Informed Trading in the Stock Market and Option Price Discovery

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Motivation

- Derivative markets should provide an interesting trading avenue for investors with private information.
  - Options may provide valuable embedded leverage (Black, 1975).
  - They may allow investors to achieve better liquidity and hide their information (Back 1993; Easley, O'Hara, and Srinivas, 1998).
- Indirect evidence on informed trading in option markets based on the predictability of stock returns by option market statistics
  (Vijh 1990; Chakravarty, Gulen, and Mayhew 2004; Chan, Chung, and Fong 2002, Roll, Schwartz, Subrahmanyam (2010), Johnson and So (2012,14)).
- Abnormal activity in option markets around surprise M&A announcements or scheduled earnings announcements may signal (illegal?) informed trading
  (Cao, Griffin, and Chen (2003), Augustin, Brenner, Subrahmanyam (2014), Dubinsky and Johannes (2006)).

What this paper is about?

- We use data on informed activist investors' trading (Schedule 13D filers) to revisit the following questions:
  - How do investors with valuable private information trade in stocks and derivatives?
  - How does private information flow into stock and option prices?
  - How do measures of adverse selection in option and stock markets behave in the presence of informed trading?
- Addressing these questions is challenging because the identity of informed investors is typically unobservable
- Standard approaches in the literature to overcome this challenge include
  - studying periods of time when informed trading is likely (e.g., M&A announcements)
  - assuming that a class of investors is informed (e.g., corporate insiders or institutional investors).
  - focusing on *known* cases of illegal insider trading (e.g., Kacperczyk and Pagnotta (2016)).

What are Schedule 13D filings?

- Activists (Icahn, Peltz, Loeb...) typically accumulate shares by trading **anonymously** in secondary markets.
- When their stake reaches the (regulatory) limit of 5%, they must disclose their holdings and intentions
  (e.g., corporate governance/managerial replacement, M&A transaction, Capital structure change, Cost reduction measures, Dividend payouts, Share buybacks, or...).
- SEC also requires these investors to disclose their trades in subject securities, and their positions in derivatives.
- Empirical evidence shows their trades are very profitable, i.e., these are **informed** traders.

Main Results

- Schedule 13D filings have information about both direction and volatility of future stock returns.
  - 6% cumulative excess return during (t-10,t+1) window around filing date.
    $\rightarrow$ the price increase is permanent.
  - 10% drop in stock price volatility after the filing date.
    $\rightarrow$ the volatility drop is temporary.

- Both types of information are reflected in stock and option prices prior to filing:
  - 50% of price run up occurs prior to filing date
  - Implied volatilities decline prior to filing date and line-up with future realized volatility
  - Implied volatility put & call skew as well as time slope steepen

- Option bid-ask spreads widen closer to the filing date
  - more for target firms that experience a large future change in volatility.

Main Results - cont.

- Informed investors rarely use derivatives
  - In only 2.3% (66 out of 2,905) Schedule 13D filings we analyze
  - Increases to 10% when exchange-traded options on target available.
- When they do, Schedule 13D filers build economically significant positions to increase their exposure to the stock (not to hedge):
  - 2.3% long exposure via derivatives and 6.4% via stocks (1.2% more than when trading only stocks)
- On days when activists trade the stock (but not derivatives):
  - stock trading volume is 35% higher
  - stock bid-ask spread is lower (CD and Fos, 2015)
  - option bid-ask spreads are wider!
  - implied volatility decreases (i.e., volatility information flows into prices)
  - no abnormal option trading volume

$\Rightarrow$ Volatility discovery without direct informed trading in options

$\Rightarrow$ Consistent with a theoretical model with rational option market making when it is common-knowledge that informed agents only trade the stock.

Literature on informed trading and derivatives

Theoretical literature

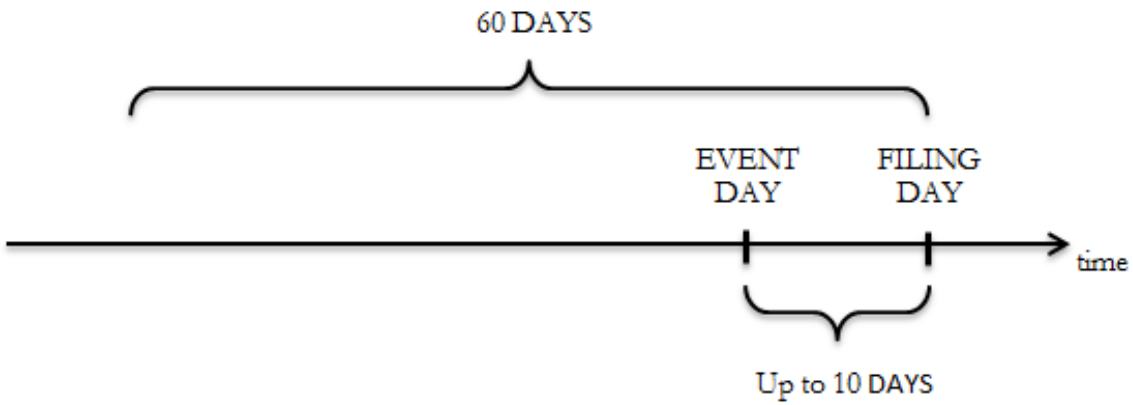
- Leverage should make options desirable for informed trading (Black (1975)).
- Informed optimally trades in both markets to minimize price impact, which can lead to long-short positions (also affects stock price volatility (Back (1993)).
- Informed may not trade in options if liquidity to low (Easley, Ohara, Srinivas (98)).
- Informed trading in both markets potentially reveals different kinds of information (directional vs. volatility; Back and Crotty (2015)).

Empirical literature

- Option to Stock abnormal volume and option order imbalance predict future stock returns. (EOS (1998), Pan and Poteshman (2006), Roll, Schwartz, Subrahmanyam (2010), Johnson and So (2012,14), Ge, Tse-Xhun and Pearson (2015))
- Option prices predict future stock returns (Cremers and Weinbaum, 10; Xing, Zhang, Zhao, 10; Conrad, Dittmar, Ghysels, 13; An, Ang, Bali, Cakici, 14)
- Intraday, option prices generally follow the underlying stock price (Muravyev, Pearson, and Broussard, 2013)
- Abnormal volume in Option market and increase in implied volatility may signal (illegal?) informed trading around surprise M& A announcements (Augustin, Brenner, Subrahmanyam (2014) and Kacperczyk and Pagnotta (2016)), or scheduled earnings announcements (Dubinsky and Johannes (2006)).

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.

