RESEARCH INSIGHT

When Explosive Price Behaviour Weakens, Does a Crash Follow?

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Executive summary



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Weakening explosive-price behaviour does not reliably predict severe market losses.

Key findings

- Some deterioration signals precede higher observed loss frequencies.
- Matched historical comparisons show little difference at the median.
- Explosive-price indicators do not improve out-of-sample forecasts over the simplest baseline.

Key metrics

Overall severe-loss rate	11.8%
Flag-off loss rate	24.1% (7/29)
Out-of-sample forecasts	448
Baseline Brier score	0.14640
Market + statistic Brier	0.14864

Why it matters

A weakening statistical signal can appear to warn of losses without improving forecasts. Detecting unusual price behaviour is not the same as predicting what follows.

Explosive-price diagnostics differ across assets

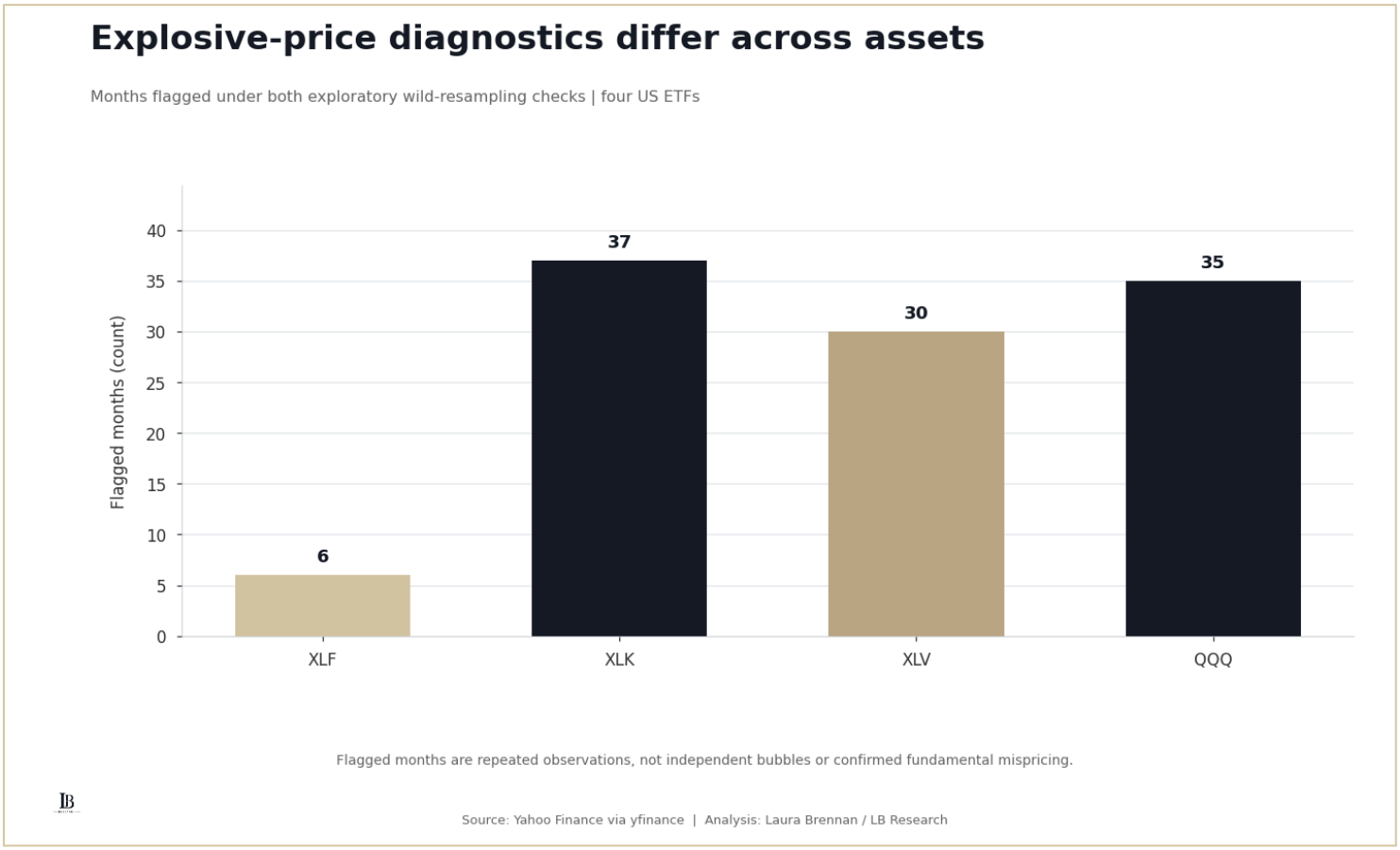


Figure 1. Months flagged under both exploratory wild-resampling checks across the four focus ETFs.

Explosive-price behaviour is not showing up everywhere. Most flagged months are concentrated in XLK, QQQ and XLV, while XLF barely registers. The signal is not uniform across these four assets. Just as importantly, these are repeated flagged months, not separate bubble events, so this is a diagnostic pattern rather than proof of mispricing.

