IS4226 Final Project Report

Adele Tan Xuanyu (A0257263B)
Bernice Beh (A0256894J)
Chua Chong Xuan (A0252471J)
Sia Zi Xuan (A0252461L)
Wong Jia Kai Benjamin (A0252300B)

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1. Stock Selection

The **goals** of our stock selection:

- Diversified stocks (individual stock returns have low correlations, and stocks are from different sectors)
- Liquid stocks (high trading volume)
- Volatile stocks (high standard deviation)

1.1 Sector Selection Process

Our stock selection methodology begins with identifying the most actively traded sectors from the S&P 500, focusing on high-liquidity sectors that can support active trading strategies. By targeting these sectors, we ensure our strategy operates within an environment of strong liquidity, reducing the risks of slippage and allowing trades to be executed efficiently.

1.1.1 Data-Driven Analysis

To determine the most actively traded sectors, we analysed the historical trading data for each sector-specific exchange-traded fund (ETF) tracking the following S&P sectors:

1. XLY (Consumer Discretionary)
2. XLP (Consumer Staples)
3. XLV (Health Care)
4. XLI (Industrials)
5. XLK (Information Technology)
6. XLB (Materials)
7. XLRE (Real Estate)
8. XLC (Communication Services)
9. XLU (Utilities)
10. XLF (Financials)
11. XLE (Energy)

Using the yfinance library, we downloaded historical daily volume data for each ETF from 2010 to 2016. By calculating the median daily trading volume for each ETF, we could gauge investor interest and sector liquidity, both of which are crucial to ensuring the stability and effectiveness of our trading strategy. Sectors with high trading volume indicate stronger investor interest and support for efficient trade execution, essential for capturing the fluctuations in price movements.

The ETFs were sorted by median daily volume, and the top five sectors with the highest volumes were selected. These top five sectors, ranked by median daily volume, were as follows:

1. Information Technology (XLK)
2. Financials (XLF)
3. Health Care (XLV)
4. Consumer Discretionary (XLY)

5. Consumer Staples (XLP)

These sectors represent a broad cross-section of industries with strong investor interest, ensuring that our selected sectors not only align with our goal of high liquidity but also provide diversified exposure. Notably, the ETF that tracks the Communication Services sector (XLC) was excluded due to insufficient historical data for the full period.

1.1.2 Example-Driven Growth Insights

In addition, we also conducted a top-down analysis by researching these 5 sectors to confirm signs of growth and indicators of improved market performance in the coming years.

Information Technology: The period saw a rapid rise in digital transformation, cloud computing, big data analytics, and mobile applications. This sector has seen exponential growth, with digital economy expansion rates averaging over 5% annually, according to the U.S. Bureau of Economic Analysis (BEA).

Financials: Following the Global Financial Crisis in 2008, the shift to mobile and online banking significantly improved the financial sector in the following years. This led to greater wealth management not only for individuals but also for companies, while also resulting in the growth of fintech companies (Ross, 2024).

Healthcare: The passing of healthcare policies, such as the Affordable Care Act (ACA) in 2010, and biotechnology advancements (Nguyen, 2024) also resulted in the rapid expansion of healthcare, driving both demand and supply for healthcare services, having huge implications on the healthcare sector's growth.

Consumer Discretionary and Staples: The rise in technology changed how consumers shopped, driving the success of e-commerce. The convenience of e-commerce supported an increase in demand for both essential and non-essential items, allowing the consumer discretionary and consumer staples market to grow (Wahba & Matcho, 2019).

With strong growth potential, the chosen sectors offer stability to our portfolio by reducing the risk of sudden, adverse price movements. Trading stocks within these sectors thus provide an added layer of safety, reducing concerns about large downturns that could impact our portfolio.

