a positive value because as the penalty rises relative to revenue, there should be more of an impact on the firm's profitability. *Ceteris paribus*, I would expect an increase in abnormal trading and thus an increase in ABPUT.

The Non-Monetary Penalty Expenditure Scale (NMPES) measures the non-quantifiable expenses incurred by the EPA-violated firm. Because of the variation in cases and penalties, NMPES has a range from zero to five in the regressions below. As the value of NMPES becomes lower, there is consequently a lesser degree of a non-monetary penalty incurred by the firm. Conversely, higher NMPES values indicate higher non-monetary penalties. NMPES equals zero when there are no non-monetary expenses incurred by the firm. NMPES equals one when non-monetary expenses are accounted for partially with the inclusion of both environmental mitigation and LDAR charges quantified in the EPA press release. NMPES equals two when non-monetary expenses are accounted for partially, including lower-end environmental mitigation projects. NMPES equals three when non-monetary expenses are

accounted for partially, including higher-end environmental mitigation projects.[7] NMPES equals four when non-monetary expenses are accounted for partially when environmental mitigation projects are not included. NMPES equals five when non-monetary expenses are not accounted for entirely in the press release. I expect the coefficient of NMPES to be positive because higher NMPES values indicate that a firm needs to fix more issues with its facilities. Accordingly, with more to fix the penalty would carry relatively more weight than the other penalties in the study and thus would be traded more frequently by insiders, *ceteris paribus.*

The next two variables are independent variables that capture certain options market characteristics. The first variable is open interest (OI) which is calculated by taking the percent change in open interest in put options the day of the announcement and dividing it by that same value twenty days prior to the announcement. Open interest is the number of options that have been purchased but not yet exercised; the open interest will return to zero on an options expiration date. I would expect this coefficient value to be positive because I would expect informed investors to have greater knowledge of particular put option contracts the day of the announcement versus twenty days beforehand. This is because if these investors predicted correctly, they would be able to execute their options at this time if the market moved in the predicted direction.

The other independent variable is call-put imbalance ratio (CP_IMBAL). This value measures the total call option activity in relation to the total put option activity one day prior to the announcement. I would expect the majority of firms to have a CP_IMBAL less than one because if the news is pertinent and leaked ahead of time to privileged investors, these individuals are much more likely than not to purchase put options than call options for the firm.

[7] The distinction between lower and higher end environmental mitigation projects is quantified as follows: lower end when the expense is at or less than ten percent of the injunctive relief expense, and higher end when the expense is greater than ten percent of the injunctive relief expense.

As Donoho (2004) mentions in his event study analysis, more calls than puts indicates optimism in the firm, whereas more puts than calls induces market pessimism. Consequently, since this value is lagged for the day before each announcement, more puts than calls would indicate short-run negativity towards the firm and thus insiders alike are likely to purchase more put options. Therefore, *ceteris paribus*, the impact of the data leakage would cause more puts to be traded than calls, bringing the coefficient below a 1:1 ratio. As such, I would expect the coefficient for CP_IMBAL to be negative because as the ratio of calls to puts increases, then abnormal put option would likely decrease to a value below one.

The final variable in the population regression function is the abnormal returns for each firm's stock on the day after the announcement. This variable (ABRETSP) is derived by creating a predicted value for each firm's stock return and then subtracting the stock's observed return. Each stock's predicted return is calculated as follows: I regress the stock's daily returns on the S&P 500's daily returns using data for 120 days prior to and including the announcement and obtain an estimate for the market beta and intercept term. *Ceteris paribus*, assuming perfect foresight of the investor, I would expect ABRETSP's coefficient to be negative because if the news is surprisingly bad to informed investors, abnormal returns will be negative. These informed investors would show their viewpoints by purchasing put options and engaging in short sale activity. This high pre-announcement short sale activity should correspond with negative post-announcement abnormal returns, yielding a negative coefficient for the model. Anderson, Reeb, and Zhao (2012) affirm this stance by showing in their study concerning family ownership in firms that abnormal prior levels of trading activity leads to a higher degree of abnormally negative returns.

