Informed Trading in the Stock Market and Option Price Discovery[☆]

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Abstract

When activist shareholders file Schedule 13D filings, the average excess return on target stocks is 6% and stock price volatility drops by about 10%. Prior to filing days, volatility (price) information is reflected in option (stock) prices. Using a comprehensive sample of trades by Schedule 13D filers which reveals on what days and in what markets they trade, we show that on days when activists accumulate *shares*, option implied volatility decreases, volatility skew increases, and option bid-ask spreads widen. The evidence is consistent with informed trading in the stock market contributing to the flow of volatility information into option prices.

It has long been argued that derivative markets should provide an interesting trading avenue for investors to exploit an informational advantage. Options may provide valuable embedded leverage for example (Black, 1975). They may also allow investors to achieve better liquidity or to hide their information better (Back, 1993; Biais and Hillion, 1994; Easley, O'Hara, and Srinivas, 1998). Indirect empirical evidence that informed trading does occur in option markets based on the predictability of stock returns by option to stock volume or other option market statistics has been documented (Vijh, 1990; Chan et al., 2002; Chakravarty et al., 2004; Pan and Poteshman, 2006). On the other hand, Muravyev, Pearson, and Broussard (2013) suggest that no economically significant price discovery occurs in the option market. Thus, whether and how informed investors actually use options and what informational linkages there are between option and stock markets remain open questions.

In this paper we use data on informed investors' trading behavior to revisit the following questions. How do investors who possess valuable private information trade in stocks and derivatives? How does private information flow into stock and option prices? Do measures of adverse selection in option and stock markets respond to the presence of informed trading?

Addressing these questions is challenging because the identity of informed investors and the timing of their trades is typically unobservable to econometricians. Standard approaches in the literature to overcome this challenge include studying periods of time when informed trading is likely (e.g., M&A announcements) or assuming that a class of investors is informed (e.g., corporate insiders or institutional investors). Researchers have also used traders that are involved in illegal insider trading to study informed trading in options (Kacperczyk and Pagnotta, 2016). Whereas these traders are clearly informed, there are strong selection concerns due to the fact that these traders were caught precisely because they were trading in a very unusual way.

In this paper we use a data set where we have detailed information about the timing of both stock and option trades by investors who we can identify as having substantial private information to study informational linkages between stock and option markets. More specifically, we follow Collin-Dufresne and Fos (2015) and exploit a disclosure requirement Rule 13d-1(a) of the 1934 Securities Exchange Act to identify trades that rely on valuable private information. Rule 13d-1(a) requires investors to file with the SEC within 10 days of acquiring more than 5% of any class of securities of a publicly traded company if they have an interest in influencing the management of the company. In addition to having to report their actual position at the time of filing, Item 6 of Schedule 13D requires the filer to disclose whether or not derivative contracts have been used. Moreover, Item 5(c) of Schedule 13D requires the filer to report the date, price, and quantity of all trades in the target company executed during the 60 days that precede the filing date. Thus, we not only know when Schedule 13D filers trade, but also what market (stock vs option) they participate in.

To the best of our knowledge, this is the first paper to use Schedule 13D trades to study informational linkages between option and stock markets. We document several new facts. First, we find that Schedule 13D filers' trades contain information about both the direction and the volatility of future stock returns. An average Schedule 13D filing in our sample is characterized by a positive and significant market reaction upon announcement. For example, the cumulative return in excess of the market is about 6% in the (t-10,t+1) window around the filing date. Moreover, stock price volatility drops by about 10% after the filing date. Whereas stock price implications of Schedule 13D filings have been studied before (e.g., Brav et al., 2008; Collin-Dufresne and Fos, 2015), the evidence on the changes in realized volatility is new.

Second, we show that both directional and volatility information is reflected in stock and option prices prior to Schedule 13D filing days. When we consider stock prices, we find that about half of the directional private information is reflected in stock prices

prior to the schedule 13D filing public announcement date. The results are even stronger for volatility. We find that option implied volatilities decline closer to the filing date, suggesting that option prices anticipate the future drop in realized volatility after the filing date. In fact, when we split the target firms into large (positive), average, and small (negative) future changes in realized volatility, we find that implied volatilities correctly track future realized volatilities in each sample. We further find that implied volatility smiles and time-slopes steepen substantially closer to the filing date, reflecting higher chances of a large informational event. Overall, these results indicate that stock and option prices reflect a substantial part of directional and volatility private information.

Third, we document when and how this class of informed traders uses derivatives. We find that Schedule 13D filers rarely use derivatives. Specifically, only in 66 out of 2,905 Schedule 13D filings we analyze do informed investors disclose the usage of derivatives. That is, in about 98% of cases Schedule 13D filers decide to trade exclusively in the stock market. This is despite the fact that Schedule 13D filers build economically significant positions: the average toehold held at the filing date is more than 7% of outstanding shares. This finding suggests that derivatives may not be that attractive for this class of informed traders and that they play a minor role in activists' trading strategies. This result is consistent with the theoretical model developed in Easley et al. (1998), which predicts that informed traders are not likely to use derivatives if the leverage advantage conferred by options is not large enough. Their model also predicts that usage of derivatives should increase if they are more liquid. Consistently, we find that when exchange traded options are available then usage by activists increases (from 2% to 10% of cases). In that case, they use OTC derivatives in around 35% of cases and exchange-listed derivatives in around 65% of cases. When they do use derivatives then activists seek to increase their overall economic exposure to the stock (and not to hedge their risk). They achieve 2.3% long exposure (as measured by the percentage of outstanding shares) via derivatives and 6.4% via stocks, which together is 1.2% more than what they achieve when trading only stocks.

Fourth, we study the role of informed trading in price discovery. In general, researchers do not observe trades by informed investors. The key advantage of our study is that we not only know when Schedule 13D filers trade, but also what market (stock vs option) they participate in. We find that when Schedule 13D filers trade in the *stock* market, directional private information flows into stock prices and volatility private information flows into option prices. This holds even when we restrict the sample to events where Schedule 13D filers did not use any derivatives.

The main implication is that option market makers must infer option-payoff-relevant private information from the trading activity and price dynamics of the stock market and not from that of the option market. Supporting this interpretation, we find that controlling for observable stock market trading activity and price dynamics explains a significant part (but not all) of the change in the measures of implied volatility and option bid-ask spreads on days when Schedule 13D filers trade. Further, we find that the cross-market impact of Schedule 13D filers stock trades on option implied volatilities and bid-ask spreads is stronger if stock and option markets are more integrated, as measured by the magnitude of observed put-call parity violations. Finally, we show that option market outcomes change not only on days when Schedule 13D filers trade stocks, but also on surrounding days and more significantly in the two days following activists' trades. These findings are consistent with option market makers not observing the actual activists' stock trades, but rather learning from a set of signals that are correlated with the activists' trading activity in the stock market.

The paper contributes to several strands of the literature.

First, the paper informs the literature that studies how information flows into option prices. As far as stock return predictability is concerned, Conrad et al. (2013) show that future stock returns are correlated with volatility skew, Johnson and So (2012) and Ge et al. (2015) show that future stock returns are correlated with option-to-stock volume, and Pan and Poteshman (2006) and Hu (2014) show that future stock

returns are correlated with option order imbalance. Aragon and Martin (2012) show that institutional investors long positions in options predict both future stock returns and volatility and Ni et al. (2008) show that option order imbalance is correlated with future realized volatility. Our contribution is to show, using a unique feature of our data which provides information on when Schedule 13D filers trade in both stock and option markets, that information flows into option prices when Schedule 13D filers trade stocks.[1]

Second, the paper contributes to the literature that studies option markets around major corporate events. The literature considers M&A deals (e.g., Cao et al., 2005; Augustin et al., 2014), analyst revisions (e.g., Hayunga and Lung, 2014), stock splits (e.g., Gharghori et al., 2016), and illegal insider trading (e.g., Kacperczyk and Pagnotta, 2016; Ahern, 2017). Whereas the existing empirical literature on Schedule 13D filings is focused on stock price changes (e.g., Brav et al., 2008; Klein and Zur, 2009; Collin-Dufresne and Fos, 2015), our paper is the first to show that stock volatility drops around Schedule 13D filings. Moreover, we are the first to analyze the flow of directional and volatility private information into option prices during these events. Importantly, our analysis is based on precise information about the timing (days) and location (stocks vs. options) of informed trades.

Third, the paper contributes to literature that studies the relation between realized and future volatility. The existing literature suggests that implied volatility is a good forecast of future realized volatility (e.g., Poon and Granger, 2003). Our contribution is to show that implied volatility also forecasts private information events, such as Schedule

[1] A recent paper by Goncalves-Pinto et al. (2017) argues that the option to stock predictability could be due to temporary price-pressure in the stock market (due to uninformed trading) that is not reflected in the option market. They document empirically that the actual stock price exhibits short-lived deviations from the option implied stock price that are correlated with the signed order-flow in the stock market. Interestingly, we also find (see appendix) that there are significant deviations between the actual stock price and the option implied stock price on days where the (informed) activists trade in the stock market, but their price impact is permanent and the changes in option implied volatilities observed on these days are persistent.

13D filings. A distinct feature of Schedule 13D filings is that the occurrence of the event is controlled by the informed trader—the Schedule 13D filer. That is, even though the mere occurrence of the informational event is Schedule 13D filer's private information, option prices are informative about the timing of the event.

Finally, our paper contributes to the literature that studies the use of derivatives by activist shareholders.[2] Theoretical literature suggests that activist shareholders may use derivatives to separate positions in a firm's shares and votes (e.g., Brav and Mathews, 2011; Burkart and Lee, 2015). Christoffersen et al. (2007) document an active market for votes and document that the average vote sells for zero. Anecdotal evidence on the usage of derivative to decouple economic exposure and voting rights are reported by Hu and Black (2007). Our paper contributes to the literature by showing that Schedule 13D filers rarely use derivatives. Moreover, when activists do use derivatives, they seek to increase their overall economic exposure to the stock. Thus, our large sample evidence does not support the idea that derivatives are generally used by activists to decouple economic exposure from voting rights.

The paper is organized as follows. Section I presents the institutional background and describes the data. The magnitude and types of information asymmetry are analyzed in Section II. Section III shows that directional and volatility private information flows into stock and option prices. Section IV analysis how private information flows into prices. Finally, Section V concludes.

[2]Whether or not activists use derivatives has important corporate governance implications and has attracted attention of academics as well as of practitioners. For example, in their petition for changing Section 13D, Wachtell, Lipton, Rosen & Katz argue that *"The increasing use of derivatives has accelerated the ability of investors to accumulate economic ownership of shares, usually with substantial leverage."*. The full text of the petition is available at http://www.sec.gov/rules/petitions/2011/petn4-624.pdf.

I. Institutional Background and Sample Description

Rule 13d-1(a) of the 1934 Securities Exchange Act requires investors to file with the SEC within 10 days of acquiring beneficial ownership of more than 5% of a voting class of a company's equity securities registered under Section 12 of the Securities Exchange Act of 1934. We refer to the date when the beneficial ownership crosses the 5% threshold as the 'event date' and to the date when the filing is sent to the SEC as the 'filing date.'

Shares of common stock and options to purchase physical shares within 60 days are examples of equity securities that can trigger the filing. Because all exchange-listed derivatives in the United States are settled in physical delivery and are immediately exercisable, they count towards the computation of the 5% beneficial ownership threshold. In contrast, any instrument that is exclusively cash-settled or is not exercisable within 60 days does not. For example, any cash-settled over-the-counter (OTC) derivative agreement (options, equity swaps, etc.) will not result in beneficial ownership and therefore will not trigger a Schedule 13D filing. For example, a shareholder who owns 3% of common stock and cash-settled options that result in additional 4% of common stock exposure upon exercise is not required to file a Schedule 13D. Thus, whether a derivative security triggers a Schedule 13D filing depends crucially on the way the derivative is settled.