Deterioration signals are not rare

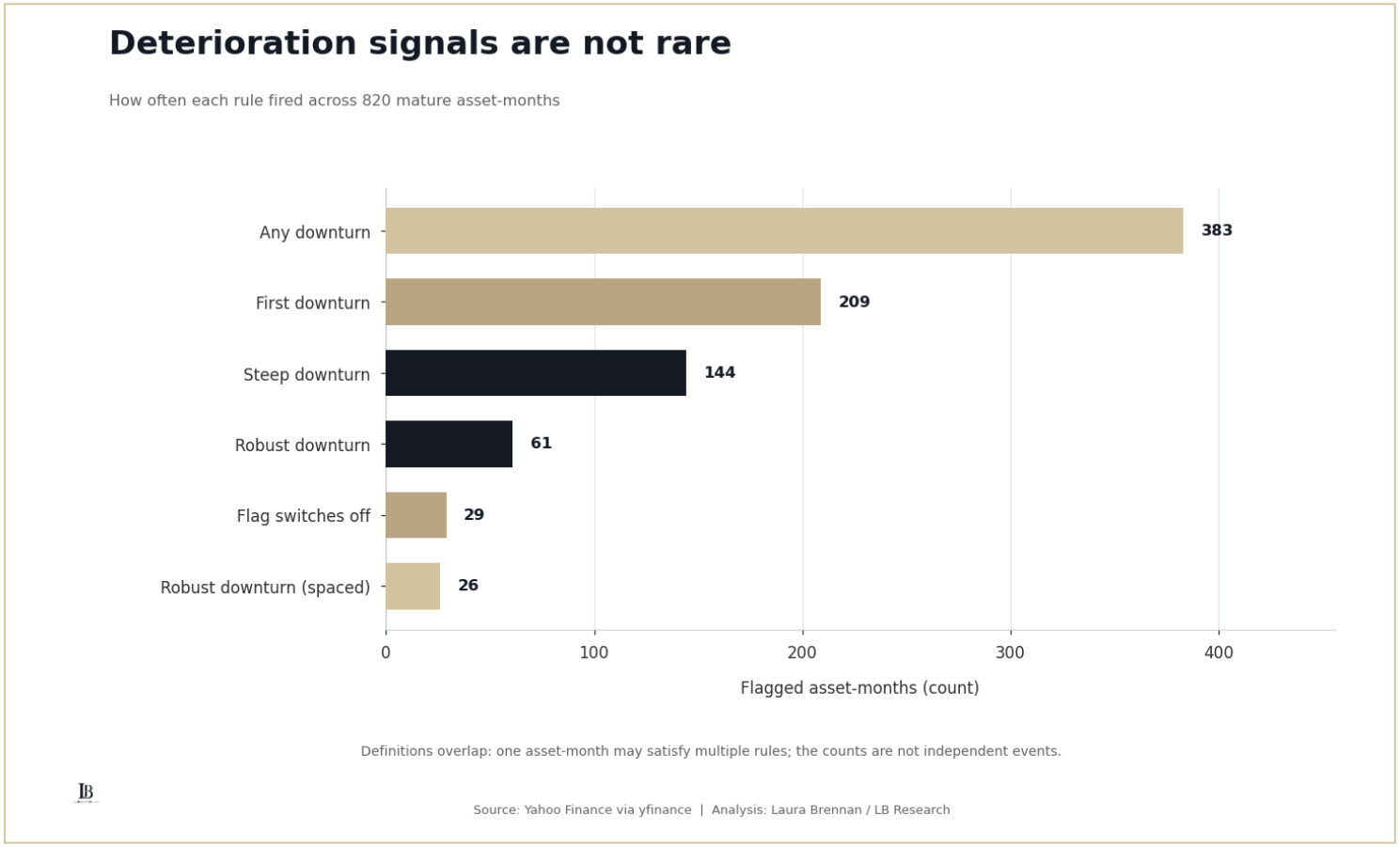


Figure 2. Counts of mature asset-months flagged by each deterioration rule across the four focus ETFs.

Deterioration signals occur fairly often, but they are not equally selective. Any downturn is the broadest rule, flagging 383 asset-months, while first downturn still appears 209 times. The tighter filters reduce coverage quickly: steep downturn flags 144 asset-months, robust downturn 61, flag switches off 29, and robust downturn (spaced) 26. The overlap matters. One asset-month can satisfy more than one rule, so these counts should be read as signal coverage, not as independent events. The next question is whether the rarer signals are actually followed by worse outcomes.