I considered using other forms of ABPUT in my analysis. The variables and associated summary statistics are shown in Table 2 as ABPUT2 and ABPUT3 and are used as robustness checks for the primary model. The two above variables are calculated by taking the average of several underlying variables to be described below. TOTPUT0 is the total put option volume the day of the announcement divided by its previous 14-day average. TOTPUT1 is the total put option volume the day before the announcement divided by the previous 14-day average. TOTPUT2 through TOTPUT5 measure the total put option volume two to five days prior to the announcement and are divided by their previous 14-day averages. Consequently, ABPUT2 is calculated by taking the average of TOTPUT0 through TOTPUT5, which is a combined total of six numbers. ABPUT3 is similar to ABPUT2 except it excludes TOTPUT0. In other words, ABPUT3 is calculated by taking the average of TOTPUT1 through TOTPUT5.

ABPUT is the optimal dependent variable because out of the three dependent variables, it incorporates the largest amount of market data. Additionally, since the exact timing of the EPA press releases is not publicly available, it is important to utilize a dependent variable that does not encompass intra-day data.

Data Description: Options Model

The data in Table 2 were collected from a variety of sources. The raw data behind the variables containing options data are from Delta Neutral. The data that involve total revenue are from Mergent Online. The monetary cost of the EPA penalties along with the non-monetary data related to each press release was determined from press releases posted on the EPA's website. Finally, the market data for the abnormal returns variable is from Yahoo.com.

The data take into account 35 firm-specific violations of legislative statutes regulated by the EPA.[8] I reached this final sample size because it encompasses all of the EPA violations for electric, natural gas, and oil companies of publicly traded firms from 2008 to 2014. Additionally, it was not necessary to go farther back than 2008 because strict amendments to the CAA and the CWA were enacted in the early 2000's. The EPA started to prosecute firms relating these statutes in 2003. However, it wasn't until the beginning of 2008 when a publicly traded company was cited for an energy-related infraction.

ABPUT has a mean of 1.2230 with a standard deviation of 1.2166. Since the maximum value of 6.5623 is more than three standard deviations away from the mean, it shows that at least one outlier is present.

LNPENTR possesses a mean of -2.7004 with a standard deviation of 3.4253. Since the minimum and maximum values of this variable are -7.4906 and 4.4817, respectively, the natural logarithm condensed the previously skewed PENTR values effectively. OI has a mean of 5.6264% with a standard deviation of 43.9524%. This variable contains one or more outliers in the upper end as there is one that has a OI of 210.7542%, showing that open interest for put options changed tremendously the day of the announcement. Finally, it is also worth noting that the mean value for ABRETSP is quite low at a value of .0648% with a standard deviation of 1.1935%. As such, the 35 firms on average did not suffer great loss accounting for market forces the day after the announcement.

[8] Originally, there were 37 firms in the data set. However, two of the firm's possessed a severely high call-put imbalance ratio, and therefore were removed because there is no anticipation of a stock price decline with extremely high levels of CP_IMBAL.

Empirical Results: Options Model

The subsequent analysis assesses whether there is abnormal put option activity prior to EPA press releases and what variables are associated with that activity. Results are presented in Table 3 below.

Using a 10% level of significance, the only two variables that are statistically significant in the put options regression are the intercept term and ABRETSP. Since the sign is positive for the intercept variable, it affirms hypothesis one for options: there is evidence of abnormally high trading ahead of news of EPA sanctions for energy firms. Additionally, since both LNPENTR and NMPES are statistically insignificant, the relative strength of the monetary and non-monetary components of the EPA penalty does not cause previous abnormal levels of trading. As such, there is no proof in this model affirming my second hypothesis.

Finally, ABRETSP is negative in the model which matches its expected sign and is statistically significant under the 10% aforementioned level above. Consequently, *ceteris paribus,* a one percentage point increase in abnormal returns is associated with a 31.95% percentage point decrease in ABPUT. My model outlined above affirms my third hypothesis concerning the link between prior abnormal put option activity and subsequently abnormally negative returns.

I estimated the second regression model using an ordinary least squares (OLS) regression model. 16.30% of the variation in abnormal put option activity is explained by the model. This value shows that the model is moderately poor at predicting abnormal put option activity. Given an F-value of 1.13 with a corresponding *p-value* of 0.3670, I fail to reject the null hypothesis that all of the coefficients for the independent variables are equal to zero. Therefore, the R-square value isn't the optimal measurement of abnormal put option activity prior to each announcement.

Using a 10% level of significance, two of the independent variables prove to be statistically significant. However, the model taken as a whole is not a reliable predictor of abnormal put option activity prior to EPA announcements.

