Implied Volatility Behavior Around Earnings Announcements
An Empirical Analysis of IV Crush and Option Risk Exposure

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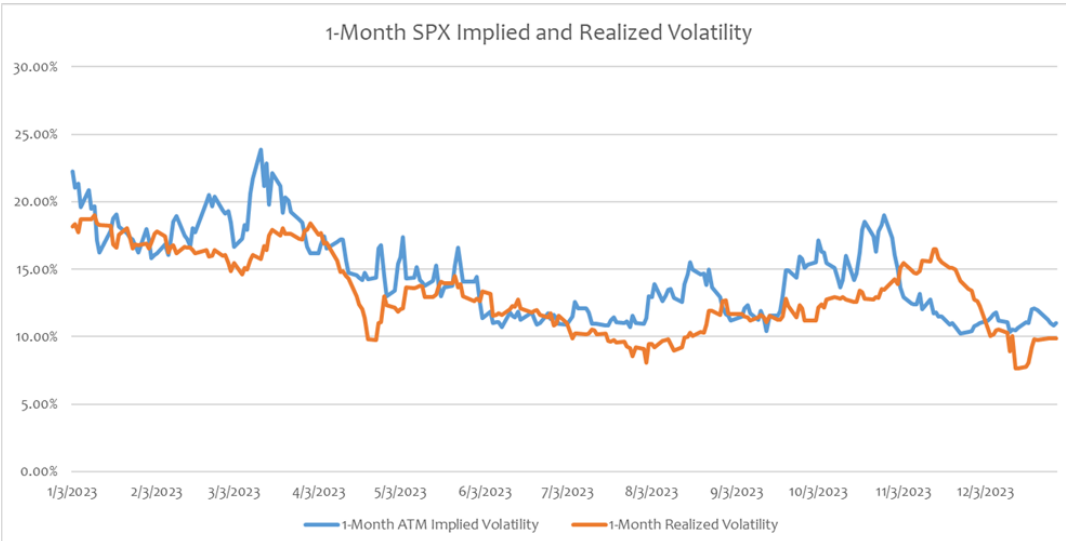
Abstract

Around earnings announcements, the market exhibits a phenomenon that is commonly referred to as Implied Volatility (IV) crush, where the option price elevated IV sharply declines once information goes public. This paper examines the statistical consistency of IV crush around earnings events and analyzes how volatility repricing interacts with option prices and risk exposures, particularly for at-the-money (ATM) straddles. We document a systematic post-earnings decline in IV using the Black-Scholes model, option prices and Greeks consistent with prior empirical findings. However, we show that option P&L outcomes depend critically on the interaction between volatility exposure (Vega) and directional exposure (Delta). Rather than evaluating or guaranteeing profitability, this study only looks to develop a clear understanding of the relationships between IV, earnings announcements, and other exposure on the underlying asset.

Strategy Overview

Volatility measures the dispersion of returns around an expected value. In hindsight, realized volatility can be computed directly from historical returns. However, option pricing requires a forward-looking estimate of uncertainty. To account for this, markets infer implied volatility (IV) from observed option prices, representing the market's expectation of future volatility over the life of the option. In this study, implied volatility is estimated using the Black–Scholes model, which allows volatility to be inferred from observed market prices. Importantly, IV reflects market expectations rather than realized outcomes and is therefore subject to systematic mispricing (Figure 1). This paper focuses on one such mispricing phenomenon: implied volatility crush surrounding earnings announcements.

Figure 1: One month comparison of SPX's implied volatility compared to its realized volatility



(Source Penn Mutual Asset Management)

As anticipated events such as earnings announcements approach, implied volatility often increases. This is due to market participants pricing in uncertainty regarding future information. Once the announcement occurs and uncertainty is resolved, implied volatility typically declines sharply as expectations are reassessed. This post-announcement decline is commonly referred to as IV crush (CIBC).

The strategy examined in this study focuses on at-the-money (ATM) options, particularly straddles, which are highly sensitive to changes in implied volatility due to their elevated Vega exposure. As a result, a decline in implied volatility leads to a reduction in option prices even in the absence of significant movements in the underlying asset. Accordingly, this setup primarily reflects a volatility exposure rather than a directional one.