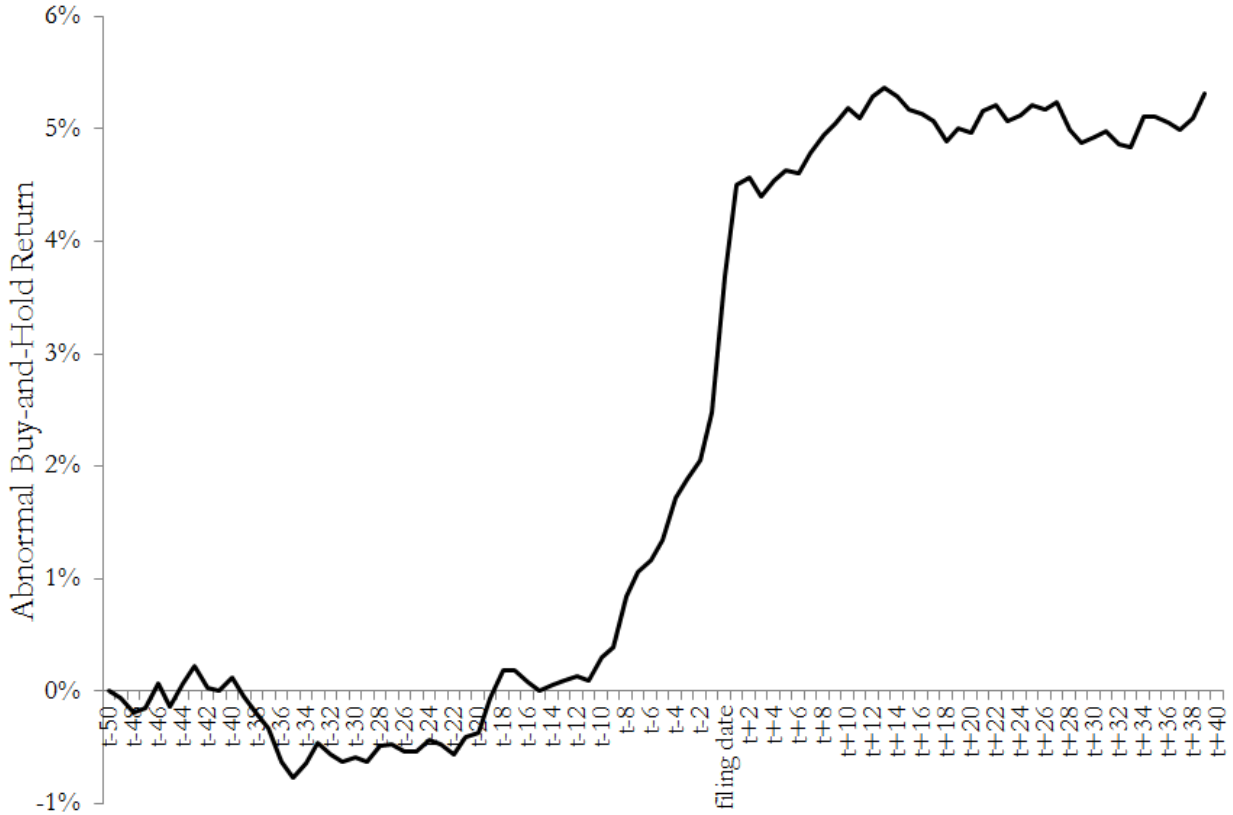


- We identify all Schedule 13D filings from 1996 to 2010
- Identify all events with information on trades.
- The final sample includes 2,905 events. Exchange-traded options are available in 580 events.

Additional data from several sources (CRSP, TAQ, OptionMetrics, and International Securities Exchange)

Directional private information

The average buy-and-hold return around the filing date in excess of the buy-and-hold return of the value-weighted market:



- The effect is permanent

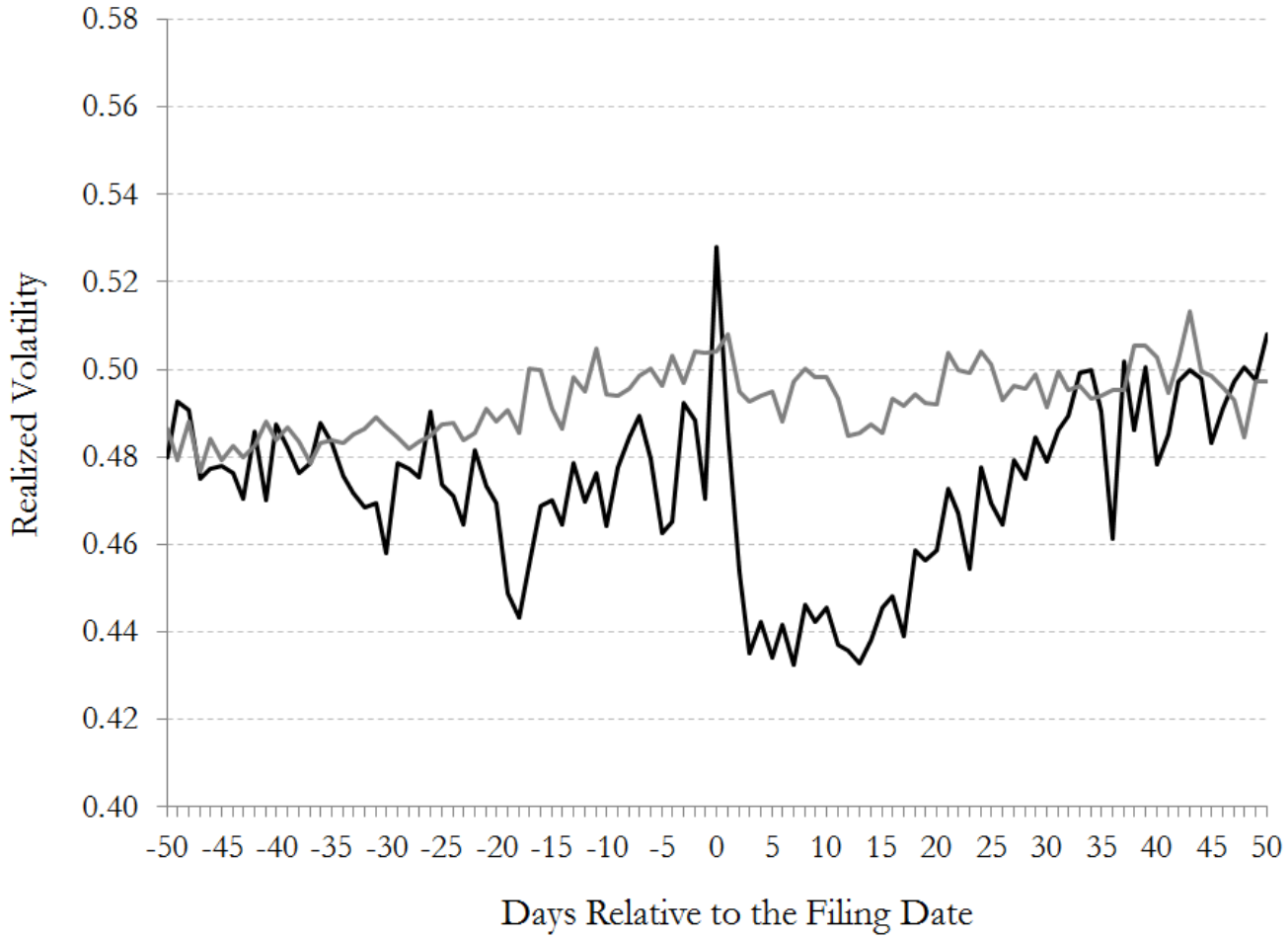
Profits from Informed Trades

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]

- These profit calculations do not include profits on derivatives positions!

