Strategies involving VIX

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July 11, 2025

Summary

Introduction: What is VIX?

The VIX Index also known as the **CBOE Volatility Index** is a measure of future volatility, derived from the prices of S&P 500 index options. It is often referred to as the "fear index" because it tends to rise during periods of market uncertainty.

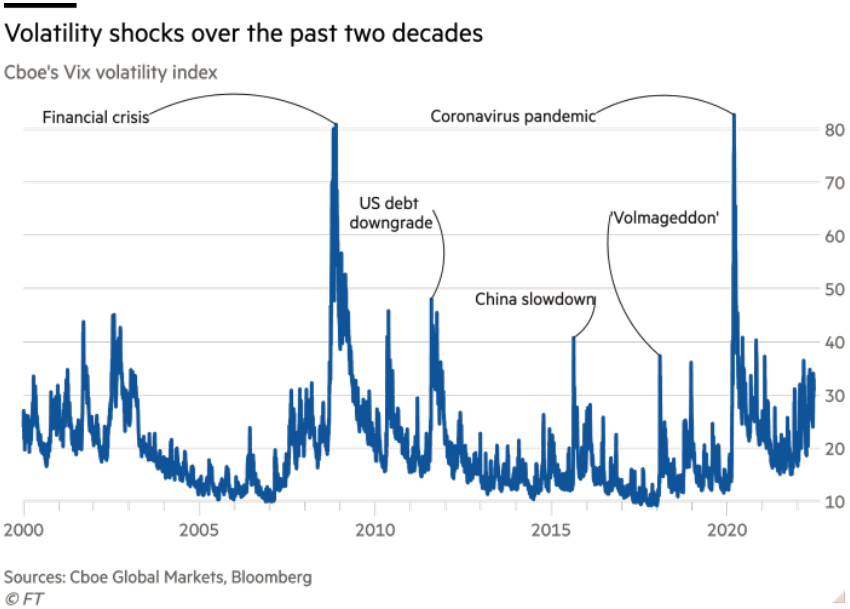

Figure: VIX Index

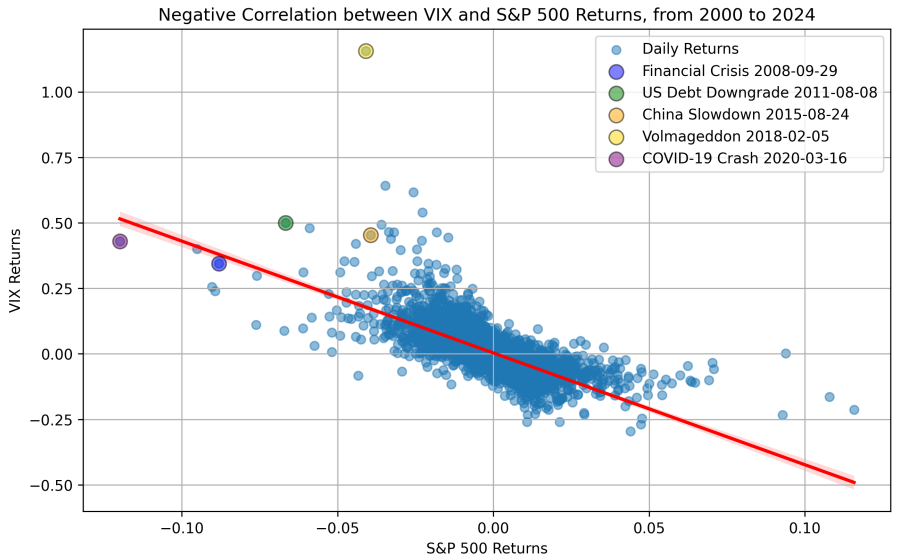

Figure: VIX and S&P 500

Introduction: VIX calculation

The VIX is calculated using the prices of S&P 500 index options:

$$VIX = 100 \times \sqrt{\frac{2e^{r\tau}}{\tau}\left(\int_0^F \frac{P(K)}{K^2}\,dK + \int_F^\infty \frac{C(K)}{K^2}\,dK\right)} \tag{1}$$

where:

- r : Risk-free interest rate
- τ : Time to expiration (30 days)
- F : Forward price of the S&P 500 index
- K : Strike price
- $P(K), C(K)$: Out-of-the-money put and call option prices

Common strategies involving VIX

We will analyze two strategies :

- A Portfolio of Stocks and Volatility (Daigler and Rossi 2006)
- VIX-managed portfolios (Božović 2024)

To compare all performances, we will use data from 2010 to 2020 if fine tuning is necessary and then data from 2020 to 2025 for testing. The main metric used will be the sharpe ratio with a null risk free rate:

$$Sharpe\ Ratio = \frac{Expected\ Return}{Standard\ Deviation}$$

Common strategies: A Portfolio of Stocks and Volatility

In order to cancel upcoming drawdown, an idea is to invest a proportion w_{VIX} of the portfolio into the VIX index:

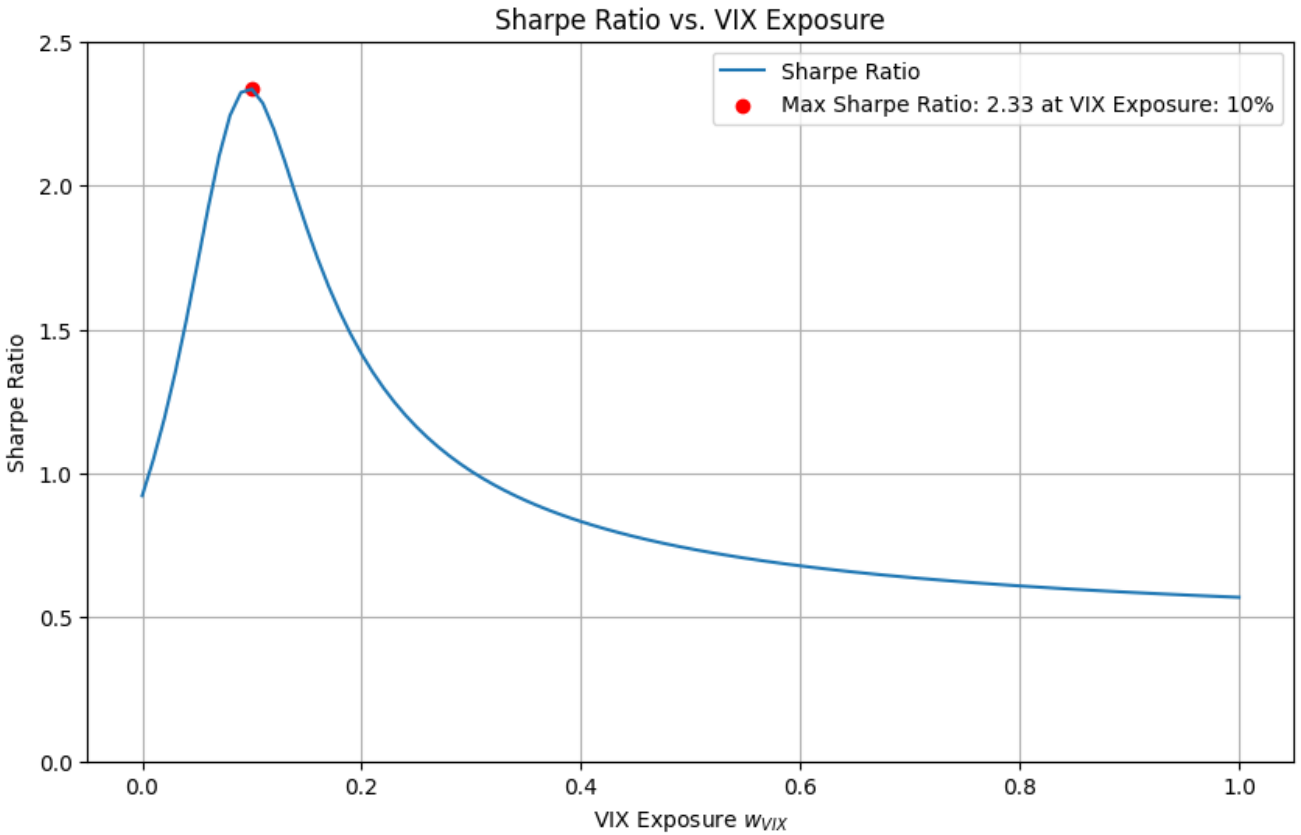

Figure: Finding the best w_{VIX} on trainset (2010-2020)

Common strategies: A Portfolio of Stocks and Volatility

Dataset	Only SP500	with 10% VIX	with 10% VXX
Trainset (2010-2020)	0.922	2.33	
Testset (2020-2025)	0.741	1.66	0.738

Table: Sharpe Ratio for different strategies

Common strategies: A Portfolio of Stocks and Volatility

The mean-variance optimisation (Markowitz 1952) is well known to perform better in-sample than out-sample. But here we should also take into account the Volatility Risk Premium (VRP):

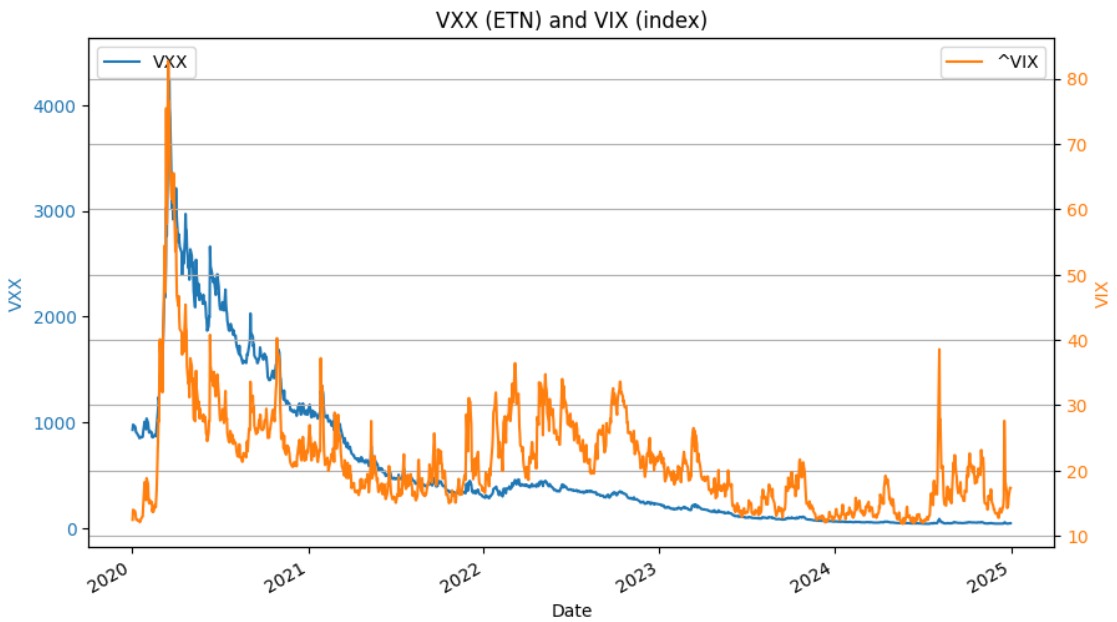

Figure: Visualisation of Volatility Risk Premium

Common strategies: VIX-managed portfolios

Rather than trying to cancel upcoming drawdown, another idea is to take less risk when implied volatility is high.