Remedies for Gauss-Markov Violations to Maintain OLS: Options Model

In order for the model to be the best estimator to determine abnormal put option activity, severe multicollinearity between two or more variables cannot exist. While extreme multicollinearity is not an issue with the model below in Table 3, I ensure that a high degree of multicollinearity is not present. There are no Pearson Correlations above 0.8 for any two variables. Furthermore, the individual variance inflations for none of the independent variables exceed the VIF threshold of 1.19 for the model. Moreover, the collinearity index shows no evidence of severe or even moderate multicollinearity as their corresponding condition index values are all significantly below 10. Since all three tests showed no signs of multicollinearity, we can confidently conclude that it is not an issue in the model.

The maintenance of OLS also requires no evidence of heteroskedasticity. Since there is a relatively narrow range of values for the dependent variable – ranging from 0.19 to 6.56 – I do not expect heteroskedasticity cause overconfidence in the subsequent t & p values. I utilize the Breusch-Pagan test in order to determine whether heteroskedasticity poses in an issue in the options model. The test results for the Breusch-Pagan test are portrayed in Table 4. Since the one-tailed *p-value* for the entire model is 0.2906, or 29.06%, it falls above the 10% level of significance. Therefore, I fail to reject the null hypothesis that all of the independent variable coefficients equal zero and conclude that heteroskedasticity does not significantly affect the standard error estimates.

Finally, Anderson (2012), Diether (2009), and Christophe (2010) all test if exogenous factors to their respective models influence their set of independent variables. All three analyses find that exogenous factors not quantified in their models have a very little impact on their results. Since my models extract concepts from all three of author's models listed above, I can conclude that exogeneity does not heavily influence my results and thus my model maintains its OLS status.

Short-sale Model

In my subsequent analysis below, I use the following population regression function:

$$ABSHORT_i = \beta_0 + \beta_1 LNPENTR_i + \beta_2 NMPES_i + \beta_3 MKTCAPSM_i + \beta_4 MKTCAPMED_i + \beta_5 ABRETSP_i + \beta_6 BTM + \beta_7 SRV + \beta_8 MOM$$

(2)

The primary dependent variable I use to capture trading activity prior to EPA announcements in this model is called abnormal short interest (ABSHORT). The first step in calculating the dependent variable is to get a measure of short sale activity. Short interest is defined as the total short-sale volume and dividing it by the total amount of trading activity in the equity market. The second step is to estimate the activity prior to the announcement. Thus, TOTSHORT0 is found by taking the total short interest the day of the announcement and dividing it by the previous 14-day average. TOTSHORT1 takes the total short interest the day before the announcement and divides this number by its previous 14-day average. TOTSHORT2 through TOTSHORT5 are calculated by taking the average short-sale volume two to five days before the announcement and dividing that number by their previous 14-day averages. Consequently, ABSHORT takes the average of TOTSHORT1 through TOTSHORT5.

As shown in regression function above, there are some variables that have been previously described in the options model and others that have been added specifically to this model. LNPENTR, NMPES, and ABRETSP are all calculated identically as they were in the options model. The sign expectations also remain the same throughout the short-sale regression analysis.

MKTCAPSM and MKTCAPMED are both dummy variables that capture the market capitalization of all 36 firms. MKTCAPSM is 1 when the firm has a total market capitalization of $2 billion or below (a small firm), and zero otherwise. Similarly, MKTCAPMED is one when the firm has a total market capitalization between $2 billion and $10 billion (a medium-sized firm), and zero otherwise. Both MKTCAPSM and MKTCAPMED would have positive coefficients because small and medium capitalization firms have less working capital than large capitalization firms. More often than not, large capitalization firms own the entire modicum of the production of power from harvesting the source to delivering the refined form to the consumer. Thus, these firms are more likely to withstand an EPA penalty and will suffer less from insider trading activity relative to that of smaller firms. Conversely, small and medium capitalization firms generally do not possess these characteristics, and – independent of how expensive the penalty is in relation to revenue – bad press generated from such events will have a greater impact on abnormal short interest on smaller firms.