Volatility private information

The realized volatility:



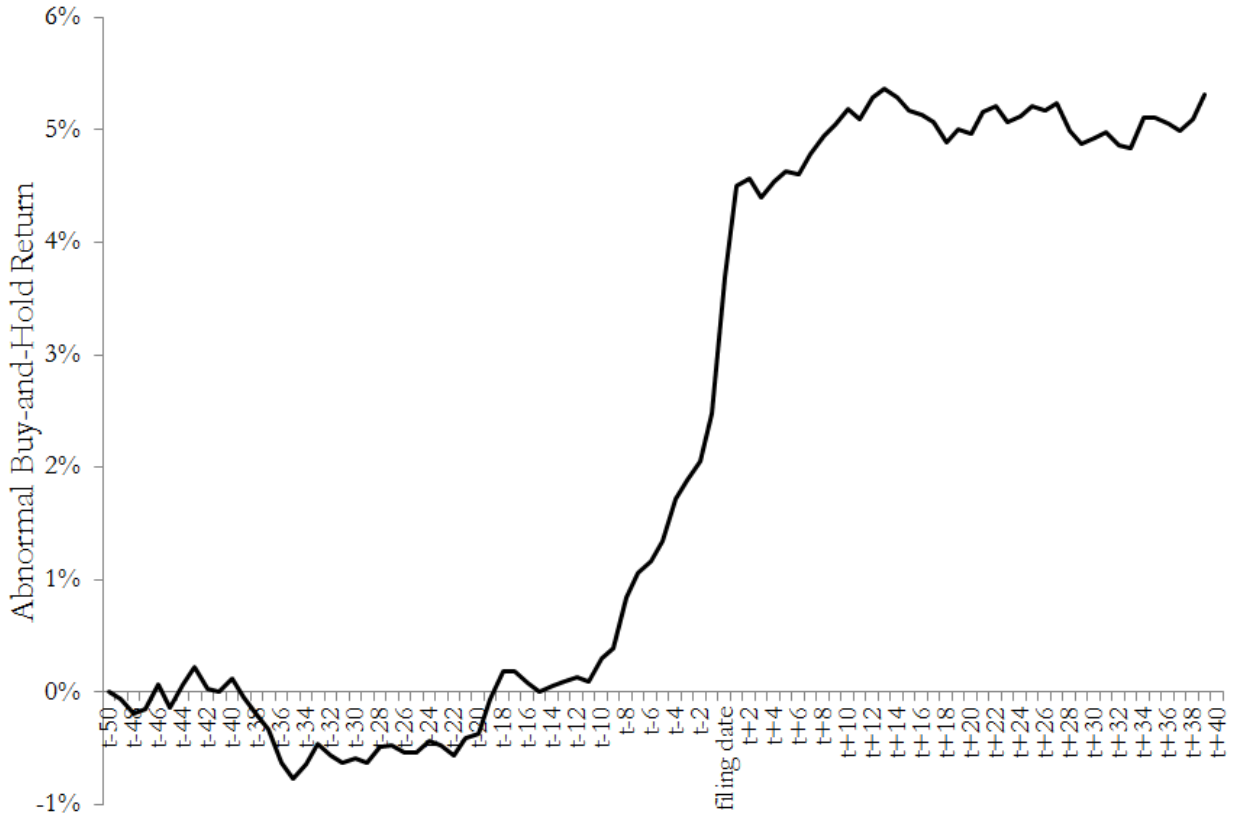
Volatility private information

	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]

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.

Flow of directional information into prices

About half of the directional private information is reflected in stock prices prior to the filing date:



Do informed trades move stock prices?

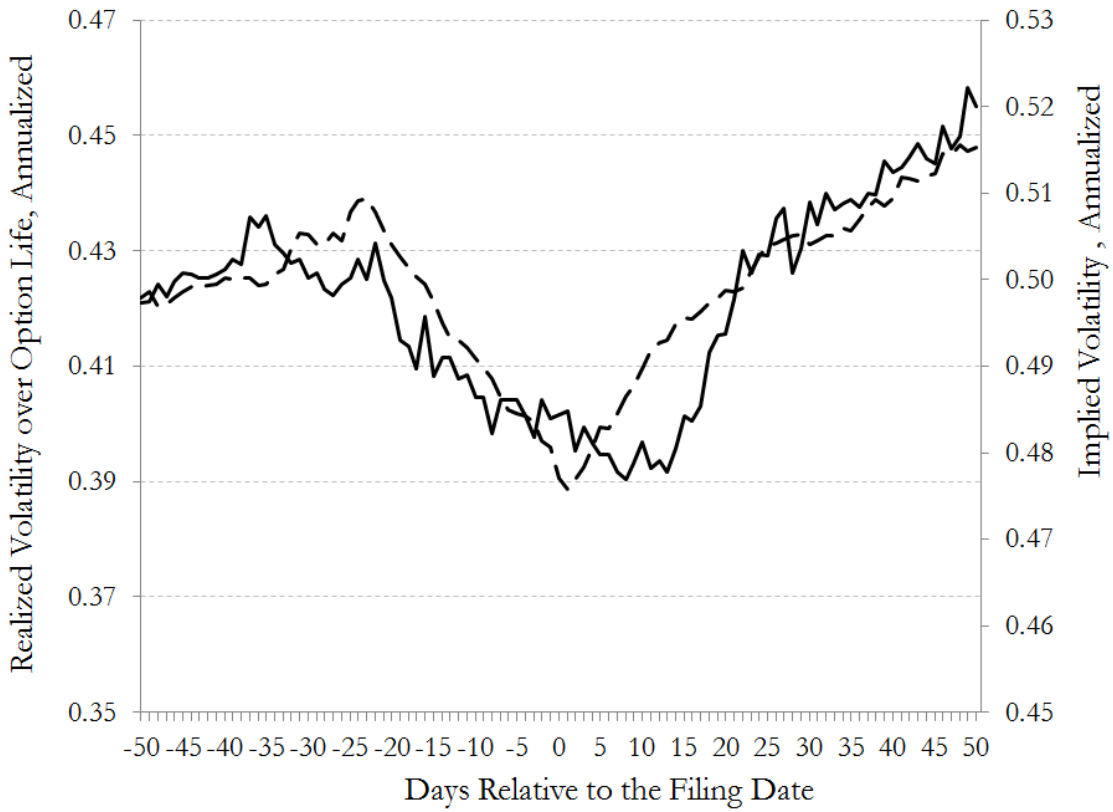
	days with informed trading (1)	days with no informed trading (2)	difference (3)	t-stat (4)
excess return	0.0064	-0.0004	0.0068***	9.94
turnover	0.0191	0.0077	0.0115***	21.67
$\lambda * 10^6$	14.3311	20.1644	-5.8334***	-8.38

