

Half the Signal

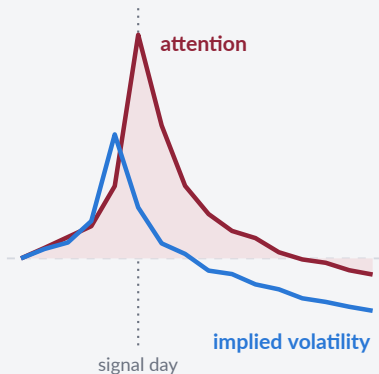
Retail Attention and the Price of Volatility

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22nd International Behavioural Finance Conference
University of Chicago · October 29, 2026
Session 1B, Attention and Information Choice



Retail investors announce in public which stocks they are crowding into

GameStop

JAN 2021

\$17 → \$483

start of January
to the intraday
high on January 28

GameStop

MAY 2024

+51%

at the open, after
Roaring Kitty's first
post in three years



JUL 2025

≈ 3×

Opendoor in a week;
Kohl's, GoPro, and
Krispy Kreme surge

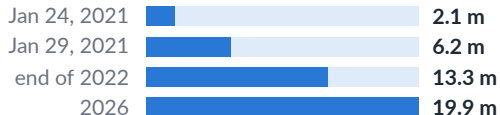
Wendy's

JUN 2026

+42%

intraday after a
"Save Wendy's" post;
lower the next day

reddit r/wallstreetbets members



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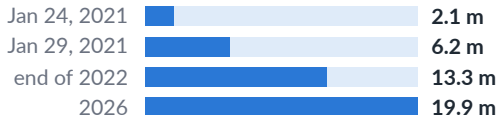
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**Option traders read the same posts.
How much of it is in option prices?**

And what happens to the option buyer?

This paper

How much of a public volatility signal do option prices contain, and what happens to the trader who buys the option?

1 SIGNAL



3.2 points

higher annualized volatility next week per s.d. of attention, across stocks on the same day

Distinct Reddit authors naming each stock, from 86.7 million comments

2 PRICES



About half

of that forecast is already in option prices; the other half still forecasts out of sample

Add option prices to the same regression, on the same stock-days

3 PAYOFF



One week

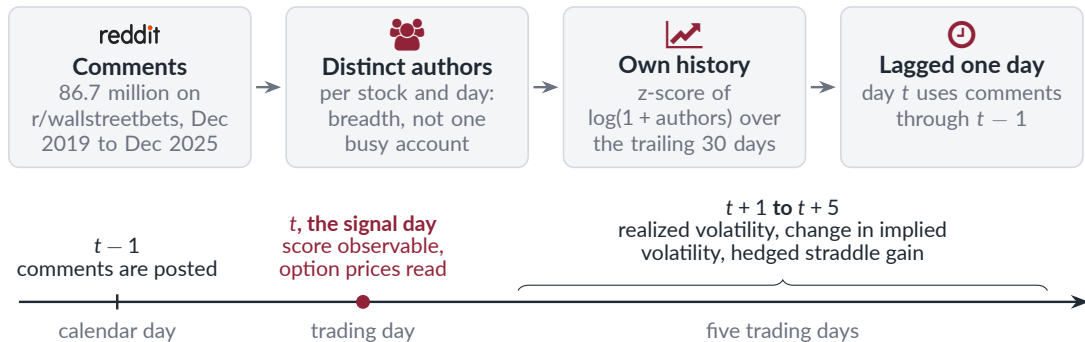
for implied volatility to give back its rise, while the stock is still volatile; option buyers earn less