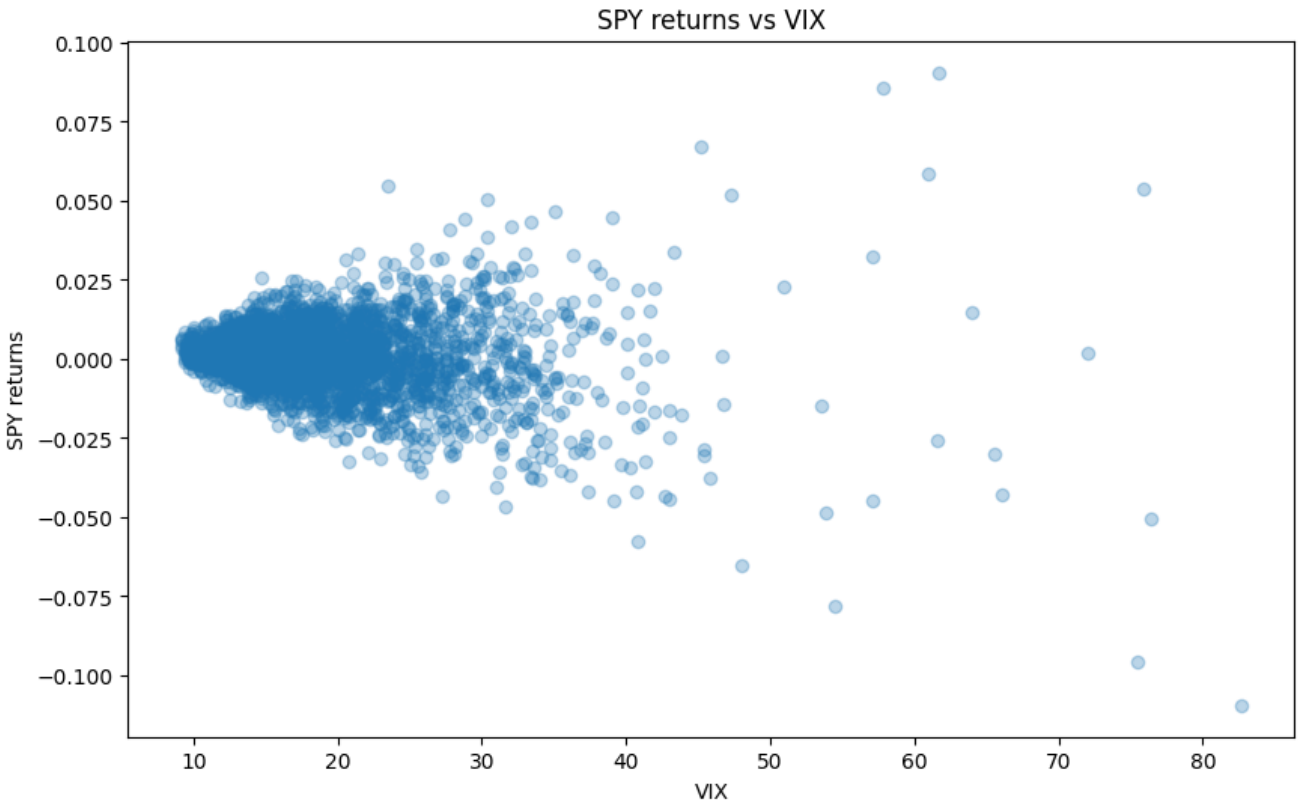

Figure: SPY returns are heteroskedastic with respect to VIX

Common strategies: VIX-managed portfolios

The idea from the paper "VIX-managed portfolios" (Božović 2024) is to scale exposure to SP500 with respect to the VIX:

$$w_t = \frac{K}{VIX_t^2}$$

with $K = 11.23$ such that $E[w_t] \approx 1$

- Low VIX ("calm market") : lever up SPY exposure
- High VIX ("turbulent market") : de-lower into cash

Dataset	Buy and Hold	VIX-managed
Trainset (2010-2020)	0.922	0.940
Testset (2020-2025)	0.741	0.945

Table: Sharpe Ratio for different strategies

Approach trading strategy

The goal of this strategy is to use the VIX index, often called the market's "fear gauge" to generate trading signals for the SPY ETF, which tracks the S&P 500. The strategy combines trend-following and mean-reversion techniques, with built-in risk management.

VIX in the last year

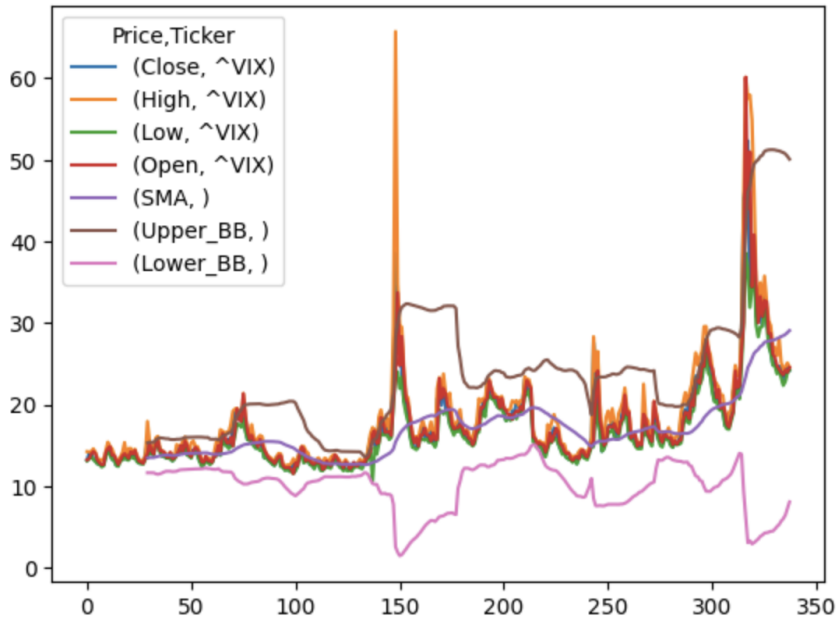

Figure: VIX levels starting in 2024, with a 30-day simple moving average and ± 2.5 standard-deviation bands.

SPY in the last year

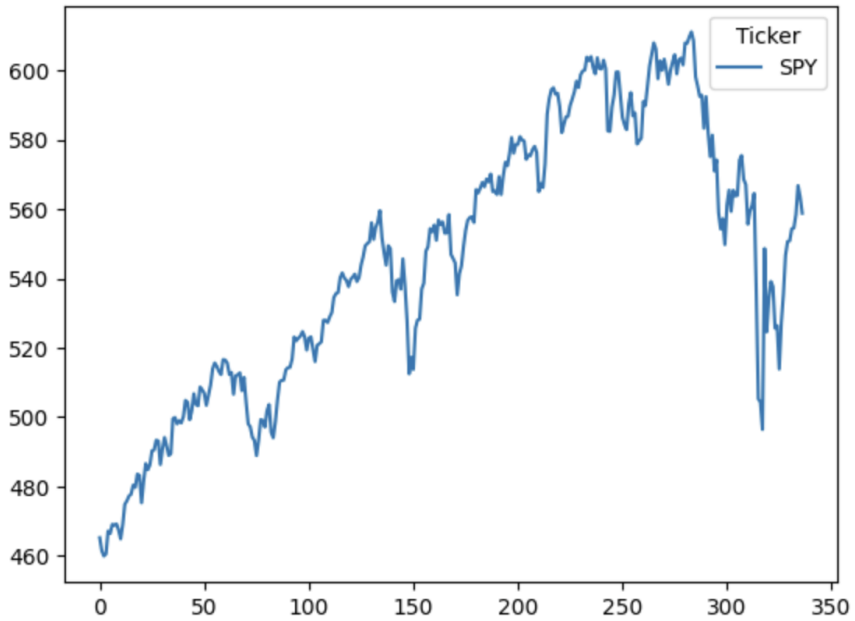

Figure: SPY Closing price starting in 2024

Signal Generation

- **Trend-Following Signal:**
  - Calculate 5-day and 15-day SMAs of the VIX.
  - **Long signal:** 5-day SMA $<$ 15-day SMA.
  - **Short signal:** 5-day SMA crosses above 15-day SMA.
- **Mean-Reversion Signal:**
  - Compute 30-day Bollinger Bands on the VIX (± 2.5 standard deviations).
  - **Long SPY:** When VIX falls below its lower Bollinger Band.

Position Management

- Positions updated daily:
  - **Long:** On long signal or extreme VIX drop.
  - **Short:** On short signal (SMA crossover).
  - **Hold:** Retain previous position otherwise.
- SPY returns adjusted for:
  - **Transaction cost:** 0.05% trading cost when position changes.