Item 6 of the Schedule 13D requires the filer to *"Describe any contracts, arrangements, understandings or relationships [...] with respect to any securities of the issuer, including but not limited to transfer or voting of any of the securities, finder's fees, joint ventures, loan or option arrangements, puts or calls, guarantees of profits, division of profits or loss, or the giving or withholding of proxies, naming the persons with whom such contracts, arrangements, understandings or relationships have been entered into."* Note that Item 6 covers all types of derivative contracts (settled in either physical or cash delivery). Thus, even if activists used non-traditional or cash-settled derivatives which do not count toward the 5% threshold, these positions have to be disclosed in Item

6 of the Schedule 13D filing. We therefore use Item 6 to identify whether a Schedule 13D filer uses derivatives.[3]

Information on trades executed by Schedule 13D filers is reported in Item 5(c). Item 5(c) of Schedule 13D requires the filer to report the date, price, and quantity of all trades in the underlying security (common stock) executed during the 60 days that precede the filing date.[4]

The sample of Schedule 13D filings with information on trades is constructed as follows.[5] First, using an automatic search script, we identify 19,026 Schedule 13D filings from 1994 to 2010. The script identifies *all* Schedule 13D filings that appear on EDGAR. Next, we check the sample of 19,026 filings manually and identify events with information on trades. Since the trading characteristics of ordinary equities might differ from those of other assets, we retain only assets whose CRSP share codes are 10 or 11, that is, we discard certificates, ADRs, shares of beneficial interest, units, companies incorporated outside the U.S., Americus Trust components, closed-end funds, preferred stocks, and REITs. We further exclude stocks whose prices are below $1 and above $1,000. Finally, we exclude Schedule 13D/A filings (i.e., amendments to previously submitted filings) that are mistakenly classified as original Schedule 13D filings. Moreover, we exclude events during 1994 and 1995 because OptionMetrics coverage starts in 1996.

The final sample comprises the universe of all Schedule 13D filings that satisfy the above criteria from 1996 to 2010, which totals 2,905 events. During the sample

[3]The rule does not specify what information needs to be disclosed. It is up to the filer to decide the precision of the information she discloses. Therefore, we find substantial variation in the precision of disclosed information. Finally, note that all other items of Schedule 13D filing do not require disclosure of any information about derivatives as long as the subject security is common stock. Of course, it can be that the 5% threshold was crossed with a position in a derivative security only. In this case the derivative security is the "subject security" and therefore all items of Schedule 13D filing will have information about the derivative security (the subject security).

[4]To quote from Item 5(c), filers have to "...describe any transactions in the class of securities reported on that were effected during the past sixty days or since the most recent filing of Schedule 13D, whichever is less,..."

[5]See Collin-Dufresne and Fos (2015) for detailed description of the procedure.

period, on average 194 events take place each year. Importantly, our top-down approach guarantees that the sample contains *all* Schedule 13D filings with information on trades. The time series distribution of events is reported in the Appendix.

For each event we extract the following information from the Schedule 13D filings: the CUSIP of the underlying security, transaction date, transaction type (purchase or sell), transaction size, and transaction price. In addition, we extract the filing date, event date (date on which the 5% threshold is crossed), and beneficial ownership of the Schedule 13D filer at the filing date. In the vast majority of cases transaction data are reported at a daily frequency. If the transaction data are at a higher-than-daily frequency, we aggregate them to the daily level. Specifically, for each day we calculate the total change in stock ownership and the average purchase price. The average price is the quantity-weighted average of transaction prices.

We compile additional data from several sources. Stock returns, volume, and prices come from the Center for Research in Security Prices (CRSP). Intraday transactions data (trades and quotes) come from the Trade and Quote (TAQ) database. Daily data on prices and trading volume of exchange-traded options as well as their implied volatilities come from OptionMetrics. Order imbalance data for exchange traded options are provided by the International Securities Exchange. These data start in 2005. See Muravyev (2015) for further details. Table A1 defines all variables and Table A2 in the Appendix reports summary statistics of all variables.

II. Stock Prices and Realized Volatility around the Filing Date

In this section we document changes in stock prices and realized volatility around the filing date. On the filing date it becomes common knowledge that an activist shareholder has accumulated a significant position in the company and has an intention to influence the company's management.

Panel A in Figure 1 plots the average buy-and-hold return, in excess of the buy-and-hold return on the value-weighted NYSE/Amex/NASDAQ index from CRSP, from 50 days prior to the filing date to 40 days afterward. As can be seen, there is a run-up of about 2% from 50 days to one day prior to the filing date. The two-day jump in excess return observed at the filing date is around 2.5%. After that the excess return remains positive for about 10 days and cumulates to a total of 5.5%, which significantly greater than zero (see Collin-Dufresne and Fos (2015) for a formal test). Thus, the stock market reaction to Schedule 13D filings is favorable and this level effect is largely permanent, as there is no evidence of significant reversal several quarters after the filing date (see also Brav et al., 2008; Klein and Zur, 2009; Collin-Dufresne and Fos, 2015).

[Insert Figure 1 here]

Note that Schedule 13D filers trade on long-lived information that, by its very nature, is not likely to be available to other market participants. In most cases, these activist shareholders know they can increase the value of the firm they invest in by their own effort (e.g., shareholder activism). Their effort level is, of course, conditional on their achieving a large stake in the firm. It is their very actions and shareholdership that constitute the "private" information in such cases. Only when they file with the SEC, at most 10 days after their holdings reach the 5% threshold, does the information become public. The extent to which the market believes their future actions have value over and above what is already impounded in prices can be measured using announcement returns. The evidence reported in Panel A of Figure 1 strongly supports the assumption that Schedule 13D filers possess valuable information on the underlying securities when they trade in the pre-announcement period.[6]

[6]In addition to the average buy-and-hold return, we follow Collin-Dufresne and Fos (2015) and analyze profits made by Schedule 13D filers on purchasing stocks at the pre-announcement prices. The results are reported in Table A3 in the Appendix and suggest that Schedule 13D filers make significant profits. For example, a Schedule 13D filer who acquires a $62 million stake in a $874 million market

We next investigate changes in realized volatility around the filing date. The realized volatility is calculated as the absolute value of daily stock return (and for robustness we also computed realized volatility measures from intra-day data). The results are reported in Panel B of Figure 1, which plots the realized volatility from 50 days before the filing date to 50 days after. The dark (gray) line plots the realized volatility for the sample of event (matched) stocks. Matched stocks are assigned based on the same industry, market cap, and previous year volatility. We find that the realized volatility is about 48% for event and matched stocks prior to the filing date. It jumps up on the filing date to 52% on the filing date (when the event becomes common knowledge), corresponding to an 11% increase. After the filing date the realized volatility decreases to about 44%. Figure A2 in the Appendix shows that there is a similar pattern of realized volatility around the filing date in the full sample of Schedule 13D filings (i.e., when we remove the requirement of target stocks having listed options).

Table I confirms the pattern we observe in Figure 1. Whereas the realized volatility measures increase insignificantly for the sample of matched stocks, there is a substantial reduction in these measures for the sample of event firms. For example, the realized volatility calculated using intra-day data decreases from 0.47 to 0.43 around the filing date, corresponding to a 9% reduction. When we consider the difference in changes of realized volatility between event and matched stocks, we find very similar results. The difference-in-differences estimates are negative and highly significant statistically. Overall, the evidence shows that the realized volatility drops after the filing date and takes more than thirty days to recover.[7]

[Insert Table I here]

cap company (i.e., a 7.14% stake, which is the average stake size in our sample) expects to benefit $2.35 million.

[7]Realized volatility could drop for several reasons. First, residual uncertainty may be resolved due to the announcement and filing of the activists' intensions. Second, activist shareholders can promote changes in corporate policies that lead to less uncertainty about future stock performance. Third, volatility can drop if the trading patterns of market participants change after the filing date.

The evidence indicates that there are two types of valuable private information revealed on the filing date. First, the excess return from 50 days prior to the filing date to 10 days after the filing date is positive and cumulates to a total of 6.5%. Thus, there is 'directional' private information. Panel A in Figure 1 shows that excess returns on event stocks are positive prior to the filing date. In fact, about half of the directional private information is reflected in stock prices prior to the filing date. Moreover, Collin-Dufresne and Fos (2015) show that directional information flows into stock prices when Schedule 13D filers purchase shares.

Importantly, the results reveal a novel empirical regularity about Schedule 13D filings: the realized volatility decreases around the filing. Specifically, the realized volatility decreases by about 10% after the filing date if we exclude the announcement day return (and about 20% if we include it). This is consistent with the presence of private information about volatility. We next investigate whether option markets reflect that private information *prior* to Schedule 13D filing dates.

III. Does volatility information flow into option prices?

In this section we investigate whether private information is incorporated into *option* prices. Whereas informed traders can potentially trade on directional information in either stock or option markets, they can only trade on volatility information in non-linear securities such as options.

Panel A in Figure 2 shows both the *future* 30-day realized volatility and the 30-day implied volatility from option prices. Both volatilities decrease in lock-step starting 30 days prior to the filing date. Clearly, the average implied volatility closely tracks the average *future* realized volatility on our target firms around the filing date. Further evidence that implied volatilities are efficiently predicting future realized volatility can be gleaned by considering the profitability of a trading strategy that would sell delta-hedged option straddles to benefit from the future drop in realized volatility around the

filing date. Such a strategy would earn an average pre transaction costs excess return of 5.5% during the 30 days pre-filing, which would be dwarfed by the option bid-ask spread (around 8%) and stock transaction costs (see Figure A3 in the appendix).

[Insert Figure 2 here]

To further investigate the relation between implied and future realized volatilities, we test whether the predictability holds when we condition on future changes in realized volatility. Specifically, we consider three sub-samples: (1) events with large drops in realized volatility around filing date, (2) events with small changes in realized volatility around filing date, and (3) events with an increase in realized volatility around filing date. Figure 3 reports the results. The results again clearly indicate that even *conditionally* implied volatility predicts future realized volatility.

[Insert Figure 3 here]

We next ask whether option prices reflect the timing and the size of the informational event. To address this question, we plot changes in time slope around the filing date. Time slope is defined as the ratio of implied volatilities for call options with 30 days to expiration and call options with 365 days to expiration, minus one. Panel B in Figure 2 presents the results and shows that the ratio between short-term and long-term implied volatilities increases closer to the filing date. This evidence suggests that option prices reflect a higher chance of an informational event in the short term relative to the long term.

To further investigate whether option prices reflect higher chances of a large stock price move, we next investigate implied volatility skews. Panels C and D of Figure 2 plot Put and Call options implied volatility skews around the filing date. Put skew is defined as the ratio of implied volatilities for out-of-the-money and at-the-money put

options, minus one. We find that put skew increases substantially closer to the filing date. In contrast, there is no change in put skew for the sample of matched stocks. Call skew is defined as the ratio of implied volatilities for out-of-the-money and at-the-money call options, minus one. Similarly to the results for put options, we find that call skew increases substantially closer to the filing date for our target stocks, but that there is no change in call skews for the sample of matched stocks.

Overall, option prices reflect higher chances of a substantial stock price movement closer to the filing date. Table II confirms the pattern we observe in Figure 2. In this table we compare differences in changes of outcome variables from (t-60,t-31) days prior to the filing date t to (t-30,t-1) days prior to the filing date between event and matched stocks.

[Insert Table II here]

First, consider changes in option market outcomes closer to the filing date. We analyze put skew, call skew, time slope, implied volatility of call options, changes in implied volatility of call options, implied volatility of put options, and changes in implied volatility of put options. Panel A in Table II reports the results. Confirming patterns documented in Figure 2, we find significant increases in put skew, call skew, and time slope as well as significantly lower levels of implied volatilities closer to the filing date. Thus, option prices change substantially closer to the filing date. Specifically, changes in implied volatilities reflect higher chances of an informational event and changes in time slope of implied volatilities indicate that market participants anticipate the timing of the event.[8]

[8]We also consider changes in stock market outcomes closer to the filing date. We follow Collin-Dufresne and Fos (2015) and analyze excess return, volatility, volume, and bid-ask spread. Consistently with Collin-Dufresne and Fos (2015), we find that changes in excess returns are higher for event stocks relative to matched stocks. This is consistent with the evidence reported in Figure 1. We also find that volatility (insignificantly) decreases and trading volume increases closer to the filing date.

Overall, the evidence indicates that volatility private information flows into option prices. In the next section we analyze *how* that information flows into option prices.

