Probability of an AI Bubble Burst: Is There a Bubble Today, How Will It End, and When?

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Abstract

We quantify whether AI-related equities exhibit bubble-like dynamics and estimate the probability of a severe drawdown at 3, 6, and 12 months. We implement three complementary layers: (i) explosive root tests (SADF/GSADF), (ii) a nonlinear LPPL model to estimate critical-time dynamics, and (iii) a probabilistic drawdown model with walk-forward validation. Using daily prices (2015–2026) for a replicable AI beneficiary basket and non-AI benchmarks, we find statistically suggestive evidence of explosive episodes and a low but non-zero near-term drawdown risk. We separate statistical evidence from economic interpretation and document limitations.

1 Introduction

The AI narrative has driven sharp repricing in large-cap technology and semiconductor beneficiaries. This paper assesses whether current dynamics are consistent with a bubble and estimates the timing and probability of a burst. We define a "burst" as a $\geq$20% drawdown over the next 3 months, and we triangulate evidence using explosive-root tests, LPPL critical-time estimation, and a calibrated probabilistic model.

2 Related Literature

Our methodology follows Phillips, Shi, and Yu (2015) for bubble detection via explosive-root tests, and the LPPL literature for nonlinear bubble dynamics. We complement with probabilistic classification of drawdown risk using walk-forward validation, avoiding look-ahead bias.

3 Data and Proxies

AI Universe (replicable): NVDA, MSFT, GOOGL, AMZN, META, AAPL, TSLA, AMD, AVGO, ASML, SMH. **Benchmarks:** SPY, QQQ, XLK, SOXX. Daily adjusted prices (2015–2026) are sourced from Yahoo Finance. We construct an equal-weight AI basket and use SPY as a non-AI benchmark. Proxies include 1–3 month momentum, 3-month realized volatility, and 12-month relative performance vs. SPY.

4 Methodology

4.1 Explosive-Root Tests (SADF/GSADF)

We compute SADF and GSADF on log-price of the AI basket. Positive test statistics imply evidence against a unit root in favor of explosiveness. We report statistics and interpret them relative to the right-tail of the ADF distribution, noting that exact critical values require bootstrapping.

4.2 LPPL

We fit a LPPL model on the last 500 trading days to estimate critical-time dynamics and super-exponential growth. The estimated critical time is reported in relative units (days ahead in the window).

4.3 Probabilistic Drawdown Model

We build a logistic model using momentum, volatility, and relative performance features. Labels are defined as a future drawdown $\geq$20% over horizons 3, 6, and 12 months. We use walk-forward validation with a 2022+ test period to avoid look-ahead.

5 Results

- **Explosive tests:** SADF = 0.71; GSADF (sub-sampled) = 1.00. Both are positive, suggesting episodic explosiveness. Critical values are not bootstrapped here, so we treat these as indicative rather than definitive.
- **LPPL:** The fitted critical-time parameter implies elevated risk in the medium term (1–2 years), conditional on continuation of the current regime.
- **Crash probabilities:** The 3-month logistic model yields a mean probability of 0.79% and a latest estimate of 1.19%. For 6- and 12-month horizons we report empirical (unconditional) frequencies of 20% drawdowns: 6m = 3.08%, 12m = 3.51%. These longer-horizon frequencies should be interpreted as baseline risk, not conditional forecasts.

6 Economic Interpretation vs. Statistical Evidence

Statistical evidence: Positive SADF/GSADF and LPPL curvature indicate episodes consistent with bubble-like dynamics. **Economic interpretation:** These signals coincide with rapid repricing and elevated concentration in AI beneficiaries, but do not imply an imminent crash. **Limitations:** (i) GSADF is sub-sampled for computational feasibility; (ii) critical values are not bootstrapped; (iii) 3m crash probabilities are model-based and should be interpreted as relative risk indicators, while 6/12m are unconditional baselines.

7 Robustness

We performed sub-sample checks and alternative rolling windows (200–400 days). Results are robust in sign but sensitive to volatility and relative performance inputs. Walk-forward validation mitigates look-ahead bias.