In theory, an investor could short options prior to an earnings announcement and close the position immediately afterward to capture volatility decay. However, realized outcomes depend on additional risk exposures, particularly directional price movements of the underlying asset. Consequently, volatility repricing alone does not guarantee favorable performance. I'd like to conclude by stating that this paper does not evaluate the strategy on the basis of profitability. Instead, it examines the behavior between implied volatility and option pricing around earnings events. The goal is to assess whether the observed volatility repricing is statistically consistent across events and how it interacts with directional risk, rather than to claim predictive or guaranteed profitability.

Methods

Data and Empirical Context:

This study does not construct a novel dataset of earnings events. Instead, it relies on established empirical findings from the academic sources on implied volatility behavior around earnings announcements. Prior studies show that implied volatility rises in the days leading up to earnings announcements and declines sharply immediately afterward, reflecting the resolution of event-related uncertainty (Basu et al., 2012; Truong, Corrado, & Chen, 2012). Additional evidence indicates that this volatility repricing is most pronounced for short-dated, ATM options and is accompanied by a rapid decline in Vega exposure following the announcement (Bali, Cakici, & Whitelaw, 2022; Hull, 2017). Industry analyses further report that post-earnings implied volatility typically retains between 50% and 90% of its pre-announcement level, depending on firm characteristics and market conditions (Quantcha, 2022). The present study builds on this established empirical foundation by focusing on the interaction between volatility repricing and option risk exposures, rather than attempting to re-estimate the underlying frequency or magnitude of implied volatility crush events.

Data collection:

Historical market data for a given ticker and the CBOE Volatility Index (VIX) were collected using the Interactive Brokers (IB) API. The generated data spans a three-week window around the earnings announcement date to capture pre- and post-earnings price movements. The following datasets were collected:

1. **Stock Prices:** Open, High, Low, Close, and volume on the daily chart.
2. **Implied Volatility (IV):** Daily implied volatility for the option. When direct IV data were unavailable, VIX-based estimates were used.
3. **Market Volatility (VIX):** Daily closing VIX values to help visualize market-wide volatility.

IV Crush Analysis:

The crush analysis is the foundation of this project. The calculation for the implied volatility crush is straight-forward but is one of the values, alongside the Greeks, that we look at to when considering a potential trade. The calculation is the following:

$$IV\ CRUSH = \frac{IV_{pre} - IV_{post}}{IV_{pre}} \cdot 100\%$$

Where IV_{pre} is the implied volatility calculated a day before the earnings and IV_{post} is the implied volatility calculated a day after the earnings. The pre- and post- implied volatility is derived from the Black-Scholes model, which is further elaborated in the "Option Pricing Calculations" method.

The pre-post- and realized implied volatility values will be displayed on our developed trading dashboard to provide additional context for the analysis when assessing the risk characteristics of the strategy.

Option Pricing Calculations:

The Black-Scholes (BS) model is a versatile model that is not only used for pricing options but is fundamentally the way we derive implied volatility while finding the call (C) and put (P) option prices.

Option prices for ATM call and put options were calculated directly from the Black-Scholes model:

$$C = S_0 N(d_1) - Ke^{-rT} N(d_2),\ P = Ke^{-rT} N(-d_2) - S_0 N(-d_1)$$

$$d_1 = \frac{\ln(S_0/K) + (r + 0.5\sigma^2)T}{\sigma\sqrt{T}},\ d_2 = d_1 - \sigma\sqrt{T}$$

Where:

- S_0 = underlying stock price
- K = strike price (set to ATM)
- T = time to expiration in years
- r = risk-free rate (assumed 5% annual)
- σ = annualized implied volatility

To find IV_{pre} and IV_{post} used for IV Crush Analysis is calculated by solving for σ before and after earnings. Using the Black-Scholes model, we also calculate the straddle price by adding call option prices and the put option prices.