Some deterioration signals precede higher loss rates

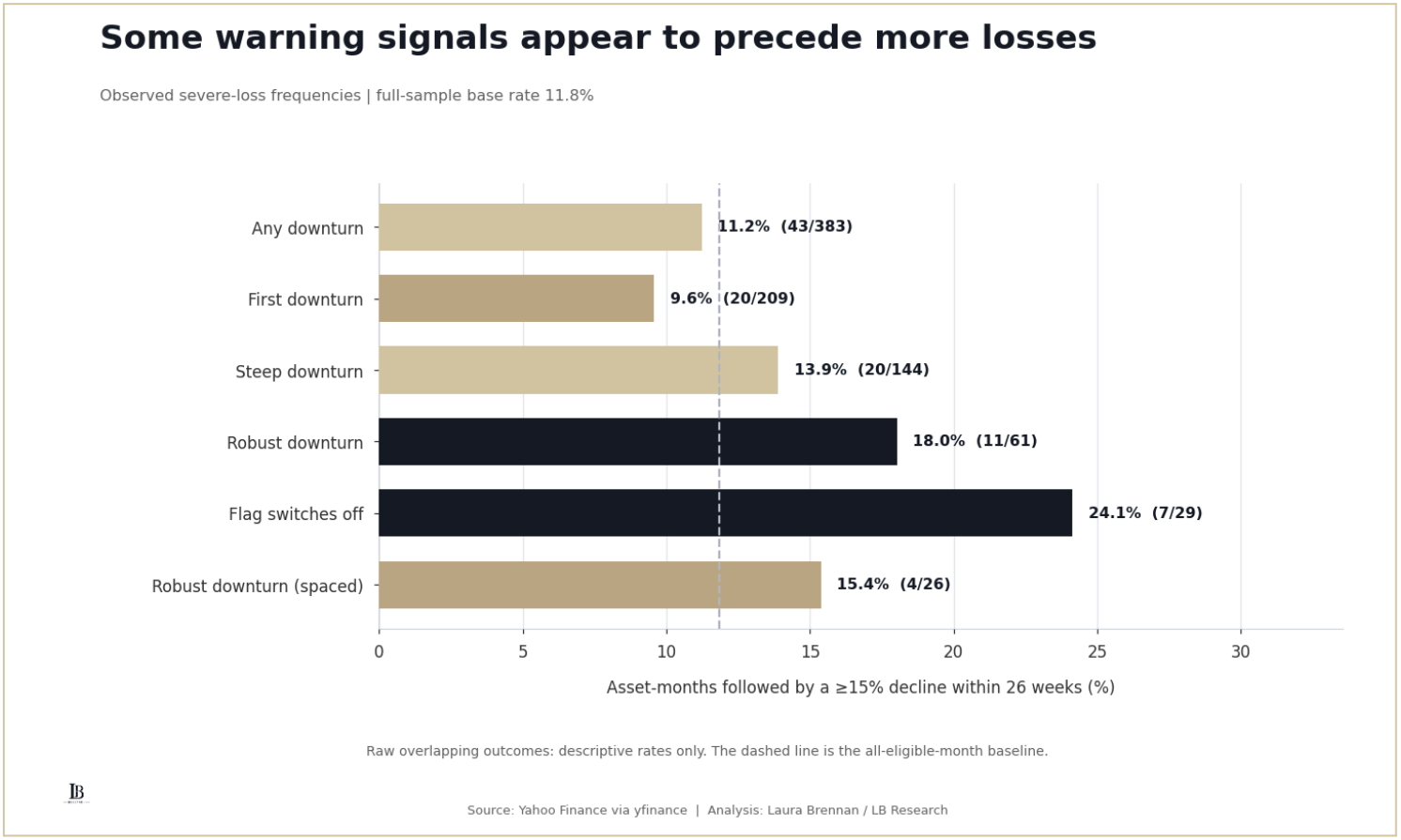


Figure 3. Observed frequency of 15% declines within 26 weeks following each deterioration signal, compared with the overall 11.8% rate.

Some deterioration signals appear to precede more frequent severe losses. When an explosive-price flag switches off, meaning the rolling test no longer detects explosive behaviour, the subsequent loss rate is 24.1%, compared with 11.8% overall. Robust downturn signals also show an elevated rate of 18.0%. However, the flag-off result is based on just 7 severe losses across 29 observations. These are overlapping historical outcomes, not independent events. The apparent relationship is worth examining, but it does not establish predictive value.