IV. How does private information flow into prices?

In this section we study the role of informed trading in price discovery using the information on Schedule 13D filers' trades in both stock and option markets. We begin from describing potential channels through which volatility private information could flow into option prices. First, the information could flow through activists' trades in the option market. Schedule 13D filers could trade options with an intention to benefit from volatility private information. The price-impact of their trades in options could lead to a decrease in implied volatility and increases in skew, time-slope, and option bid-ask spread.

Second, the information could also flow through activist's trades in the stock market. Schedule 13D filers' trades price impact in the stock market could help option-market participants make inferences about the stock's future volatility. In this case, the flow of information into option prices should be stronger when the level of integration between stock and option markets is high. Moreover, controlling for stock market outcomes (return and order-flow dynamics) should mitigate the relation between Schedule 13D filers' trades in the stock market and option market outcomes.

To evaluate these predictions empirically, one needs to observe where informed investors trade. Whereas in general market participants and researchers do not know whether informed trading is taking place, the unique feature of our data set allows us to know (i) whether Schedule 13D filers traded options and/or stocks, (ii) activists' positions in options and stocks, and (iii) days when informed investors trade and days when they do not trade. We next explore our data to shed light on the channel through which volatility private information flows into option prices.

A. When do activists use derivatives?

How often do activists use derivatives? To address this question, we manually check all Schedule 13D filings in our sample for information on any type of derivatives. We find that activists do not use derivatives in the vast majority of Schedule 13D campaigns. Specifically, we could find information on derivatives only in 66 Schedule 13D filings, corresponding to 2.27% of the sample.

This result is consistent with the theoretical model developed in Easley et al. (1998). The model predicts that informed traders are not likely to use derivatives if the leverage effect of options is not strong enough. Since most of the Schedule 13D filers in our sample are hedge funds this suggests they have access to other sources of leverage. Leverage may also be a reason for the striking difference in usage of derivatives by activist shareholders versus illegal insider traders. In a recent paper, Kacperczyk and Pagnotta (2016) document that traders who are accused of illegal insider trading often use derivatives. These traders are often private individuals, who may find leverage embedded in options particularly attractive.

Easley et al. (1998) also predict that informed traders are more likely to use derivatives if these securities are more liquid. To investigate this conjecture, we check for how many Schedule 13D filings targets have exchange-traded options. For every event, we calculate the number of days with positive option trading volume during an 80-day period prior to the filing date. For each event, we set 'Options available' indicator to one if the number of days with days with positive option trading volume exceeds 40, and zero otherwise.

Indeed, we find that exchange-traded options are available in 580 events, corresponding to 20% of the events.[9] When exchange-traded options are available, the probability that an activist uses derivatives (including OTC) is 10%. In contrast, when

[9]Mayhew and Mihov (2004) study factors influencing the selection of stocks for option listing.

exchange-traded options are not available, the probability that the activist discloses information on derivatives decreases to 0.34%. Thus, the availability of exchange-traded options is a strong predictor of the usage of derivatives by activists. In the Internet Appendix we provide further evidence on characteristics of campaigns in which derivatives are used to characteristics of campaigns in which derivatives are not used.

Overall, the evidence indicates that in the vast majority of cases Schedule 13D filers do not use derivatives.[10]

B. How Do Activists Use Derivatives?

Schedule 13D filers disclosed the usage of derivatives in 66 cases. Schedule 13D filers could use derivatives to either increase their exposure to the underlying, to hedge their exposure to the underlying, or to benefit from volatility information. Table III characterizes the usage of derivatives in the full sample (column (1)), in the sample with listed options (column (2)), and in the sample of events in which activists indicated the usage of OTC derivatives (column (3)).

[Insert Table III here]

Full-sample results reveal that activists seek a 'long' stock price exposure in most of events. Specifically, activists hold long call (short put) positions in 84.8% (36.4%) of events. The activists have both long call and short put positions in 24.2% of events.

[10]This finding is consistent with a view that informed trading in option markets is associated with higher risk of detection. In his Bloomberg article, Matt Levine writes "*As I may have mentioned over and over and over and over and over again, the first rule of insider trading is just don't insider trade, but the second rule is: If you have inside information about an upcoming merger, don't buy short-dated out-of-the-money call options on the target. The SEC will get you!*" See https://www.bloomberg.com/view/articles/2014-06-17/there-might-be-a-lot-of-insider-trading. Consistently with this view, Kacperczyk and Pagnotta (2016) find that traders caught in illegal insider trading cases often use derivatives. It could however also indicate that schedule 13D filers misreport their option trading to the SEC (but given they are actually filing a 13D this seems like a dangerous strategy).

Further, the activists have long equity swap positions in 10.6% of events. Either short call positions or long put positions are rare. In less than 2% of events activists had no long exposure through positions in derivatives. Overall, the evidence indicates that the main driving force behind the usage of derivatives by Schedule 13D filers is achieving positive exposure to targets' stock prices. This result is not consistent with the notion that Schedule 13D filers use derivatives to decouple economic and voting exposure to their targets (Hu and Black, 2007).

When we consider what fraction of activists' beneficial ownership is in derivatives, we find that activists who use derivatives hold on average 6.4% of outstanding common stock in direct stock ownership. In addition, these activists hold 2.3% of outstanding common stock through derivatives positions. Thus, activists who decide to use derivatives achieve more than 25% of the economic exposure through derivatives. We also find that when activists use derivatives, 87.9% of targets have listed stock options and in 42.4% of events activists use over-the-counter derivatives, suggesting that exchange-listed options are not necessary for the activists to achieve exposure through derivatives.

When we relate this result to the percentage of outstanding shares held by activists in cases when activists do not use derivatives, we find that when activists use derivatives they hold a larger proportion of outstanding shares. Specifically, activists hold 7.5% of outstanding shares when no information on derivatives is disclosed (see Collin-Dufresne and Fos, 2015), which is lower than 8.7% reported in the sample of events with information on derivatives (6.4% in direct stock ownership plus 2.3% of outstanding common stock through derivatives positions).

When we compare the full sample results to results in the sub-sample of events with listed options, we find little difference in the way the activists use derivatives. In contrast, we find that activists use derivatives more aggressively when they use over-the-counter derivatives. For instance, activists' exposure through derivatives increases from 2.3% in the full sample to 4.0% when they use over-the-counter derivatives. Similarly,

activists are more likely to seek long exposure in this sub-sample: incidences on long call positions and short put positions are more likely in this sub-sample.

Overall, the evidence suggests that activist rarely use derivatives, in 66 out of 2,905 events. When the do so, they seek long stock price exposure. In less than 2% of 66 events activists had no long exposure through positions in derivatives.

C. The Role of Informed Trading

In this section we investigate the role of informed trading in price discovery. The key feature that distinguishes our paper from existing literature is that we use Schedule 13D filers' trades in option and stock markets to study the flow of information into option prices. We estimate the following regression:

$$y_{it} = \gamma_1 itrade_{it} + \gamma_2 itrade\_opt_{it} + \gamma_3 itrade_{it} * itrade\_opt_{it} + \eta_i + X_t'\gamma_4 + \epsilon_{it}, \quad (1)$$

where y_{it} is a measure of trading activity for company i on day t minus a measure of trading activity for a matched stock, *itrade* indicates days on which Schedule 13D filers trade the stock, *itrade_opt* indicates days on which Schedule 13D filers trade options,[11] X is a vector of control variables (four Fama-French factors and VIX), and η_i are event fixed effects. The interaction term captures days when Schedule 13D filers trade in stock and derivatives markets. The results are reported in Table IV.

[Insert Table IV here]

First, we compare implied volatility measures on days when Schedule 13D filers trade stocks and on days when Schedule 13D filers do not trade stocks (*itrade*). The

[11] While *itrade* is comprehensive in the sense that every stock trade by activists has to be reported and is therefore in our sample, *itrade_opt* is voluntary. That is, since activists are not required to report transactions in derivatives we will know about their trades only when they choose to include their brokerage trade-reports in the filing.

results are reported in Panel A of Table IV and suggest that changes in outcome variables are larger on days when Schedule 13D filers trade stocks than on days when Schedule 13D filers do not trade stocks. Specifically, put and call implied volatility skew measures increase, time slope increases, and put and call implied volatilities decrease when Schedule 13D filers trade stocks. Thus, more information flows into *option* prices on days when Schedule 13D filers trade in the stock market. When we consider days when Schedule 13D filers trade in the option market ($itrade\_opt$), we find no significant changes in implied volatility when Schedule 13D filers trade derivatives, which is consistent with the activists' trades in the option market not carrying incremental volatility information. Interestingly, both put and call implied volatilities are higher on days when Schedule 13D filers trade stocks and options ($itrade * itrade\_opt$).

Next, we consider the relation between Schedule 13D filers' trades and option market bid-ask spreads. The results are reported in Panel B of Table IV. We find that option bid-ask spreads are wider when Schedule 13D filers trade in the underlying shares. In contrast, $itrade\_opt$ indicates that there are no significant changes in option market bid-ask spreads when Schedule 13D filers trade derivatives. The results are robust across different types of options and regression specifications. The positive relation between option market bid-ask spreads and trades by Schedule 13D filers in the stock market suggests that option market makers price the increase in adverse selection risk on days when Schedule 13D filers trade stocks.

To further understand how the information flows into option prices, we study trading activity in the option market. Specifically, we look at put and call volume, and option order imbalance measures. The results are reported in Panels C and D of Table IV. We find that put volume increases significantly on days when Schedule 13D filers trade in the stock market. But, call volume decreases (not statistically significantly) so that total option volume is not significantly different from zero. On the other hand,

both put and call volume are significantly higher on days when schedule 13D filers trade options.

Option volume has little to say about trade direction, i.e. whether investors buy or sell options. To explore this dimension we analyze option order imbalance, computed as the difference between the number of buy and sell-initiated option trades by non-market-makers divided by total number of option trades for a given stock and day.[12] We consider both the total order imbalance and the order imbalance for trades when a new option contract is opened.

Panel D shows that measures of order imbalance are significantly higher only on days when Schedule 13D filers trade both stocks and derivatives ($itrade * itrade\_opt$).

Finally, we describe the relation between Schedule 13D filers' trades in stock market ($itrade$) and stock market activity measures. We compare the market-adjusted returns, bid-ask spread, volatility, and trading volume on days when Schedule 13D filers trade and on days when Schedule 13D filers do not trade during the 60-day disclosure period. The evidence is consistent with trades by Schedule 13D filers affecting stock prices. Consistently with the evidence documented by Collin-Dufresne and Fos (2015), market-adjusted returns ($eret$) are higher by 0.18% on days when Schedule 13D filers trade. Thus, the evidence indicates that on days when Schedule 13D filers trade, prices move in the 'right' direction. Even though they have significant private information (as evidenced by the abnormal profits they generate) we find that, on days when Schedule 13D traders trade stocks, bid-ask spreads are lower and trading volume is higher. These results are consistent with Collin-Dufresne and Fos (2016), who predict that informed traders should select to trade when noise trading activity is large and when price impact is smaller. Finally, we find that the realized volatility is (insignificantly) higher on days

[12]Order imbalance ranges between -1 and +1. Our data identifies who (market-maker or non market-maker) takes each side of option transaction and are aggregated at the option contract by day level. Muravyev (2015) describes the data and order imbalance measures in detail.

when Schedule 13D filers trade, which is also consistent with more information being incorporated in prices on those days.

We next consider days when Schedule 13D filers trade derivatives ($itrade\_opt$). We find that the market-adjusted stock returns, volatility, and trading volume are higher on days when Schedule 13D filers trade options. For example, the market-adjusted returns are higher by 0.52% on days when Schedule 13D filers trade derivatives.

As we discussed in Section I, whereas Schedule 13D filers have to disclose whether they have used derivatives, the precision of the disclosed information is vaguely specified if derivatives are not the subject security. For example, Schedule 13D filers do not have to disclose on what days they traded derivatives. To avoid any selection bias induced by voluntary disclosure of information, hereafter we drop events when activists use derivatives. It leaves us with 522 Schedule 13D filings, where we know when informed activists trade in the underlying shares, as well as that they do not trade any derivatives. Thus, if we detect an impact of informed stock trading on option markets, this cannot be due to the direct effect of informed order flow in options, but rather must be due to an indirect channel, e.g., to option traders reacting to the information revealed by the trading activity in the stock market.