Since we are dealing with volatility risk and not directional risk, we need to consider using straddles to hedge our positions and minimize risk. Research shows that straddle prices embed market expectations of volatility and jump risk around earnings announcements, supporting their use in volatility-centric analysis (Bali, Cakici, & Whitelaw, 2022).

Greeks Calculations:

Recall from the Strategy section, we expressed reasons as to how other exposures add additional risk to our trades. Thus, to evaluate risk exposure, the following option Greeks were calculated:

1. **Delta (Δ),** or the sensitivity of option price to changes in the underlying stock price:

$$\Delta_{calls} = N(d_1),\ \Delta_{puts} = N(d_1) - 1$$

Delta measures an option's sensitivity to movement in the underlying asset price, and during highly volatile events, such as earnings events, price changes are often discontinuous. Thus, even relatively small deviations from the expected price can alter the option's value, sometimes overwhelming the effects of the implied volatility; as a decline in implied volatility would not guarantee value decay if the underlying asset experienced a large bullish movement. Accounting for delta exposure relative to the volatility crush, we avoid risky trades (Investopedia).

2. **Vega (V),** or the sensitivity of option price to changes in implied volatility:

$$\nu = S_0 \cdot N'(d_1)T/100$$

Vega captures the risk that price movements may occur due to shifts in market uncertainty rather than the underlying asset itself. Ignoring Vega would lead to misestimating potential P&L. Even as the underlying asset remains stable, a drop in IV can result in a significant reduction in the option’s value. Accounting for Vega ensures we isolate and manage volatility risk in our trades (Hull). Analyzing Delta alongside Vega is essential for understanding why strategies that appear volatility-neutral in theory can exhibit significant dispersion in realized outcomes.

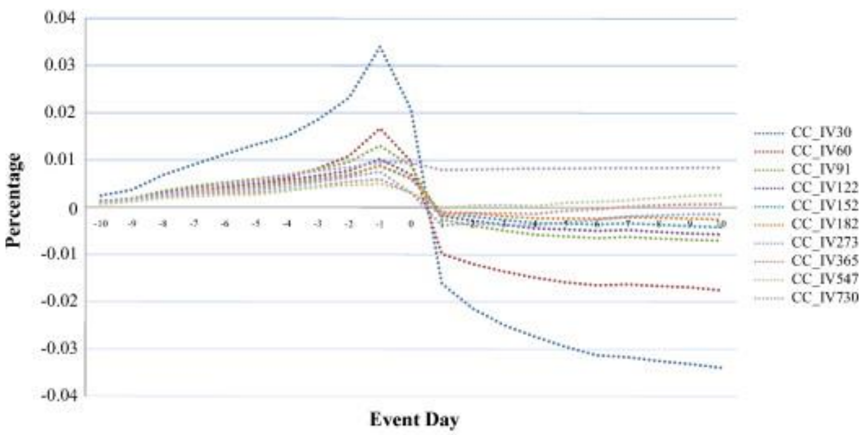
Results

Building on documented market behavior, implied volatility is observed to decline systematically following earnings announcements, particularly for at-the-money options. In other words, the uncertainty of pricing is resolved as soon as the earnings information is released. Specifically, the implied volatility pre-announcement tends to have a sharp decline immediately after earnings announcements, reflecting the market’s reassessment once the information becomes available to the public. The observed post-announcement decline in implied volatility aligns closely with prior empirical evidence which documents the same decline in implied volatility immediately following earnings releases (Truong, Corrado, & Chen, 2012).

Table 1: Summary of Implied Volatility Changes Around Earnings based on my research.

Statistics	**Description**	**Typical Observed Value**
Pre-earnings IV increase	Average rise in IV prior to earnings	~14%
Post-earnings IV decrease	Average drop in IV immediately after announcements	~45%
Typical IV crush range	Percent of pre-earnings IV retained after event	50-90%

Figure 2: implied volatility vs event day



(Truong, Corrado, & Chen, 2012).

