SYSTEMATIC STRATEGY NOTE | RISK-MANAGED BETA

Volatility-Managed Equity Exposure on the S&P 500

A monthly rule that holds the index at a constant risk budget instead of a constant weight, with a 200-day trend gate and Treasury collateral.

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Universe SPY, IEF sleeve
Rebalance Monthly
Direction Long / flat
Sample 2001 - 2026
Platform vectorbt 1.2

7.29%	0.829	-22.6%	$617k	240
CAGR, FULL SAMPLE	SHARPE, FULL SAMPLE	MAX DRAWDOWN	ENDING EQUITY	ORDERS, 26 YEARS
SPY 9.02%	SPY 0.550	SPY -55.2%	from $100,000 start	$197.6k total fees

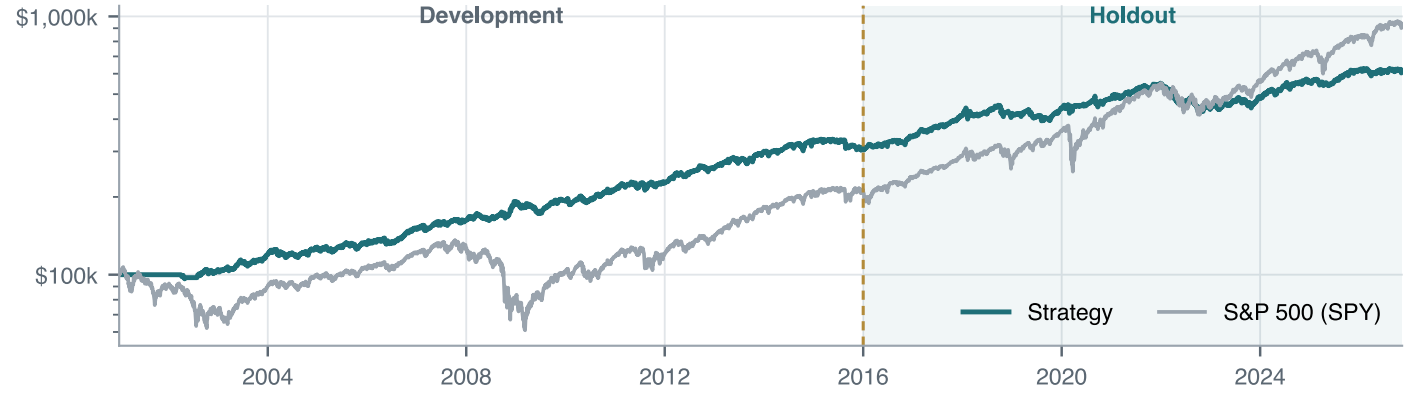
EXECUTIVE SUMMARY

The rule sets the equity weight each month to 8% divided by the index's 21-day realised volatility, capped at 100%, and sets it to zero when the index trades below its 200-day moving average. Anything not in equities sits in 7-10 year Treasuries. Over 2001-2026 that produced 7.29% CAGR, a 0.829 Sharpe and a -22.6% maximum drawdown, against 9.02%, 0.550 and -55.2% for buy-and-hold. The development period was stronger (0.926) than the holdout (0.725), and 2022 was the hole in the thesis: the gate stayed long into a rising-volatility decline and the book lost 20.2%.

KEY TAKEAWAYS

- Holding risk constant instead of weight constant raised the full-sample Sharpe from 0.550 to 0.829 while cutting the drawdown from -55.2% to -22.6%.
- 2008 is the advertisement: the book returned 17.3% while the index fell 37%, because realised volatility tripped the exposure down before the worst of it.
- 2022 is the counter-example: -20.2% for the book against -18.1% for the index. The gate was long at the start of the year and volatility rose faster than the monthly rebalance could react.
- The holdout Sharpe of 0.725 is below the development 0.926. Some of the development result was a favourable volatility regime, and the honest expectation is the lower number.

Exhibit 1. Growth of $100,000, strategy versus S&P 500 (SPY)



Shaded region is the holdout window (parameters locked before 2016). Log scale.