The apparent warning weakens under historical comparison

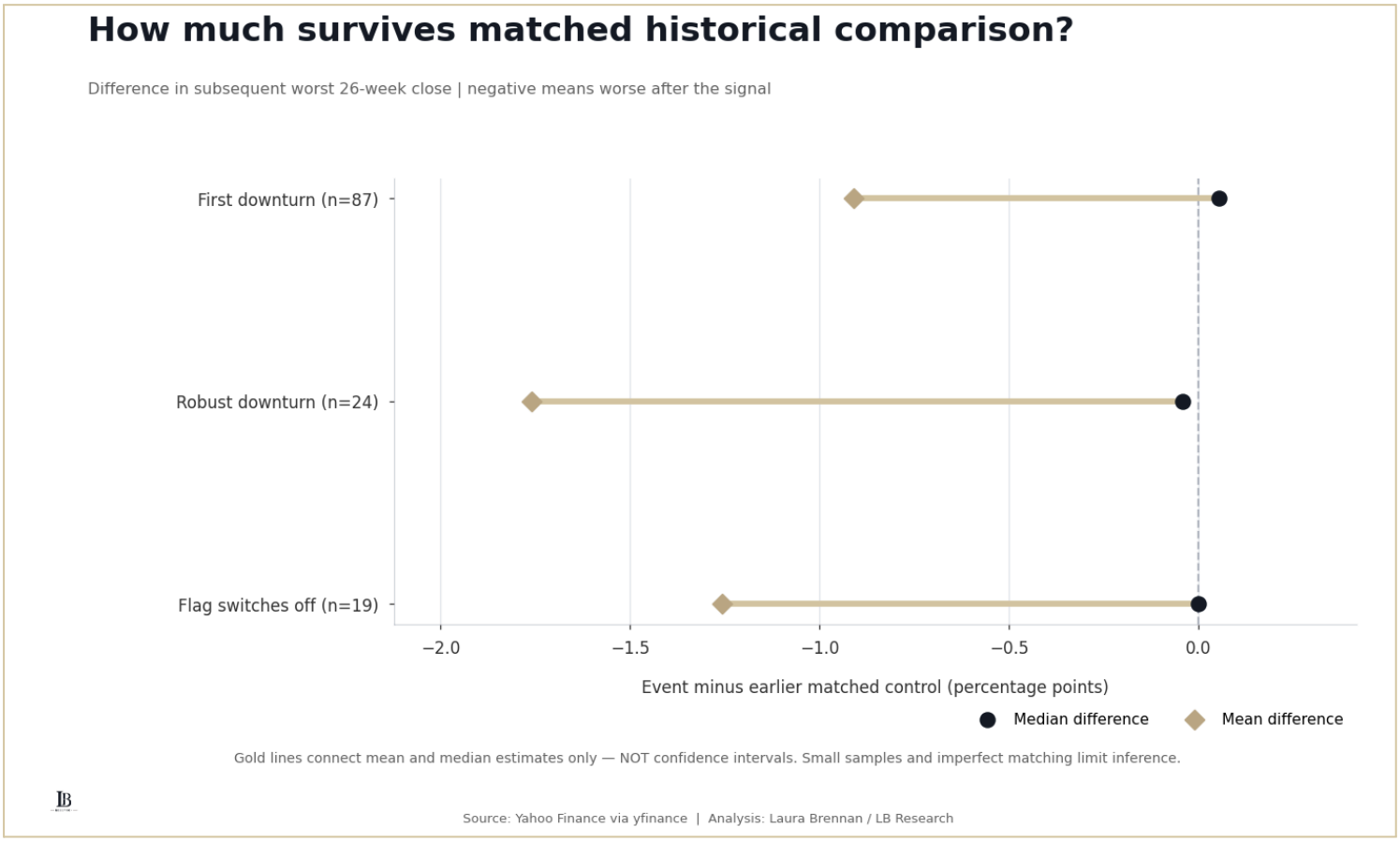


Figure 4. Mean and median differences in subsequent worst 26-week price outcomes between deterioration signals and earlier matched historical observations.

The apparent warning becomes less convincing when compared with similar historical conditions. Across the three deterioration signals, median differences remain close to zero, while mean differences range from −0.9 to −1.8 percentage points. This suggests that worse outcomes are not consistently observed across matched comparisons. Small samples, overlapping observations and imperfect historical matching limit the strength of the evidence. A higher observed loss frequency does not necessarily indicate independent predictive information.

