Internet Appendix for

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

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Internet Appendix: Additional results

A. Model Proofs

A.1. Proof of Theorem 2

First we note that if the insider follows the strategy listed in the theorem, then the price $P_t = p_t \mathbf{1}_{\{\tau > t\}} + v \mathbf{1}_{\{\tau \leq t\}}$, where p_t is defined in equation (A.3). That is the price is consistent with the equilibrium zero-profit condition of the market maker. It remains thus to show that θ_t given in the theorem, is an optimal trading strategy for the insider, i.e., that it solves the optimization problem (A.9) on $\tau > t$.

To that effect, consider an arbitrary admissible trading strategy $\theta_t \in \mathcal{A}$ and apply Itô's lemma to the candidate quadratic value function (A.12):

$$\begin{aligned} e^{-\int_0^T \rho_s ds} J(T, p_t, v) - J(0, p_0, v) &= \int_0^T e^{-\int_0^t \rho_s ds} \left(dJ(t, p_t, v) - \rho_t J(t, p_t, v) dt \right) \\ &= -\int_0^T e^{-\int_0^t \rho_s ds} (v - p_t)(\theta_t dt + \sigma_t dZ_t) \end{aligned}$$

Taking expectation we find that for any admissible trading strategies:[34]

$$J(0, p_0, v) = \mathrm{E}\left[e^{-\int_0^T \rho_s ds} J(T, p_t, v) + \int_0^T e^{-\int_0^t \rho_s ds} (v - p_t) \theta_t dt \right] \tag{.1}$$

Now, note that by definition $J(T, p_t, v) \geq 0$, thus

$$J(0, p_0, v) \geq \mathrm{E}\left[\int_0^T e^{-\int_0^t \rho_s ds} (v - p_t) \theta_t dt \right] \tag{.2}$$

[34] The fact that the strategy is admissible guarantees that the stochastic integral is a martingale, since $\mathrm{E}[\int_0^T e^{-\int_0^t 2\rho_s ds} (v - p_t)^2 \sigma_t^2 dt] < \infty$ for any $\theta_t \in \mathcal{A}$.

for all θ_t and all T. In particular, taking the limit as $T \to \infty$ we have by bounded convergence:

$$J(0, p_0, v) \geq \mathrm{E}\left[\int_0^\infty e^{-\int_0^t \rho_s ds}(v - p_t)\theta_t dt\right] \tag{.3}$$

Further, if we can find an admissible trading strategy such that $\lim_{T\to\infty} \mathrm{E}\left[e^{-\int_0^T \rho_s ds} J(T, p_T, v)\right] = 0$ then we obtain an equality in equation (.3) which proves the optimality of the strategy. Now, note that

$$\begin{aligned}
\mathrm{E}\left[e^{-\int_0^T \rho_s ds} J(T, p_T, v)\right] &= \mathrm{E}\left[e^{-\int_0^T \rho_s ds}\{\frac{(v - p_T)^2}{2\lambda_T} + f(T)\}\right] \\
&= \frac{\Sigma_T}{2\lambda_0} + e^{-\int_0^T \rho_s ds} f(T) \\
&= \frac{2\Sigma_T - \Sigma_\infty}{2\lambda_0}
\end{aligned}$$

Clearly a sufficient condition for a the right-hand side to go to zero and a strategy to be optimal is that $\lim_{T\to\infty} \Sigma_T = 0$ as stated in the theorem.

A.2. Constant intensity and noise trading volatility

Here we explicitly compute the equilibrium when σ, ρ are both constant in theorem 2 (which corresponds to $m = r_1 = 0$ in corollary 1).