PERFORMANCE SUMMARY

WINDOW	CAGR	SHARPE	MAX DD
Development 2001-2015	7.76%	0.926	-10.2%
Holdout 2016-2026	6.74%	0.725	-22.6%
Full sample 2001-2026	**7.29%**	**0.829**	**-22.6%**
Walk-forward 2005-2026	8.84%	0.888	-21.6%
S&P 500 (SPY), full	9.02%	0.550	-55.2%

$100,000 grew to $616,921. Average exposure 100% including the Treasury sleeve; the equity sleeve averages 100% with 1.8% daily turnover.

Hypothetical backtested results have inherent limitations, do not reflect actual trading, and are not indicative of future performance. Costs are modelled at 5 bp of traded notional with no financing, borrow or market-impact charge. This document is for informational purposes only and is not investment advice.

1. STRATEGY OVERVIEW

One asset, one risk budget. The strategy decides how much equity risk to own, not which stocks to own, and it never shorts. The two decisions - how much risk, and whether to be invested at all - are deliberately separated.

2. MECHANICS

- **Risk budget.** Weight = 8% / 21-day annualised realised volatility of SPY, capped at 100%. At 16% realised volatility the book holds half the index; at 8% it holds all of it.
- **Trend gate.** If SPY closes below its 200-day moving average, the equity weight goes to zero. This is a slow filter by design; it is there to avoid owning equities in a sustained downtrend, not to time turns.
- **Collateral.** Capital not in equities is held in IEF. Without this, the strategy would hold non-interest-bearing cash in roughly a third of months and give away the term premium.
- **Cadence.** Month-end decision, next-close fill, 240 orders over 26 years. The low order count is why fees are 0.2% of starting capital per decade.

PARAMETER SPECIFICATION

PARAMETER	LITERATURE	FINAL	NOTE
Volatility target	10%	**8%**	Book-level risk budget
Volatility window	21 days	**21 days**	Annualised with sqrt(252)
Trend gate	200-day	**200-day**	On; equity weight to zero below
Exposure cap	100%	**100%**	No leverage
Collateral	Cash	**IEF**	Treasury sleeve
Rebalance	Monthly	**Monthly**	Month-end, next close
Universe	S&P 500	**SPY**	Single index

Exhibit 2. Rolling 12-month return



Strategy versus buy-and-hold, month-end returns compounded over 12 months.

3. SOURCE OF EDGE AND WHY IT EXISTS

The mechanism is volatility clustering, not forecasting.

- **Volatility clusters.** Realised volatility is persistent: high-volatility months follow high-volatility months. Scaling exposure by inverse variance therefore reduces risk exactly when risk is rising, without needing to predict returns.
- **Published effect.** Moreira and Muir (2017) show that volatility-managed factor portfolios earn higher Sharpe ratios and positive alpha against their unmanaged counterparts. This is the equity-only version of that result.
- **Trend gate.** A 200-day moving-average filter has been documented on the S&P 500 since Faber (2007). It is a crude regime switch that avoids the worst sustained drawdowns at the cost of whipsaw around flat markets.

4. WHERE THE STRATEGY IS EXPECTED TO STRUGGLE

- **Lag.** A 21-day volatility estimate reacts after the shock. A gap move is taken at the previous, larger weight; 2022 and the February 2018 shock both show this.
- **Whipsaw at the gate.** Markets that cross the 200-day average repeatedly force the book in and out at the wrong times. 2015 (-6.6%) is the clearest example.
- **Single asset.** All equity risk sits in one index. The strategy manages timing and sizing risk, not concentration risk.
- **Low-volatility bull markets.** When volatility is low and the index Grinds higher, the cap binds at 100% and the strategy is simply the index with extra fees.