Explosive-price signals do not improve downside forecasts

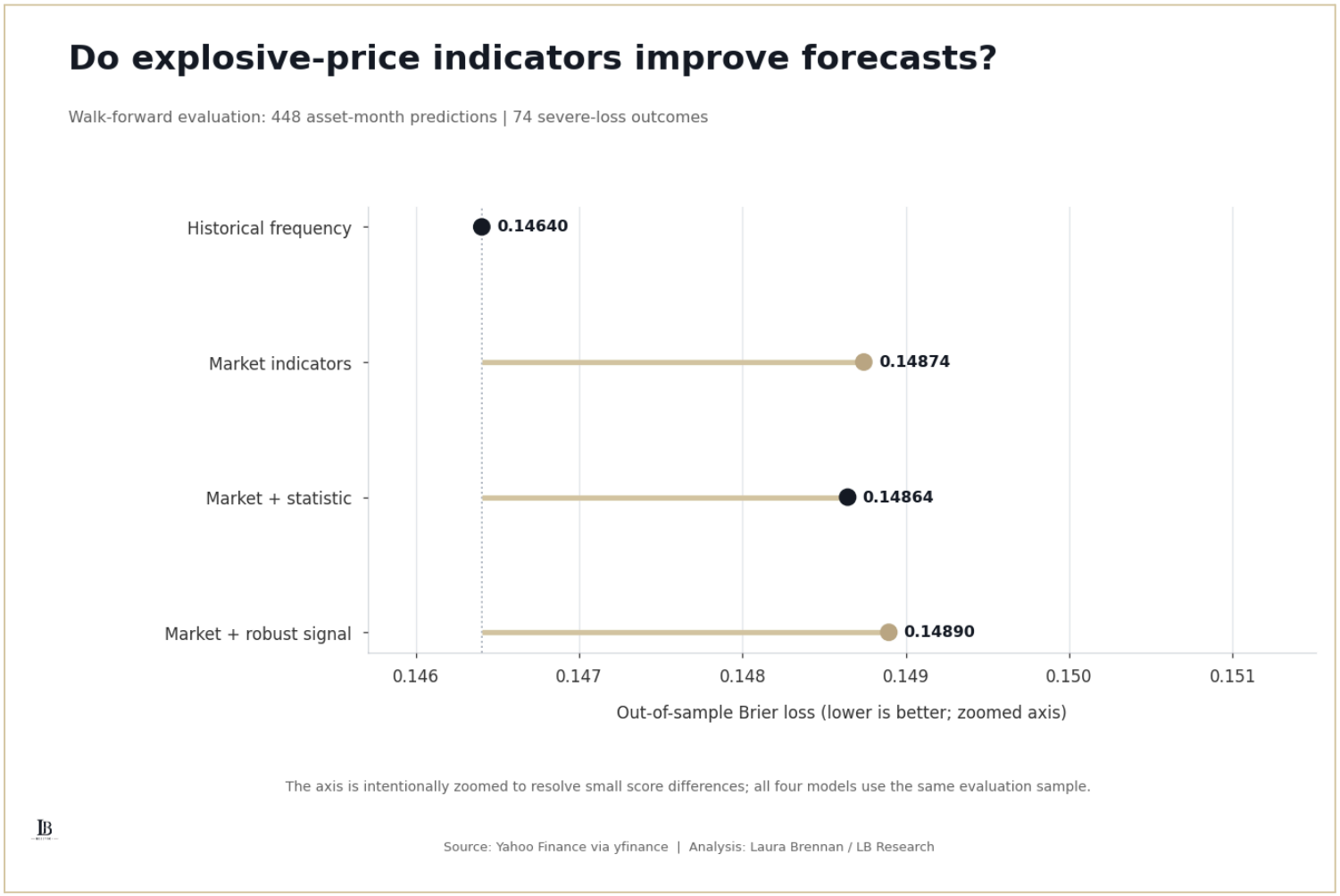


Figure 5. Out-of-sample Brier scores across four forecasting models, evaluated using 448 asset-month predictions. Lower scores indicate better probability forecasts.

The forecasting test changes the picture. Across 448 out-of-sample predictions, the historical-frequency baseline achieves the lowest Brier score of 0.14640. The market-only model records 0.14874. Adding the recursive explosiveness statistic improves this marginally to 0.14864, while the robust downturn indicator worsens performance to 0.14890. The Brier score measures the accuracy of predicted loss probabilities, with lower values indicating better forecasts. Neither augmented model outperforms the simple baseline. Additional statistical information does not necessarily translate into better downside predictions.