If option market participants infer information from sources unrelated to Schedule 13D filers' trades, then changes in option market outcomes should be similar on days when Schedule 13D filers trade and on days when Schedule 13D filers do not trade. In contrast, if option market participants infer information from sources directly related to Schedule 13D filers' trades in the stock market, the changes in option market outcomes should be larger on days when Schedule 13D filers trade than on days when Schedule 13D filers do not trade. We estimate the following regression:

$$y_{it} = \gamma_1 itrade_{it} + X_t'\gamma_2 + \eta_i + \epsilon_{it}, \tag{2}$$

where y_{it} is a measure of trading activity for company i on day t, *itrade* indicates days on which Schedule 13D filers trade in stock market, X is a vector of control variables (four Fama-French factors and VIX), and η_i are event fixed effects. Results are reported in Table V.

[Insert Table V here]

Overall, the results show that much of the changes in implied volatilities and in option bid-ask spreads happen on days when informed schedule 13D filers trade in the underlying equity market and even though they do not trade any derivatives.

So far, the evidence indicates that when information flows into prices, option bid-ask spreads increase. We next investigate whether this increase in bid-ask spreads reflects increased adverse-selection risk due to directional or volatility information. To capture differences in directional information, we split the sample based on the average buy-and-hold return around the filing date in excess of the buy-and-hold return of the value-weighted market from 30 days prior to the filing date to 1 day afterwards. To capture differences in volatility information, we split the sample based on the difference in realized volatility during (t+2,t+6) and the remaining sample period. For each sub-sample, we report estimates of γ_1 in regression (2). Table VI reports the results.

[Insert Table VI here]

Panel A explores the role of directional information. When we split the sample based on the average buy-and-hold return, we find that both in the high and low buy and hold return sub-samples, the coefficient of *itrade* for the change in option bid-ask is positive and economically significant. However, whereas the point estimate is slightly larger in the high than in the low buy-and-hold return sub-sample (0.40% versus 0.27%), the difference is not statistically significant. In contrast, Panel B shows that

the coefficient of *itrade* is significantly larger when the volatility drop is large. The coefficient is 0.58% when the volatility drop is large (highly statistically significant) versus 0.15% when the volatility drop is small. Overall, the results are consistent with volatility private information contributing more than directional private information to the increase in option bid-ask on days when activist trade stocks.

Column (3) in Table VI shows that changes in option market trading activity are also related to the type of private information. Whereas the coefficient of *itrade* does not change significantly with the magnitude of the directional information (Panel A), it does depend on the magnitude of volatility information (Panel B). The estimate of γ_1 is positive and significant in option trading volume regression when the magnitude of the volatility information is small. In contrast, the estimate is negative and insignificant when the magnitude of the volatility information is large. When we consider the difference between the two estimates, we find that the estimate of γ_1 is significantly more negative when the magnitude of the volatility information increases. This is consistent with option market participants staying out of the market when the magnitude of the volatility information is large.

D. How do option market makers learn about activist trading?

The results in the previous section show that much of the changes in implied volatilities and in option bid-ask spreads happen on days when informed Schedule 13D filers trade in the underlying equity market. This happens even when Schedule 13D filers do not trade any derivatives. In this section we investigate what mechanism might lead option market participants to adjust option prices on days when Schedule 13D filers trade in the underlying equity market.

We perform three tests. First, if option market participants learn from observing stock markets dynamics, then we would expect option prices to better reflect private information that flows into stock prices the higher the level of integration between two

markets. To test this empirically, we use the negative of the average absolute difference between implied volatility for call and put options during (t-90,t-60) prior to filing date as a proxy for integration between stock and option markets. The results are reported in Panel C of Table VI.

We find that the coefficient of *itrade* in the bid-ask spread regression is significantly larger when the level of integration is high. The coefficient is 0.57% when the level of integration is high (highly statistically significant) versus 0.07% when the level of integration is low (indistinguishable from zero). The difference between two coefficients is 0.50% and is highly statistically significant. Overall, the results suggest that private information on which informed investors trade in the stock market is better reflected in option bid-ask spreads when the level of integration between two markets is high.

Second, option market participants could learn from the price and volume activity in the stock market, as well as from lagged measures of price and volume activity in the option market. To investigate this possibility, we estimate equation (2), while expanding the list of control variables to include measures of price and volume activity in stock and option markets. Table VII reports the results.

[Insert Table VII here]

Column (1) reports estimates from the basic specification, which controls for four Fama-French factors and VIX. When we augment the specification with stock market bid-ask spread, stock volume, and realized volatility (column (4)), the coefficient of *itrade* decreases from 0.0361 to 0.0230 in implied volatility regression (Panel A). When we further control for option volume and call skewness, the coefficient of *itrade* further decreases to 0.0205 (column (6)). Taken together, these observable characteristics lead to a significant reduction in the coefficient of *itrade*, explaining about 3/7 of the coefficient. Thus, the results support our conjecture that observable stock and option characteristics

lead market participants to adjust option prices on days when Schedule 13D filers trade in the underlying equity market.

In panel C we report coefficients of *itrade* in implied volatility time slope regression. We find that controlling for basic stock and option market observable characteristics explains about 1/5 of *itrade* coefficient, which decreases from 0.1123 to 0.0879. Similarly, panel D shows that the coefficient of *itrade* in option bid-ask spread regression decreases from 0.33% to 0.27%, corresponding to a reduction of about 1/5 in the coefficient. On the other hand, the same observables do not seem to explain a significant part of the *itrade* coefficient in implied volatility skew regression.

We conclude the analysis in this section by investigating the possibility that option market outcome variables change not only on days when Schedule 13D filers trade stocks, but also on surrounding days. If option market makers observed trades by Schedule 13D filers, option market outcome variables would differ from their normal levels only on days when Schedule 13D filers trade stocks. In contrast, if option market makers use a a variety of observable characteristics (that are not directly observable to the econometrician) that confer them with an imperfect signal of the activists' trading activity, then option market outcome variables would be expected to differ from their normal levels also on days surrounding Schedule 13D filers' trades.

To test this hypothesis, we estimates the following regression:

$$y_{it} = \sum_{\tau=-2}^{\tau=2} \gamma_\tau itrade_{it-\tau} + \eta_i + X_t'\beta + \epsilon_{it}, \tag{3}$$

where y_{it} is an outcome variable for company i on day t minus the outcome variable for the matched stock, $itrade_{it-\tau}$ indicates days before and after days on which Schedule 13D filers trade in stock market, X is a vector of control variables, and η_i are event fixed effects. The results are reported in Table VIII. Columns (1), (3), (5), and (7) report

estimates from regression (2) and columns (2), (4), (6), and (8) report estimates from regression (3).

[Insert Table VIII here]

We find that implied volatility, implied volatility skew, and implied volatility time slope also experience significant changes in the couple of days that surround days when Schedule 13D filers trade the underlying stock. For instance, implied volatility is lower not only on the day when schedule 13D trade the stock but also in the two days prior. Similarly, implied volatility skew and time slope are higher in the two days prior as well as after the day when scheduel 13D trade stocks. Only option bid-ask spread seems to be statistically significantly different only when $itrade = 1$. Overall, the evidence is consistent with option market makers not knowing precisely when Schedule 13D filers trade, but using variables observable to them to infer when informed trading is ocurring.

V. Conclusion

In this paper we use Schedule 13D data on trades by activist investors, who on average have substantial private information, to study how their information flows into stock and option prices. We find that Schedule 13D filers trades contain information about both the direction and the volatility of future stock returns. We find that both types of information are reflected in stock and option prices prior to Schedule 13D filing days. On days when Schedule 13D filers trade in stocks, option prices reflect the adverse selection risk associated with the volatility component of private information rather than the directional component.

We find that this class of informed investors rarely use derivatives. They trade little in derivatives (2.2%), but more (10%) when listed option markets are available. Schedule 13D filers use derivatives to leverage up their position in stocks and reduce the

cost of the HSR disclosure rule. Interestingly, even when informed investors do not trade in derivatives, option markets seem to respond to their trades in the stock market. On days when they trade in stocks, realized volatility increases, implied volatilities decrease, bid-ask spreads in options widen, and put volume increases.

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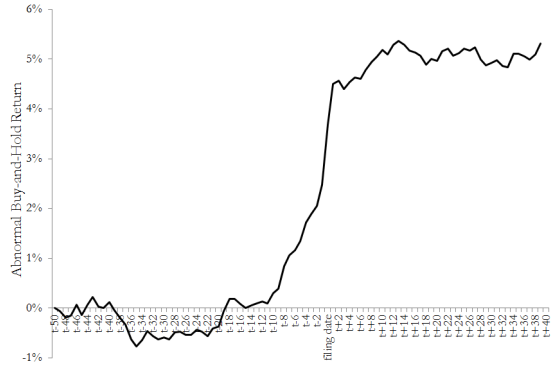
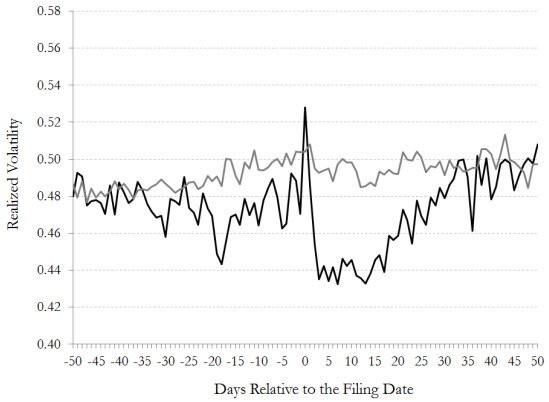
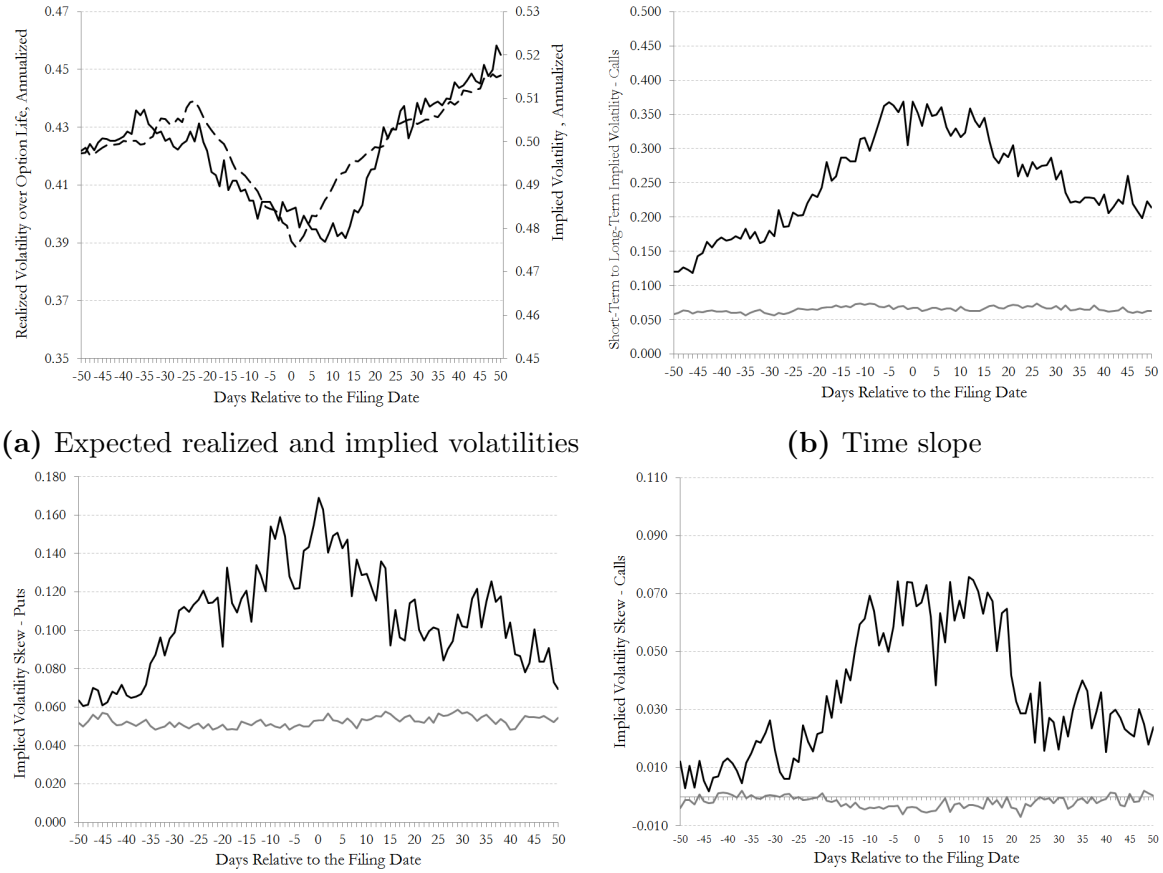


(a) BHAR in excess of the buy-and-hold return of the market.