1.2 Stock Selection Process

After deriving the top 5 sectors, we refined stock selection by choosing a stock from each sector through the application of a volume filter, volatility, and then computing the correlation matrix. The criteria used for selection are as follows:

Volume Filter: As an ETF generally has a larger trading volume than an individual stock, we determined a multiplier of 3 to be applied to an individual stock's trading volume. Post-multiplication of a stock's median trading volume, we compared this value to its sector's median trading volume (i.e. post multiplication of stock's median trading volume must be higher than its sector's median trading volume). This is to ensure that our strategy focuses on highly traded stocks within the sector chosen. Stocks meeting this threshold are more likely to provide the liquidity required to minimise slippage and allow for efficient trade execution, especially in volatile markets.

Volatility: Stocks were prioritised based on volatility, calculated as the standard deviation of daily returns. High volatility indicates greater potential for price movements, which aligns with our goal of capturing active price fluctuations. This metric was applied to the stocks meeting the volume filter criterion to narrow down to the most dynamic stocks.

Correlation: Finally, we ensured diversification and reduced redundancy in price patterns by selecting stocks with returns that have correlation coefficient of less than 0.6 to other chosen stocks in the portfolio. By focusing on stocks with less correlated price movements from each other, we increase our strategy's ability to diversify returns and capture varied market behaviours, which supports more stable performance.

The stock selection process thus produces a basket of high-liquidity, high-volatility stocks that also show low correlation with each other, providing an optimal balance for training our strategy on diverse price patterns. The basket of stocks, each from a different sector, also provides diversity in our portfolio to reduce the probability of our portfolio being impacted by sudden large losses in a particular stock/sector.

1.3 Stock Selection Finalised List

Our final selection of stocks represents each of the top five sectors, with each stock showing high liquidity and strong trading activity to support active trading. The selected stocks are:

- **Utilities:** NextEra Energy (NEE) – As one of the largest utilities providers in the U.S., NEE exhibits high trading volume and serves as a stable representative for the utility sector. Its high liquidity ensures minimal slippage and smooth execution.
- **Information Technology:** Advanced Micro Devices (AMD) – AMD is highly active in the semiconductor market, a sub-industry with rapid growth and high volatility, aligning well with our strategy's goal of capturing price fluctuations in the tech sector.
- **Industrials:** Caterpillar Inc. (CAT) – CAT, an industrial heavyweight, offers steady volatility and trading activity, enabling our strategy to capture price patterns in this sector. Its liquidity further supports efficient trade execution.
- **Financials:** Bank of America (BAC) – With high trading volume and significant exposure to the financial sector, BAC aligns well with our strategy, representing a core component of the sector with strong investor interest.
- **Energy:** Williams Companies, Inc. (WMB) – WMB operates in the energy infrastructure industry, providing exposure to the Energy sector with a mix of liquidity and volatility, fitting well with the requirements of our active trading approach.

These selected stocks provide diversified exposure across sectors and ensure that our strategy operates on highly liquid and active stocks with unique price patterns. Each stock fits well within the criteria of high median volume, high volatility, and minimal correlation with other stocks in the basket.

1.4 Overall Rationale

- High trading volume: Ensures high liquidity, allowing us to capture price fluctuations by enabling quick and easy reversal of positions.
- High volatility: Grants us the opportunity to take advantage of price fluctuations to increase our capital
- Different sectors and low correlation in individual stock’s returns: Ensures a diversified portfolio, minisming our portfolio risk
- Sectors with strong growth potential: Provides an added layer of security from large downturns in our portfolio

2. Strategy

Our trading strategy is designed to adapt to varying market conditions by segmenting market environments in volatile and non-volatile periods based on the market's sentiment, represented by the VIX Index. This adaptive approach allows us to optimise entry and exit points across different market conditions by using specific indicators and thresholds.

2.1 Rules of Strategy

The strategy makes use of the Volatility Index (VIX) as an indicator of market sentiment. Often referred to as the "fear gauge," the VIX tends to increase during periods of heightened uncertainty and market pessimism, indicating volatile conditions. Conversely, a low VIX suggests stability and investor confidence in the economic outlook. By distinguishing between volatile and non-volatile conditions, our strategy tailors its indicators and stop-loss mechanisms to capitalise on price movements effectively while managing risk. Below, we outline the two primary market segments and the specific strategy logic applied within each.