- Informed trade about 1/3 of the days.
- When they trade they trade around 10-25% of the daily volume.
- Measures of information asymmetry and liquidity indicate that stocks are more liquid when informed trades take place

Flow of volatility information into prices

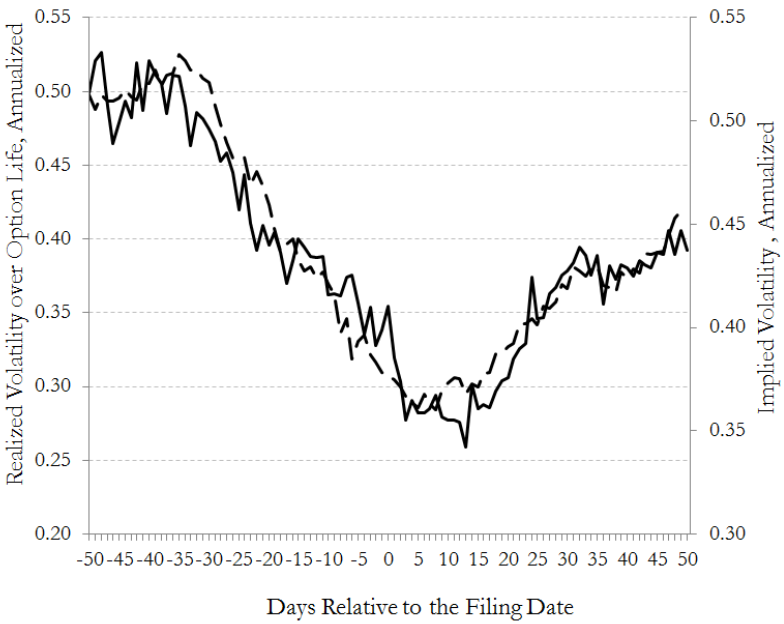
The flow of volatility information into *option* prices:

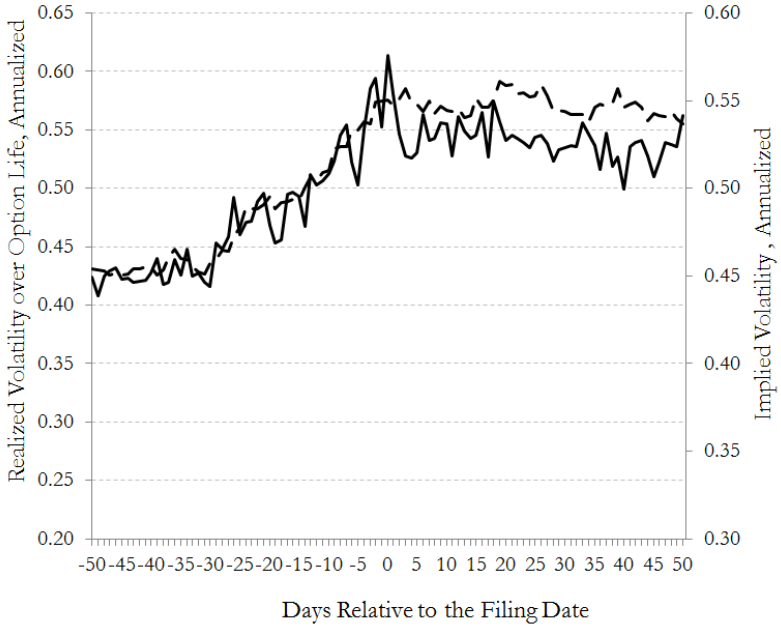
- the *future* 30-day realized volatility
- the 30-day implied volatility from option prices



Flow of volatility information into prices

Does the predictability hold when we condition on future changes in realized volatility?

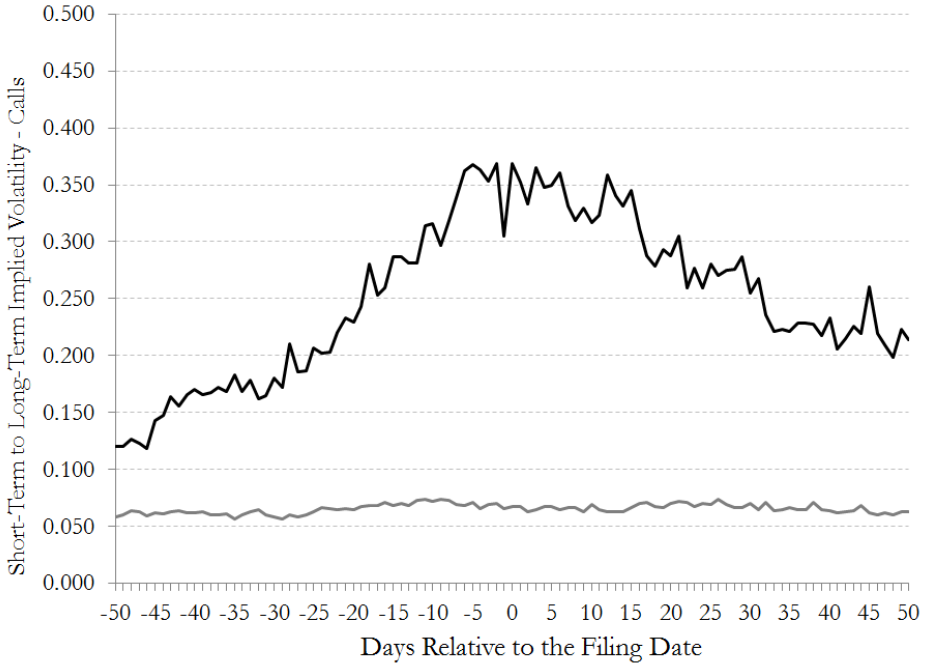




Flow of volatility private information into prices

Do option prices reflect the timing of the informational event?