Solving for the posterior variance and imposing the terminal condition $\lim_{t\to\infty} \Sigma(t) = 0$ we obtain:

$$\Sigma(t) = \frac{\lambda_0^2 \sigma^2}{2\rho} e^{-2\rho t} \tag{.4}$$

Then an equilibrium exists if we can find λ_0 such that we satisfy the initial condition $\Sigma(0) = \Sigma_0$. Indeed, we find that the solution is:

$$\lambda_0 = \frac{\sqrt{2\rho\Sigma_0}}{\sigma} \tag{.5}$$

and the corresponding posterior variance is:

$$\Sigma(t) = \Sigma_0 e^{-2\rho t} \tag{.6}$$

Further, we can compute the equilibrium trading strategy:

$$\theta_t = \frac{2\rho e^{\rho t}}{\lambda_0}(v - p_t) \tag{.7}$$

and the price process starts from $P_0 = v_0$ and has jump-diffusion dynamics:

$$dP_t = 2\rho(v - P_t)dt + \sqrt{2\rho\Sigma_0}e^{-\rho t}dZ_t + (v - P_t)d\mathbf{1}_{\{\tau \leq t\}} \tag{.8}$$

We note that the equilibrium price prior to the announcement is a Gaussian mean-reverting process *in the filtration of the insider* with mean-reversion strength equal to twice the announcement intensity and an exponentially decreasing volatility.

We can compute its expectation and variance, conditional on the insider's information:

$$\mathrm{E}_t[p_T - v | v, \tau > T] = e^{-2\rho(T-t)}(p_t - v) \tag{.9}$$

$$V_t[p_T - v | v, \tau > T] = e^{-2\rho T}(1 - e^{-2\rho(T-t)})\Sigma_0 \tag{.10}$$

And we see that p_t converges in L^2 to v when t goes to infinity.

Note that the true price has continuous dynamics prior to the announcement and jumps to v at τ. Further its volatility jumps to zero. Instead, when there are multiple announcements then the process will start anew at τ.

A.3. Closed-form Option prices

The market maker sets call option prices prior to the first announcement (i.e., on $t < \tau_1$) such that:

$$\begin{aligned} C(P_t, K, t, T) &= \mathrm{E}[|P_T - K|^+ \mid \mathcal{F}_t^Y, \tau_1 > t] \\ &= S^0_{t,0,T}\mathrm{E}_t[|P_T - K|^+ | \tau_1 > T] + \int_t^T \delta S^0_{t,0,s} \Big\{ S^1_{s,s,T}\mathrm{E}_t[|P_T - K|^+ | \tau_1 = s, \tau_2 > T] \\ &\quad + \int_s^T \delta S^1_{s,s,u}\mathrm{E}_t[|P_T - K|^+ | \tau_1 = s, \tau_2 = u] \Big\} \end{aligned}$$

where $C(P, K, t, T)$ denotes the price of the option written on P at strike K at time t with maturity T and we define for $\tau \leq t$:

$$S^j_{t,\tau,T} = \mathrm{E}[\mathbf{1}_{\{\tau_{j+1} > T\}} \mid \mathcal{F}_t^Y, \tau_j = \tau] = e^{-\int_t^T \rho(s,j,\tau)ds}$$

which denotes the probability that event τ_{j+1} does not occur between t and T conditional on $\tau_j = \tau \leq t$. We also define $\delta_u S^j_{t,u,\tau} = S^j_{t,u,\tau}\rho(u, j, \tau)du$ as the probability that the event τ_{j+1} occurs at u (conditional on $\tau_j = \tau \leq t$).

We can compute the various expectations in the option price formula as follows.

$$
\begin{aligned}
\mathrm{E}[|P_T - K|^+ \,|\, \mathcal{F}_t^Y, \tau_1 > t] &= \mathrm{E}[|P_t + \int_t^T \sigma_P(s,0,0) d\hat{Z}_s - K|^+ \,|\, \mathcal{F}_t^Y, \tau_1 > t] \\
&= NC(P_t - K, \int_t^T \sigma_P(s,0,0)^2 ds)
\end{aligned}
$$

where we define the function:

$$
\begin{aligned}
NC(k,\Sigma) &= \mathrm{E}[|\epsilon\sqrt{\Sigma} + k|^+] \\
&= \int_{-k/\sqrt{\Sigma}}^{\infty} (x\sqrt{\Sigma} + k)\mathbf{n}(x)dx \\
&= k\mathbf{N}(k/\sqrt{\Sigma}) + \sqrt{\Sigma}\mathbf{n}(k/\sqrt{\Sigma})
\end{aligned}
$$

where ϵ is a standard normally distributed random variable and $\mathbf{n}(x)$ and $\mathbf{N}(x)$ are the normal density and normal cumulative density function respectively.