BTM is the ratio of the firm's book value to its corresponding market value. Both values were gathered and analyzed as of December 31st, 2014. I expect the coefficient for BTM to be negative or close to zero because as a firm's BTM decreases, it becomes either closer to a growth stock or a more extreme one. Investors are expecting growth in divergent directions, which increases investor uncertainty and level of short interest. SRV is found by calculating the

standard deviation of each firm's stock returns 120 days prior to the announcement until 10 days prior to the announcement. The expected sign for SRV is positive because an increase in the firm's price volatility would subsequently cause an increase in divergence of opinion. The investors on the negative side demonstrate their forecasts by shorting the firm, resulting in a higher level of short interest. Similarly, MOM is determined utilizing this same period by calculating each firm's cumulative rate of return and subtracting that of the S&P 500. I would expect MOM to have a negative sign because if the firm's rate of return is consistently higher than the market's return, this constitutes a buy signal for traditional investors. In accordance with Carhart (1997) as an extension of the Fama-French Model for predicting returns in the market, there is a tendency for firms with positive past returns to produce positive future returns. Because of this market trend, firms with high momentum will likely have lower short volume and interest prior to the announcement, *ceteris paribus*.

I considered using varied forms of the dependent variable for my regression analysis. They are shown in Table 5 as ABSHORT2 and ABSHORT3 and are used as robustness checks for the primary model. ABSHORT2 takes the average of TOTSHORT0 through TOTSHORT5. Whereas ABSHORT3 takes the average short-sale volume five days prior to the announcement and divides it by the previous 14-day short-sale volume average.

ABSHORT is preferred over the other two dependent variables. From a theoretical perspective, ABSHORT is the best measurement of abnormal short-sale activity because while ABSHORT3 contains a larger amount of market data, the averages comprising ABSHORT are more relevant to tracking total market activity than those of ABSHORT3. Taking the trailing 14-day averages of short *interest* in ABSHORT versus taking previous changes in *volume* constitute a more comprehensive measurement of overall market activity versus just isolating short-sale

volume without controlling for total market volume. Additionally, ABSHORT2 contains intraday data which we cannot control for in the model below due to data limitations on exactly when the EPA released its announcements.

Data Description: Short-sale Model

All of the data in Table 5 were collected from a variety of sources. All of the variables using underlying short-sale data come from the Bats Global Market Exchange. The variables containing information pertaining to market capitalization and return volatility stem from underlying data gathered from Yahoo.com.

The data take into account 36 violations of environmental legislative statutes regulated by the EPA.[9] As mentioned above, this includes all of the cases where publicly traded companies breached energy-related statutes from the beginning of 2008 through the end of 2014.

ABSHORT possesses a mean of 1.00136 with a standard deviation of 13.59336%. The number ranges from 0.74075 to 1.37604, showing that there aren't any particularly extreme values for this dependent variable. The average value for BTM is 0.73704 with a standard deviation of 78.68751%. One firm to note for BTM is AK Steel Holdings (AKS), which had a negative book value as of December 31st, 2014. This is why the minimum value for BTM is -.60435. The firms' average MOM is negative at a value of -0.01647 with a standard deviation 26.258%. This shows that on average, the 36 energy firms underperformed relative to the market four months prior to the announcement up until ten days beforehand. Finally, SRV has a mean of 2.10051% with a standard deviation of 1.51918%. HollyFrontier Corp (HFC) possesses the highest SRV of 7.19497%, and it also possesses the highest ABSHORT2 value of 1.3816971,

[9] One additional case was added to the sample because since CP_IMBAL is not one of the independent variables in the short-sale model, it is able to be included.

showing that greater stock price volatility is aligned with a greater degree of short interest for HFC.

Empirical Results: Short Interest Model

The subsequent analysis assesses whether there is abnormal short interest activity prior to EPA press releases and what variables are associated with that activity. Results are presented in Table 6 below.

Using a 10% level of significance, the only two variables that are statistically significant in the put options regression are the intercept term and MKTCAPSM. However, since the coefficient value for the intercept is less than one, it does not affirm hypothesis one for short interest. Therefore, there is no evidence of abnormally high trading ahead of news of EPA sanctions for energy firms. Additionally, since both LNPENTR and NMPES still remain statistically insignificant, the relative strength of the monetary and non-monetary components of the EPA penalty does not cause previous abnormal levels of trading. As such, there is no proof in the short interest model affirming my second hypothesis.

MKTCAPSM has an individual *p-value* of 10.47%. For the purposes of my analysis, I am considering this value to be close enough to the 10% level of significance needed to analyze further. Additionally, the expected positive sign matches the positive sign on the MKTCAPSM coefficient of 0.14. Therefore, *ceteris paribus*, having a market capitalization below $2 billion increases abnormal short interest by 0.14 percentage points.