Small forecasting gains are not robust

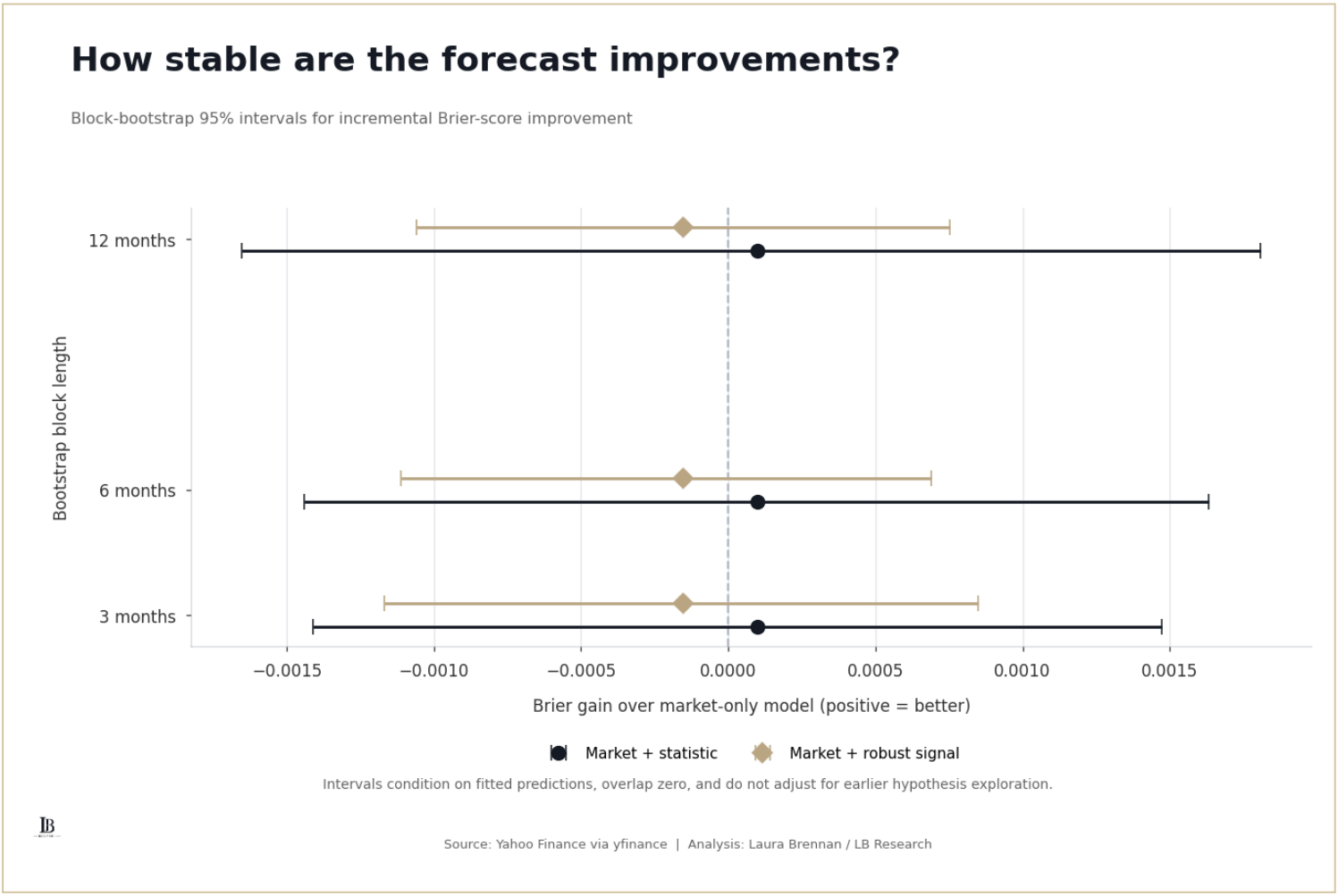


Figure 6. Incremental Brier-score gains over the market-only model, with 95% block-bootstrap intervals using 3-, 6- and 12-month blocks. Positive values indicate improvement.

The small forecasting gains do not hold up under uncertainty testing. Adding the recursive explosiveness statistic improves the Brier score by just 0.00010 relative to the market-only model, while the robust downturn indicator slightly worsens performance. Across all three bootstrap block lengths, the 95% intervals include zero, providing no reliable evidence of incremental predictive value. These intervals hold fitted forecasts fixed and do not adjust for earlier hypothesis exploration. Weakening explosive-price behaviour may be statistically detectable, but it does not establish a dependable warning of subsequent losses.

Methodology

Data

Sample period

Daily market data: 01 April 1999 to 29 October 2026.

6,938 trading dates across the four-ETF panel. Recursive tests require historical estimation windows, reducing the eligible sample.

Universe

Four US exchange-traded funds:

- **XLF** — Financials
- **XLK** — Technology
- **XLV** — Healthcare
- **QQQ** — Nasdaq 100

Primary downside outcome

A decline of at least 15% within the subsequent 26 weeks, measured using daily closing prices.

Data source

Yahoo Finance, accessed through yfinance.

Daily closing prices are used to construct the final price-dynamics indicators and downside outcomes. Trading volume was examined in preliminary exploratory tests.

Explosive-price diagnostics

Recursive testing

Rolling 120-month endpoint BSADF statistics, constructed from right-tailed ADF regressions, are used to examine potentially explosive price behaviour.

Each monthly observation is evaluated using historical price information available at that point.

Statistical calibration

Explosive-price classifications are assessed using two exploratory wild-resampling checks.

A month is flagged under the combined criterion when both checks identify explosive behaviour.