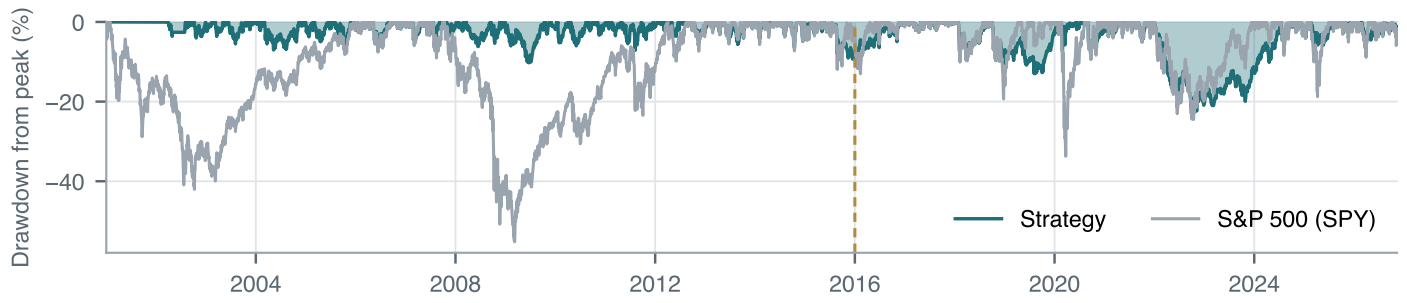
5. BACKTEST SPECIFICATION

Instruments	SPY, IEF
Data	Adjusted daily OHLCV, 2001-2026
Initial capital	$100,000
Execution	Month-end signal, next-close fill
Orders	240
Fees	$197.6k at 5 bp
Code	quant/qresearch/strategies.py::volmanaged

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6. PERFORMANCE ANALYSIS

Exhibit 3. Drawdown from peak



Dashed line marks the start of the out-of-sample window.

Exhibit 4. Calendar-year returns

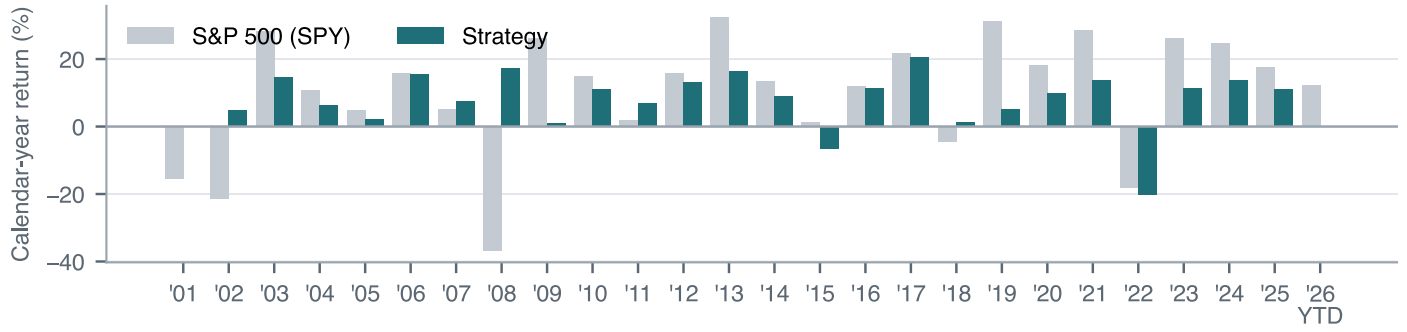
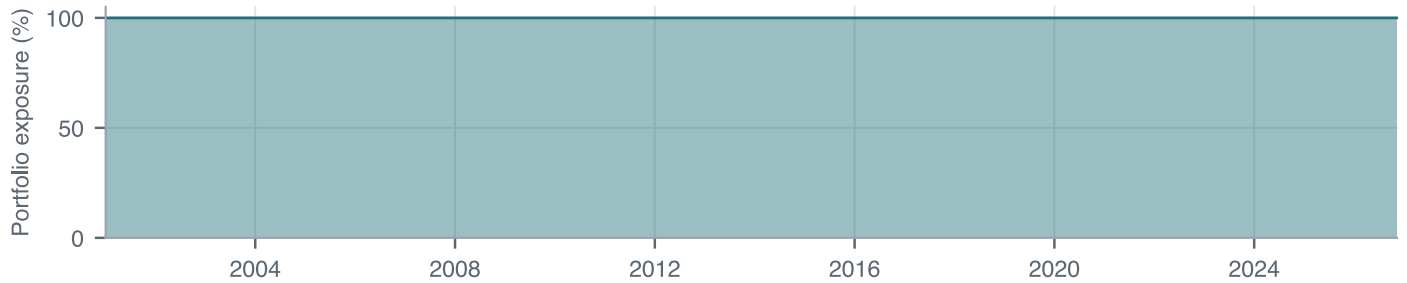