Results

- Strategy reacts to volatility spikes, often buying after panic-driven drops.
- Uses fear levels, not price action, for timing entries and exits.
- Demonstrates the power of combining:
  - Trend-following (SMA crossovers)
  - Mean-reversion (Bollinger Band extremes)

Plot

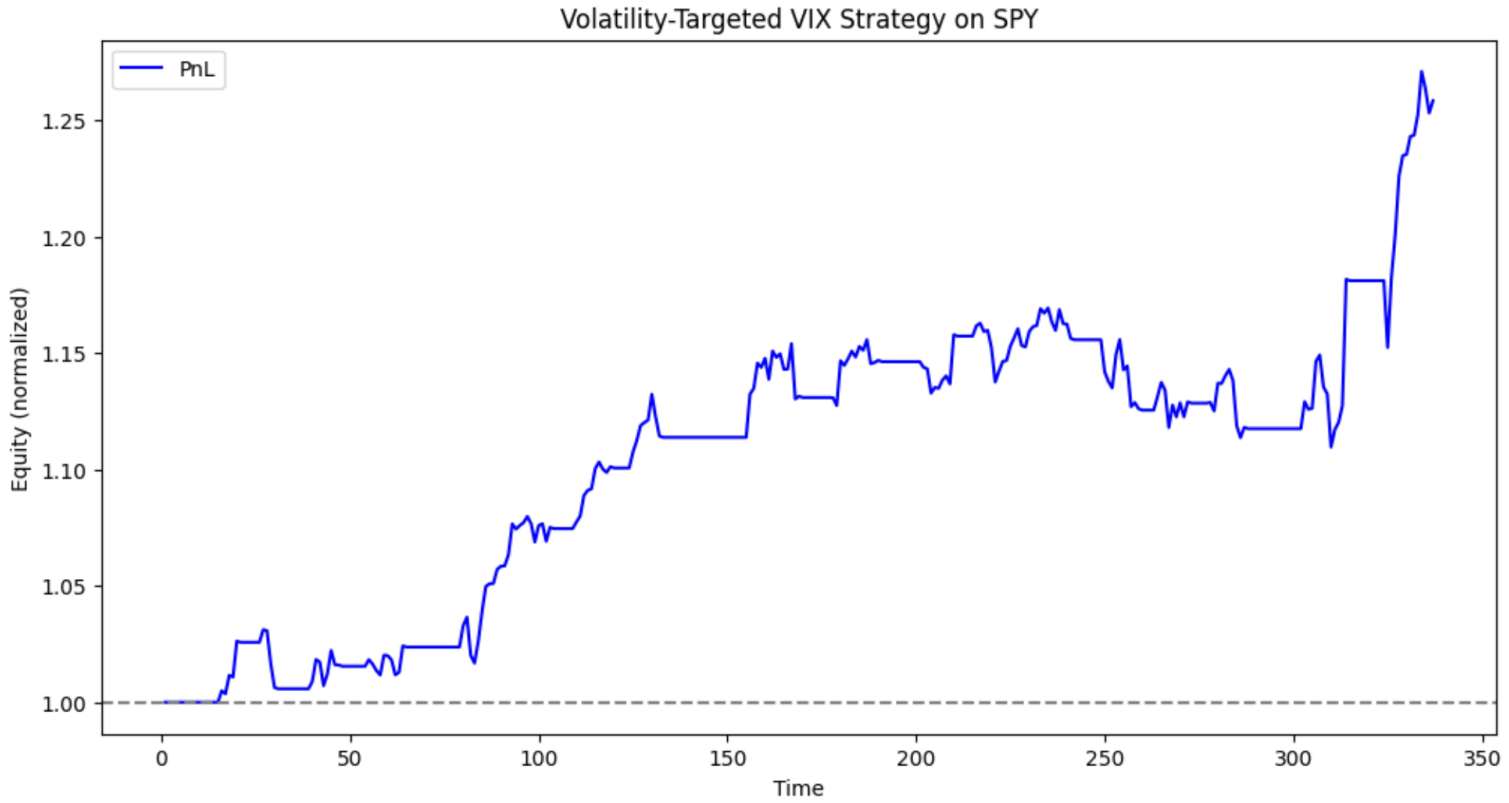

Figure: Normalized equity curve of a volatility-targeted SPY strategy using VIX SMA crossovers, Bollinger Bands, Sharpe Ratio 1.8

Introducing a SPY Market-Regime Filter

- **Goal:** Enhance VIX-based strategy robustness over an extended 2020–present period.
- **Core VIX Signals:**
  - 5-day vs. 15-day SMA crossover
  - 30-day Bollinger Band
- **Regime Filter Rule:**

> Only long SPY if prior close $>$ 100-day SMA;
> only short SPY if prior close $<$ 100-day SMA.

- **Benefits:**
  - Avoid false signals from quick back-and-forth price swings when the market is moving sideways.
  - Reduces drawdowns during strong one-sided trends
  - Combines volatility mean-reversion with price momentum