Similarly, we have:

$$
\begin{aligned}
\mathrm{E}_t[|P_T - K|^+ | \tau_1 = s, \tau_2 > T] =& \mathrm{E}_t[|P_t + \int_t^s \sigma_P(u,0,0) d\hat{Z}_u \\
&+ \int_s^T \sigma_P(u,1,s) d\hat{Z}_u + J(s,0,0) - K|^+ | \tau_1 = s, \tau_2 > T] \\
=& NC(P_t - K, \int_s^T \sigma_P(u,1,s)^2 du + \Sigma(t,0,0))
\end{aligned}
$$

We note a useful relation which we use to simplify slightly the solution for any $\tau_i \leq t < s \leq \tau_{i+1}$ we have:

$$
\Sigma(t,i,\tau_i) = \int_t^s \sigma_P(u,i,\tau_i)^2 du + \Sigma(s,i,\tau_i)
$$

which can be interpreted as the total uncertainty remaining at time t about the next announcement τ_{i+1} will be disclosed to the market through diffusion risk and the variance of the jump at the time of the next announcement s.

$$\begin{aligned}\mathrm{E}_t[|P_T - K|^+|\tau_1 = s, \tau_2 = u] =& \mathrm{E}_t[|P_t + \int_t^s \sigma_P(v,0,0)d\hat{Z}_v + \int_s^u \sigma_P(v,1,s)d\hat{Z}_v \\ &+ J(s,0,0) + J(u,1,s) - K|^+|\tau_1 = s, \tau_2 = u] \\ =& NC(P_t - K, \Sigma(t,0,0) + \Sigma_0^2)\end{aligned}$$

Putting everything together we get the value of the call option prior to the first announcement, i.e., on $t < \tau_1$.

A similar formula obtains for the value after the first event, i.e., on $\tau_1 < t < \tau_2$:

$$\begin{aligned}C(P_t, K, t, T) &= \mathrm{E}[|P_T - K|^+ \,|\, \mathcal{F}_t^Y, \tau_2 > t > \tau_1] \\ &= S^1_{t,\tau_1,T}\mathrm{E}_t[|P_T - K|^+|\tau_2 > T] + \int_t^T \delta S^1_{t,\tau_1,s}\mathrm{E}_t[|P_T - K|^+|\tau_2 = s] \\ &= S^1_{t,\tau_1,T} NC(P_t - K, \int_t^T \sigma_P(s,1,\tau_1)^2 ds) + \int_t^T \delta S^1_{t,s,\tau_1} NC(P_t - K, \Sigma(t,1,\tau_1))\end{aligned}$$

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. Indeed, 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. Table 3 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 3 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. 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. When do activists use derivatives?

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 A5. 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 A5 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.[35] If a notification is 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."[36]

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

[35] 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 5% toehold triggers HSR filing requirement, the activist is required to notify the company about the intended transaction.

[36] 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.

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 A5 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 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 A5. 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 A5 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 A6.

[Insert table A6 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.

D. The Role of Informed Trading - Additional results

In this section we investigate the role of informed trading in price discovery, while considering events with information on trades in 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. The reader should therefore exercise caution in interpreting the results on changes in outcome variables on days when Schedule 13D filers trade options.

We estimate the following regression:

$$y_{it} = \gamma_1 itrade_{it} + \gamma_2 itrade\_opt_{it} + \gamma_3 itrade_{it} * itrade\_opt_{it} + \eta_i + X_t'\gamma_4 + \epsilon_{it}, \quad (.11)$$

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, 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. 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. The results are reported in table A7.

[Insert table A7 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 results are reported in panels A and B of table A7 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 C of table A7. 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 D and E of table A7. 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.[37] We consider both the total order imbalance and the order imbalance for trades when a new option contract is opened.

Panel E 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 (2016a), 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 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

[37] 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.

market-adjusted returns are higher by 0.52% on days when Schedule 13D filers trade derivatives.