Exhibit 5. Monthly returns of the strategy (%)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2001		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2002	0.0	0.0	0.0	-3.2	0.6	0.0	0.9	2.5	3.9	-1.3	-2.1	3.5
2003	-0.8	2.2	-0.4	0.1	4.5	0.1	-1.5	1.4	0.6	2.5	0.6	4.5
2004	1.8	1.5	-1.5	-2.7	0.8	1.4	-2.1	1.0	0.8	0.7	2.1	2.4
2005	-2.2	1.6	-1.5	-0.8	2.6	0.1	3.6	-0.8	0.2	-2.3	2.7	-0.8
2006	2.4	0.6	1.0	1.2	-2.9	0.5	1.0	2.1	2.5	3.2	2.0	1.0
2007	1.5	-2.0	0.3	2.8	3.2	-1.4	-0.4	1.9	1.5	1.0	-0.4	-0.6
2008	2.8	1.2	1.3	-2.4	-1.8	1.1	0.7	1.5	-0.1	-0.9	7.8	5.2
2009	-3.9	-0.7	3.3	-2.7	-2.1	-1.6	3.6	2.1	2.6	-1.0	3.8	-1.7
2010	-3.0	2.3	2.2	1.0	-2.1	2.1	0.9	3.4	-0.0	1.7	-0.3	2.7
2011	1.7	3.1	-0.4	2.4	-0.8	-1.9	0.8	-0.6	1.3	-1.3	0.6	2.0
2012	1.4	3.2	3.0	0.4	-2.1	2.7	1.2	1.3	2.2	-1.4	0.6	-0.1
2013	2.7	1.1	2.5	2.1	-0.6	-1.7	2.3	-4.1	3.1	4.3	1.7	2.1
2014	-2.5	2.5	0.3	0.6	2.1	1.8	-1.4	3.3	-1.5	1.9	1.9	-0.1
2015	0.2	1.4	-1.3	0.1	0.5	-1.8	2.1	-4.2	-0.8	-0.6	-0.9	-1.3
2016	2.0	1.5	-0.1	-0.4	1.4	1.1	1.6	-0.1	0.0	-1.7	4.0	1.5
2017	1.6	3.9	0.1	1.0	1.4	0.6	2.1	0.3	1.4	2.2	3.1	1.2
2018	5.6	-3.4	-1.3	-0.3	1.6	0.1	3.4	3.1	0.6	-6.9	2.2	-2.6
2019	0.6	-0.5	1.0	2.9	-6.2	0.4	0.3	-1.0	-0.7	3.0	2.8	3.0
2020	-0.0	-3.9	6.5	0.3	0.3	0.5	2.3	3.5	-3.9	-1.4	4.3	1.5
2021	-0.4	0.9	1.1	3.3	0.6	1.7	2.2	1.8	-4.5	4.4	-0.3	2.6
2022	-3.4	-1.4	-5.1	-6.1	1.0	-0.9	3.0	-3.9	-4.7	-1.5	3.6	-2.4
2023	3.2	-3.1	3.7	1.1	-0.5	3.5	2.2	-1.6	-4.0	-2.2	4.4	4.5
2024	1.4	3.2	2.3	-4.1	3.5	3.3	1.0	1.0	1.4	-1.7	4.4	-2.3
2025	1.8	0.4	-3.3	1.0	-1.2	2.8	1.7	2.5	2.4	2.3	0.6	-0.3
2026	1.2	-0.0	-3.9	0.3	3.4	-0.9	-0.7	1.5	-1.0	0.1	0.2	

Months with no position show 0.0.