Follow implied volatility and a hedged straddle through the week

What this paper adds to the closest work

	THEY SHOW	THIS PAPER
Choy and Wei (2023)	Options on attention-grabbing stocks attract buying and earn lower hedged returns	Discussion forecasts risk beyond return-based attention; the lower gains come from the fall in implied volatility
Xu, Yan, and Zhang (2017)	Google search, 2004 to 2010: implied volatility rises the next week; straddles earn more	Reddit, 2020 to 2024: implied volatility rises within the week and falls the next; their strategy earns nothing
Basistha, Kurov, and Wolfe (2020)	Market level: implied volatility subsumes search-based volatility forecasts	Individual stocks: the full surface absorbs about half; for ETFs and index funds, all of it
Bryzgalova et al. (2023); Eaton et al. (2026)	Retail option traders favor short-dated contracts and move the surface	Where the response to attention sits, how fast it reverses, and who opens the positions

Attention counts distinct authors naming a stock, relative to its history



Sample, 2020 to 2024

938 stocks, 93,350 stock-days with discussion
61,434 with the full 12-node surface, 538 stocks

Data

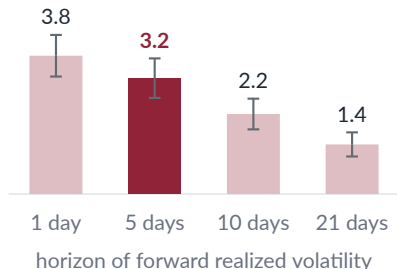
CRSP returns, Compustat earnings dates
OptionMetrics implied volatility surface
Cboe C1 and C2 customer records, 2025

Attention predicts next week's volatility across stocks on the same day

$$RV_{i,t+1:t+5} = \beta z_{i,t} + \gamma' x_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t}$$

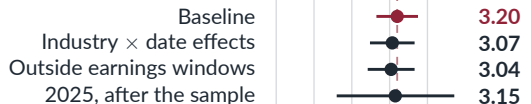
x : trailing 21-day volatility, log size • α_i, λ_t : ticker and date effects • clustered by ticker and date

By horizon, points per s.d. of attention



Five-day forecast, other specifications

SPECIFICATION



WHICH VOLATILITY



3.2 volatility points per s.d. of attention ($t = 11.5$), about 5 percent of the 67-point average

How much of the forecast is already in option prices? The spanning share

attention alone
with controls



β_0

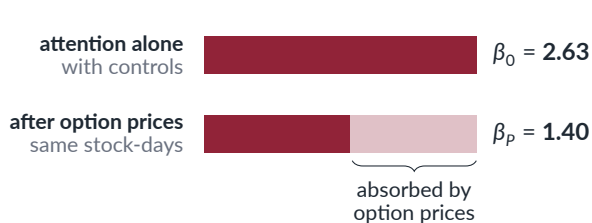
after option prices
same stock-days



β_P

- 1 Regress next week's realized volatility on attention and controls: slope β_0
- 2 Add option prices P on the same stock-days: slope β_P
- 3 The spanning share is the part of the slope that prices absorb

How much of the forecast is already in option prices? The spanning share



$$\phi(P) = 1 - \frac{\beta_P}{\beta_0} = 0.47$$

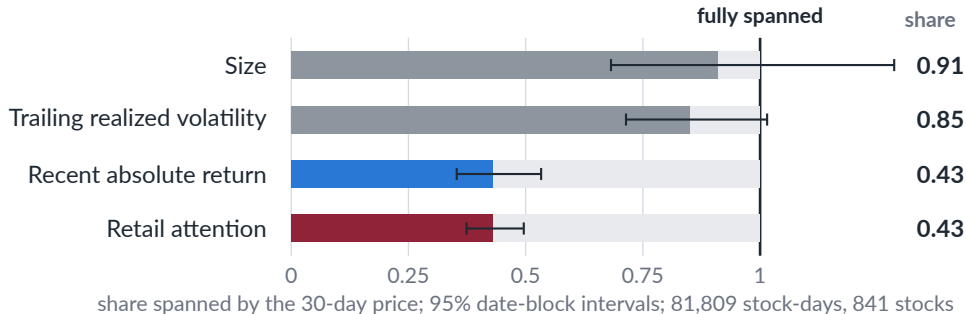
full 12-node surface, 61,434 stock-days

- 1 Regress next week's realized volatility on attention and controls: slope β_0
- 2 Add option prices P on the same stock-days: slope β_P
- 3 The spanning share is the part of the slope that prices absorb

An identity, not a model. It measures predictive redundancy, whatever makes prices and attention move together.

