

# Stock Event Study and Decile Backtest

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## Stock Event Study

### Analysis Report

S&P 500 Stocks

Benchmark: SPY

2020-01-02 to 2025-03-20

Lookback: 5 days

Lookforward: 15 days

## 1. Introduction

- This report presents a quantitative event study that measures the impact on stock prices when specific events occur. The methodology uses benchmark-relative abnormal returns to isolate stock-specific price movements from broad market effects, following the standard approach used in empirical finance research.
- The analysis covers S&P 500 constituents over the period 2020-01-02 to 2025-03-20, with SPY (the S&P 500 ETF) serving as the market benchmark. A lookback window of 5 trading days and a lookforward window of 15 trading days are used throughout. Three experiments are conducted:
  - o (1) the provided event definition
  - o (2) a random-event baseline
  - o (3) a custom Bollinger Band technical analysis event.

## 2. Handling Missing and Problem Data

- The raw price matrix contains 1,311 trading days and 502 ticker

columns (including SPY). Across this matrix there were 6,846 missing

or non-numeric values. These arise from several

- **Tickers not yet listed: Several stocks had IPOs or spin-offs well after**

the dataset start date of January 2, 2020. For example, GEHC (GE

HealthCare, Jan 2023), GEV (GE Vernova, Apr 2024), KVUE (Kenvue,

May 2023), SW (Smurfit WestRock, Jul 2024), SOLV (Solventum, Apr

2024), and VLTO (Veralto, Oct 2023) each had the majority of their

rows empty. Others like ABNB (Dec 2020), PLTR (Sep 2020), and CEG

(Feb 2022) were missing for shorter periods corresponding to their

listing dates.

- **Occasional data-feed gaps: Some tickers have isolated missing**

days, likely caused by exchange halts, data-vendor issues, or

corporate actions (e.g., CARR and OTIS missing their first ~53 entries

from their Raytheon spin-off in April 2020).

### Cleaning Strategy

The following multi-step cleaning procedure was applied:

- **Numeric coercion: All cells are coerced to numeric. Any non-numeric**

text becomes NaN.

- **Gap filling: Forward-fill (limit 5 days) followed by back-fill (limit 5**

days) closes small gaps without fabricating prices over long stretches.

This reduced NaN count from 6,846 to 1,023.

- **Column removal: Tickers with more than 50% of rows still missing**

were dropped entirely: GEHC, GEV, KVUE, SOLV, SW, VLTO (6 tickers removed).

- **Window validation: Any event window that overlaps a residual NaN**

is discarded. This ensures every analyzed event has complete data for the full lookback + lookforward period.

After cleaning, 496 tickers remain with 1,023 residual NaN values (primarily from stocks that listed mid-period such as ABNB and PLTR).

### **3. Methodology**

#### **1. Benchmark-Relative Returns (BRR): For each trading day,**

compute the daily return for SPY (the benchmark return, BR) and each stock. The benchmark-relative return for stock  $i$  on day  $t$  is:  $BRR(i,t) = \text{return}(i,t) - \text{return}(\text{SPY},t)$ . This isolates the stock-specific (abnormal) component of returns.

#### **2. Event Window Assembly: For each event, extract a vector of 21**

consecutive BRR values (5 days before through 15 days after the event date).

#### **3. Cumulative Returns: Convert each event vector to cumulative form**

by computing the running product of  $(1 + BRR)$  across the window.

#### **4. Normalization: Divide each cumulative return series by its value at**

$t=0$  (the event day), so that all events begin at 1.0 on the event date.

This allows meaningful aggregation across events of different magnitudes.

#### **5. Aggregation & Visualization: Compute the mean and standard**

deviation of the normalized cumulative returns across all events at

each time offset. Plot the mean cumulative return line with shaded

bands at  $\pm 0.25$  and  $\pm 0.5$  standard deviations.

#### **4. Provided Events Analysis**

The provided events.csv flags an event whenever a stock's daily return falls

5 percentage points or more below SPY's return on the same day. This

captures significant single-day relative underperformance. Of the 6,959

flagged events, 6,853 had complete data windows and were included in the

analysis.