Exhibit 6. Portfolio exposure over time



Gaps at zero are cash or Treasury-sleeve periods; partial exposure reflects volatility scaling.

7. RESEARCH PROCESS

V1 **Constant-weight index.** Buy-and-hold for reference: Sharpe 0.550, drawdown 55.2%. This is the number to beat.

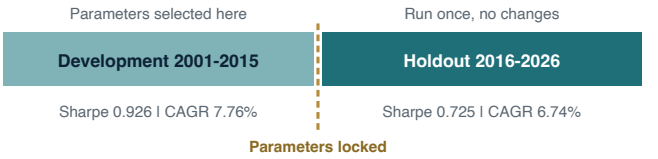
V2 **Volatility scaling only.** Inverse-variance sizing without a trend gate: Sharpe 0.68, drawdown 32%. Sizing helped; the drawdown was still too deep.

V3 **Add the trend gate.** Gate on the 200-day average cut the drawdown to the low twenties at a small cost in return. Adopted.

REJECTED **Daily rebalancing.** Rebalancing the weight every day added turnover without improving the Sharpe ratio; the volatility estimate moves too slowly to justify it.

ADOPT **Holdout and walk-forward.** Holdout Sharpe 0.725; eleven walk-forward folds with 0.95 efficiency and 10/11 positive.

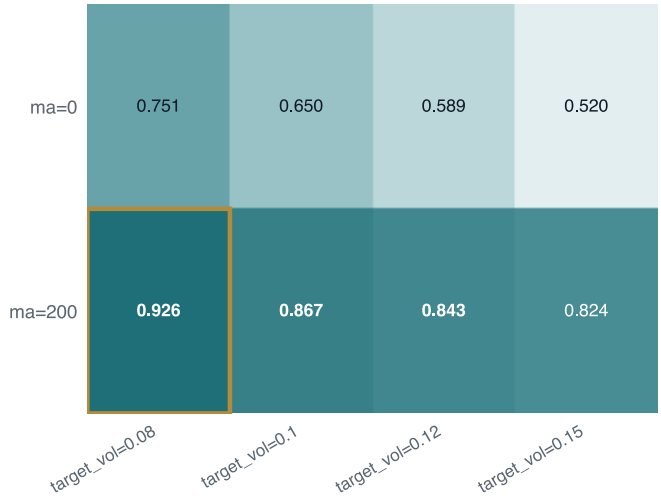
Exhibit 7. Walk-forward design



the holdout: Sharpe above 0.50, drawdown below 30%, positive in at least seven of eleven walk-forwar

GRID DIMENSION	VALUES TESTED
Volatility target	8%, 10%, 12%, 15%
Trend gate	on, off
Trials reported	8 (all shown)

Exhibit 8. Development-window Sharpe across the parameter grid



Outlined cell is the adopted configuration. A broad high-Sharpe region, not an isolated peak, is the robustness test.

8. WHY THE RESULT IS UNLIKELY TO BE OVERFIT

- **Holdout fixed in advance.** Grid scored on 2001-2015, holdout run once at 2016-2026: Sharpe 0.725 against 0.926 in development.
- **Eight configurations.** Volatility target (8/10/12/15%) and trend gate (on/off). Eight trials, all reported.
- **Plateau.** The top cells cluster: development Sharpe 0.926, 0.867, 0.843. No isolated spike.
- **Economic anchoring.** Both components are published, replicated effects with a mechanism, not data-mined patterns.
- **Deflated Sharpe.** Deflated for eight trials and 6,503 observations: 0.996.

LIMITATIONS

Disappointing 2022. The strategy lost 20.2% in 2022, worse than 60/40. Volatility targeting is not a crisis hedge when the crisis is a slow repricing.

Regime dependence. The 2001-2015 development window contained two large volatility events (2008, 2011). The holdout contained one (2020) plus a slow 2022 decline.

Benchmark risk. With beta near 0.2 on average the book will lag a strong equity market, as it did in 2023-2025.

Status. Backtest only, no paper trading.