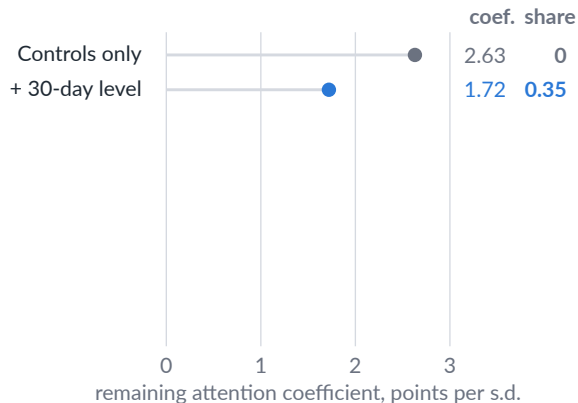
Signals the market has long known are almost fully spanned; attention is not

Same regression for each signal, with 30-day implied volatility as the only price control



The 30-day price absorbs the known signals, and **less than half** of attention or recent returns.

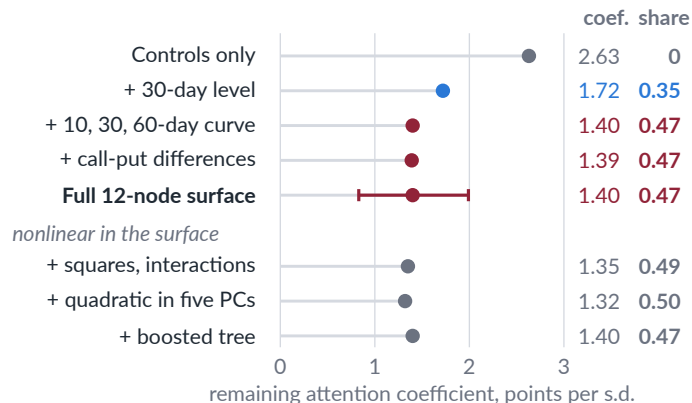
The surface spans about half, nearly all of it through the maturity curve



A third at 30 days

The level forecasts volatility well but moves little with attention

The surface spans about half, nearly all of it through the maturity curve



61,434 stock-days, 538 stocks; interval from date-block bootstrap draws.

A third at 30 days

The level forecasts volatility well but moves little with attention

About half with the curve

The full surface adds 0.12 [0.08, 0.18], nearly all from the 10- and 60-day levels

Same gap when nonlinear

Squares, principal components, and a boosted tree leave 1.3 to 1.4

The unspanned half is not recent returns, and it forecasts out of sample

⇔ RECENT RETURNS

0.50

share spanned with recent absolute returns and the full surface; both stay predictive

Also beyond the Choy and Wei winner and loser indicators

📈 OUT OF SAMPLE

+0.29 pp

gain in cross-sectional R^2 , 2022 to 2024, over forecasts using all 12 nodes

Positive every year; Clark-West $t = 7.4$; economically small

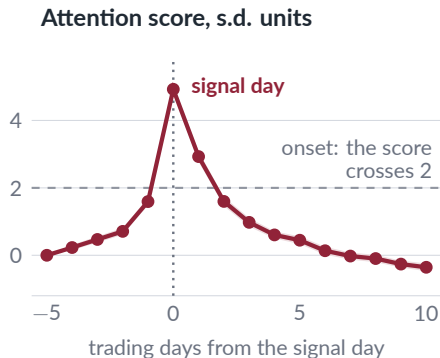
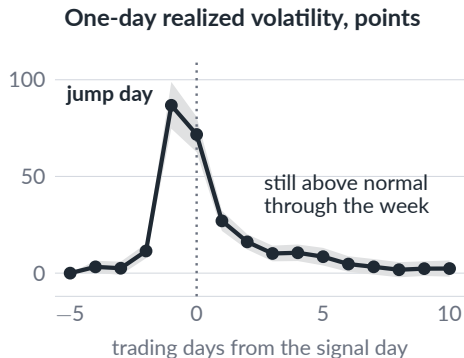
🏢 STOCKS VS FUNDS