Plot

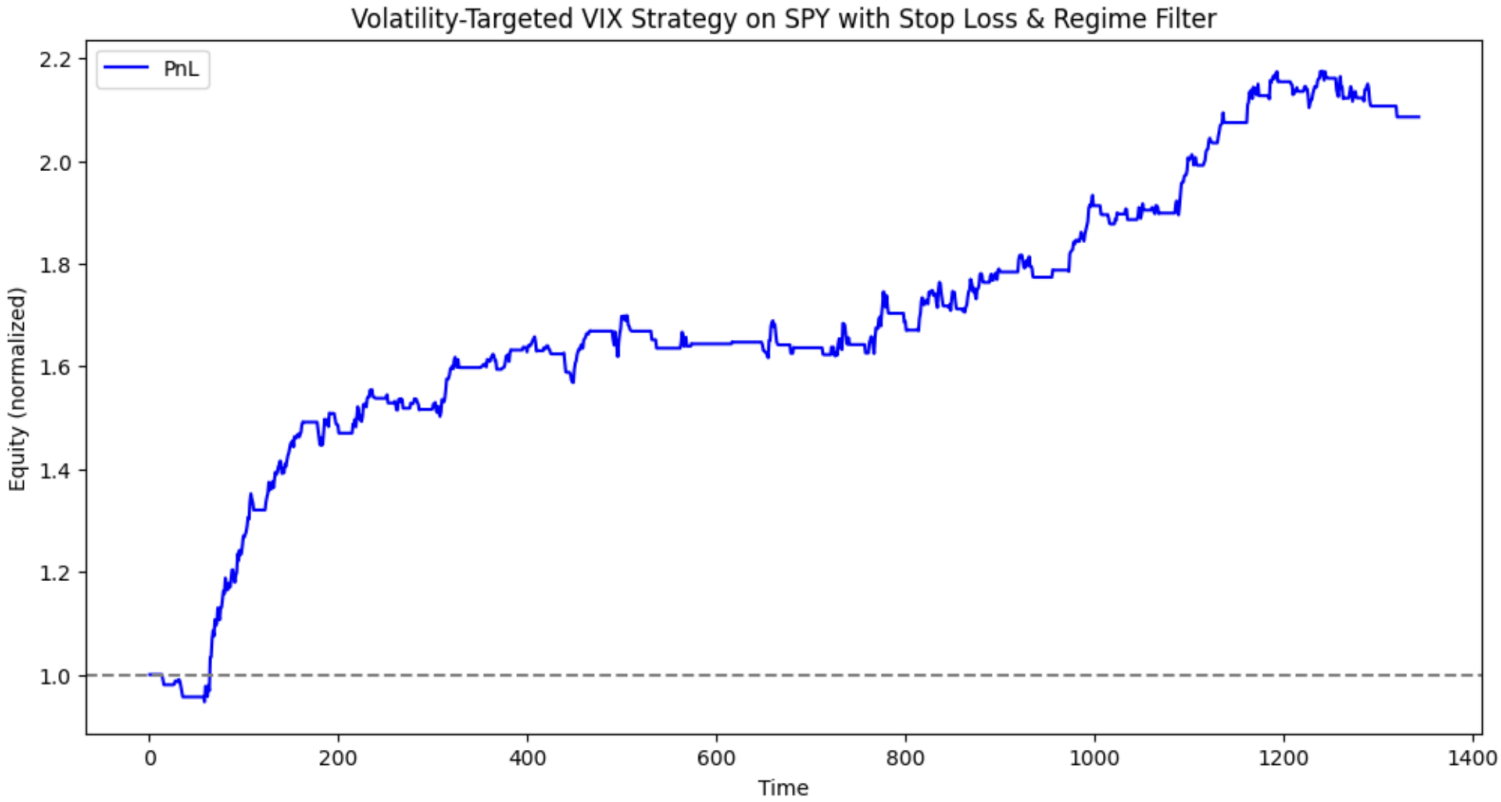

Figure: Normalized equity curve of a volatility-targeted SPY strategy using VIX SMA crossovers, Bollinger Bands, a 2% daily stop-loss, and a 100-day SMA regime filter, Sharpe Ratio 1.1

VIX Spike-Fade Reversion

- **Fear spikes often mark market bottoms.** When volatility surges (VIX > 30), driving prices far below their value.
- **Buying the panic.** We step in at the next open after a big jump in fear, capturing the rebound as volatility cools.
- **Volatility as a timing signal.** Exit when VIX < 20: As soon as the VIX drops under 20, you sell your SPY position at that day's close.
- **Why it works:** The strategy relies on buying during panic "spikes". Markets often overreact to shocks. This approach systematically exploits that overreaction.

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Strategy Overview

- **Intuition:**
  - VIX (*"fear index"*) often peaks at market bottoms.
  - SPY tends to rebound market calm returns.
- **Trade Rules:**
  1. Enter long at the next day's open after a qualifying VIX spike ($VIX_{t-1} > 30$ & rising).
  2. Exit at the close when any of the following is met:
     - Held ≥ 21 trading days
     - SPY has gained $\geq 8\%$
     - VIX falls below 20
- **Risks:**
  - Erratic price reversals and deceptive signals during extended high-volatility periods can result in successive losses.
  - Cash drag in low-volatility phases may cause underperformance relative to a buy-and-hold strategy.

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Plot

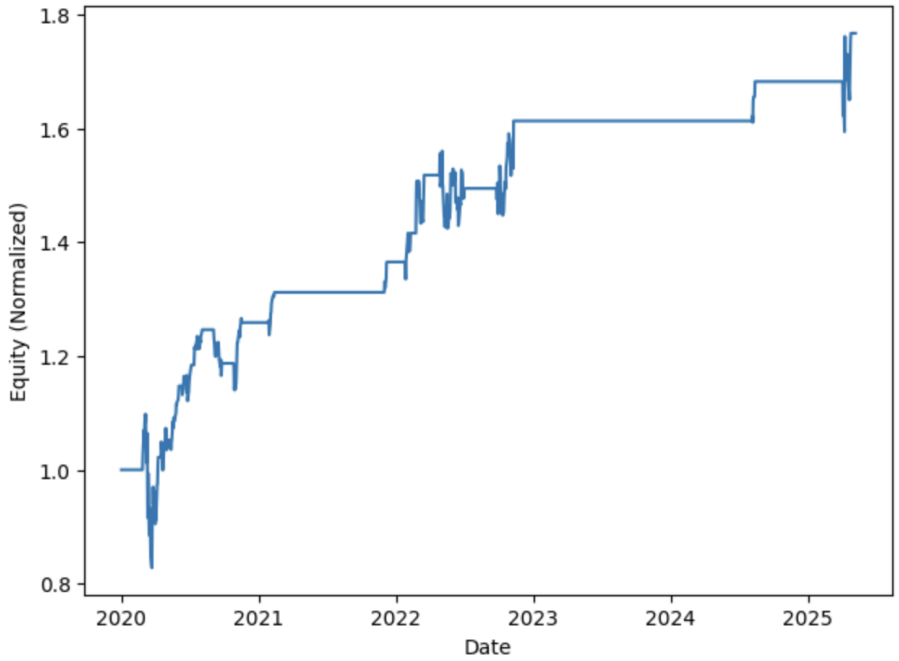


Figure: Normalized equity curve for the VIX Spike-Fade Reversion strategy, Sharpe ratio 0.9

Approach trading strategy:Volatility

This strategy exploits the structural variance-risk premium— the fact that option-implied volatility on the S&P500 (VIX) usually trades above the realised volatility—to earn the "insurance" investors pay against tail events.

Implied Volatility vs Realised Volatility

Implied vs. Realised Volatility

- *Implied volatility (σ^2_{IV}):* forward-looking, derived from option prices.
- *Realised volatility (σ^2_{RV}):* backward-looking, computed from actual returns.
- IV typically exceeds RV. (from Feb 1990–Jun 2008, IV beat RV in **86.36%** of one-month windows (Loggie 2008).