In contrast to the options model, ABRETSP is statistically insignificant. However, this conclusion contrasts what has been empirically proven in other similar models, such as the one

produced by Anderson (2012) and Diether (2009). More specifically, they assert that abnormal short volume and interest prior to an announcement procures abnormally negative returns. One possible explanation for the contradiction could be that the market corrected itself the day of the announcement and not the day after, depending upon when time of day the announcement was released. An alternative explanation is that these announcements do not negatively impact stock prices as much as expected.

The model explains 27.24% of the variation in abnormal short interest. Additionally, the model has an F-value of 1.26 with a corresponding *p-value* of 0.3027. Thus, we fail to reject the null hypothesis that all of the coefficients for the independent variables are statistically significantly different than zero, and conclude that the R-square listed above is not the best predictor for the model. One independent variable in the short-sale model –MKTCAPSM – provides a decent indicator of abnormal short interest prior to EPA announcements. However, the adjusted R-square value of 5.69% shows that many variables in the model do not have a great impact on the degree of short interest for each firm.

Remedies for Gauss-Markov Violations to Maintain OLS: Short Sale Model

In order to ensure that the above short-sale model is best estimator for short interest, OLS assumptions need to be upheld. Addressing the presence of severe multicollinearity, none of the pairwise Pearson Correlations between two independent variables are above the 0.8 threshold. However, the individual variance inflations for three of the independent variables – LNPENTR, MKTCAPSM, and SRV – exceed the VIF threshold of 1.37 for the model. Nevertheless, the collinearity index shows no evidence of severe or even moderate multicollinearity as their corresponding condition index values are all below 7. Since two out of the three tests showed no signs of severe multicollinearity, I conclude that multicollinearity is not an issue in the model.

The maintenance of OLS also requires no evidence of heteroskedasticity. Since there is a relatively narrow range of values for the dependent variable – ranging from 0.74 to 1.38 – heteroskedasticity is presumably not an issue. I utilized the Breusch-Pagan test in order to determine whether heteroskedasticity poses an OLS issue in the short-sale model. The test results for the Breusch-Pagan test are portrayed in Table 7. Since the one-tailed *P-value* for the entire model is 0.3196, or 31.96%, it falls above our 10% level of significance. Therefore, I fail to reject the null hypothesis that all of the independent variable coefficients equal zero and can conclude that heteroskedasticity does not exist in the short-sale model.

Conclusions and Final Remarks

The intercept from the options model indicates elevated put option trading ahead of EPA and related announcements, while the intercept from the short interest model indicates no difference in short sale activity ahead of such announcements. Nevertheless, both the options and short-sale models produce unpersuasive results that the independent variables outlined above have a great influence on abnormal levels of trading activity before the announcements. In fact, the presence of informed trading seems to have more of an influence in the equity market, if present at all. This finding contradicts recent findings by Dong and Sinha (2012) as well as others determining a movement of informed trading from the equity to the options market after 2008.

Appendix:

Table 1: Variable Descriptions

Variable	Description
ABPUT	Abnormal put option activity 1: average of TOTPUT0 through TOTPUT5
ABPUT2	Abnormal put option activity 2: average of TOTPUT1 through TOTPUT5
ABPUT3	Abnormal put option activity 3: average put option volume five days prior to announcement divided by its previous 14-day moving average
TOTPUT0	Total put option volume the day of the annoucement divided by its previous 14-day moving average
TOTPUT1	Total put option volume the day before annoucement divided by its previous 14-day moving average
TOTPUT2	Total put option volume two days before annoucement divided by its previous 14-day moving average
TOTPUT3	Total put option volume three days before annoucement divided by its previous 14-day moving average
TOTPUT4	Total put option volume four days before annoucement divided by its previous 14-day moving average
TOTPUT5	Total put option volume five days before annoucement divided by its previous 14-day moving average
PENTR	Total EPA monetary penalty divided by the firm's total revenue, percent form
LNPENTR	The natural logarithmic values of PENTR
NMPES	Non-monetary penalty expenditure scale
OI	Percent change in open interest on the day of the announcement from twenty days prior, percent form
CP_IMBAL	Total call option volume divided by the total put option volume one day before the announcement, percent form
ABRETSP	Abnormal stock return day after the announcement, percent form
ABSHORT0	Abnormal short sales 1: average of TOTSHORT0 through TOTSHORT5
ABSHORT2	Abnormal short sales 2: average of TOTSHORT1 through TOTSHORT5
ABSHORT3	Abnormal short sales 3: average short sale volume five days prior to announcement divided by its previous 14-day moving average
SHORTINTEREST	Totlal short sale volume divided by total share volume
TOTSHORT0	Total short interest the day of the announcement divided by its previous 14-day moving average
TOTSHORT1	Total short interest one day before the announcement divided by its previous 14-day moving average
TOTSHORT2	Total short interest two days before the announcement divided by its previous 14-day moving average
TOTSHORT3	Total short interest three days before the announcement divided by its previous 14-day moving average
TOTSHORT4	Total short interest four days before the announcement divided by its previous 14-day moving average
TOTSHORT5	Total short interest five days before the announcement divided by its previous 14-day moving average
MKTCAPSM	Dummy variable, 1 if firm has below $2 million in market capitalization, one year lag
MKTCAPMED	Dummy variable, 1 if firm has between $2 million and $10 million in market capitalization, one year lag
BTM	Book to market ratio
MOM	Momentum of rate of return
SRV	Stock return volatility
RESBP2OP	Residuals squared value of ABPUT3
RESBP2SI	Residuals squared value of ABSHORT2