E. Leverage effect

In table A8 we investigate whether the relation between informed order flow and implied volatility measures is explained by the so-called 'leverage effect.' Specifically, we augment regression (19) with the current and lagged stock returns, the current and lagged absolute value of stock returns, as well as with the lagged change in implied volatility. The findings indicate that the coefficient of *itrade* remains almost unchanged when these control variables are added to the regression. For instance, the coefficient changes from -0.0341 to -0.0334 in the implied volatility regression. Thus, the leverage effect is not likely to drive the results.

[Insert table A8 here]

Internet 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.

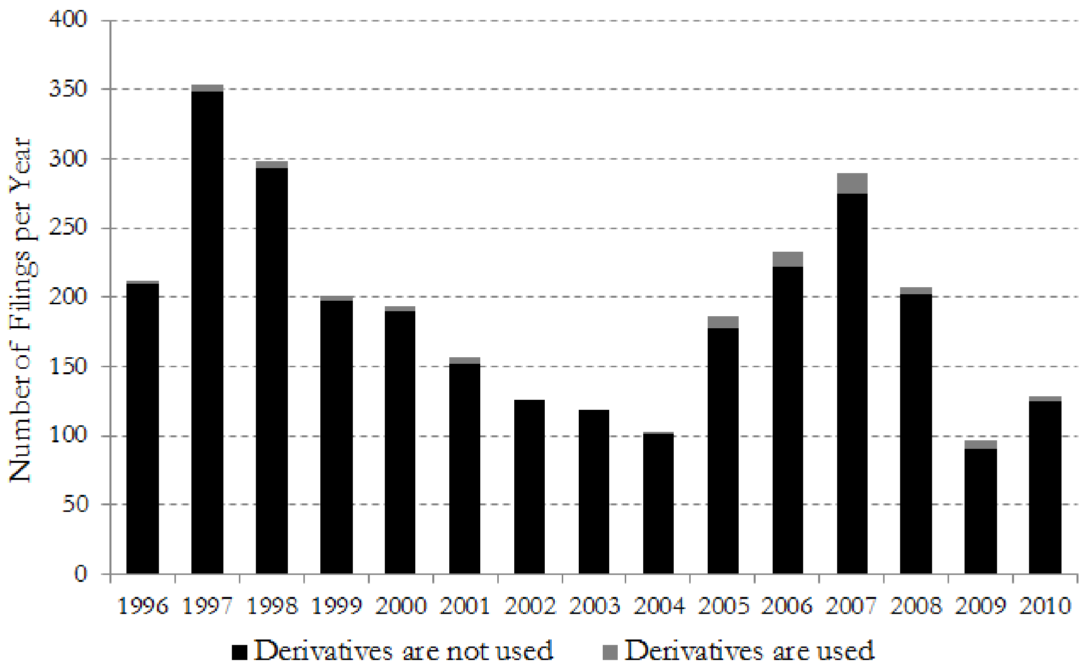
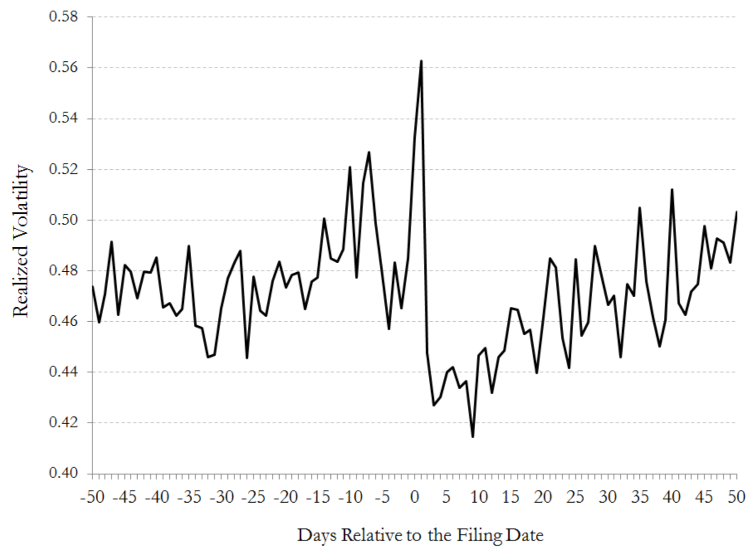
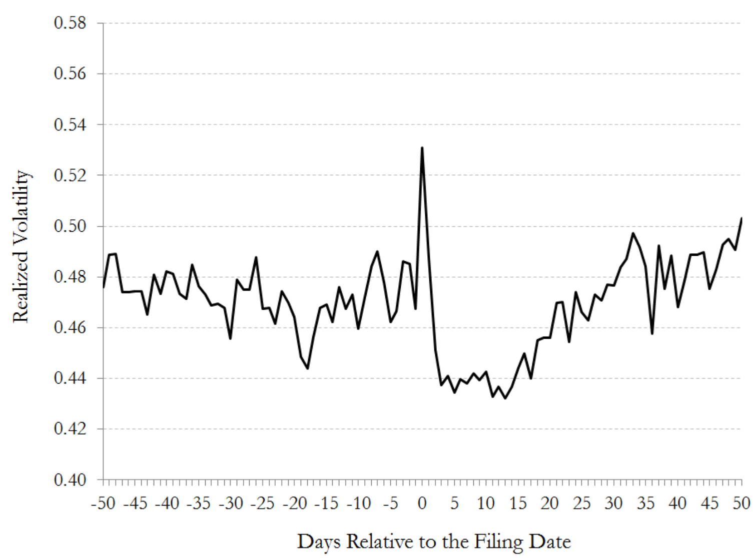