- Time slope is the ratio of 30-day to 365-day option implied volatilities minus one

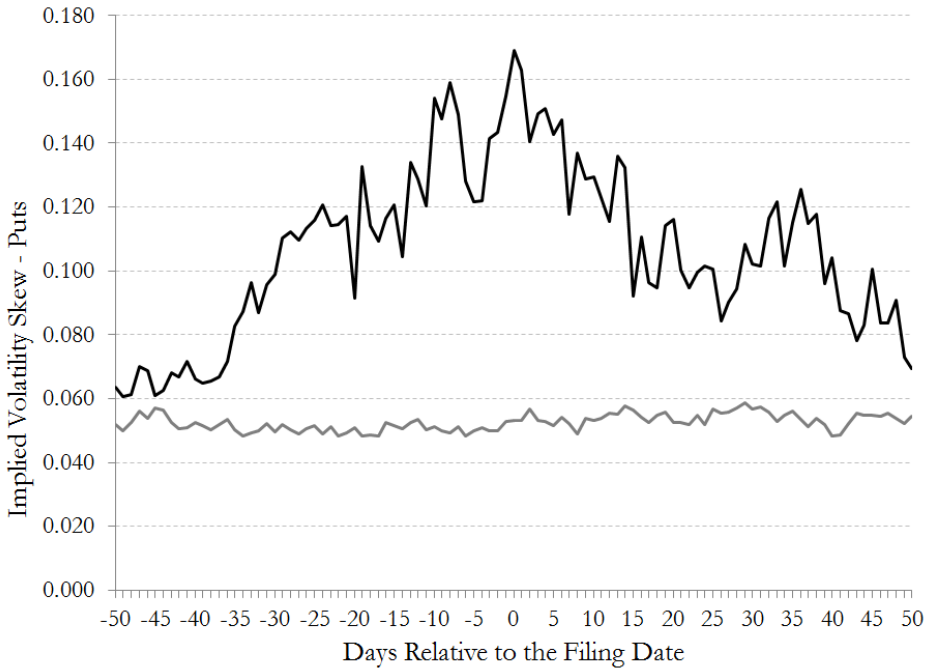


Option prices reflect a higher chance of an informational event in the short term relative to the long term.

Flow of volatility information into prices

Do option prices reflect the chances of a large stock price move?

- Put skew is the ratio of OTM and ATM put options implied volatilities minus one



Option prices reflect higher chances of a significant stock and/or volatility change closer to the filing date.

Flow of volatility information into prices

We next 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.

	Diff – event	Diff – control	Diff-in-diff	t-stat
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
Option market – Implied volatility				
IV Call	-0.0153	0.0064	-0.0217***	-3.10
IV Put	-0.0146	0.0046	-0.0192***	-2.79
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

Schedule 13D derivatives disclosure requirements

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."*

We use Item 6 to identify whether a Schedule 13D filer uses derivatives.

- The rule does not specify what information needs to be disclosed

Information on trades executed by Schedule 13D filers is reported in Item 5(c)

- The filer is required to report the date, price, and quantity of all trades in the underlying security executed during the 60 days that precede the filing date
- Item 5(c) does not require, however, the filer to disclose trades in either exchange-traded options or over-the-counter contracts

When do activists use derivatives?

Schedule 13D filers disclose information on derivatives only in 66 Schedule 13D filings, corresponding to 2.27% of the sample

- When exchange-traded options are available, the probability that an activist uses derivatives increases to from 2% to 10%

Schedule 13D filers are more likely to use derivatives when:

- exchange-traded options are available
- option markets are more liquid
- put-to-call volume ratio is high
- the HSR rule is binding
- activist hedge funds ownership is high

How Do Activists Use Derivatives?

Schedule 13D filers seek 'long' stock price exposure in most of events:

Sample type: Sample size:	Full sample 66 events	Listed options 58 events	Over-the-counter 28 events
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

The role of informed trading in price discovery

The unique feature of our data is that we can separate days when informed investors trade from days when they do not trade

We estimate the following regression:

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

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 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)
- η_i are event fixed effects

The role of informed trading in stock market

- We also consider the sample of 522 Schedule 13D filings in which there are listed options but Schedule 13D filers do not use any type of derivatives
- 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.

- In this sub-sample we know when and where informed investors trade!

The flow of information into prices and informed trading - stock market

Sample:	580 events with listed options					No derivatives are used		
	itrade (1)	*t*-stat (2)	*itrade_opt* (3)	*t*-stat (4)	*N* (5)	*itrade* (6)	*t*-stat (7)	*N* (8)
Excess Return	0.0018***	3.79	0.0049**	2.19	39,113	0.0019***	4.16	35,917
Bid-ask spread	-0.0004***	-3.27	0.0001	0.45	39,113	-0.0004***	-3.28	35,917
Volatility	0.0003	0.74	0.0059**	2.49	39,113	0.0004	0.84	35,917
Vol (log)	0.3483***	13.24	0.2811***	3.95	39,113	0.3496***	13.01	35,919

When Schedule 13D filers trade stocks

- market-adjusted returns and volume are higher
- stock market bid-ask spread is narrower
- the realized volatility is (insignificantly) higher

When Schedule 13D filers trade options

- the market-adjusted returns, volatility, and trading volume are higher

The flow of information into prices and informed trading - implied volatility

Sample:	580 events with listed options					No derivatives are used		
	itrade (1)	*t*-stat (2)	*itrade_opt* (3)	*t*-stat (4)	*N* (5)	*itrade* (6)	*t*-stat (7)	*N* (8)
IV Call	-0.0326***	-4.97	0.0131	1.25	38,988	-0.0361***	-4.67	35,681
Change in IV Call	-0.0022***	-3.78	-0.0008	-0.33	38,481	-0.0026***	-4.24	35,346
IV Put	-0.0288***	-4.36	0.0117	1.09	38,988	-0.0317***	-4.71	35,815
Change in IV Put	-0.0012**	-2.25	0.0016	0.60	38,481	-0.0013**	-2.25	35,346
Put skew	0.0268***	4.77	0.0137	1.56	38,988	0.0285***	4.65	35,681
Call skew	0.0200***	4.02	0.0000	0.00	38,988	0.0356***	3.71	35,681
Time slope	0.1074***	6.48	0.0157	0.56	38,988	0.1123***	6.25	35,681

When Schedule 13D filers trade stocks

- changes in implied volatilities are more negative
- skew and time-slope are higher

When Schedule 13D filers trade options

- no significant changes in implied volatility (consistent with the activists' trades not carrying volatility information)