Table 2: Put Option Descriptive Statistics

Options Summary Statistics

Variable	N	Mean	Std. Dev	Minimum	Maximum
ABPUT	35	1.23	1.2166	0.1878	6.5626
ABPUT2	35	1.1557	0.9185	0.2103	4.742
ABPUT3	35	1.1195	0.761	0.2735	3.9773
TOTPUT0	35	0.9385	0.6606	0	3.5349
TOTPUT1	35	0.9725	1.0493	0	5.7512
TOTPUT2	35	1.2599	2.0523	0	10.7487
TOTPUT3	35	1.171	1.379	0	7.3545
TOTPUT4	35	0.9728	0.9647	0	5.7635
TOTPUT5	35	1.4022	2.2929	0	12.5676
PENTR	35	6.399	19.5597	0.0006	88.3844
LNPENTR	35	-2.7	3.4253	-7.4906	4.4817
NMPES	35	2.4286	1.8987	0	-5
OI	35	0.0563	0.4395	-0.6798	2.1075
CP_IMBAL	35	2.1171	2.5646	0	13.1178
ABRETSP	35	-7E-04	0.0121	-0.0301	0.0318

Notes:

Variables are defined in Table 1.

Table 3: Put Option Model: OLS

Options Regression

	Dependent Variable	ABPUT	
	Number of Observations	35	
Variable	Parameter Estimate	T-Value	P-Value
Intercept	1.1765	2.72	0.0109
LNPENTR	-0.0831	-1.32	0.1962
NMPES	-0.0492	-0.44	0.6608
OI	-0.0713	-0.14	0.8866
CP_IMBAL	-0.0322	-0.39	0.6969
ABRETSP	-31.9484	-1.82	0.0786
	F-Value	1.13	
	Pr > F	0.367	
	R-Square	0.163	
	Adj R-Square	0.0187	

Notes: Variable definitions are as in Table 1. Columns 1-2 outline the variables and coefficient estimates for the Abnormal Put Option Activity (ABPUT3) OLS model. Columns 3-4 portray the coefficient estimates' corresponding P & T values.

Table 4: Put Option Test For Heteroskedasticity

Options Heteroskedasticity Test

	Dependent Variable	RESBP2OP	
	Number of Observations	35	
Variable	Parameter Estimate	T-Value	P-Value
Intercept	1.6772	1.19	0.244
LNPENTR	-0.3258	-1.58	0.1257
NMPES	-0.4814	-1.33	0.1948
OI	-2.3488	-1.44	0.1588
CP_IMBAL	0.0404	0.15	0.8815
ABRETSP	-105.1255	-2.66	0.0125
	F-Value	1.3	
	Pr > F	0.2906	
	R-Square	0.1482	
	Adj R-Square	0.0346	

Notes: Variable definitions are as in Table 1. Columns 1-2 outline the variables and coefficient estimates for the Breusch-Pagan test for heteroskedasticity to maintain OLS for the options regression shown in Table 3. Columns 3-4 portray the coefficient estimates' corresponding P & T values.