(b) Realized volatility.

Figure 1
Stock Return and Volatility around the filing date. In Panel A the solid line plots the average buy-and-hold stock return around the filing date in excess of the buy-and-hold return of the value-weighted market from 50 days prior to the filing date to 40 days afterwards. Panel B plots the realized volatility from 50 days before the filing date to 50 days after. The realized volatility is defined in Table A1. The dark (gray) line plots the realized volatility for the sample of event (matched) stocks. Matched stocks are assigned based on the same industry, market cap, and previous year volatility. The filing date is the day on which the Schedule 13D filing is submitted to the SEC. The sample covers 580 Schedule 13D filings in which there are listed options on target firms.



(a) Expected realized and implied volatilities

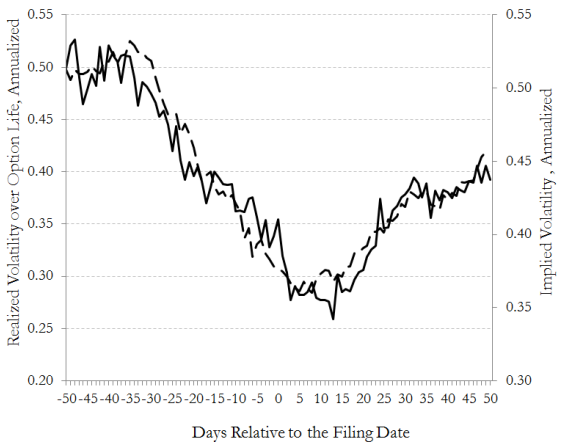
(b) Time slope

(c) Put options implied volatility skew

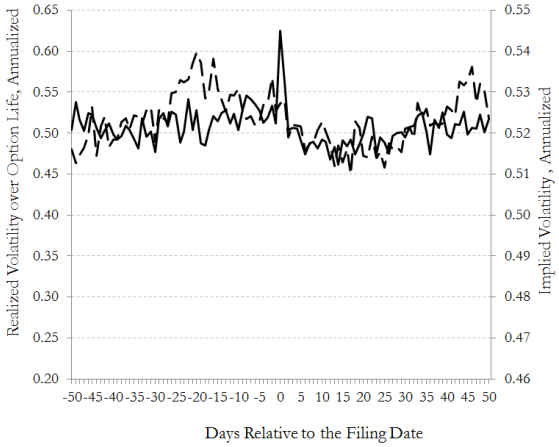
(d) Call options implied volatility skew

Figure 2

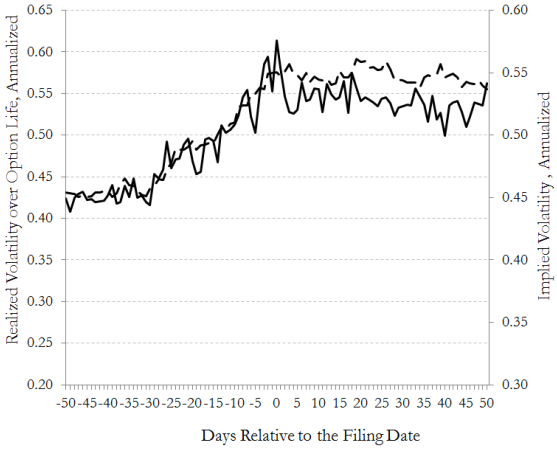
Option implied volatility. In Panel A the dark line plots the average realized volatility over the next month from 50 days before the filing date to 50 days after. The dashed line plots implied volatilities of at-the-money options with one month till expiration. In Panel B the dark (gray) line plots the time slope for the sample event (matched) stocks from 50 days before the filing date to 50 days after. In Panels C and D the dark (gray) line plots put and call skew for the sample event (matched) stocks from 50 days before the filing date to 50 days after. All outcome variables are defined in Table A1. The sample covers 580 Schedule 13D filings in which there are listed options on target firms. Matched stocks are assigned based on the same industry, market cap, and previous year volatility.



(a) Events with large drop in realized volatility.



(b) Events with small change in realized volatility.



(c) Events with an increase in realized volatility.

Figure 3

Implied and future realized volatilities: conditional results. Dark lines plot the average realized volatility over the next month from 50 days before the filing date to 50 days after. Dashed lines plot implied volatilities of at-the-money options with one month till expiration. In Panel A the sample is restricted to events with large decrease in realized volatility around the filing date. In Panel B the sample is restricted to events with small change in realized volatility around the filing date. In Panel C the sample is restricted to events with an increase in realized volatility around the filing date. All outcome variables are defined in Table A1. The sample covers 580 Schedule 13D filings in which there are listed options on target firms.

Table I

Realized volatility around the filing date. This table compares the level of annualized realized volatility before and after the filing date. The realized volatility is defined in Table A1. The sample covers 580 Schedule 13D filings in which there are listed options on target firms. Column (1) reports the average level of realized volatility for 50 days that precede the filing date. Column (2) reports the average level of realized volatility for 50 days after the filing date. Column (3) reports the average change in realized volatility around the filing date and the t-stat of the difference. Columns (4) to (6) repeat the analysis for the sample of matched stocks. Matched stocks are assigned based on the same industry, market cap, and previous year volatility. Column (7) reports the average difference-in-difference in the realized volatility and the t-stat of the difference. *** indicates statistical significance at the 1% level.

	Event stocks			Matched stocks			
	Before	After	Difference	Before	After	Difference	Diff-in-diff
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Realized volatility (daily)	0.4075***	0.3687***	-0.0388***	0.4281***	0.4353***	0.0072	-0.0460***
			[-3.75]			[0.88]	[-3.49]
Realized volatility (intra-day)	0.4700***	0.4328***	-0.0372***	0.4961***	0.5022***	0.0061	-0.0433**
			[-2.70]			[0.51]	[-2.37]

Table II
Does information flow into prices? Difference-in-differences estimates. This table analyzes differences in changes in outcome variables between event and matched stocks during (t-1,t-30) and (t-31,t-60) periods before the filing date. Matched stocks are assigned based on the same industry, market cap, and previous year volatility. All outcome variables are defined in Table A1. Column (1) reports the estimated difference-in-differences coefficients. Column (2) reports the corresponding t-statistics. The sample covers 580 Schedule 13D filings in which there are listed options on target firms. The sample covers the 60-day disclosure period only. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Diff – event (1)	Diff – control (2)	Diff-in-diff (3)	t-stat (4)
Panel A: Option market				
IV Call	-0.0153	0.0064	-0.0217***	-3.10
Change in IV Call	-0.0001	0.0004	-0.0005	-1.30
IV Put	-0.0146	0.0046	-0.0192***	-2.79
Change in IV Put	-0.0002	0.0005	-0.0007*	-1.86
Put skew	0.0170	-0.0032	0.0202***	3.99
Call skew	0.0157	-0.0004	0.0161***	4.26
Time slope	0.1050	0.0111	0.0938***	6.91
Panel B: Stock market				
Excess Return	0.0008	-0.0002	0.0010**	2.21
Volatility	-0.0004	0.0004	-0.0008	-1.45
Vol (log)	0.1913	0.0264	0.1649***	7.32

Table III
How do activists use derivatives? This table shows how activists use derivatives. Column (1) reports results for all Schedule 13D filing with information on derivatives (66 events). Column (2) reports results for sub-sample with available listed options (58 events; see Section A for description of the "options available" criteria). Column (3) reports results for sub-sample with over-the-counter derivatives being used by activists (28 events).

Sample type: Sample size:	Full sample 66 events (1)	Listed options 58 events (2)	Over-the-counter 28 events (3)
Types of derivatives			
Long Call	0.848	0.828	0.964
Short Put	0.364	0.396	0.429
Long Call and Short Put	0.242	0.259	0.428
Long Equity Swap	0.106	0.121	0.107
Short Call	0.054	0.054	0.000
Long Put	0.000	0.000	0.000
No Long Exposure	0.015	0.017	0.000
Ownership structure			
Beneficial ownership - derivatives	2.3%	2.1%	4.0%
Beneficial ownership - common stock	6.4%	6.3%	5.4%
Sample type			
Options Available	0.879	1.000	0.714
Over-the-counter	0.424	0.345	1.000

Table IV

The flow of information into prices and informed trading. This table compares the outcome variables on days when Schedule 13D filers trade and on days when Schedule 13D filers do not trade. All outcome variables are defined in Table A1. The table reports estimates of γ_1, γ_2, and γ_3 from regression (1): $y_{it} = \gamma_1 itrade_{it} + \gamma_2 itrade\_opt_{it} + \gamma_3 itrade_{it} * itrade\_opt_{it} + \eta_i + X_t'\gamma_4 + \epsilon_{it}$, where y_{it} is a measure of trading activity for company i on day t minus a measure of trading activity for the matched stock, *itrade* indicates days on which Schedule 13D filers trade in stock market, *itrade_opt* indicates days on which Schedule 13D filers trade in option market, X is a vector of control variables (four Fama-French factors and VIX), and η_i are event fixed effects. Matched stocks are assigned based on the same industry, market cap, and previous year volatility. The sample covers 580 Schedule 13D filings in which there are listed options on target firms and covers (t-1,t-60) period before the filing date. Heteroskedasticity-robust standard errors are clustered at the event level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	itrade	t-stat	*itrade_opt*	t-stat	*itrade*∗ *itrade_opt*	t-stat	N
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Implied volatility							
IV Call	-0.0327***	-4.98	0.0093	0.91	0.0470***	2.89	38,988
Change in IV Call	-0.0022***	-3.73	0.0004	0.15	-0.0145	-0.99	38,481
IV Put	-0.0289***	-4.38	0.0062	0.62	0.0688***	2.73	38,988
Change in IV Put	-0.0012**	-2.30	0.0004	0.16	0.0154	1.10	38,481
Panel B: Measures based on implied volatility							
Put skew	0.0268***	4.77	0.0126	1.35	0.0141	0.47	38,988
Call skew	0.0201***	4.03	0.0037	0.45	-0.0474	-1.31	38,988
Time slope	0.1069***	6.45	-0.0063	-0.35	0.2779	1.57	38,988
Panel C: Bid-Ask spread							
All options	0.0030***	3.37	0.0001	0.08	0.0000	-0.01	32,193
Call options	0.0028***	2.98	-0.0012	-0.63	0.0048	0.73	30,611
Put options	0.0028***	2.71	0.0017	0.94	-0.0066	-0.83	29,870
Panel D: Trading activity							
Option Volume (log)	-0.0202	-0.24	0.7466***	4.58	-0.1725	-0.28	38,827
Put volume (log)	0.2564***	2.77	0.5628*	1.87	0.4434	0.65	38,827
Call volume (log)	-0.1341	-1.46	0.7805***	5.14	-0.3197	-0.53	38,827
Panel E: Order Imbalance							
All trades	-0.0072	-0.49	0.0340	0.87	0.0654*	1.79	11,816
Open trades	-0.0064	-0.40	0.0212	0.62	0.0751**	2.32	11,816
Panel F: Stock market							
Excess Return	0.0018***	3.81	0.0052**	2.21	-0.0035	-0.38	39,113
Bid-ask Spread	-0.0004***	-3.27	0.0001	0.45	0.0011*	1.66	37481
Volatility	0.0003	0.69	0.0049**	1.98	0.0127	1.14	39,113
Vol (log)	0.3485***	13.23	0.2865***	3.84	-0.0684	-0.35	39,113