0.47 vs 1.04

full-surface share for common stocks, against ETFs and index funds

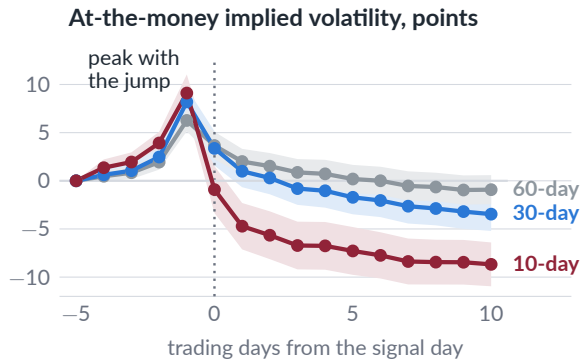
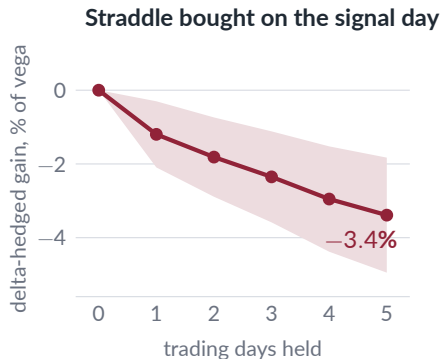
As Basistha, Kurov, and Wolfe find for the market

The attention score peaks the day after the jump, and volatility then decays



2,155 onsets in 507 stocks, 2020 to 2024: days on which the lagged score crosses 2 after ten trading days below it. Ticker and date effects; paths relative to day -5; bands are 95% intervals.

After the signal, implied volatility falls and the straddle buyer loses

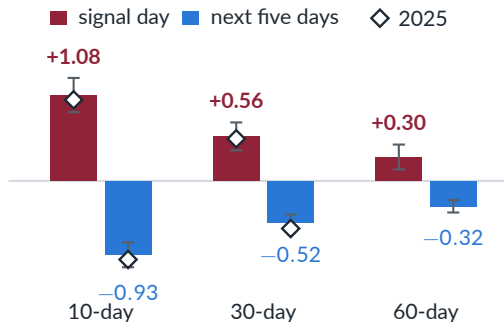


Relative to day -5; 95% bands; 1,776 onsets with a 10-day quote, 1,595 with a hedged straddle path.

The rise in implied volatility reverses within a week and costs the buyer

Implied volatility, points per s.d. of attention

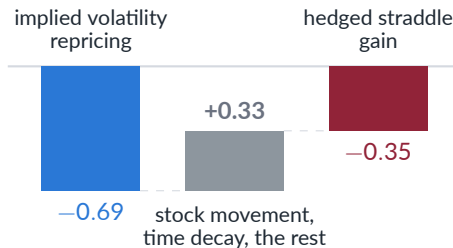
53,976 stock-days, 527 stocks; 95% intervals



Realized volatility: +1.39 in week one, +0.04 in week two

Five-day hedged straddle gain, % of vega

per s.d. of attention, following the same contracts

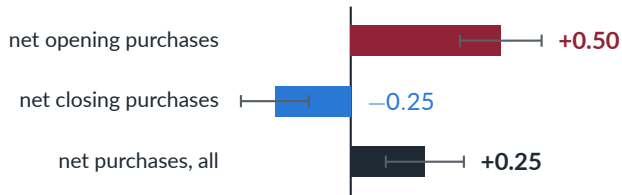


The repricing is twice the rest: **more stock volatility does not protect the buyer.**

Also negative with option-return controls.