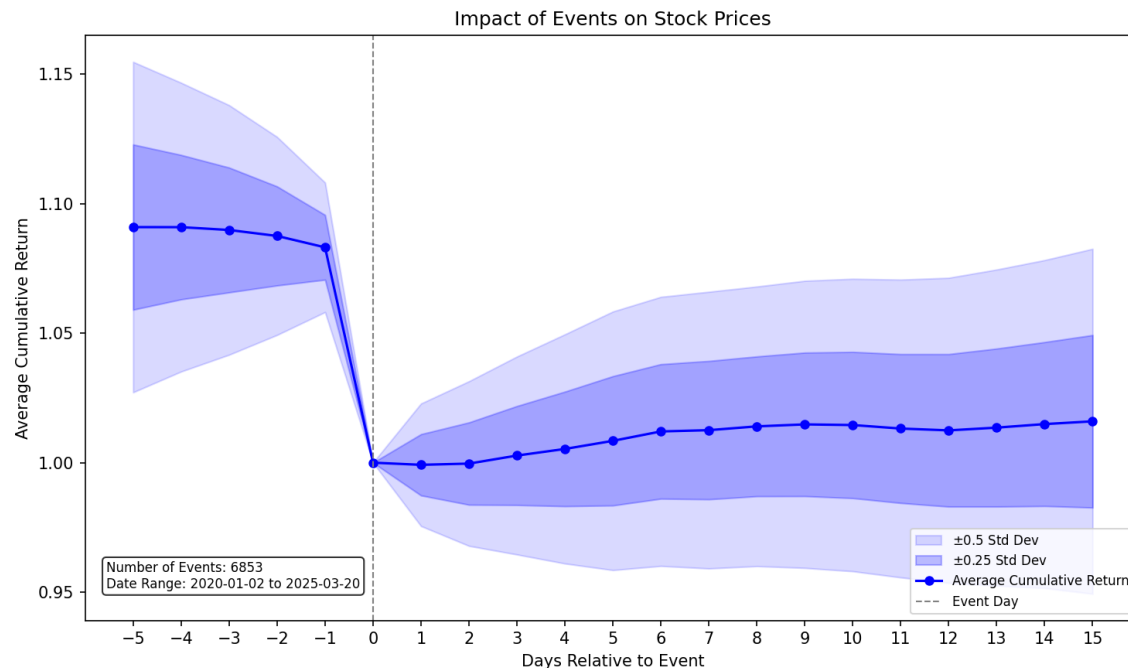


Figure 1: Event study for provided events (stock return  $\geq 5\%$  below SPY).

## Interpretation:

- The pre-event region ( $t < 0$ ) shows cumulative abnormal returns well above 1.0 ( $\sim 1.09$  at  $t = -5$ ), reflecting the large drop that defines the event: the cumulative line plunges from  $\sim 1.09$  to 1.0 at  $t = 0$ .
- After the event, the mean line drifts upward to approximately 1.016 by  $t = +15$ , an average abnormal gain of +1.60%.
- This is consistent with short-term mean reversion: stocks that suffer an extreme single-day drop tend to partially recover over the subsequent two to three weeks.
- The error bands widen as the horizon increases, indicating substantial cross-event dispersion.

## 5. Random Events Baseline

To confirm that the pattern above is genuine rather than an artifact of the

methodology, events were generated uniformly at random with the same overall frequency as the provided file. 6,726 valid random-event windows were analyzed.

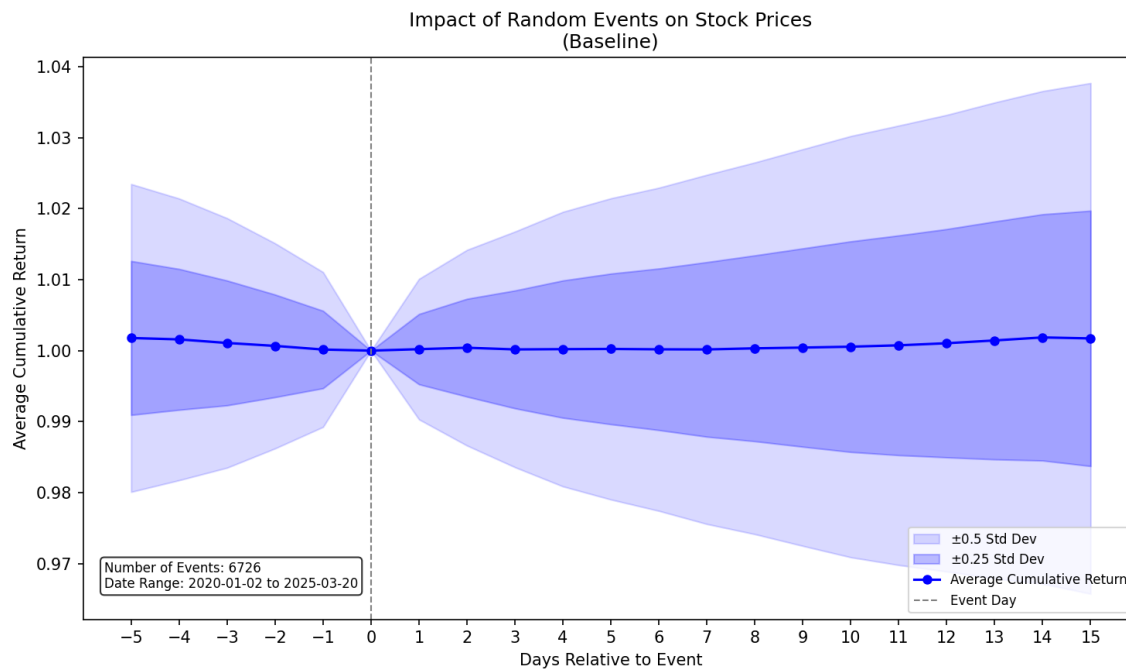


Figure 2: Event study for randomly generated events (baseline).

**Interpretation: The mean cumulative return is essentially flat at 1.0** throughout the window (post-event drift = +0.17%). There is no systematic pre-event decline or post-event recovery. This confirms that the provided-events pattern is not a statistical artifact and is driven by the specific event definition.