Figure A2

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.



(a) Full sample



(b) Sample with listed options

Figure A3

Volatility around the filing date – Long horizon. Dark (gray) line plots the realized volatility for the sample of event (matched) stocks from 250 days before the filing date to 250 days after. The realized volatility is defined in table A1. 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.

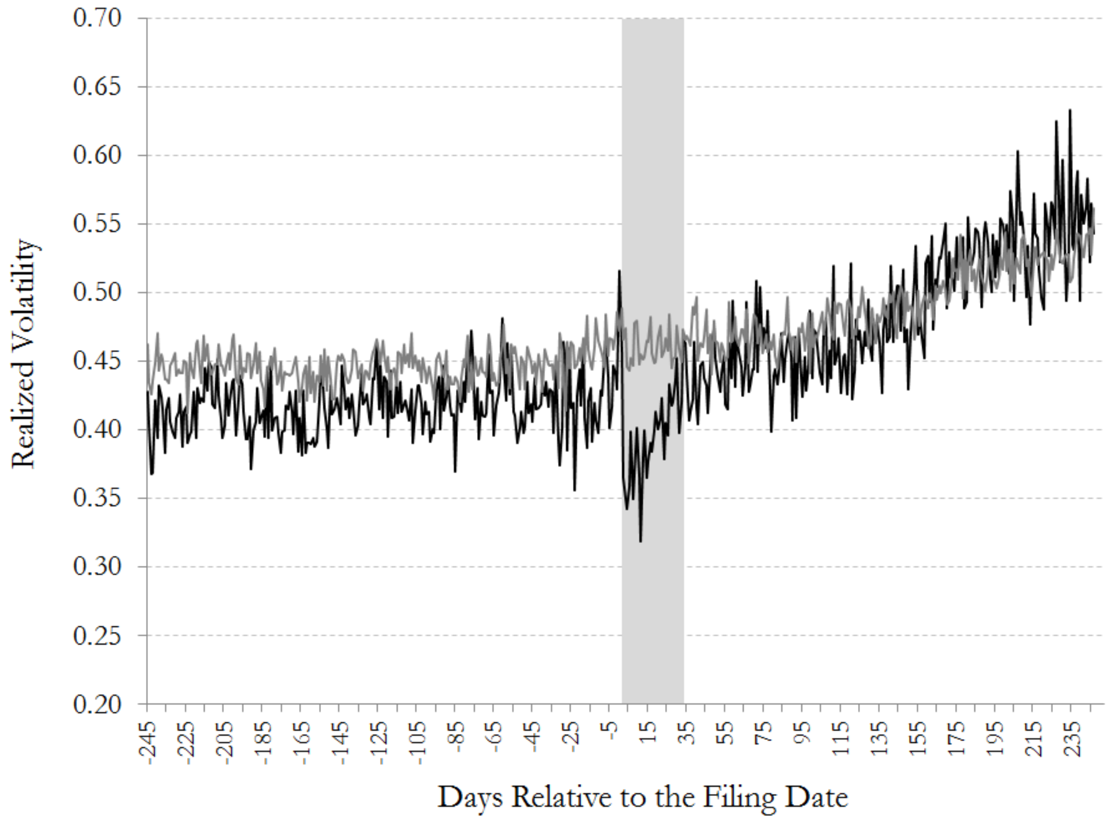


Figure A4

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.