Variance Swap: Direct Exposure to volatility

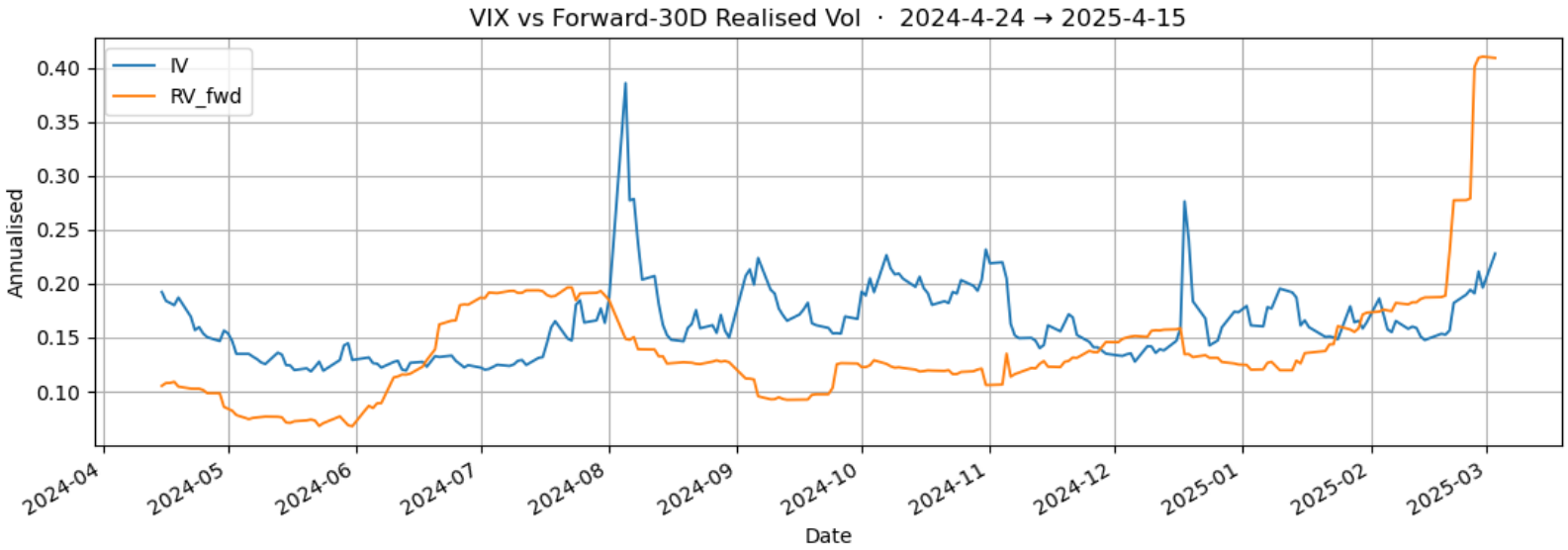
There exists an OTC derivative known as a Variance swap.(Loggie 2008)
The payoff at expiration of a variance swap is:

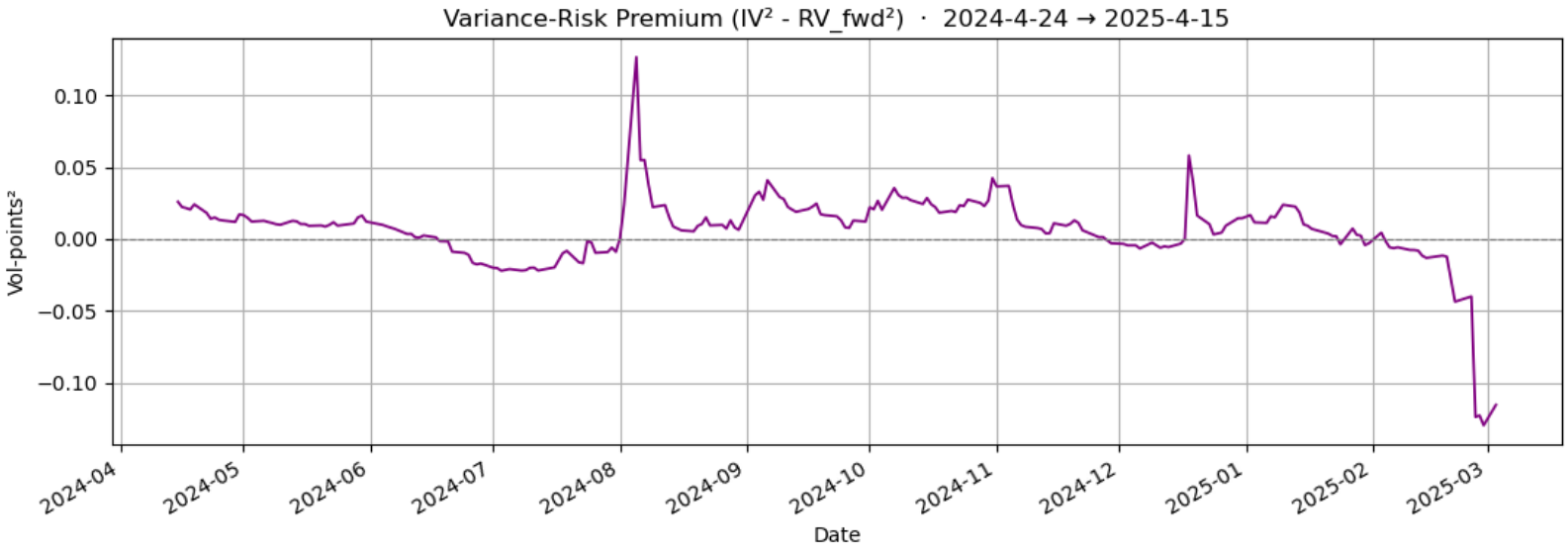
$$\text{Variance Swap Payoff} \;=\; N_{\text{var}}\left(\sigma_{\text{RV}}^2 - \;\sigma_{\text{IV}}^2\right) \tag{2}$$

where:

- $N_{\text{var}} = \dfrac{\text{Vega}}{2\,\sigma_{\text{IV}}}$: Variance notional that converts a 1-point move in variance into dollars. Vega is normally 30%.
- $\sigma_{\text{IV}} = \dfrac{\text{VIX}}{100}$: 30-day option-implied volatility (decimal form).
- $\sigma_{\text{RV}} = \sqrt{\frac{252}{n}\sum_{i=1}^{n}\left(\ln\frac{S_i}{S_{i-1}}\right)^2}$: Annualised 1-month realised volatility from daily log returns.

Volatility plots





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Tail events: How to mitigate them?

Tail Events – when RV > IV

They tend to follow after market stress(liquidity squeezes, macro shocks, news), that was not priced in via the options

- Forecasting Signals
  1. Stress detection via Hidden Markov model, give transition probabilities between high volatility state and low volatility state
- Rebalancing Portfolio after Signal
  1. Long futures in proportion of probability of stress as protection