Table V
The flow of information into prices and informed trading: No derivatives are used. This table compares the outcome variables on days when Schedule 13D filers trade and on days when Schedule 13D filers do not trade. All outcome variables are defined in Table A1. The table reports estimates of γ_1 from regression (2): $y_{it} = \gamma_1 itrade_{it} + \eta_i + X_t'\gamma_3 + \epsilon_{it}$, where y_{it} is a measure of trading activity for company i on day t minus a measure of trading activity for the matched stock, *itrade* indicates days on which Schedule 13D filers trade in stock market, X is a vector of control variables (four Fama-French factors and VIX), and η_i are event fixed effects. Matched stocks are assigned based on the same industry, market cap, and previous year volatility. The sample covers 522 Schedule 13D filings in which there are listed options on target firms but Schedule 13D filers do not use any type of derivatives and covers (t-1,t-60) period before the filing date. Heteroskedasticity-robust standard errors are clustered at the event level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	itrade (1)	*t*-stat (2)	*N* (3)
Panel A: Implied volatility			
IV Call	-0.0361***	-4.67	35,681
Change in IV Call	-0.0026***	-4.24	35,346
IV Put	-0.0317***	-4.71	35,815
Change in IV Put	-0.0013**	-2.25	35,346
Panel B: Measures based on implied volatility			
Put skew	0.0285***	4.65	35,681
Call skew	0.0356***	3.71	27,510
Time slope	0.1123***	6.25	35,681
Panel C: Bid-Ask spread			
All options	0.0033***	3.22	27,510
Call options	0.0030***	3.10	27,510
Put options	0.0030***	2.77	27,158
Panel D: Trading activity			
Option Volume (log)	-0.0159	-0.19	35,675
Put volume (log)	0.2503***	2.68	35,675
Call volume (log)	-0.1307	-1.42	35,675
Panel E: Order Imbalance			
All trades	-0.012	-0.82	10,338
Open trades	-0.0118	-0.72	10,338
Panel F: Stock market			
Excess Return	0.0019***	4.16	35,917
Bid-ask Spread	-0.0004***	-3.28	34,366
Volatility	0.0004	0.84	35,917
Vol (log)	0.3496***	13.01	35,919

Table VI

Cross-section variation tests. This table presents cross-sectional variations in the relations between changes in option market bid-ask spread, implied volatility, and option market volume reported in Table V. Columns (1) and (3) report estimates of γ_1 from regression (2): $y_{it} = \gamma_1 itrade_{it} + \eta_i + X_t'\gamma_3 + \epsilon_{it}$, where y_{it} is option bid-ask spread for company i on day t minus option bid-ask spread for the matched stock, *itrade* indicates days on which Schedule 13D filers trade in stock market, X is a vector of control variables, and η_i are event fixed effects. Matched stocks are assigned based on the same industry, market cap, and previous year volatility. Columns (2) and (4) report the corresponding t-statistics, calculated using heteroskedasticity-robust standard errors clustered at the event level. In Panel A we split the sample based on CAR, which is the average buy-and-hold return around the filing date in excess of the buy-and-hold return of the value-weighted market from 30 days prior to the filing date to 1 day afterwards. It measures the magnitude of directional private information. In Panel B we split the sample based on volatility drop, which is the difference in realized volatility during (t+2,t+6) and the remaining sample period. It measures the magnitude of volatility private information. In Panel C we split the sample based on the level of integration between stock and option markets. We use absolute difference between implied volatility for calls and puts during (t-90,t-60) as a proxy for integration between stock and option markets. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Option bid-ask spread		Option volume (log)	
	Coefficient	t-stat	Coefficient	t-stat
	(1)	(2)	(3)	(4)
Panel A: Sort on CAR around Schedule 13D filing date				
Large CAR	0.0040***	3.29	-0.0126	-0.13
Small CAR	0.0027***	2.98	0.0050	0.05
Difference	0.0013	0.89	-0.0176	-0.13
Panel B: Sort on volatility drop around Schedule 13D filing date				
Large volatility drop	0.0058***	3.99	-0.1450	-1.42
Small volatility drop	0.0015**	2.04	0.1439*	1.72
Difference	0.0043***	2.63	-0.2889**	-2.19
Panel C: Sort on the level of integration between stock and option markets				
High integration	0.0057***	5.00	-0.0574	-0.69
Low integration	0.0007	0.71	0.0562	0.53
Difference	0.0050***	3.38	-0.1136	-0.85

Table VII

Do observable characteristics explain changes in implied volatility and option bid-ask spread? This table compares implied volatility measures and option bid-ask spread on days when Schedule 13D filers trade and on days when Schedule 13D filers do not trade, while expending the list of control variables. All variables are defined in Table A1. The table reports estimates of γ_1 from regression (2): $y_{it} = \gamma_1 itrade_{it} + \eta_i + X_t'\gamma_3 + \epsilon_{it}$, where y_{it} is an outcome variable for company i on day t minus the outcome variable for the matched stock, *itrade* indicates days on which Schedule 13D filers trade in stock market, X is a vector of control variables, and η_i are event fixed effects. Matched stocks are assigned based on the same industry, market cap, and previous year volatility. In each panel, we report the difference between the coefficients in columns (6) and (1) and the corresponding χ^2-statistics. The sample covers 522 Schedule 13D filings in which there are listed options on target firms but Schedule 13D filers do not use any type of derivatives and covers (t-1,t-60) period before the filing date. Heteroskedasticity-robust standard errors are clustered at the event level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Implied volatility						
itrade	-0.0361***	-0.0303***	-0.0316***	-0.0230***	-0.0228***	-0.0205***
	[-4.67]	[-4.11]	[-4.36]	[-3.73]	[-3.76]	[-3.50]
Difference with column (1)						0.0156***
χ^2-stat						20.15
Panel B: Implied volatility skew						
itrade	0.0285***	0.0294***	0.0293***	0.0270***	0.0272***	0.0273***
	[4.65]	[4.69]	[4.79]	[4.59]	[4.61]	[4.65]
Difference with column (1)						-0.0012
χ^2-stat						0.71
Panel C: Implied volatility time slope						
itrade	0.1123***	0.1076***	0.0934***	0.0873***	0.0868***	0.0879***
	[6.25]	[6.15]	[5.67]	[5.64]	[5.66]	[5.74]
Difference with column (1)						-0.0244***
χ^2-stat						23.41
Panel D: Option bid-ask spread						
itrade	0.0033***	0.0031***	0.0030***	0.0030***	0.0029***	0.0027***
	[3.22]	[2.96]	[2.89]	[2.91]	[2.89]	[2.70]
Difference with column (1)						-0.0006**
χ^2-stat						5.86
Controls:						
Event fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Four Fama-French factors and VIX	Yes	Yes	Yes	Yes	Yes	Yes
Stock bid-ask spread	No	Yes	Yes	Yes	Yes	Yes
Stock volume (log)	No	No	Yes	Yes	Yes	Yes
Realized volatility	No	No	No	Yes	Yes	Yes
Option volume (log)	No	No	No	No	Yes	Yes
Call skew (lag)	No	No	No	No	No	Yes

Table VIII
Outcome variables before and after days when Schedule 13D filers trade.
This table compares outcome variables on days before and after days when Schedule 13D filers trade. All variables are defined in Table A1. The table reports estimates of γ_τ from regression (3): $y_{it} = \sum_{\tau=-2}^{\tau=2} \gamma_\tau itrade_{it-\tau} + \eta_i + X_t'\beta + \epsilon_{it}$, where y_{it} is an outcome variable for company i on day t minus the outcome variable for the matched stock, $itrade_{it-\tau}$ indicates days before and after days on which Schedule 13D filers trade in stock market, X is a vector of control variables, and η_i are event fixed effects. Matched stocks are assigned based on the same industry, market cap, and previous year volatility. The sample covers 522 Schedule 13D filings in which there are listed options on target firms but Schedule 13D filers do not use any type of derivatives and covers (t-1,t-60) period before the filing date. Heteroskedasticity-robust standard errors are clustered at the event level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable:	Implied volatility		Implied volatility Skew		Implied volatility Time Slope		Option Bid Ask spread	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
itrade (t+2)		-0.0172***		0.0163***		0.0511***		0.0007
		[-3.31]		[3.09]		[4.61]		[0.85]
itrade (t+1)		-0.0173***		0.0068		0.0311***		0.0011
		[-3.82]		[1.57]		[3.19]		[1.39]
itrade	-0.0361***	-0.0395***	0.0285***	0.0325***	0.1123***	0.1275***	0.0033***	0.0035***
	[-4.67]	[-4.53]	[4.65]	[4.73]	[6.25]	[6.38]	[3.22]	[3.11]
itrade (t-1)		-0.0065*		0.0092**		0.0343***		0.0011
		[-1.73]		[2.53]		[5.09]		[1.47]
itrade (t-2)		0.0028		0.0096**		0.0411***		-0.0003
		[0.71]		[2.49]		[5.51]		[-0.39]
R^2	1.30%	1.60%	0.60%	0.80%	2.40%	3.20%	0.30%	0.30%
N	35,681	35,681	35,681	35,681	35,681	35,681	27,510	27,510

Appendix for

"Informed Trading in the Stock Market and Option Price Discovery"

A. When do activists use derivatives? - Additional results

To further investigate when activists are more likely to use derivatives, we next compare characteristics of firms that use derivatives to characteristics of firms that do not use derivatives. Results are reported in Table A4. Consistent with the previous result, the evidence in columns (1) to (4) shows that activists are more likely to use derivatives when targets have exchange-traded options: when activists (do not) use derivatives, 84% (21%) of targets (do not) have exchange-traded options.

[Insert Table A4 here]

Activists are also more likely to use derivatives when the targets' market capitalization is larger (on average it is three times larger than when activists do not use derivatives). Additional factors that are positively associated with the usage of derivatives are high stock liquidity, large number of analysts covering the stock, low book-to-market ratio, and high institutional and activist ownership.

We next test whether activists are more likely to use derivatives when a 5% toehold in the target company meets the "Size-of-Transaction Test" specified by the Hart-Scott-Rodino (HSR) Act of 1976. The HSR Act requires parties to file notifications with the Federal Trade Commission, Department of Justice, and the *firm* when a proposed transaction—such as a merger, joint venture, stock or asset acquisition, or exclusive license—meets specified thresholds and no exemptions apply.[13] If a notification is

[13] A filing is required if the parties meet both the "size of person" and "size of transaction" thresholds. Size-of-Person Test is met if one party to the transaction has $152.5 million or more in annual sales or total assets and the other has $15.3 million or more in annual sales or total assets. If the acquired party is not engaged in manufacturing, the test is slightly different: while one party must meet the $15.3 million test and the other party must meet the $152.5 million test, in addition the acquired company must have $15.3 million of assets or $152.5 million of revenues. Size-of-Transaction Test is met if, as a result of the transaction, the buyer will acquire or hold voting securities or assets of the seller, valued in excess of $76.3 million. All information and materials provided in connection with a HSR filing are treated as confidential and will not be disclosed by the government to third parties. The materials are even exempt from Freedom of Information Act requests. However, if the activist's purchase of a

required, the transaction cannot close while the statutory waiting period runs and the agencies review the transaction. Activists shareholders fall into the group of investors that is required to issue such a notification. They view this filing requirement as costly. For instance, a prominent activist shareholder Bill Ackman referred to this filing requirement as follows: "The last thing you want to do is alert the target that you are going to buy a big stake in a company."[14]

Derivative contracts can mitigate the cost of this filing. An activist shareholder can enter into a derivative contract that provides economic exposure with no direct ownership and therefore delay the HSR filing. Specifically, an activist can build economic exposure through derivative contracts, file Schedule 13D, and only then follow the HSR filing procedure to get approval to acquire the underlying shares. Thus, derivatives can delay the HSR filing until after the Schedule 13D filing is made. This way the notification is sent to all relevant parties after the activist's intention is common knowledge.

To capture the effect of the HSR Act, we set "HSR" to indicate cases when a 5% toehold meets the "Size-of-Transaction Test" specified by the HSR Act. The evidence in Table A4 reveals that activists are more likely to use derivatives when crossing a 5% toehold meets the "Size-of-Transaction Test" specified by the HSR Act of 1976. Specifically, when activists (do not) use derivatives, 66% (18%) of targets have a 5% toehold that meets (does not meet) the "Size-of-Transaction Test" specified by the HSR Act. The results therefore confirm that activists are more likely to use derivatives when an equity-only 5% toehold would trigger the HSR Act filing.

Of course, several firm characteristics that are associated with the usage of derivatives might simply proxy for the availability of exchange-listed derivatives. For

5% toehold triggers HSR filing requirement, the activist is required to notify the company about the intended transaction.