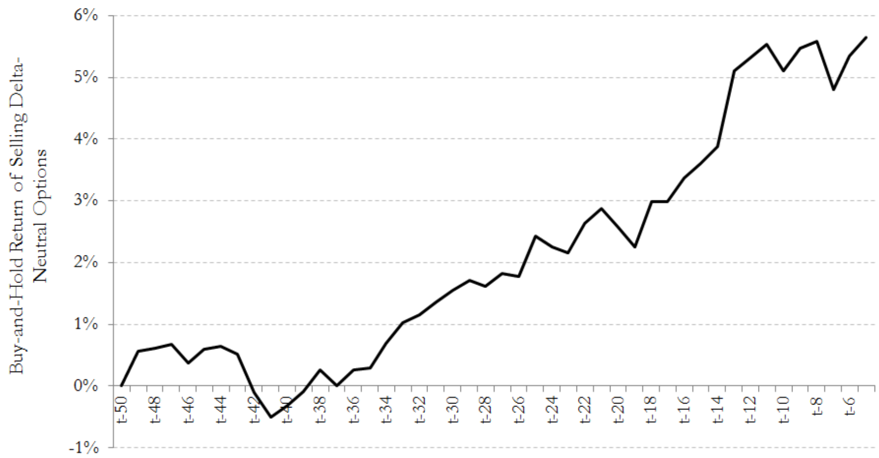


Table A1
Variable definitions.

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 30-day 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.

	Mean	SD	1%	5%	25%	50%	75%	95%	99%
	1	2	3	4	5	6	7	8	9
Variable Name									
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

Realized volatility and trading volume around filing date. The table reports estimates of γ_τ from the following regression: $y_{it} = \sum_{\tau=-3}^{\tau=5} \gamma_\tau fdate_{it-\tau} + \eta_i + X_t'\beta + \epsilon_{it}$, where y_{it} is a measure of volatility or trading activity for company i on day t, $fdate$ indicates Schedule 13D filing date, X is a vector of control variables (four Fama-French factors and VIX), and η_i are event fixed effects. The sample covers 522 Schedule 13D filings in which there are listed options on target firms and activist do not use derivatives and covers (t-10,t+5) period before the filing date. The coefficient correspond to the difference between the outcome variables on day $fdate_{it-\tau}$ and (t-10,t-4) 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:	Volume (log)	Volatility $\lvert Ret \rvert$	Volatility Intra-day
	1	2	3
$fdate_{it-3}$	-0.0246	0.0178	0.0128
	[-0.77]	[0.75]	[1.17]
$fdate_{it-2}$	-0.0262	0.0049	0.0057
	[-0.78]	[0.21]	[0.56]
$fdate_{it-1}$	-0.0517	0.0061	-0.0062
	[-1.49]	[0.27]	[-0.68]
$fdate_{it}$	0.0277	0.0626**	0.0450***
	[0.78]	[2.55]	[3.84]
$fdate_{it+1}$	-0.0218	0.0257	0.0082
	[-0.63]	[1.11]	[0.81]
$fdate_{it+2}$	-0.1145***	-0.0402*	-0.0208**
	[-3.40]	[-1.90]	[-2.21]
$fdate_{it+3}$	-0.1581***	-0.0703***	-0.0368***
	[-4.72]	[-3.69]	[-3.72]
$fdate_{it+4}$	-0.2367***	-0.0900***	-0.0360***
	[-7.28]	[-4.85]	[-3.71]
$fdate_{it+5}$	-0.2604***	-0.0601***	-0.0438***
	[-7.41]	[-3.17]	[-4.62]
R^2	0.027	0.013	0.043
N	7,579	7,579	7,579