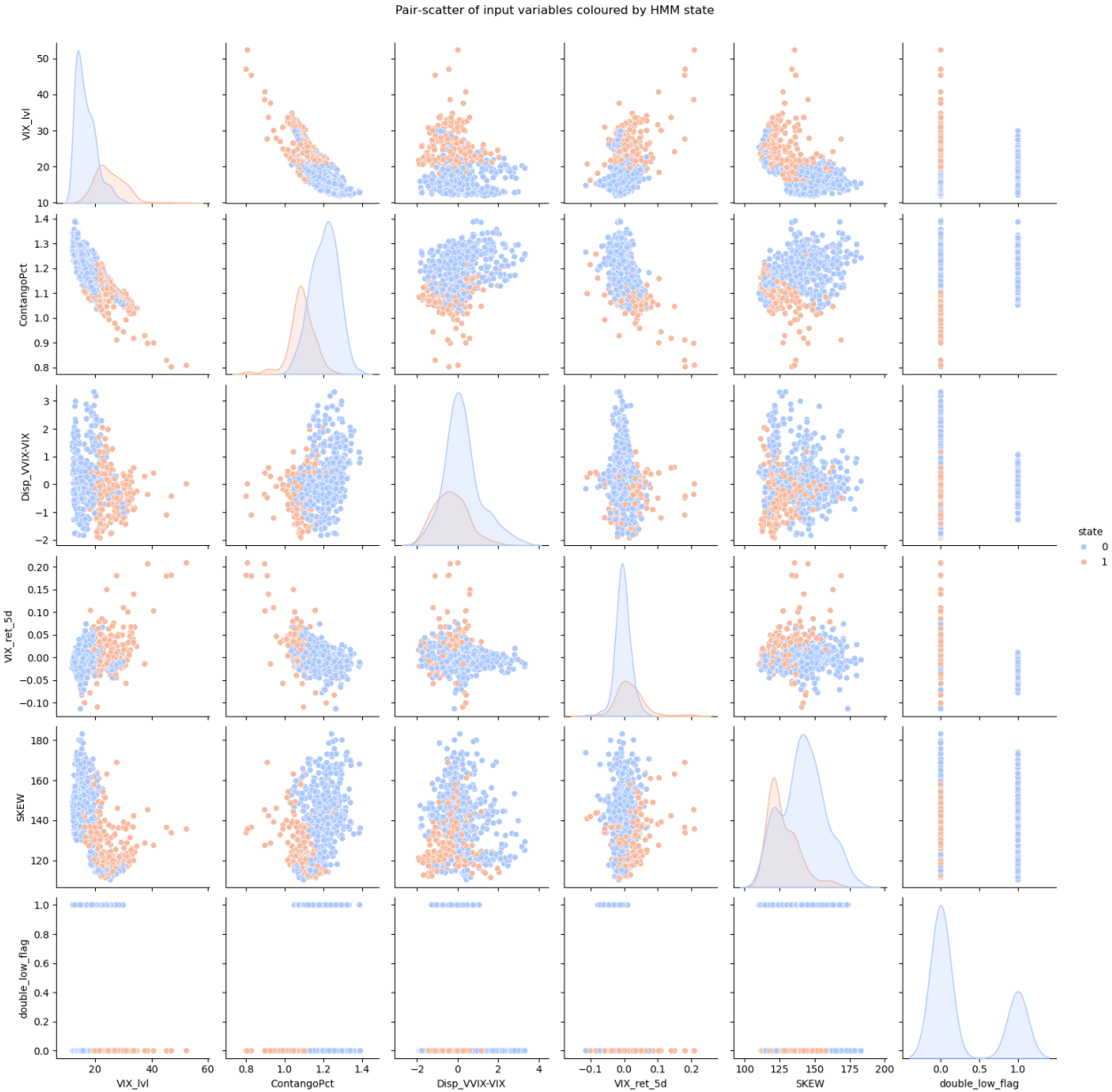
HMM feature set for volatility–regime detection I

The Hidden-Markov Model is fed with a 6-dimensional feature vector:

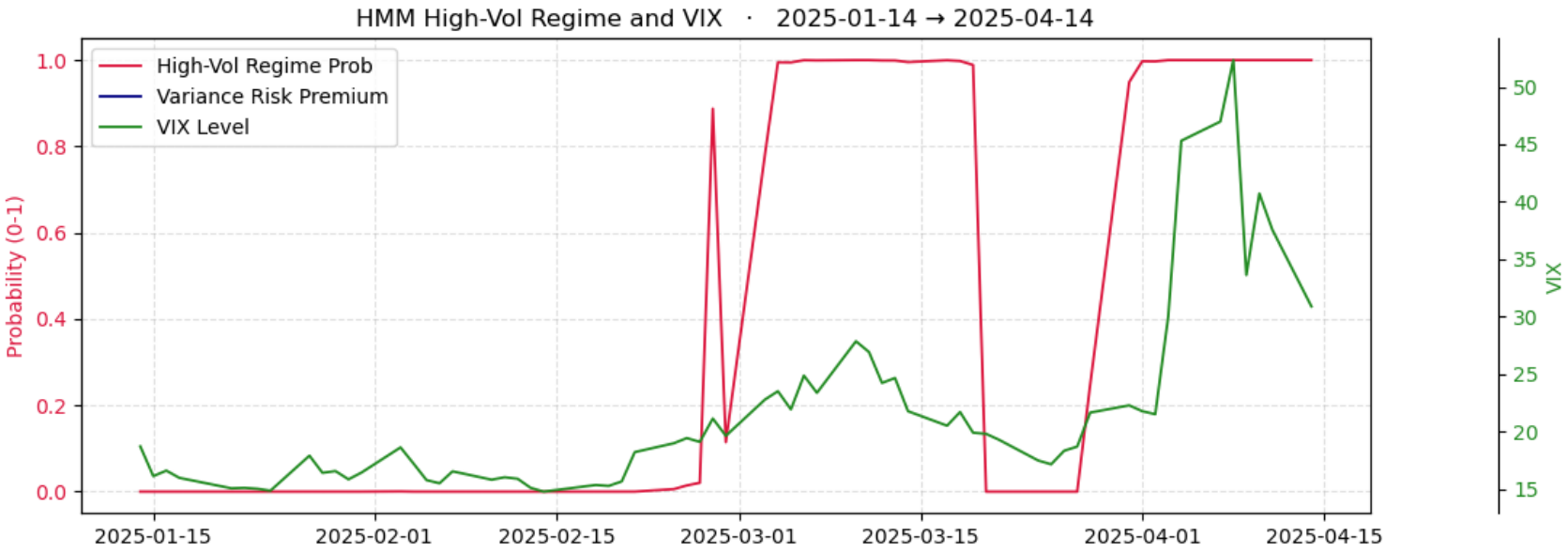
$$X_t = (\text{VIX}_t, \text{VIX\_roll}_t, \text{Contango}_t, \text{Skew}_t, \text{Dispersion}_t, \text{LowVolTrigger}_t)$$