Assumptions of our strategy:

- The Risk-Free Rate is 0
- Transaction cost is 0
- All trades can be executed at Adjusted Close Price
- VIX effectively classifies the market into volatile and non-volatile conditions
- Liquidity is sufficient
- Price patterns will recur
- The market is inefficient at times

2.1.1 High VIX (Volatile Market Conditions)

A high VIX reading signals a period of increased market volatility and greater uncertainty. In these environments, we assume that price reversals will be more frequent, and large, rapid price movements may occur. To capitalise on these short-term fluctuations while managing risk, our strategy shortens the cooldown period for trade entry and employs tighter stop-loss levels. This setup enables the strategy to exit positions quickly if the market moves contrary to the position, mitigating potential losses.

Indicators Used:

1. **Relative Strength Index (RSI)**: The RSI helps to identify potential overbought and oversold conditions. By using a lower RSI threshold (RSI_lower) to identify potential price rebounds and an upper threshold (RSI_upper) for potential reversals, we can better time entries and exits.
2. **Weighted EMA Difference**: The weighted difference between EMA5 and EMA10 signals potential reversals by examining momentum shifts. The strategy looks at the change in the Weighted EMA difference over the past few days, aiming to capture short-term trends before they fully develop.

Trading Logic:

- **Buy Condition** (Go Long): The strategy initiates a long position when the Weighted EMA difference has decreased over recent days (indicating a potential reversal) and the RSI is below the lower quantile threshold, indicating that the stock might be oversold. This combination signals a potential short-term rally suitable for volatile markets.
- **Sell Condition** (Go Short): Conversely, the strategy goes short if the Weighted EMA difference is narrowing (indicating a momentum slowdown) and the RSI is above the upper quantile, signalling overbought conditions. This setup positions the strategy to profit from anticipated downward movements in a high-volatility environment.

Stop Loss and Risk Management: In volatile conditions, the stop-loss multiplier is set lower to tighten the stop-loss level. This precaution allows the strategy to exit positions more quickly if prices reverse unexpectedly. By combining tighter stop losses with shorter holding periods, the strategy seeks to protect against sudden market shifts that are more likely during volatile periods.

2.1.2 Low VIX (Non-Volatile Market Conditions)

A low VIX indicates a stable market environment where volatility is relatively low. In such conditions, the strategy assumes that price movements will be smoother and that large reversals will be less frequent. Therefore, the focus is on capturing long-term trends, reducing over-trading, and holding positions longer to capitalise on gradual market trends.

Indicators Used:

1. **Short-Term Moving Average (STMA)**: The STMA serves as a trend indicator to capture near-term momentum changes. By comparing it with the LTMA, we can gain insights into trend direction and strength.
2. **Long-Term Moving Average (LTMA)**: The LTMA smooths out price fluctuations, providing a broader view of the trend direction. Comparing STMA to LTMA enables the strategy to avoid reacting to short-term noise, which is important in low-volatility environments.

Trading Logic:

- **Buy Condition** (Go Long): The strategy enters a long position when the STMA crosses above the LTMA, signalling the start of an uptrend. By waiting for a sustained uptrend indication, the strategy avoids over-trading during stable periods.
- **Sell Condition** (Go Short): The strategy initiates a short position when the STMA crosses below the LTMA, suggesting a downtrend. This crossover helps capture downward trends early without reacting to minor fluctuations.

Stop Loss and Risk Management: In non-volatile conditions, the stop-loss multiplier is set higher to widen the stop-loss level. This adjustment helps the strategy avoid premature exits due to minor price movements, which are more likely to reverse in stable conditions. The wider stop-loss allows the strategy to stay invested in positions that align with the longer-term trend, reducing the impact of small

fluctuations that do not indicate significant reversals and preventing unnecessary transactions and trades from being made.