Small customers buy short-dated volatility on high-attention days

Small-customer flows, contracts expiring within 30 days
percentage points of the day's vega traded, per s.d. of attention



Cboe C1 and C2 open-close records, March to August 2025; 3,989 stock-days; about 13% of industry volume in these stocks



Who buys. Small customers: mostly calls, within 30 days



Who sells. Market makers on C1; firms, broker-dealers, and large orders do not respond



Not the day's buying. Stocks with heavier small-customer buying show no larger decline

Opening purchases exceed closing sales: small customers end **longer volatility at the short end**, where the price response is largest

Takeaways



Public retail attention forecasts next week's stock volatility

3.2 points per s.d., within stock and day; firm-specific; it recurs in 2025



Option prices contain about half of it

The maturity curve does the work; the rest still forecasts out of sample



The price response is transitory and expensive

Implied volatility gives back its rise within a week while the stock is still volatile; hedged buyers lose on the repricing

Controlling for implied volatility does not control for what retail attention predicts.

Backup slides

SIGNAL

- ▶ Nested samples
- ▶ The forecast in regressions
- ▶ What is discussed

OTHER

- ▶ References

PRICES

- ▶ Joint spanning by the surface
- ▶ Spanning by maturity
- ▶ Nonlinear and out of sample
- ▶ Attention against known signals
- ▶ Funds, timing, intraday

PAYOFF

- ▶ Payoff under other controls
- ▶ Xu, Yan, and Zhang on Reddit
- ▶ Earnings windows
- ▶ 2025, after the sample
- ▶ Cboe customer records

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Nested samples: every price comparison holds the stock-days fixed

Sample	Stock-days	Stocks	Used for
Active: a lagged mention, 2020 to 2024	93,350	938	volatility forecast
With a 30-day at-the-money quote	81,809	841	30-day share, benchmarks
Complete 12-node surface	61,434	538	surface comparisons
Common price, volatility, payoff sample	53,976	527	rise, reversal, gain
2025, January to August	6,337		replication

- Average forward five-day volatility 67% annualized; median market capitalization \$7.9 billion
- The complete-surface sample keeps 66% of active stock-days and tilts toward larger, less volatile stocks
- Controls: trailing 21-day volatility, log size; ticker and date effects; clustered by ticker and date

The volatility forecast in regressions

Forward five-day realized volatility, annualized, per s.d. of attention; errors clustered by ticker and date

	Coefficient	<i>t</i>	<i>N</i>
Ticker effects only	0.0380	11.29	93,350
+ trailing volatility and size	0.0329	10.77	93,350
+ date effects (baseline)	0.0320	11.48	93,350
Baseline, stock-days with an industry code	0.0318	10.79	80,218
Industry-by-date effects in place of date effects	0.0307	10.19	80,218
Idiosyncratic component (trailing 60-day beta)	0.0322	12.43	92,310
Systematic component	−0.0007	−1.03	92,310
No observed earnings in the forward window	0.0304	9.61	74,852
Observed earnings in the forward window	0.0167	2.37	9,479

Recency raises the forecast (same-day authors 0.0678, lagged 0.0448) but leaves the full-surface share unchanged (0.456 and 0.457).

Joint spanning by the standardized surface

61,434 stock-days, 538 stocks; errors clustered by ticker and date; 95% intervals from 2,000 ten-day date-block draws, the wider bootstrap

Specification	Estimate	Clustered SE	95% CI
Controls only, β_0	0.0263	0.0032	
+ 30-day ATM, β_1 (share ϕ_1)	0.0172 (0.345)	0.0024	
+ 10, 30, 60-day ATM curve, β_2 (ϕ_2)	0.0140 (0.466)	0.0023	
+ ATM call-put asymmetry, β_3 (ϕ_3)	0.0139 (0.473)	0.0023	
Full 12-node surface, β_4	0.0140	0.0023	[0.0083, 0.0199]
Spanning share, ϕ_4	0.466		[0.394, 0.581]
Additional share over the 30-day level	0.122		[0.083, 0.181]