[14]Allergan, INC. and Karah H. Parschauer against Valeant Pharmaceuticals International, INC., Valeant Pharmaceuticals International, AGMS, INC., Pershing Square Capital Management, L.P., PS Management, GP, LLC, PS Fund 1, LLC and William A. Ackman.

example, large firms with high stock liquidity are more likely to have actively traded listed options. To address this possibility, we next compare characteristics of targets that use and do not use derivatives in the sub-sample of firms with available listed options. Results are reported in columns (5) to (8) of Table A4. Consistent with our prior, we find the several firm characteristics have weaker associations with the usage of derivatives in this sub-sample (e.g., institutional ownership, book-to-market ratio, and stock liquidity).

On the other hand, four firm characteristics—market cap, the number of analysts covering the stock, activist ownership, and the HSR Act dummy—continue to be positively and significantly associated with the usage of derivatives. For example, when activists (do not) use derivatives the average number of analysts covering the target is 11.75 (9.44). This difference corresponds to 25% increase in the number of analysts covering the target. Similarly, the average market cap is $1,073m ($690m) when activists do (do not) use derivatives.

We next consider option-market variables. Panel B in Table A4 reports the results. We find that activists are more likely to use derivatives when option markets are more liquid (bid-ask spreads are narrower). Moreover, we find that a higher put-to-call volume ratio is also positively associated with the usage of derivatives.

To conclude the analysis of firm characteristics that are associated with the usage of derivatives and, in particular to account for the fact that many significant variables uncovered above are likely to be correlated, we estimate a multivariate linear probability model to predict the usage of derivatives by Schedule 13D filers. The regressions are estimated using firm characteristics that are measured at the end of the fiscal year that precedes the Schedule 13D filing. Results are reported in Table A5.

[Insert Table A5 here]

We find that the availability of listed options, the HSR indicator, and activist ownership continue to be positively associated with the usage of derivatives. Perhaps surprisingly, the table reveals that effects of market cap and stock illiquidity become insignificant after we augment the regression with the HSR indicator.

B. Activist trading and Call-Put Parity violaations

In this section we compares the difference between implied volatilities of Call and Put options on days before and after days when Schedule 13D filers trade. Estimate regression (3) are reported in Table A6. We find that there are significant deviations between the actual stock price and the option implied stock price on days where the (informed) activists trade in the stock market, but their price impact is permanent and the changes in option implied volatilities observed on these days are persistent.

[Insert Table A6 here]

C. Appendix Figures and Tables

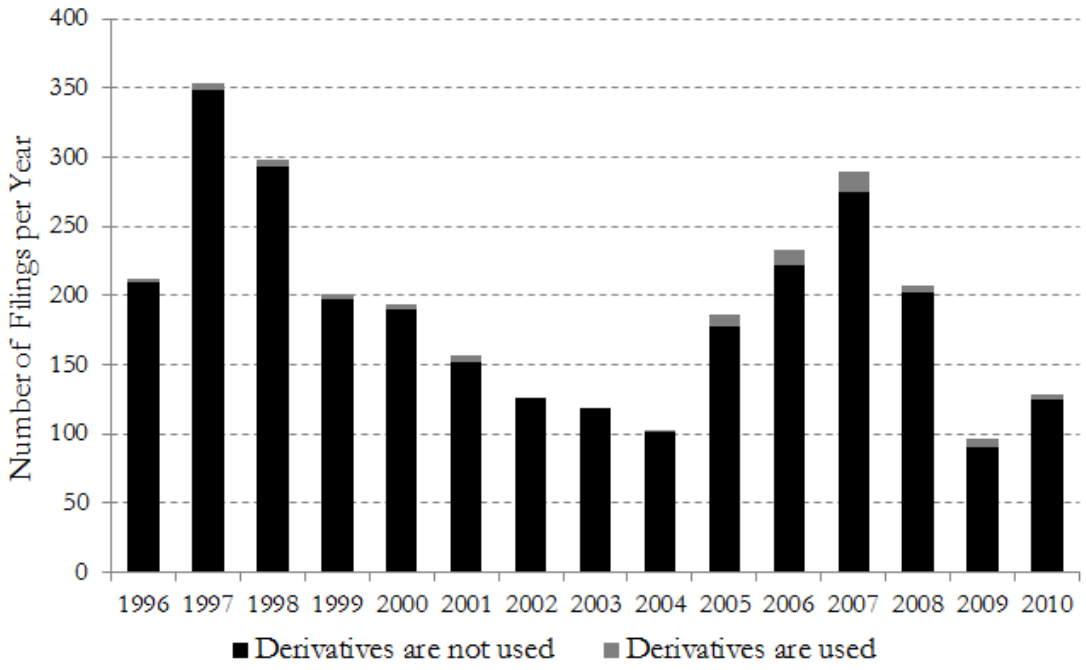
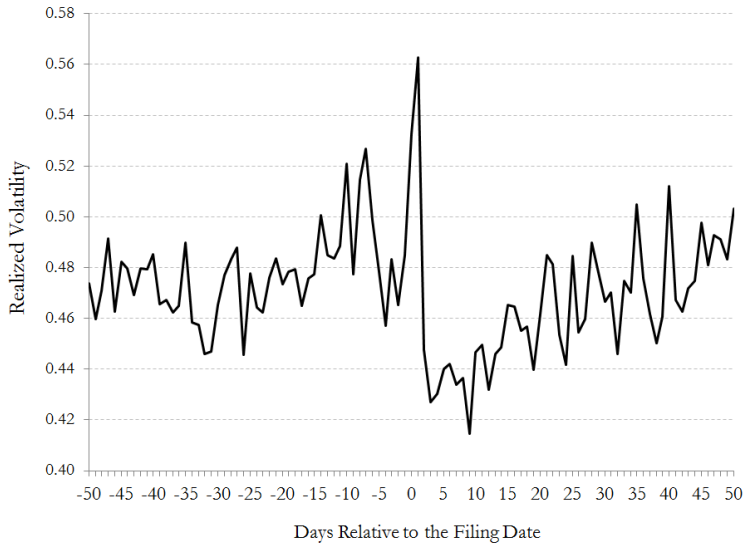
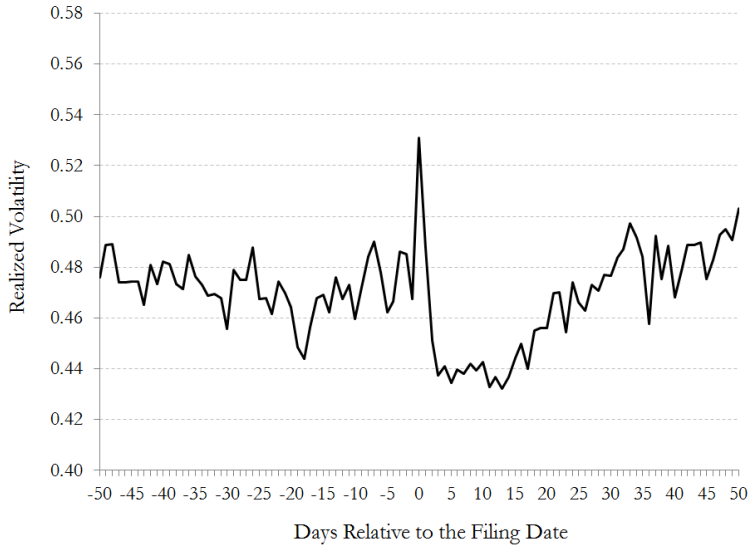


Figure A1
Time distribution of Schedule 13D filings. This chart plots the number of Schedule 13D filings that satisfy the criteria listed in Section I. The dark bars represent Schedule 13D filings with no information on derivatives. The gray bars represent Schedule 13D filings with information on derivatives.



(a) Full sample



(b) Sample with listed options

Figure A2
Realized volatility around filing date. Dark lines plot the realized volatility from 50 days before the filing date to 50 days after. The realized volatility is defined in Table A1. The filing date is the day on which the Schedule 13D filing is submitted to the SEC. Panel A plots the realized volatility in the full sample of 2,905 Schedule 13D filings. Panel B plots the realized volatility in the sample of 580 Schedule 13D filings in which there are listed options on target firms.

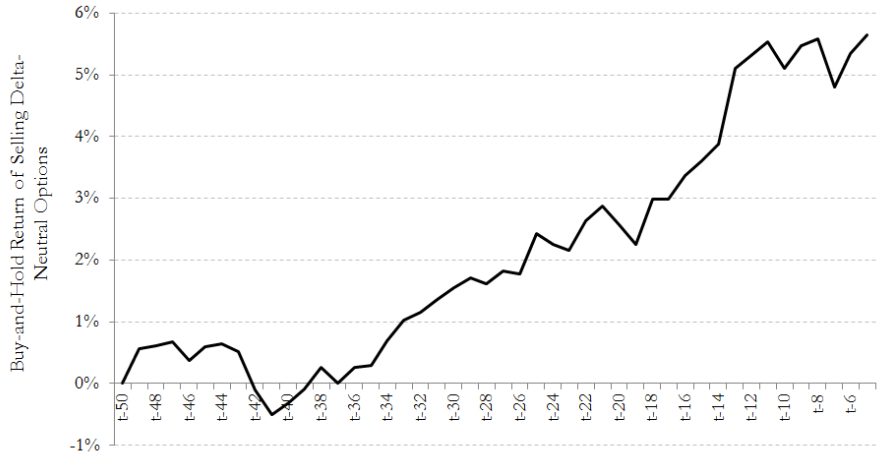


Figure A3

Buy-and-hold return on selling delta-neutral option strategies. The solid line plots the average buy-and-hold return on selling delta-neutral option strategies, in excess of the average buy-and-hold return on selling delta-neutral option strategies for matched stocks, from 50 days prior to the filing date to 5 days prior to the filing date. The strategy for betting on a drop in volatility is to sell options (both calls and puts) that are close to at-the-money (their prices are most sensitive to volatility information) and then (delta) hedges them by trading the underlying stock (making it immune to small directional changes in the stock price). The portfolio is revised daily. The filing date is the day on which the Schedule 13D filing is submitted to the SEC. The sample covers 580 Schedule 13D filings in which there are listed options on target firms.

Table A1
Variable definitions.

Panel A. Stock market variables	
Excess Return	Stock return in excess of the CRSP value-weighted return.
Volatility	Volatility of daily stock returns.
Realized Vol	Realized volatility based on the absolute value of daily stock return.
Intraday Realized Vol	Computed from the sum of squared 5-minute returns over a trading day. The returns are computed from the TAQ trade transaction data.
Bid-Ask Spread	The percentage spread, calculated using daily close ask and bid.
Volume	Daily trading volume.
Panel B. Option market variables	
IV	Implied volatility provided by OptionMetrics; calculated based on 30 days to expiration.
Skew	The ratio of implied volatilities for out-of-the-money and at-the-money options, minus one. A put option is out-of-the-money (at-the-money) if delta is -0.3 (-0.5). A call option is out-of-the-money (at-the-money) if delta is 0.3 (0.5).
Time slope	The ratio of implied volatilities for call options with 30 days to expiration and call options with 365 days to expiration, minus one.
Spread, %	The percentage spread, calculated using daily close ask and bid.
Order Imbalance	The difference in the proportion of buy- and sell-initiated trades.
Panel C. Firm characteristics (firm-year level)	
Options available	Equals one if exchange traded options are available.
Market cap	Market capitalization.
Illiquidity	Amihud (2002) illiquidity measure, defined as the yearly average (using daily data) of $1000\sqrt{\frac{\lvert Return\rvert}{DollarTradingVolume}}$.
BM	The ratio of the book value of equity to the market value of equity.
Analyst	The number of analysts covering the stock.
Stock return	12-month buy-and-hold return.
INST	The proportion of shares held by institutions.
INST AHF	The proportion of shares held by activist hedge funds. Data on activist hedge funds are from Brav et al. (2008).
HSR	Equals one when a 5% toehold meets the "Size-of-Transaction Test" specified by the HSR Act.