2.1.3 Stop loss using Average True Range (ATR)

On top of the different market conditions mentioned, where we run a different strategy each during volatile/non-volatile time periods, we also introduce stop loss, where we aim to minimise monetary losses in times of sudden and unexpected large price movements. This prevents the strategy from maintaining its position, which might cause losses to be incurred. Different stop-loss levels for the strategy will be utilised for the volatile and non-volatile periods, respectively. During non-volatile periods, we do not expect large, sudden price movements. Hence, we can afford to take more risks and thus set higher stop-loss levels. During volatile periods, we expect more sudden huge price movements. Hence, we want to take fewer risks and thus set lower stop loss levels. Our stop loss level is decided by the following formula.

$$\text{Stop loss price} = \text{Entry price} +- (\text{ATR} * \text{Multiplier})$$

The ATR measures the average volatility over a specified period, reflecting price fluctuations. Therefore, using ATR with the multiplier as the basis of our stop-loss price allows us to adapt to the different market conditions since the stop-loss price adjusts according to recent market volatility during entry, which is more beneficial than using a fixed value. This ensures that our strategy is responsive to the current market environment.

On top of that, we set multipliers at different levels. For example, we set the multiplier to 1.5 during non-volatile periods and 1.0 during volatile periods. The multiplier helps tailor the stop-loss level to suit different market conditions, such as high VIX and low VIX. For non-volatile periods, where smaller fluctuations are expected, a larger multiplier can widen the stop-loss, reducing the likelihood of triggering stops during minor price movements, which can possibly cause great losses. In contrast, during volatile periods, a smaller multiplier tightens the stop loss, reducing potential losses by closing positions more quickly if prices start to move in the opposite direction.

Therefore, by using ATR along with a multiplier, our strategy is able to adjust dynamically to manage risk appropriately across varying levels of market volatility. This improves risk management allowing minor price fluctuations during stable periods without triggering stop loss while limiting risks during volatile times while showing our risk tolerance during different periods of volatility.

2.1.4 Cooldown Period

We also introduce a cooldown period to prevent too frequent trading. Frequent trading incurs higher transaction costs, which are costly in real life and can significantly reduce profits over time. By implementing a cooldown period, the strategy limits the number of trades, helping to minimise these

costs. Small fees might seem negligible initially but can snowball and erode overall returns, especially when unnecessary trades are frequently made.

Cooldown periods also prevent the strategy from reacting too frequently to minor price fluctuations, which might not be meaningful in achieving long-term profits. Frequent trades are often considered counterproductive as they might lead to unnecessary position reversals without contributing to net gains, undermining the objective of maximising profits while minimising risks.

On top of that, we adjust the cooldown based on different market conditions. During volatile periods, prices fluctuate greatly, creating instability as unexpected price swings can quickly shift positions from profitable to unprofitable. Therefore, a shorter cooldown of 3 days is implemented to allow the strategy to react faster to these shifts, protecting gains by allowing quick exits or re-entries based on emerging price movements and trends. On the other hand, during more stable conditions, a longer cooldown period of 10 is implemented as prices tend to fluctuate less and movements are more predictable. This longer cooldown helps maintain positions and prevents us from incurring transaction costs unnecessarily due to meaningless trades, allowing the strategy to benefit from only meaningful price movements.

Therefore, by adjusting the cooldown period based on volatility, the strategy strikes a good balance between responsiveness and caution. Short cooldowns during volatile periods help capture quick gains, while longer cooldowns in stable economic conditions focus on holding profitable positions longer, ultimately allowing for better risk-adjusted returns.