- Why a third at 30 days: the level forecasts realized volatility with a loading of 0.75, but moves with attention by only 0.014 per s.d.
- Dropping any single ticker or month leaves the share inside its interval; by year, 0.52 in 2020 to 2021 and 0.46 in 2022 to 2024

Short-dated options carry more of the signal

Share spanned by a single option node

realized-volatility horizon		10-day option	30-day option	60-day option
	5 days	0.51	0.35	0.25
	10 days	0.69	0.47	0.33
	21 days	0.85	0.63	0.45

- The 10-day node spans half of the five-day forecast; the 60-day node, a quarter
- Longer realized horizons are spanned more at every maturity
- Trailing volatility is nearly fully spanned in every cell

Each cell is $1 - \beta_{IV}/\beta_0$ with the baseline controls, ticker and date effects; 61,434 stock-days, 538 stocks.

Nonlinear functions of the surface, and the recursive forecast

In sample, the same 61,434 stock-days

Benchmark	β	t	Share
Linear 12-node grid	0.0140	6.20	0.466
Quadratic in ATM levels	0.0135	6.17	0.488
Quadratic in five PCs	0.0132	6.04	0.497
Shallow boosted tree	0.0140	6.21	0.469

Every benchmark leaves a precisely estimated coefficient of about 1.4 points.

Out of sample, 2022 to 2024

Monthly expanding windows	36
Stock-days, dates	30,183, 748
Gain in cross-sectional R^2	0.293 pp
Loss reduction, t	4.66
Clark-West t	7.41
Gain in daily rank correlation	0.0009

The benchmark holds all 12 nodes, volatility at several horizons, and size. The loss reduction is positive every year, and Clark-West is positive in every residual-spread tercile.

Attention against signals the market already knows

Each signal alone, 30-day level only

Signal	Share	95% CI
Retail attention	0.427	[0.374, 0.496]
Absolute 5-day return	0.427	[0.353, 0.533]
Trailing realized volatility	0.846	[0.714, 1.015]
Log market capitalization	0.911	[0.682, 1.286]

Attention and recent returns jointly

With the full surface	Before	After	Share
Attention	0.0151	0.0076	0.500
Absolute 5-day return		0.0419	0.399

Both stay predictive. With the Choy and Wei prior-month winner and loser indicators, discussion still forecasts 1.27 points, and 0.66 after the full surface.

Funds are fully spanned; for stocks the residual is broad

Common stocks against ETFs and funds

	β_0	Share	Remaining
Common stocks (47,006)	0.0250	0.473	0.0132
ETFs and funds (6,183)	0.0102	1.036	-0.0004

Complete-surface sample. The surface spans funds as it spans the market in Basistha, Kurov, and Wolfe.

- **Timing.** Attention arriving in trading hours is spanned slightly more than overnight attention (pooled contrast 0.031, interval excludes zero)
- **Intraday, 2024.** With five-minute returns, continuous and jump, upside and downside volatility all remain after the surface (shares 0.28 to 0.32)
- **Overnight.** The surface spans 0.43 of the overnight forecast and 0.29 of the intraday one

The hedged straddle gain under alternative controls and accounting

Signal-day ATM straddle, hedged daily; five-day gain per unit of entry vega, per s.d. of attention

Specification	Coefficient	t	N
Baseline controls and recent absolute return (common sample)	−0.0031	−4.74	53,976
Standard option-return controls	−0.0019	−3.35	57,095
Baseline controls and the full 12-node surface	−0.0012	−2.02	57,095
Option-return controls, with financing and cash dividends	−0.0020	−3.29	53,971
Option-return controls, raw outcome	−0.0020	−2.99	57,095
Option-return controls, full quoted spread charged	−0.0026	−3.99	57,095
Option-return controls, Fama-MacBeth	−0.0015	−2.25	57,095