Deterioration signals

Six candidate indicators are examined:

- **Any downturn** — a decline in the recursive statistic.
- **First downturn** — the initial observed deterioration.
- **Steep downturn** — a larger deterioration.
- **Robust downturn** — deterioration satisfying stricter conditions.
- **Flag switches off** — explosive behaviour is no longer statistically detected.
- **Robust downturn (spaced)** — separated observations to reduce repeated signals.

Interpretation

Flagged months are statistical classifications, not independently confirmed speculative bubbles.

Deterioration does not necessarily imply falling prices or an approaching crash.

Forecast evaluation and robustness

Downside measure

A decline of at least 15% from the signal date to the lowest daily closing price within the following 26 weeks. Only observations with complete forward periods are evaluated.

Forecast models

Four specifications are compared:

- Historical-frequency baseline
- Market indicators
- Market indicators + recursive explosiveness statistic
- Market indicators + robust downturn signal

Out-of-sample evaluation

Chronological walk-forward testing covers January 2017 to April 2026, producing 448 asset-month forecasts. Forecast accuracy is measured using the Brier score. Lower values indicate better probability forecasts.

Historical matching

Deterioration signals are compared with earlier observations from the same ETF under similar market conditions. Poor matches are excluded.

Robustness testing

Forecast differences are assessed using 95% block-bootstrap intervals with 3-, 6- and 12-month blocks. Additional checks examine non-overlapping evaluation dates, crisis exclusions and individual ETFs. Bootstrap intervals hold fitted forecasts fixed. Overlapping forward outcomes and earlier hypothesis exploration limit statistical inference.

Research workflow

Step	Description
Data	Daily prices and trading volumes for four US ETFs
Monthly observations	Completed calendar months, using historical information
Recursive testing	Rolling 120-month endpoint BSADF statistics
Statistical calibration	Two exploratory wild-resampling checks
Explosive classification	Months flagged under both calibration checks
Deterioration signals	Six definitions of weakening explosive-price behaviour
Downside outcome	At least 15% decline within the following 26 weeks
Sample eligibility	Complete forward outcomes; 820 mature asset-months
Historical matching	Earlier same-ETF observations under comparable conditions
Forecast models	Historical frequency, market indicators and two augmented models
Walk-forward validation	448 out-of-sample predictions, January 2017–April 2026
Forecast accuracy	Brier score of predicted severe-loss probabilities
Uncertainty	95% block-bootstrap intervals using 3-, 6- and 12-month blocks
Robustness	Non-overlapping dates, crisis exclusions and individual-ETF checks

Interpretation

Explosive-price deterioration does not reliably predict severe losses or improve forecasts. Statistical detection does not necessarily imply predictive value.

Research implications

The evidence shows that weakening explosive-price behaviour can coincide with elevated downside risk without demonstrating reliable incremental forecasting value.

Key observations

- Explosive-price diagnostics differ substantially across the four ETFs.
- Deterioration signals vary considerably in frequency and selectivity.
- Flag-off observations show a 24.1% severe-loss rate, compared with 11.8% overall.
- That apparent warning rests on just seven severe losses across 29 flagged observations.
- Matched historical comparisons show little difference at the median.
- Across 448 out-of-sample forecasts, the historical-frequency baseline performs best.
- Bootstrap tests provide no robust evidence of incremental forecasting gains.

Together, these findings distinguish statistical detection from predictive usefulness. A deterioration signal may identify changing price dynamics without reliably anticipating subsequent losses.

For risk management, the relevant question is not simply whether an indicator identifies unusual market behaviour, but whether it improves forecasts beyond existing information. In this analysis, that additional value is not established.

References

Data

Yahoo Finance, accessed through yfinance.

XLF, XLK, XLV and QQQ.

Daily market data through 29 October 2026.

Methodology

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Efron, B. and Tibshirani, R. J. (1993). *An Introduction to the Bootstrap*. Chapman & Hall.

Software

Python, pandas, NumPy, scikit-learn, statsmodels, matplotlib and yfinance.

Recursive statistical testing, forecasting and bootstrap analysis conducted in Python.

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