2.1.5 Training and testing

To improve the strategy's performance, we optimise the following parameters during the training phase:

- **RSI5 Rolling Window**: Controls the period for the RSI5 indicator to detect short-term price reversals. Optimising this window allows the strategy to adjust for different volatility levels.
- **ATR Window**: Determines the lookback period for the ATR, helping to set more precise stop-loss levels based on recent volatility trends.
- **STMA and LTMA Windows**: These windows define the short-term and long-term simple moving averages for the non-volatile strategy. Finding the optimal windows helps the strategy identify trends accurately and avoid reacting to short-term fluctuations in stable conditions.

Once these parameters are optimised during the training period (2010 to 2016), the strategy applies them during the testing period (2017 to 2019). This process allows us to evaluate the strategy's effectiveness on unseen data and gauge its robustness across different market conditions.

2.1.6 Performance Evaluation

To assess the performance of our strategy, we will compare it to an equal-weighted Buy-and-Hold strategy over the testing period. Key performance metrics include:

- **Annualised Returns and Standard Deviation**: These metrics measure the strategy's overall profitability and risk.
- **Sharpe Ratio**: Indicates the risk-adjusted return, helping us understand how well the strategy performs relative to the risk taken.
- **Beta and Alpha**: Beta indicates the strategy's market sensitivity, while Alpha shows excess returns over the benchmark. A positive Alpha would suggest that the strategy can generate returns above the market average.
- **Drawdowns**: Measures the maximum drop from peak equity, assessing the strategy's risk in adverse conditions.
- **Calmar and Sortino Ratios**: These ratios account for downside risk and help us evaluate performance relative to losses.
- **Information Ratio and Treynor Ratio**: These additional risk-adjusted metrics provide insights into the strategy's consistency relative to the benchmark and its performance per unit of market risk.

This comprehensive analysis enables us to compare the strategy's returns, volatility, and drawdowns to a buy-and-hold strategy providing a well-rounded view of its effectiveness and robustness in real-world market conditions.

2.1.7 Variables / Parameters of the Strategy

Key Variables and Parameters

- **RSI Rolling Window**: Defines the lookback period for calculating the Relative Strength Index, used to assess overbought or oversold conditions.
- **ATR Window**: Sets the period for calculating the Average True Range, used to determine volatility-based stop-loss levels.
- **Short-Term Moving Average (STMA) Window**: Lookback period for short-term moving averages, used in non-volatile periods to capture shorter trends.
- **Long-Term Moving Average (LTMA) Window**: Lookback period for long-term moving averages, smoothing out trends in non-volatile markets.
- **EMA Short-Term Window** and **EMA Long-Term Window**: These parameters control the short- and long-term EMAs used in volatile periods for trend identification.
- **Stop-Loss Multiplier**: Adjusts the stop-loss level based on the ATR, with a different multiplier for volatile vs. non-volatile periods.
- **Cooldown Periods**: The period of bars to wait before re-entering a position after a trade to prevent over-trading.
- **VIX Threshold**: A threshold value of the VIX used to divide market conditions into volatile and non-volatile periods.

Derived Variables

- **EMA Difference** and **Weighted EMA Difference**: Used to detect momentum shifts by calculating the difference between short and long-term EMAs and smoothing the result.

2.1.8 Parameter Set for Training

Initial Parameter Values for Training

1. **RSI Rolling Window Options**: 10, 15, 20
2. **ATR Window Options**: 5, 10, 15
3. **STMA and LTMA Window Combinations**: (25, 50), (50, 100)
4. **Stop-Loss Multiplier for Volatile Periods**: 1.0
5. **Stop-Loss Multiplier for Non-Volatile Periods**: 1.5
6. **Cooldown Periods**: 3 days during volatile periods, 10 days during non-volatile periods

These initial values are used to train the model on historical data from 2010 to 2016. The optimization process adjusts parameters 1, 2, and 3 to maximise returns, providing the best combination for each indicator. After optimization, the strategy is evaluated with the best parameters on the testing data (2017-2019).