## 6. Custom Event: Bollinger Band Breakdown

A custom technical-analysis event was designed as an alternative signal. An event fires when all three conditions are met simultaneously:

- The stock's closing price falls below its lower Bollinger Band (20-day SMA minus 2 standard deviations), indicating a technically oversold

condition.

- The stock's 5-day rate of change (momentum) is negative, confirming a genuine downtrend rather than sideways noise.
- The stock underperforms SPY on that day, filtering out broad-market sell-offs that would affect all stocks equally.

This triple filter produced 26,018 events, of which 25,419 had complete data windows.

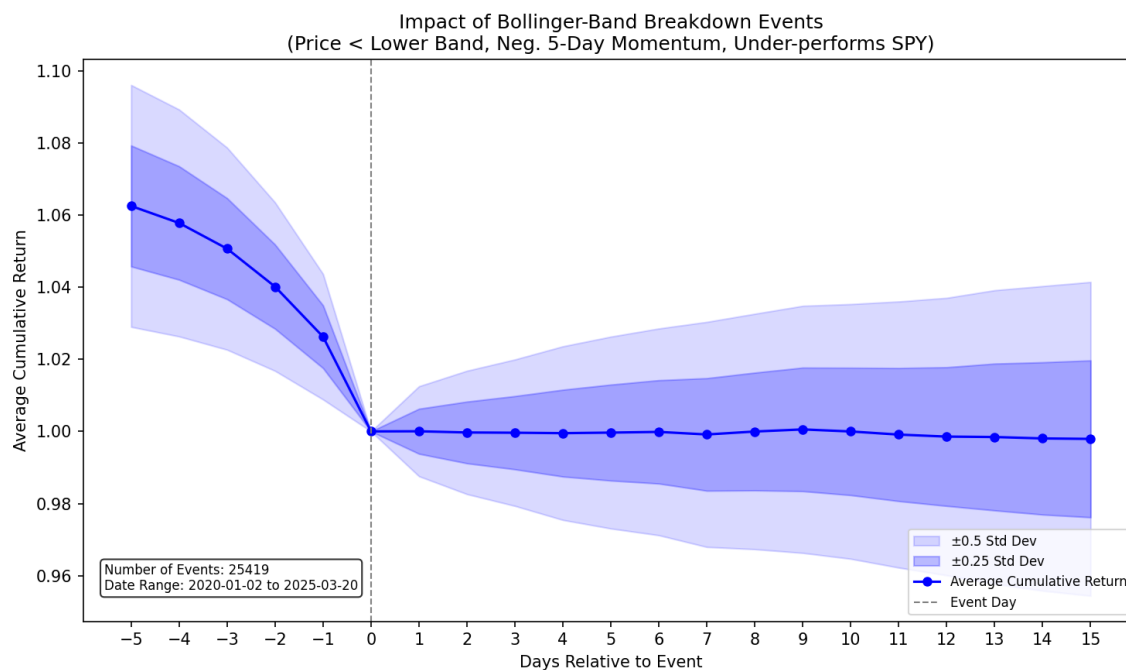


Figure 3: Event study for Bollinger Band breakdown events.

## Interpretation: The Bollinger Band strategy shows a post-event average

abnormal return of  $-0.21\%$  over 15 trading days. While the pre-event pattern is similar to the provided events (stocks declining into the event), the broader trigger definition captures many events that do not reverse, diluting the signal.

## Proposed Trading Strategy

A trader could use the Bollinger breakdown signal as follows: When the signal fires for a stock, enter a long position at the next day's open while simultaneously shorting an equivalent dollar amount of SPY to hedge broad-market risk. Hold the pair for 10-15 trading days, then unwind. The edge would derive from short-term mean reversion in technically oversold names. However, the current results show this particular parameterization does not produce reliable post-event gains, suggesting the signal could be improved with tighter filters (e.g., requiring the drop to exceed a minimum threshold relative to SPY, or requiring volume confirmation). Transaction costs, bid-ask spread, and borrow availability would also need to be factored into any live implementation.

## 7. Summary of Results

| Analysis         | N Events | Mean at $t = +15$ | Abnormal Gain |
|------------------|----------|-------------------|---------------|
| Provided Events  | 6,853    | 1.0160            | +1.60%        |
| Random Events    | 6,726    | 1.0017            | +0.17%        |
| Bollinger Events | 25,419   | 0.9979            | -0.21%        |

The provided event definition (daily return  $\geq 5\%$  below SPY) produces a clear and statistically meaningful post-event recovery of +1.60%, consistent with short-term mean reversion. The random baseline confirms this is genuine.

The Bollinger Band variant, while theoretically motivated, requires further refinement to be profitable.

## 8. Conclusion

- This event study demonstrates that stocks experiencing significant single-day underperformance relative to SPY tend to exhibit positive

abnormal returns over the subsequent 15 trading days, consistent with short-term mean reversion.

- The random events baseline confirms this finding is not a methodological artifact.
- The custom Bollinger Band event offers an alternative technical signal that could be further refined with additional filters, tighter parameterization, and proper risk management for a practical trading strategy.