Table A5

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 IV 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 A6

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 A7

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 (.11): $y_{it} = \gamma_1 itrade_{it} + \gamma_2 itrade\_opt_{it} + \gamma_3 itrade_{it} * itrade\_opt_{it} + \eta_i + X_t'\gamma_4 + \epsilon_{it}$, 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	-0.0320***	-4.91	0.0096	0.92	0.0461***	2.80	39,017
IV Put	-0.0282***	-4.28	0.0067	0.67	0.0678***	2.66	39,017
Panel B: Measures based on implied volatility							
Put skew	0.0269***	4.75	0.0128	1.37	0.0139	0.47	39,017
Call skew	0.0195***	3.91	0.0034	0.41	-0.0467	-1.28	39,017
Time slope	0.1068***	6.46	-0.0064	-0.35	0.2782	1.57	39,017
Panel C: Bid-Ask spread							
All options	0.0030***	3.28	0.0001	0.04	0.0001	0.02	32,221
Call options	0.0027***	2.89	-0.0013	-0.68	0.005	0.77	30,637
Put options	0.0027***	2.62	0.0017	0.92	-0.0065	-0.81	29,898
Panel D: Trading activity							
Option-to-stock volume ratio	-1.7421***	-3.33	0.3458*	1.74	1.3738***	2.94	38,856
Option Volume (log)	-0.0199	-0.24	0.7472***	4.60	-0.1776	-0.29	38,856
Put volume (log)	0.2546***	2.74	0.5645*	1.89	0.4314	0.63	38,856
ATM put volume (log)	0.2641**	2.46	0.8345**	2.34	1.5406*	1.65	33,158
OTM put volume (log)	0.2998***	3.16	0.4927*	1.69	0.5655	0.94	38,341
Call volume (log)	-0.1318	-1.43	0.7823***	5.14	-0.3219	-0.54	38,856
ATM call volume (log)	0.0727	0.65	0.7779***	3.24	0.5025	0.58	33,158
OTM call volume (log)	-0.0998	-1.01	0.5189**	2.31	0.4878	0.91	38,341
Put-to-call volume ratio	0.0231***	2.66	-0.0073	-0.14	0.0434	0.42	38,856
Panel E: Order Imbalance							
All options, all trades	-0.0060	-0.41	0.0343	0.87	0.0640*	1.75	11,816
All options, open trades	-0.0062	-0.39	0.0195	0.58	0.0776**	2.41	11,816
Put options, all trades	0.0201	1.36	-0.0272	-0.77	0.0156	0.48	11,816
Put options, open trades	0.0231	1.31	0.0072	0.17	0.1003***	2.62	11,816
Call options, all trades	0.0164	1.08	0.036	0.69	0.0741	1.53	11,816
Call options, open trades	0.0152	0.89	0.017	0.32	0.1541***	3.13	11,816
Panel F: Stock market							
Excess Return	0.0019***	3.91	0.0050**	2.10	-0.0034	-0.36	39,142
Bid-ask Spread	-0.0004***	-3.21	0.0001	0.48	0.0011	1.64	37,510
Volatility	0.0003	0.71	0.0048*	1.95	0.0126	1.13	39,142
Vol (log)	0.3468***	13.21	0.2836***	3.79	-0.0672	-0.34	39,142