- Calls and puts are each negative when hedged separately
- Weekly sort on residual attention: the top quintile loses 0.0081 of entry vega more than the bottom (0.0115 net of spreads), against an average straddle loss of 0.035

Their straddle strategy, applied to Reddit attention in 2020 to 2024

Weekly straddle sort on the attention change

Timing and weighting	High minus low	<i>t</i>
Their timing, equal-weighted	0.12%	0.46
Their timing, value-weighted	0.00%	0.00
Attention through Tuesday, equal	0.41%	1.13
Attention through Tuesday, value	0.48%	0.83

Why the strategy no longer pays

- In 2004 to 2010, implied volatility rose in the week after the search spike
- Here 30-day implied volatility is 0.26 points higher within the week and 0.46 lower over the next one
- A buyer who enters after the signal bears the decline

Earnings announcements do not carry the pattern

48,914 stock-days with earnings coverage; 15% have an announcement between the day before the signal and the option's exit

Per s.d. of attention	Outside the window	Inside the window	Placebo difference
Realized volatility, next week	0.0111	−0.0116	−0.0040 (t −1.30)
30-day implied volatility, signal day	0.0059	−0.0049	−0.0098 (t −4.51)
Change over the next five days	−0.0022	0.0015	0.0056 (t 4.68)
Hedged straddle gain per vega	−0.0019	−0.0009	0.0049 (t 3.44)

Outside earnings windows the full pattern holds. A placebo window that closes before the signal day removes the realized split but not the price splits.

2025, after the estimation sample

Forecast and spanning, January to August 2025

Object	2025	95% CI
Attention on five-day volatility	0.0315	[0.016, 0.047]
30-day spanning share	0.232	[0.125, 0.463]
10-day less 30-day share	0.156	[0.083, 0.228]
Full-surface rank-correlation gain	0.0017	[0.0002, 0.0032]

Price pattern, points per s.d.

	2020 to 2024	2025
10-day IV, signal day	+1.08	+1.02
10-day IV, next five days	−0.93	−0.99
30-day IV, signal day	+0.56	+0.53
30-day IV, next five days	−0.52	−0.60
Realized, next five days	+1.39	+1.68

6,337 stock-days in 2025

Who takes which side: Cboe C1 and C2 customer records

Small customers, contracts within 30 days

points of the day's matched vega per s.d.; 3,989 stock-days

Flow	Coefficient	SE	t
Net opening purchases	0.496	0.069	7.14
Net closing purchases	-0.251	0.057	-4.42
Net purchases, all	0.245	0.066	3.73

March to August 2025. The records do not link an opening trade to its later close; the two exchanges carry about 13% of industry volume.

- Gross customer opening volume: +0.19 log points on C1, +0.24 on C2
- Small customers' net opening vega: +0.72 points of the day's vega, mostly calls within 30 days
- Market makers take the other side on C1, not on C2; firms and large orders do not respond
- Adding that day's demand changes the signal-day coefficient only from 0.65 to 0.62 points

Option talk predicts a larger price rise and less volatility than firm talk

Firm discussion against option discussion

disjoint author groups, entered jointly, 53,976 stock-days

Per s.d.	Firm	Options
Realized volatility, next week	0.0186	0.0095
30-day IV, signal day	0.0038	0.0094
Change over the next five days	-0.0055	-0.0041
Hedged straddle gain per vega	-0.0029	-0.0032
Share spanned by the surface	0.460	0.533

- **Direction.** Stated long calls over long puts predict a 10-day smile tilted toward calls (0.0019 per s.d.)
- **Topic.** Volatility and option-trading talk predict larger ATM rises than fundamentals talk (0.0095, 0.0098, 0.0030)
- **Forum.** With r/options attention the 30-day rise is 0.76 of its volatility forecast (WSB 0.37); both reverse alike