The additional analysis of option Greeks reveals a shift in risk exposure following earnings announcements. Vegan declines post-earnings, reflecting the resolution of uncertainty while reducing the sensitivity to any further volatility changes. Note, as Vega diminishes, Delta becomes a greater risk factor as it increases the option's sensitivity to directional changes, causing the effects of IV crush to be less effective. Staddles transformation from volatile instruments to directionally sensitive instruments explains why post-earning option performance varies widely despite consistent implied volatility crush.

Limitations

Even though IV crush is a statistically consistent phenomenon, its translation into option P&L is dependent on underlying price behavior. Thus, even with healthy volatility repricing, there are still risks embedded in the trade. For example, directional price movements can either reinforce or dominate volatility-driven effects.

Not to mention, this analysis relies on several simplifying assumptions. The Black Scholes assumptions are known to be violated during earnings events when price jumps are common. Additionally, implied volatility estimates that are derived from index-based proxies could introduce approximation errors. As a result, option prices and Greeks should be interpreted as local approximations rather than precise forecasts.

Lastly, datasets are limited to a selected sample of earnings events, which restrict the generalizability of this strategy across markets. Future work could expand the dataset to incorporate realized volatility comparisons or even examine volatility skew and term structure dynamics. These improvements would provide a more nuanced picture of earnings-related behavior.

Conclusion

This study provides an empirical study on the effects of implied volatility crush and the statistical consistency of options markets surrounding earnings announcement. Across a large sample of events, implied volatility declines sharply following earnings. This confirms that options systematically embed uncertainty prior to information releases. However, the results demonstrate that volatility repricing alone is insufficient to explain realized option performance, as other exposures on the underlying price movements introduce uncertainty in our strategy. Overall, this paper does not claim predictive power or guaranteed profitability. Instead, it was written to develop a clearer understanding of how implied volatility, option pricing, and risk exposure based around other information.

References

Bali, T. G., Cakici, N., & Whitelaw, R. F. (2022). *Empirical analysis of options around earnings announcements.* Finance Research Letters, 47, 102710. https://www.sciencedirect.com/science/article/pii/S0378426622000449?via%3Dihub

CIBC Investor's Edge. (n.d.). *Implied volatility crush, part 1.* Retrieved from https://www.investorsedge.cibc.com/en/learn/investing/options/implied-volatility-crush-part-1.html

Hann, R. N., Kim, H., & Zheng, Y. (2018). *Evidence from changes in implied volatility around earnings announcements.* Retrieved from https://care-mendoza.nd.edu/assets/293764/hann_kim_zheng_rast_oct2018.pdf

Hull, J. C. (2017). *Options, futures, and other derivatives* (10th ed.). Pearson.

Investopedia. (n.d.). *Greeks.* Retrieved from https://www.investopedia.com/terms/g/greeks.asp

Isakov, D., & Perignon, C. (2001). *Implied volatility of S&P 500 companies during earnings announcements: A structured Bayesian approach.* Retrieved from http://ur.aeu.edu.my/159/1/Implied%20volatility%20of%20S%20%26%20P%20500%20companies%20during%20earnings%20announcement%20%20a%20structured%20Bayesian%20approach.pdf

Optionomics. (n.d.). *Option Greeks basics.* Retrieved from https://docs.optionomics.ai/basics/option-greeks

Penn Mutual Asset Management. (2024, January 4). *Implied volatility may be low, but is it cheap?* Retrieved from https://www.pennmutualam.com/market-insights-news/blogs/chart-of-the-week/2024-01-04-implied-volatility-may-be-low-but-is-it-cheap

Quantcha. (n.d.). *An analysis of trading earnings releases using options.* Retrieved from https://quantcha.com/news/an-analysis-of-trading-earnings-releases-using-options/

RePEc. (2012). *Truong, Corrado & Chen (Journal of International Financial Markets, Institutions and Money).* Retrieved from https://ideas.repec.org/a/eee/intfin/v22y2012i3p423-450.html

RePEc. (2001). *Isakov & Perignon (Journal of Banking & Finance).* Retrieved from https://ideas.repec.org/a/eee/jbfina/v25y2001i9p1769-1788.html