The flow of information into prices and informed trading - bid-ask spread

Sample:	580 events with listed options					No derivatives are used		
	itrade (1)	*t*-stat (2)	*itrade_opt* (3)	*t*-stat (4)	*N* (5)	*itrade* (6)	*t*-stat (7)	*N* (8)
Stocks	-0.0004***	-3.25	0.0002	0.89	37,481	-0.0004***	-3.28	34,366
All options	0.0030***	3.37	0.0001	0.08	32,193	0.0033***	3.22	27,510
Call options	0.0028***	2.99	-0.0009	-0.45	30,611	0.0030***	3.10	27,510
Put options	0.0028***	2.71	0.0012	0.63	29,870	0.0030***	2.77	27,158

When Schedule 13D filers trade stocks

- stock bid-ask spreads are lower and trading volume is higher (CD and Fos, 2015)
- option bid-ask spreads are wider

When Schedule 13D filers trade options

- no significant changes in option market bid-ask spreads

The flow of information into prices and informed trading - option market trading activity

Sample:	580 events with listed options					No derivatives are used		
	itrade (1)	*t*-stat (2)	*itrade_opt* (3)	*t*-stat (4)	*N* (5)	*itrade* (6)	*t*-stat (7)	*N* (8)
Option Volume (log)	-0.0202	-0.24	0.7466***	4.58	38,827	-0.0159	-0.19	35,675
Put volume (log)	0.2564***	2.77	0.5628*	1.87	38,827	0.2503***	2.68	35,675
Call volume (log)	-0.1341	-1.46	0.7805***	5.14	38,827	-0.1307	-1.42	35,675

When Schedule 13D filers trade stocks

- there is an insignificant decrease in option volume
- put volume is higher

When Schedule 13D filers trade options

- option volume is higher

The role of informed trading in stock market: Summary

- Significant 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

$\Rightarrow$ Option market participants infer information about future stock volatility from the price and trading activity in the stock market

Q? How would we expect option prices to react if informed agents trade in the stock but not in options (and this is common-knowledge)?

Q? Can price dynamics in option market be explained by cross-market price impact (i.e, stock order flow and price dynamics explains option prices)?

- Extension of continuous time Kyle (1985) model to n random announcements.
- A risk-neutral informed investor accumulates position $X_t = \int_0^t \theta_s ds$ trading anonymously in a secondary market to maximize his expected profits:

$$\max_{\theta_t} \mathrm{E}\left[\int_0^{\tau_n} (V_{\tau_n} - P_t)\theta_t dt \,|\mathcal{F}_t^I\right] \tag{3}$$

- The terminal value of the firm is V_{τ_n} where $V_t = \sum_{i=0}^n v_i \mathbf{1}_{\{\tau_i \leq t\}}$ and v_i are iid $N(0, \Sigma^i)$.
- The market learns each random variable v_i at its announcement date τ_i.
- The informed investor learns v_{i+1} at τ_i. She is one-step ahead of the market.
- The announcement dates $\tau_0 = 0 < \tau_1 < \tau_2 < \ldots$ are unpredictable stopping times with intensity $\rho_i(t - \tau_i)$ for $t \in [\tau_i, \tau_{i+1})$.

Market Maker

- The market maker is risk-neutral and has a prior about each $v_i \sim N(0, \Sigma^i)$.
- The market maker also observes the total order flow for:

$$dY_t = \underbrace{\theta_t\, dt}_{\substack{\textit{informed} \\ \textit{order flow}}} + \underbrace{\sigma_t\, dZ_t}_{\substack{\textit{uninformed} \\ \textit{order flow}}} \tag{4}$$

- Noise trading volatility is deterministic between events: $\sigma_t = \sigma_i(t - \tau_i)$.
- Since the market maker is risk-neutral, equilibrium imposes that

$$P_t = \mathrm{E}\left[V_{\tau_n} \mid \mathcal{F}_t^M\right] \tag{5}$$

- Related work: Admati Pfleiderer (1988), Foster and Viswanathan (1990), Back (1992), Back and Pedersen (1998), Caldentey and Stacchetti (2000), Back and Baruch (2004), Collin-Dufresne and Fos (2016)...

Solving for Equilibrium with one announcement

- Let us consider the case $n = 1$ (i.e., one single random announcement).
- The equilibrium price has (jump-diffusion) dynamics starting from $P_0 = v_0$:

$$dP_t = \lambda_t \underbrace{(\theta_t dt + \lambda_t \sigma_t dZ_t)}_{dY_t} \mathbf{1}_{\{\tau > t^-\}} + (v_0 + v_1 - P_t) d\mathbf{1}_{\{\tau_1 \leq t\}}$$

- The optimal trading strategy is: $\theta_t = \beta_t(v_0 + v_1 - P_t)$ where $\beta_t = \frac{\lambda_t \sigma_t^2}{\Sigma_t}$
- Price impact is: $\lambda_t = \lambda_0 e^{-\int_0^t \rho_s ds}$
- The posterior variance of v_1 (for the market maker) is $\Sigma_t = \Sigma^1 - \int_0^t \lambda_s^2 \sigma_s^2 ds$.
- An equilibrium exists if λ_0 exists s.t. $\lim_{t\to\infty} \Sigma_t = 0$. Then:
  - P_t is a martingale in the filtration of the market maker
  - Absent an announcement, price converges to (and thus reveals) v_1 only at infinity.

Constant intensity and noise trading volatility

- If the intensity ρ and noise trading volatility σ are constant, then an equilibrium exists.
- Price is affine mean-reverting (in insider's filtration):

$$dP_t = (2\rho(v_0 + v_1 - P_t)dt + \sqrt{2\rho\Sigma_0}e^{-\rho t}dZ_t)\mathbf{1}_{\{\tau_1 > t^-\}} + (v_0 + v_1 - P_t)d\mathbf{1}_{\{\tau_1 \leq t\}}$$

- Price impact is decreasing: $\lambda_t = \lambda_0 e^{-\rho t}$ with $\lambda_0 = \frac{\sqrt{2\rho\Sigma_0}}{\sigma}$
- The posterior variance (of the price jump) is given by $\Sigma_t = \Sigma^1 e^{-2\rho t}$
- Price 'realized volatility' is always decreasing prior to the event, and
- Price is constant after the event.
- To capture some features of our data however, it is natural to assume:
  - Noise trading volatility is increasing.
  - Event intensity is increasing (i.e., inversely related to Σ_t).