Table A8

Robustness: Leverage effect. 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 (19): $y_{it} = \gamma_1 itrade_{it} + \eta_i + X_t'\gamma_3 + \epsilon_{it}$, 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, 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. 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. In columns (1) and (4), X includes four Fama-French factors and VIX. In other columns we extend the list of control variables and report estimated coefficients of these additional controls. 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, Calls			Implied volatility skew			Implied volatility time slope			Option bid-ask spread		
	1	2	3	4	5	6	7	8	9	10	11	12
itrade	-0.0341***	-0.0337***	-0.0334***	0.0275***	0.0275***	0.0268***	0.1125***	0.1126***	0.1115***	0.0032***	0.0032***	0.0033***
	[-4.98]	[-4.92]	[-5.11]	[4.64]	[4.64]	[4.56]	[6.44]	[6.45]	[6.43]	[3.42]	[3.44]	[3.45]
stock return (t)		-0.2374***	-0.2894***		-0.0081	0.0063		-0.0492	-0.0518		-0.0185***	-0.0180***
		[-9.04]	[-11.36]		[-0.34]	[0.27]		[-1.11]	[-1.14]		[-3.63]	[-3.46]
stock return (t-1)			-0.0982***			-0.0016			0.2130***			-0.0063
			[-4.21]			[-0.08]			[4.53]			[-1.40]
change in implied vol (t-1)			0.2089***			-0.0289***			0.2996***			-0.0047*
			[17.54]			[-2.71]			[12.40]			[-1.85]
abs(stk return) (t)			0.6057***			-0.2174***			-0.1949*			-0.0199***
			[11.11]			[-5.97]			[-1.90]			[-2.96]
abs(stk return) (t-1)			0.5157***			-0.2053***			-0.1708*			-0.0196***
			[10.60]			[-5.81]			[-1.88]			[-2.81]
Constant	-0.0233*	-0.0236**	-0.0247**	0.0133	0.0133	0.0149	0.0708***	0.0708***	0.0733***	0.0069***	0.0069***	0.0070***
	[-1.96]	[-1.99]	[-2.18]	[1.33]	[1.33]	[1.52]	[3.00]	[3.00]	[3.08]	[4.16]	[4.15]	[4.15]
R^2	0.016	0.02	0.067	0.007	0.007	0.01	0.027	0.027	0.031	0.003	0.004	0.005
N	35,699	35,699	34,770	35,699	35,699	34,770	35,699	35,699	34,770	29,345	29,345	28,545

Table A9

Integration between stock and option markets: Additional robustness tests.

This table presents cross-sectional variations in the relations between changes in option market bid-ask spread and option market volume reported in table 4. Columns (1) and (3) report estimates of γ_1 from regression (19): $y_{it} = \gamma_1 itrade_{it} + \eta_i + X_t'\gamma_3 + \epsilon_{it}$, 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 report results for our main measure of integration between stock and option markets: the absolute difference between implied volatility for calls and puts during (t-90,t-60). In panel B we use the difference between implied volatility for calls and puts during (t-90,t-60) as the measure of integration between stock and option markets. In panel C we use the negative option bid-ask spread during (t-90,t-60) as the measure of integration between stock and option markets. In panel D we use option volume during (t-90,t-60) as the measure of integration between stock and option markets. In panel E we use option open interest during (t-90,t-60) as the measure of integration between stock and option markets. In panel F co-movements of changes in IV of call and put options during (t-90,t-60) as the measure of integration between stock and option markets. For every trading date, co-movement is 1 if call and put IVs move in the same direction, and zero otherwise. *, **, 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 the absolute difference between implied volatility for call and put options				
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
Panel B: Sort on the difference between implied volatility for call and put options				
High	0.0022**	1.97	-0.0241	-0.24
Low	0.0044***	4.21	0.0165	0.19
Difference	-0.0022	-1.47	-0.0406	-0.31
Panel C: Sort on the negative option bid-ask spread				
High integration	0.0051***	4.55	0.0649	0.84
Low integration	0.0015	1.54	-0.124	-1.17
Difference	0.0036**	2.41	0.1889	1.45
Panel D: Sort on the option volume				
High integration	0.0054***	4.51	0.0386	0.49
Low integration	0.0012	1.33	-0.0443	-0.42
Difference	0.0042***	2.79	0.0829	0.63
Panel E: Sort on the option open interest				
High integration	0.0051***	4.01	0.0143	0.18
Low integration	0.0017**	1.98	-0.0202	-0.19
Difference	0.0035**	2.28	0.0345	0.26
Panel F: Sort on co-movement of changes in call and put IV				
High integration	0.0045***	3.68	0.0083	0.09
Low integration	0.0023**	2.52	-0.0115	-0.12
Difference	0.0022	1.45	0.0198	0.15

Table A10

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 (20): $y_{it} = \sum_{\tau=-2}^{\tau=2} \gamma_\tau itrade_{it-\tau} + \eta_i + X_t'\beta + \epsilon_{it}$, 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