Table A2

Summary statistics. Panel A reports summary statistics for stock market variables. Panel B reports summary statistics for option market variables. Panel C reports summary statistics for firm characteristics. All potentially unbounded variables are pre-winsorized at the 1% and 99% extremes. Columns (1) and (2) report the mean and standard deviation of each variable. Columns (3)–(9) report their values at the 1st, 5th, 25th, 50th, 75th, 95th, and 99th percentiles.

Variable Name	Mean (1)	SD (2)	1% (3)	5% (4)	25% (5)	50% (6)	75% (7)	95% (8)	99% (9)
Panel A. Stock market variables									
Excess Return	-0.0002	0.0313	-0.1009	-0.0508	-0.0152	-0.0002	0.0141	0.0517	0.1062
Volatility	0.0223	0.0242	0.0002	0.0006	0.0061	0.0147	0.0294	0.0710	0.1338
Volatility, Annualized	0.4412	0.4804	0.0034	0.0121	0.1211	0.2907	0.5833	1.4067	2.6511
Realized Vol, Annualized	0.5175	0.3824	0.0571	0.1441	0.2651	0.3969	0.6420	1.3288	2.0765
Bid-Ask Spread	0.0061	0.0095	0.0002	0.0003	0.0008	0.0018	0.0072	0.0271	0.0498
(log) Volume	12.9108	1.2036	10.0257	10.9081	12.1046	12.8949	13.7029	14.9645	15.8899
Panel B. Option market variables									
(log) Open Interest	13.3312	1.5986	9.8508	10.7974	12.1943	13.2388	14.4042	16.1567	17.1965
Opt to Stock Volume	11.0066	22.5263	0.0000	0.0000	0.4084	2.6336	10.1160	53.5803	140.6059
(log) Put Volume	5.5082	4.7646	0.0000	0.0000	0.0000	7.2306	9.5105	12.2361	13.7787
(log) Call Volume	7.4322	4.2349	0.0000	0.0000	6.1377	8.6410	10.3675	12.6749	14.0925
Put skew	0.0538	0.1097	-0.1116	-0.0334	-0.0014	0.0194	0.0743	0.2333	0.6983
Call skew	-0.0002	0.0920	-0.2044	-0.1119	-0.0369	-0.0043	0.0107	0.1423	0.5120
Time slope	0.0886	0.2351	-0.2564	-0.1402	-0.0233	0.0463	0.1365	0.4015	1.5847
IV(t-1)-IV(t)	0.0038	0.0879	-0.2582	-0.1317	-0.0395	0.0001	0.0417	0.1516	0.3345
IV Call	0.5151	0.2320	0.1133	0.2216	0.3508	0.4643	0.6406	0.9671	1.2995
IV Put	0.5242	0.2345	0.1276	0.2300	0.3575	0.4722	0.6503	0.9772	1.3356
Spread, % - ATM	0.0769	0.0346	0.0176	0.0279	0.0499	0.0732	0.0996	0.1416	0.1724
Spread, % - Call ATM	0.0813	0.0385	0.0168	0.0280	0.0512	0.0762	0.1064	0.1538	0.1818
Spread, % - Call OTM	0.1485	0.0505	0.0385	0.0667	0.1111	0.1435	0.1833	0.2381	0.2500
Spread, % - Put ATM	0.0693	0.0356	0.0141	0.0236	0.0420	0.0627	0.0893	0.1415	0.1746
Spread, % - Put OTM	0.1362	0.0480	0.0361	0.0625	0.1016	0.1324	0.1667	0.2250	0.2500
Order Imbalance - Total	-0.0203	0.3881	-0.8571	-0.6667	-0.2600	0.0000	0.2222	0.6667	0.8571
Order Imbalance - Open	0.0039	0.4355	-0.8889	-0.7500	-0.2952	0.0000	0.3077	0.7500	0.8889
Order Imbalance - Puts	-0.0257	0.4026	-0.8889	-0.7500	-0.2500	0.0000	0.1538	0.7000	0.8750
Order Imbalance - Puts Open	-0.0067	0.4309	-0.9000	-0.7500	-0.2500	0.0000	0.2143	0.7500	0.9091
Order Imbalance - Calls	-0.0418	0.4077	-0.8750	-0.7500	-0.3158	0.0000	0.1944	0.6667	0.8571
Order Imbalance - Calls Open	0.0091	0.4518	-0.9000	-0.7500	-0.3000	0.0000	0.3500	0.7500	0.9000
Panel C. Firm characteristics									
Options available	0.2222	0.4158	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000
(log) Market cap	4.2113	1.5800	0.9660	1.7093	3.0751	4.0841	5.2875	7.0443	7.9461
Illiquidity	0.4756	0.5933	0.0127	0.0237	0.0872	0.2513	0.6203	1.7384	3.1201
BM	0.7617	0.5962	-0.3447	0.1185	0.3746	0.6299	0.9853	1.9475	3.3276
Analyst	3.9935	5.3926	0.0000	0.0000	0.0000	2.0000	6.0000	16.0000	24.0000
Stock return	0.0081	0.0441	-0.1061	-0.0631	-0.0163	0.0058	0.0310	0.0839	0.1560
INST	0.4574	0.2918	0.0035	0.0361	0.2071	0.4282	0.6975	0.9667	1.0000
INST AHF	0.0605	0.0676	0.0000	0.0000	0.0046	0.0413	0.0864	0.2066	0.3180
HSR	0.1979	0.3985	0.0000	0.0000	0.0000	0.0000	0.0000	1.0000	1.0000

Table A3

Profits from Informed Trades. This table presents summary statistics for three measures of profits. *Trading Profit* is defined as $\mathbf{q}'(p_{post} - \mathbf{p})$, where $\mathbf{q}$ is the vector of trades (purchases are positive and sales are negative), p_{post} is the post-announcement price, and $\mathbf{p}$ is the vector of transaction prices. The post-announcement price is the average price during the week that follows the filing date. *Total Profit* is defined as $Trading\ Profit + (p_{post} - p_0)w_0$, where p_0 is the price of the first transaction disclosed in the Schedule 13D filing and w_0 is the initial ownership, established prior to the first transaction disclosed in the Schedule 13D filing. $Value\ Created$ is defined as $(p_{post} - p_0)SHOUT$, where $SHOUT$ is the number of shares outstanding. The sample covers 580 Schedule 13D filings in which there are listed options on target firms. Average measures of profits as well as t-statistics are reported for five Market CAP quantiles, where Market CAP is the market capitalization of the targeted company. ** and *** indicate statistical significance at the 5% and 1% levels, respectively.

Market CAP Quantile	Market CAP (1)	Trading Profit (2)	Total Profit (3)	Value Created (4)
Q1 - low	214,795,218	(15,119)	52,892	(2,224,586)
		[-0.09]	[0.16]	[-0.35]
Q2	438,976,302	1,011,851***	1,850,709***	25,966,410**
		[3.56]	[2.75]	[2.55]
Q3	873,588,004	1,758,625***	2,345,792**	39,050,138**
		[4.62]	[2.35]	[2.26]
Q4	1,760,772,119	1,999,809***	2,791,390**	57,376,458**
		[4.73]	[2.54]	[2.57]
Q5 - high	3,916,358,736	2,675,665***	3,720,508**	53,740,776*
		[4.95]	[2.52]	[1.87]

Table A4

When do activists use derivatives? This table presents characteristics of targets when activist use and do not use derivatives. Columns (1) to (4) report results for all Schedule 13D filing with available data on firm characteristics (2,466 events). Columns (5) to (8) report results for sub-sample with available listed options (580 events; see Section A for description of the "options available" criteria). Firm characteristics are measured at the end of the past fiscal year. Columns (1) and (5) report averages for targets when activist use derivatives. Columns (2) and (6) report averages for targets when activist do not use derivatives. Columns (3) and (7) report differences between (1) and (2) and (5) and (6) accordingly. Columns (4) and (8) report t-statistics of the differences. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Full sample				Sample with available options			
	Use derivatives (1)	Do not use derivatives (2)	Diff (3)	t-stat (4)	Use derivatives (5)	Do not use derivatives (6)	Diff (7)	t-stat (8)
Panel A: *Stock-market characteristics*								
Options Available	0.84	0.21	0.63***	11.98				
Market cap	906.88	211.23	695.65***	12.18	1073.08	689.54	383.54***	3.63
Illiquidity	0.1517	0.4859	-0.3341***	-4.35	0.0456	0.0584	-0.0128*	-1.81
BM	0.61	0.77	-0.16**	-2.07	0.57	0.48	0.10*	1.71
Analyst	10.15	3.81	6.34***	9.26	11.75	9.44	2.31**	2.22
Stock return	0.0105	0.0081	0.0025	0.43	0.0095	0.0122	-0.0027	-0.41
Volatility	0.5034	0.5532	-0.0498	-1.42	0.4755	0.4997	-0.0242	-0.72
INST	0.7093	0.4492	0.2601***	6.36	0.7630	0.7148	0.0482	1.29
INST AHF	0.0798	0.0597	0.0201**	2.11	0.0852	0.0574	0.0279***	2.72
HSR	0.6557	0.1847	0.471***	9.30	0.7647	0.5645	0.2002***	2.78
Panel B: *Option-market characteristics*								
IV					0.4828	0.4980	-0.0152	-0.46
Put skew					0.0525	0.0710	-0.0185	-0.89
Call skew					0.0053	0.0063	-0.001	-0.06
Time slope					0.1002	0.1623	-0.0621	-0.98
Bid-Ask spread					0.0676	0.0823	-0.0147***	-2.98
Bid-Ask spread - Call options					0.0734	0.0887	-0.0153***	-2.83
Bid-Ask spread - Put options					0.0604	0.0753	-0.0148***	-2.94
Put volume (log)					5.50	5.46	0.04	0.07
Call volume (log)					6.64	7.30	-0.66	-1.62
Put-to-Call volume					0.3364	0.2821	0.0543**	2.37

Table A5

When do activists use derivatives? Multivariate analysis. This table presents estimates of a linear probability model that predicts the usage of derivatives by Schedule 13D filers. Sample covers 2,021 Schedule 13D filings with available information on firm characteristics. Firm characteristics are measured at the end of the fiscal year that precedes the Schedule 13D filing. Table reports estimated coefficients and t-statistics. The t-statistics are calculated using heteroscedasticity robust standard errors. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)
Options Available	0.0668***	0.0648***
	[4.47]	[4.38]
Market cap	0.0122**	0.0036
	[2.12]	[0.58]
Illiquidity	0.0131*	0.0060
	[1.68]	[0.71]
HSR		0.0326**
		[2.05]
BM	0.0079	0.0071
	[1.54]	[1.40]
Analyst	0.0024	0.0023
	[1.60]	[1.50]
Stock return	0.0289	0.0449
	[0.33]	[0.50]
Stock return vol	0.0126	0.0126
	[0.80]	[0.80]
INST	-0.0390*	-0.0295
	[-1.87]	[-1.37]
INST AHF	0.1703**	0.1773**
	[2.41]	[2.50]
Constant	-0.0653***	-0.0352
	[-2.66]	[-1.44]
R^2	0.074	0.077

Table A6
Call-Put Parity violations before and after days when Schedule 13D filers trade. This table compares the difference between implied volatilities of Call and Put options on days before and after days when Schedule 13D filers trade. All variables are defined in Table A1. The table reports estimates of γ_τ from regression (3): $y_{it} = \sum_{\tau=-2}^{\tau=2} \gamma_\tau itrade_{it-\tau} + \eta_i + X_t'\beta + \epsilon_{it}$, where y_{it} is an outcome variable for company i on day t minus the outcome variable for the matched stock, $itrade_{it-\tau}$ indicates days before and after days on which Schedule 13D filers trade in stock market, X is a vector of control variables, and η_i are event fixed effects. Matched stocks are assigned based on the same industry, market cap, and previous year volatility. The sample covers 522 Schedule 13D filings in which there are listed options on target firms but Schedule 13D filers do not use any type of derivatives and covers (t-1,t-60) period before the filing date. Heteroskedasticity-robust standard errors are clustered at the event level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)
itrade (t+2)		-0.0036
		[-1.56]
itrade (t+1)		-0.0038
		[-1.62]
itrade	-0.0040**	-0.0045**
	[-2.44]	[-2.44]
itrade (t-1)		-0.0013
		[-0.67]
itrade (t-2)		0.0026
		[1.47]
R^2	0.10%	0.10%
N	35,681	35,681
N-clusters	487	487