Increasing intensity and noise trading volatility

- For illustration, set $\sigma_t = \sigma_0 e^{mt}$ and $\rho_t = \rho_0 + \rho_1 t$.
- In that case $P_0 = v_0$ and:

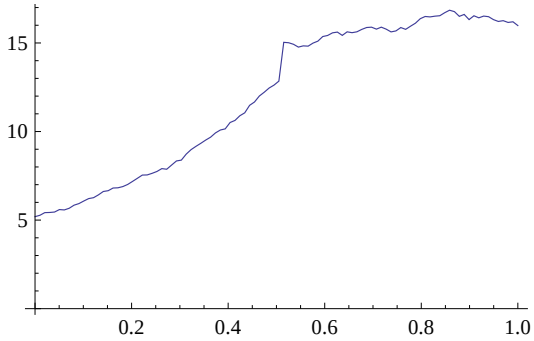
$$dP_t = \frac{\lambda_t^2 \sigma_t^2}{\Sigma_t}(v_0 + v_1 - P_t)dt + \sigma_0 \lambda_0 e^{((m-\rho_0)t - \rho_1 t^2)} \mathbf{1}_{\{\tau_1 > t\}} dZ_t + (v_0 + v_1 - P_t) d\mathbf{1}_{\{\tau_1 \leq t\}}$$

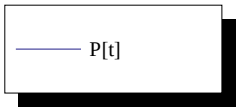
- Price impact is decreasing: $\lambda_t = \lambda_0 e^{-\rho_0 t - \rho_1 \frac{t^2}{2}}$
- There exists an equilibrium, if either $\rho_0 > m$ or $\rho_1 > 0$.
- Then the posterior variance (of the price jump) $\Sigma_t = \Sigma^1 \frac{N(\frac{(m-\rho_0-\rho_1 t)\sqrt{2}}{\sqrt{\rho_1}})}{N(\frac{(m-\rho_0)\sqrt{2}}{\sqrt{\rho_1}})}$
- Further, if $m > \rho_0$ then realized volatility is initially increasing as the informed delays trading to benefit from the expected larger liquidity and then eventually trades more agressively (as the horizon effects start to dominate via ρ_1).

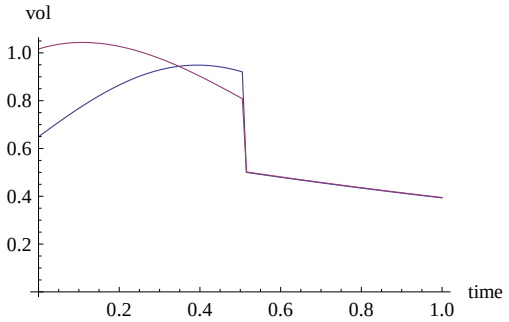
Multiple (random) announcement dates

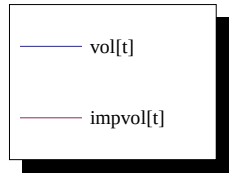
- We can extend this to multiple announcement dates.
- The price has same dynamics in between announcements, but on an announcement it 'renews' itself as new 'private information' appears.
- If $n = 2$, then $P_0 = v_0$ with same dynamics as when $n = 1$ until τ_1 when:
  - Price jumps to its new publicly known level $P_{\tau_1} = v_0 + v_1$,
  - The target mean reversion price level (in insider filtration) jumps to $v_0 + v_1 + v_2$.
  - Posterior uncertainty about the next announcement value v_2 is reset at Σ^2.
  - Noise trading volatility jumps to its new value σ^i.
- The price process is a Gaussian affine jump-diffusion process (a martingale in the filtration of the market maker) with jumps in (i) level, (ii) volatility and, in the filtration of the insider, (iii) in the target mean-reversion level.
- We can derive an explicit solution for the equilibrium price of a (call) option when the insider only trades stocks.

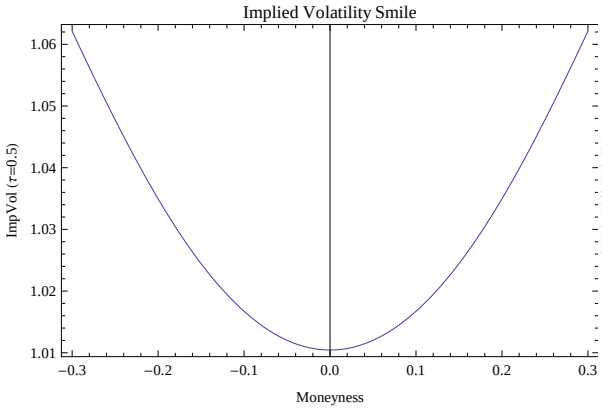
Model Option prices, implied and realized volatility