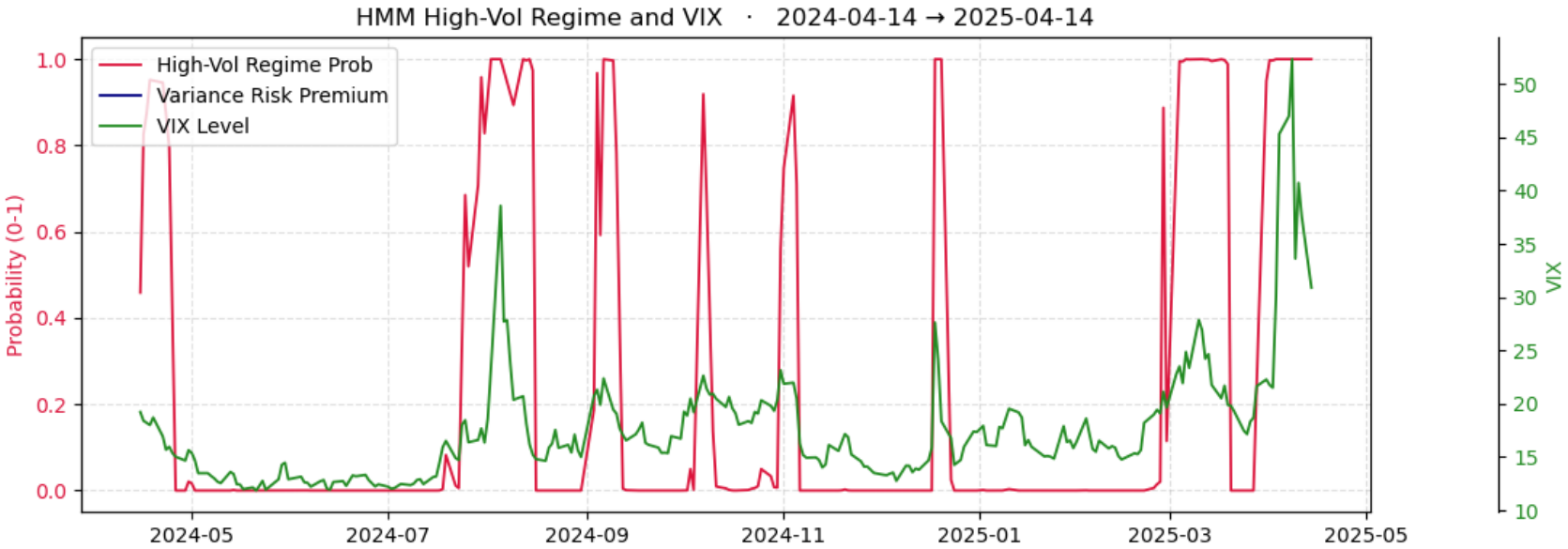
- (VIX_t): 30-day implied volatility of the S&P500.
- (VIX_roll_t): VIX 5 day roll, Short-term momentum Helps the HMM differentiate spikes from slow drifts.
- (Contango_t): Front- vs second-month VIX-futures slope, steep contango signals calm periods
- (Skew_t): CBOE skew index, measures the price of deep out-of-the-money options.
- $(VVIX_z - VIX_z)$: Z-score gap between VVIX and VIX itself. A widening gap hints at latent uncertainty about future vol.
- LowVolTrigger(Thrasher 2017): $\left[\mathbf{1}_{\{\text{VIX}_z \leq -0.75 \ \wedge \ \text{VVIX}_z \leq -0.50\}}\right]$, Encoded as an indicator, allow HMM to learn about dispersion.

Covariance plot between input variables



Signals Generated





Position Management

- Variance Swap Positions rebalanced monthly, on 3rd Friday of every month
  - Vega is rescaled each month by the filtered high-vol probability p_t: $N_t = N_{var}(1 - p_t)$, where exposure is reduced when probability of transitioning to high volatility is high.
- VIX futures positions entered when p_t is above a threshold $p_t \geq 0.6$, with stop loss implementation. Used to hedge against tail events when (RV $>$ IV).
  - stop loss at -5%, profit taking at $+20\%$
  - 7day cooldown period after exiting a trade
- Strategy returns adjusted for:
  - VIX quote Slippage during execution (0.5%)
  - Transaction cost (Half a variance point)

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Results

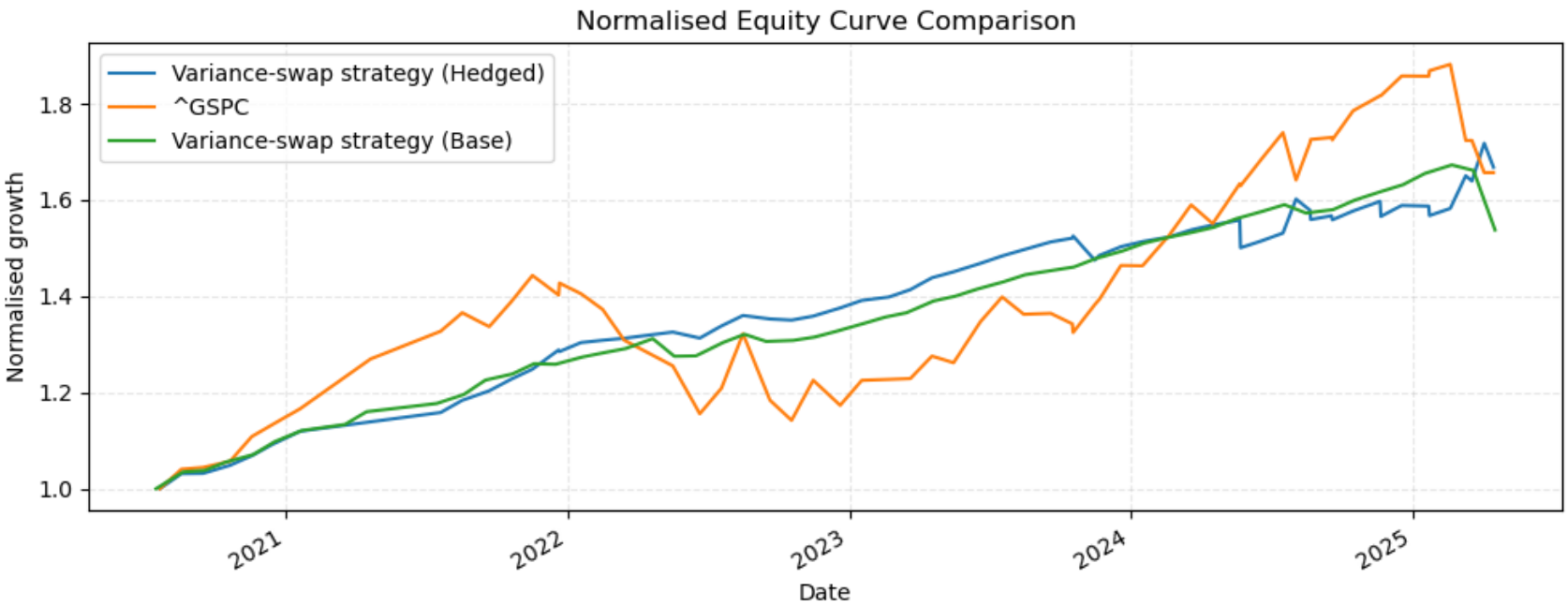

Figure: Comparison of Variance Swap without hedging (Sharpe 1.05) and with hedging (Sharpe 1.21)

Future direction

- Trade variance swaps themselves by modelling and pricing them
- Generate better signal, incorporate speculation from social media
- Variance arbitrage of an index against their constituents

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