Table 5: Short Interest Descriptive Statistics

Short Sale Summary Statistics

Variable	N	Mean	Std. Dev	Minimum	Maximum
ABSHORT	36	1.0014	0.1359	0.7406	1.3817
ABSHORT2	36	1.012	0.1312	0.7407	1.376
ABSHORT3	36	1.0011	0.1601	0.6924	1.357
TOTSHORT0	36	1.0655	0.2079	0.5743	1.539
TOTSHORT1	36	1.0439	0.2128	0.7125	1.556
TOTSHORT2	36	1.0072	0.192	0.6943	1.4714
TOTSHORT3	36	0.987	0.2199	0.4826	1.5686
TOTSHORT4	36	0.9876	0.2353	0.5443	1.6323
TOTSHORT5	36	0.9811	0.207	0.3952	1.4027
PENTR	36	6.2213	19.3077	0.0006	88.3844
LNPENTR	36	-2.7097	3.3732	-7.4906	4.4817
NMPES	36	2.4444	1.8738	0	5
ABRETSP	36	-0.0002	0.0128	-0.0302	0.0318
MKTCAPSM	36	0.1667	0.378	0	1
MKTCAPMED	36	0.2222	0.4216	0	1
BTM	36	0.737	0.7869	-0.6043	4.3674
MOM	36	-0.0165	0.2626	-1.027	0.6323
SRV	36	0.021	0.0152	0.007	0.0719

Notes: Variables are defined in Table 1.

Table 6: Short Interest Regression: OLS

Short Interest Regression

	Dependent Variable	ABSHORT	
	Number of Observations	36	
Variable	Parameter Estimate	T-Value	P-Value
Intercept	0.9984	16.11	0.0001
LNPENTR	-0.0006	-0.07	0.9459
NMPES	-0.0144	-1.16	0.2551
ABRETSP	0.8338	0.44	0.6627
MKTCAPSM	0.1414	1.68	0.1047
MKTCAPMED	0.0041	0.07	0.9447
BTM	0.0328	0.85	0.4011
MOM	0.101	1.02	0.3186
SRV	-0.4788	-0.23	0.8228
	F-Value	1.26	
	Pr > F	0.3027	
	R-Square	0.2724	
	Adj R-Square	0.0569	

Notes: Variable definitions are as in Table 1. Columns 1-2 outline the variables and coefficient estimates for the Abnormal Short Sales (ABSHORT2) OLS model. Columns 3-4 portray the coefficient estimates' corresponding P & T values.

Table 7: Short Interest Test For Heteroskedasticity

Short Interest Heteroskedasticity Test

	Dependent Variable	**RESBP2SI**	
	Number of Observations	**36**	
Variable	**Parameter Estimate**	**T-Value**	**P-Value**
Intercept	**0.0158**	**1.96**	**0.0603**
LNPENTR	**-0.001**	**-0.92**	**0.3645**
NMPES	**-0.0021**	**-1.27**	**0.2146**
ABRETSP	**0.6287**	**2.55**	**0.0166**
MKTCAPSM	**-0.0017**	**-0.15**	**0.8789**
MKTCAPMED	**-0.0059**	**-0.78**	**0.4429**
BTM	**0.0043**	**0.87**	**0.3934**
MOM	**0.0128**	**0.99**	**0.331**
SRV	**-0.079**	**-0.29**	**0.7767**
	F-Value	**1.23**	
	Pr > F	**0.3196**	
	R-Square	**0.2672**	
	Adj R-Square	**0.05**	

Notes: Variable definitions are as in Table 1. Columns 1-2 outline the variables and coefficient estimates for the Breusch-Pagan test for heteroskedasticity to maintain OLS for the short interest regression shown in Table 6. Columns 3-4 portray the coefficient estimates' corresponding P & T values.

Table 8: Skewness Testing

PENTR Skewness Test		
Variable		**PENTR**
Number of Observations		**41**
Mean		**9.2581**
Std Deviation		**24.0648**
Kurtosis		**5.5694**
Skewness		**2.6122**
Median		**0.0371**
Mode		**0.001**
Range		**88.3838**
IQR		**0.6728**
Quantile		**Estimate**
100%	**Max**	**88.3844**
99%		**88.3844**
95%		**66.5249**
90%		**44.5637**
75%	**Q3**	**0.6774**
50%	**Median**	**0.0371**
25%	**Q1**	**0.0046**
10%		**0.001**
5%		**0.001**
1%		**0.0006**
0%	**Min**	**0.0006**

Notes: Variables are defined in Table 1.

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