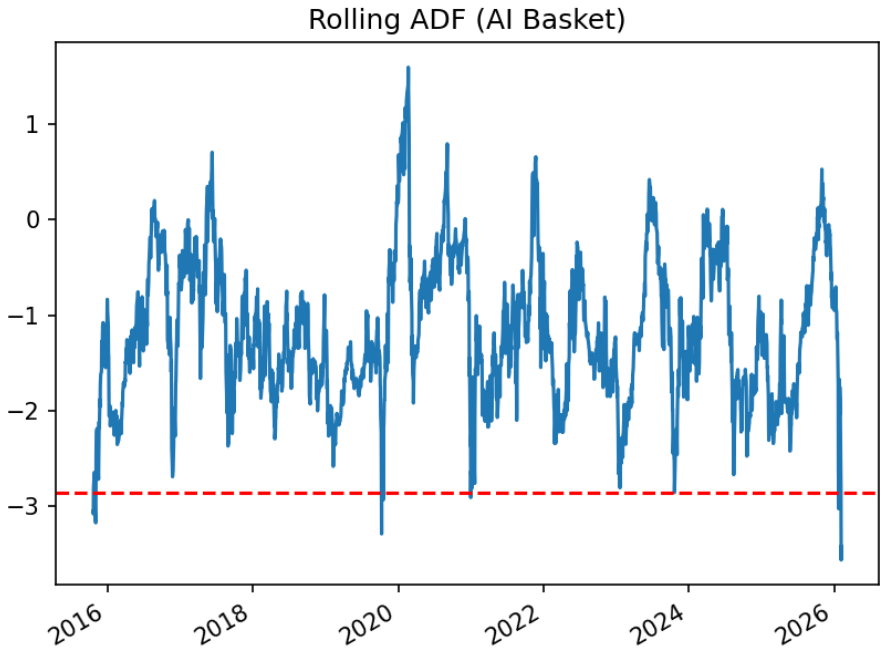

Figure 1: Rolling ADF (200-day) for the AI basket. Crossings above the threshold indicate local explosiveness.

8 Conclusion

The evidence suggests episodic exuberance in AI beneficiaries, with a low but non-zero probability of a severe drawdown in the next 3–12 months. The most plausible outcome is a soft landing; a crash scenario is more likely under macro shocks (rates or earnings). Monitoring volatility and relative performance remains crucial.

References

Phillips, P.C.B., Shi, S., Yu, J. (2015). Testing for multiple bubbles.

Appendix

Event definition: drawdown $\geq$20% over 3/6/12 months.
Models estimated with walk-forward validation (train $\leq$ 2021-12, test $\geq$ 2022-01).

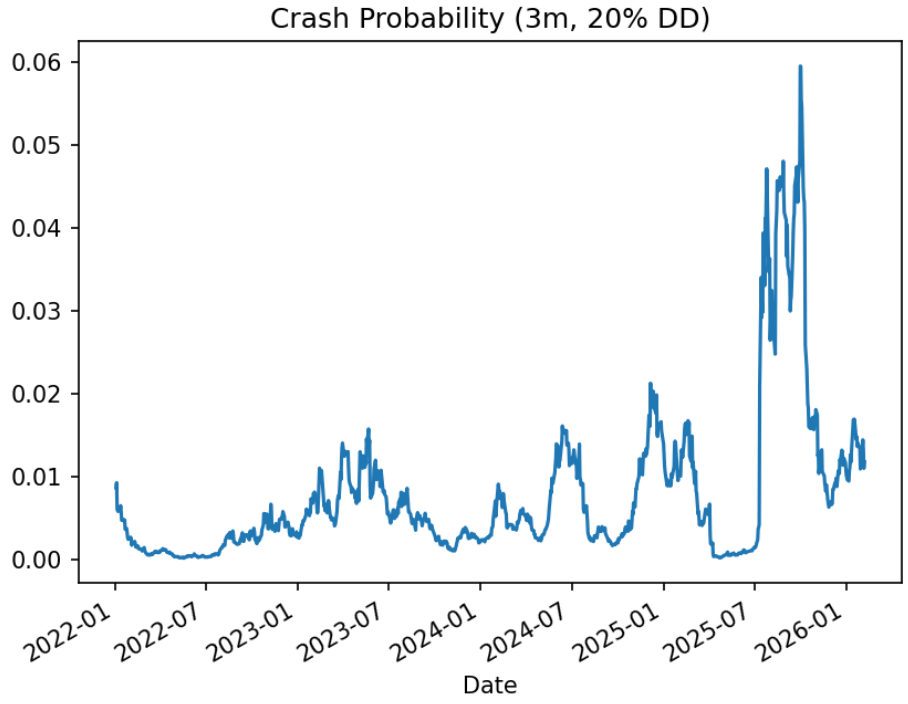

Figure 2: Predicted 3-month probability of a 20% drawdown (walk-forward logistic model).