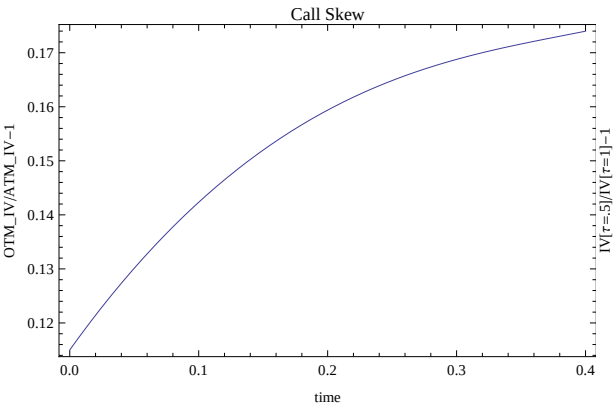


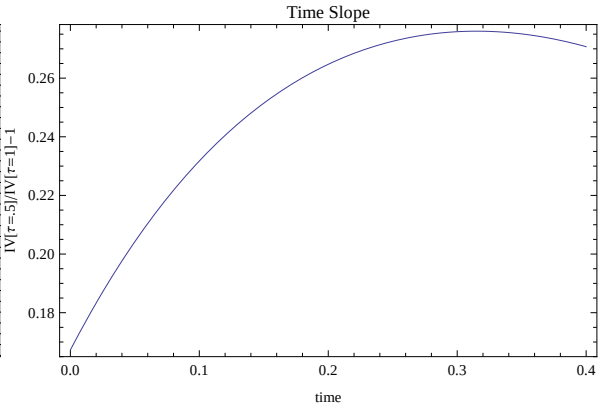










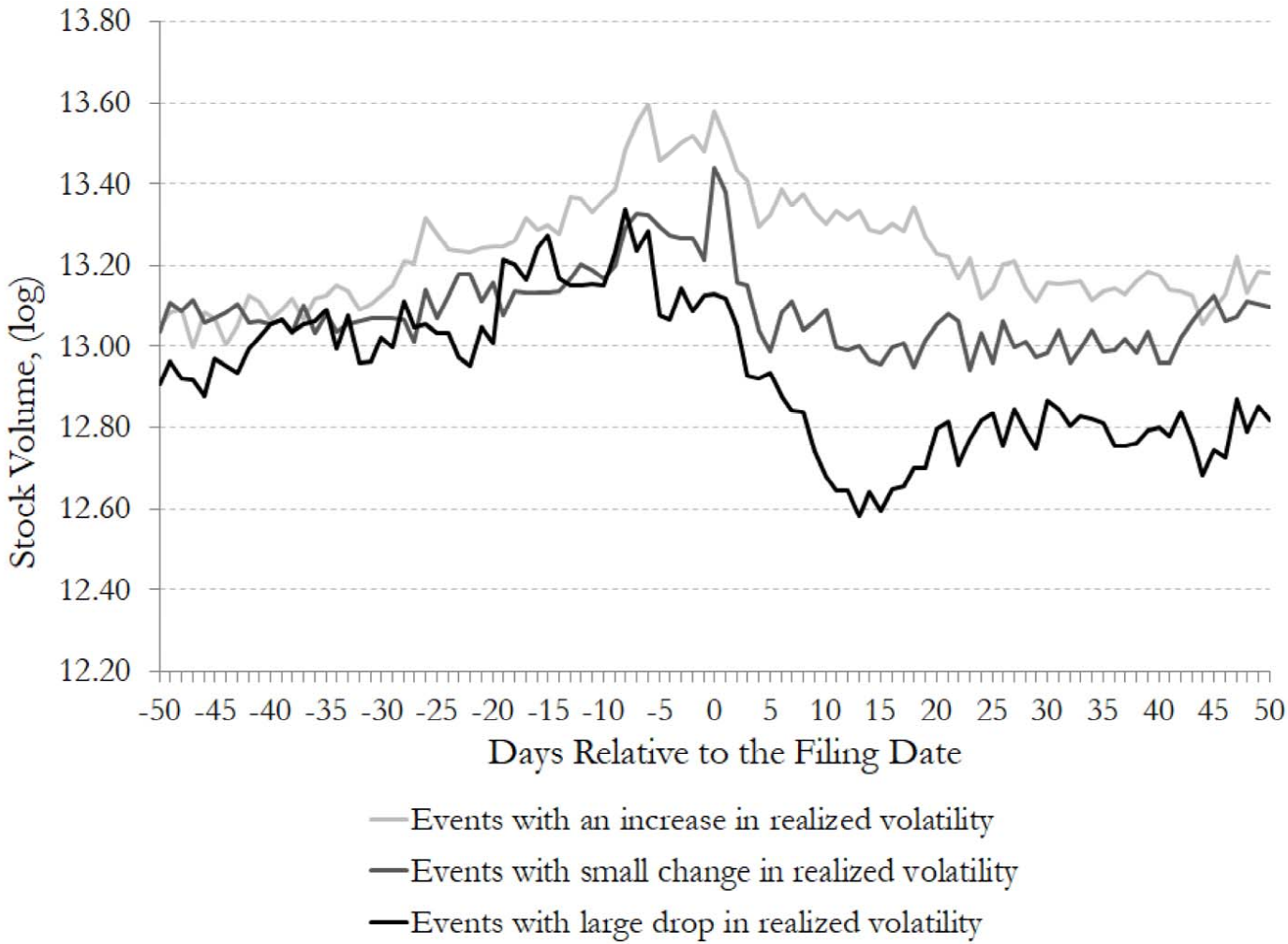


Model Summary

- This model can replicate qualitatively some observed features:
  - Positive announcement jump at event date
    - Insider buys shares in undervalued firm
    - All information not in price on event date.
  - Increase in the realized volatility prior to, and drop on, the event date
    - Increase in uninformed volume leads to more agressive insider trading and higher price volatility.
    - Drop in realized volatility on the event date due to (a) information release, and (b) drop in uninformed volume (which makes informed trade less aggressively), but potentially tempered by (c) new private information.
  - Decrease in the implied volatility on options
    - Reflects expected drop in future realized volatility around announcement date.
  - An increase in both Put skew and Call skew prior to the event
    - Due mostly to the expected jump in volatility around announcement.
    - $\neq$ standard crash-probability intuition (the expected jump in the price level is zero unconditionally).
- It cannot however explain an increase in option Bid-ask spreads or Option volume.

$\rightarrow$ requires informed trading (or perception thereof by market maker).

Post announcement volatility and volume



Cross-sectional variation in the coefficient on *itrade*

Does effect of *itrade* on option market characteristics (IV, skew, slope, bid-ask spreads) depend on stock price jump, volatility jump, and level of integration?

Dependent variable:	IV		IV Skew		IV Time Slope		Option bid-ask spread	
	Coefficient	*t*-stat	Coefficient	*t*-stat	Coefficient	*t*-stat	Coefficient	*t*-stat
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Sort on CAR around Schedule 13D filing date								
Large CAR	-0.0608***	-6.18	0.0311***	3.77	0.1650***	6.46	0.0040***	3.29
Small CAR	0.0021	0.30	0.0009	0.13	0.0300**	2.23	0.0027***	2.98
Difference	-0.0628***	-5.24	0.0302***	2.77	0.1350***	4.68	0.0013	0.89
Panel B: Sort on volatility drop around Schedule 13D filing date								
Large volatility drop	-0.0798***	-8.07	0.0351***	3.54	0.1780***	6.62	0.0058***	3.99
Small volatility drop	0.0186***	3.03	-0.0017	-0.35	0.0232**	2.03	0.0015**	2.04
Difference	-0.0985***	-8.46	0.0368***	3.35	0.1548***	5.31	0.0043***	2.63
Panel C: Sort on the level of integration between stock and option markets								
High integration	-0.0419***	-4.89	0.0302***	3.88	0.1311***	5.46	0.0057***	5.00
Low integration	-0.0183**	-2.01	0.0016	0.20	0.0671***	3.83	0.0007	0.71
Difference	-0.0237*	-1.89	0.0286***	2.59	0.0640**	2.16	0.0050***	3.38

Observable characteristics

If option market participants do not observe the insiders' trading, do they infer it from other observables (contemporaneous and lagged price and volume information from stock and options)?

	(1)	(2)	(3)	(4)	(5)	(6)
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
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

Outcome variables around days when Schedule 13D filers trade

Do option market makers infer trades by Schedule 13D filers?

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

Conclusion

- We use data set of trades by investors who we can identify as having substantial private information to study how private information flows into option prices
- Schedule 13D filers trades contain information about both the direction and the volatility of future stock returns
- Both types of information are reflected in stock and option prices prior to the announcemen.
- Schedule 13D filers use derivative to leverage up their position in stocks, but only rarely trade in derivatives (only 10% of cases when a listed exchange is available).
- Information on volatility flows into option prices on days when informed trade in the stock market even when they do not trade options.
- Option Bid-ask spreads widen on days when informed trade in the stock (even though the stock bid-ask spreads decrease).