Optimised Parameters:

1. **RSI Rolling Window Options**: 20
2. **ATR Window Options**: 15
3. **STMA and LTMA Window Combinations**: (25, 50)

2.1.9 Unique Ideas or Features

Unique Strategy Elements

1. **VIX-Based Segmentation**: Adapts dynamically to market sentiments by modifying strategy components based on VIX levels, allowing different approaches in volatile vs. stable markets.
2. **ATR-Based Adaptive Stop Loss**: Dynamically adjusts the stop-loss level based on recent volatility, improving risk management in both stable and volatile periods.
3. **Cooldown Periods**: Introduces cooldowns after trades to limit excessive trading, especially in stable markets.
4. **Parameter Optimization**: Optimizes RSI, ATR, and moving averages windows specifically for the training period, enhancing performance.
5. **Weighted EMA Difference**: Uses a weighted EMA difference to identify momentum shifts, smoothing out noise in volatile markets.

Each feature enhances the adaptability, risk management, and overall robustness of the strategy, creating a more comprehensive trading system.

2.2 Interpretations

For both performance metrics and plots, we compare our strategy against an equal-weighted buy-and-hold portfolio of the stocks selected. For our performance metrics, we calculated the ratios by using a benchmark, which we used SPY.

2.2.1 Risk

1. Market Risks

The Dynamic Strategy has a very low Beta of -0.013 in the training period, indicating minimal correlation with the overall market and, hence, reduced market risk.

In the testing period, Beta remains low at 0.023, suggesting that the strategy remains relatively insulated from market-wide movements.

The low Beta is generally positive for risk management, as it implies that the Dynamic Strategy could outperform or maintain stability during adverse market conditions. However, in cases of extreme market behaviour, such as crashes or rapid recoveries, the low Beta might limit the strategy's responsiveness to broader trends, impacting returns negatively.

2. Calmar Ratio:

The Calmar Ratio for the Dynamic Strategy is higher in both periods (0.62 in training and 0.77 in testing) than for Buy-and-Hold (0.15 in training and 0.71 in testing).

A higher Calmar Ratio suggests that the Dynamic Strategy is more effective at managing drawdowns relative to returns, a positive sign for long-term capital preservation. However, the risk remains that, in extended downturns, this advantage may erode if the strategy experiences increased volatility.

3. Risk of Overfitting and Return Stability

The Sortino Ratio is higher for the Dynamic Strategy than for Buy-and-Hold in both periods (1.55 vs. 0.53 in training and 1.74 vs. 1.59 in testing), indicating strong risk-adjusted returns considering only downside volatility.

The Information Ratio also supports the strategy's outperformance, especially in the training period, where it is 0.27, compared to -0.20 for Buy-and-Hold, and is maintained at 0.31 in testing.

These higher ratios suggest that the strategy performs well in terms of managing downside risks and provides consistent returns over the benchmark. However, the performance during testing indicates that the optimised parameters may result in lower-than-expected returns in out-of-sample data. This risk of

overfitting may mean that returns could decline in unseen future data if market conditions diverge from those in the training set.

4. Risk of Large Position Losses

During the testing period, the Treynor Ratio for the Dynamic Strategy is exceptionally high at 8.40, suggesting very high returns per unit of systematic risk (Beta).

While the high Treynor Ratio shows excellent returns per unit of risk, the strategy's reliance on low Beta implies that its performance could deteriorate if market beta were to rise or volatility conditions shift unexpectedly. If market correlation increases suddenly (e.g., due to sector-wide movements), the strategy could face unexpected losses.

5. Standard Deviation

The standard deviation for the Dynamic Strategy is consistently lower than that of the Buy-and-Hold strategy, at 0.195 in the training period and 0.167 in the testing period, compared to 0.251 and 0.195 for Buy-and-Hold, respectively. This lower standard deviation implies that the Dynamic Strategy achieves returns with reduced volatility, making its performance more predictable and stable over time.

A lower standard deviation is generally advantageous for risk management, as it reduces the likelihood of large fluctuations in returns and, thus, capital preservation.

2.2.2 Returns

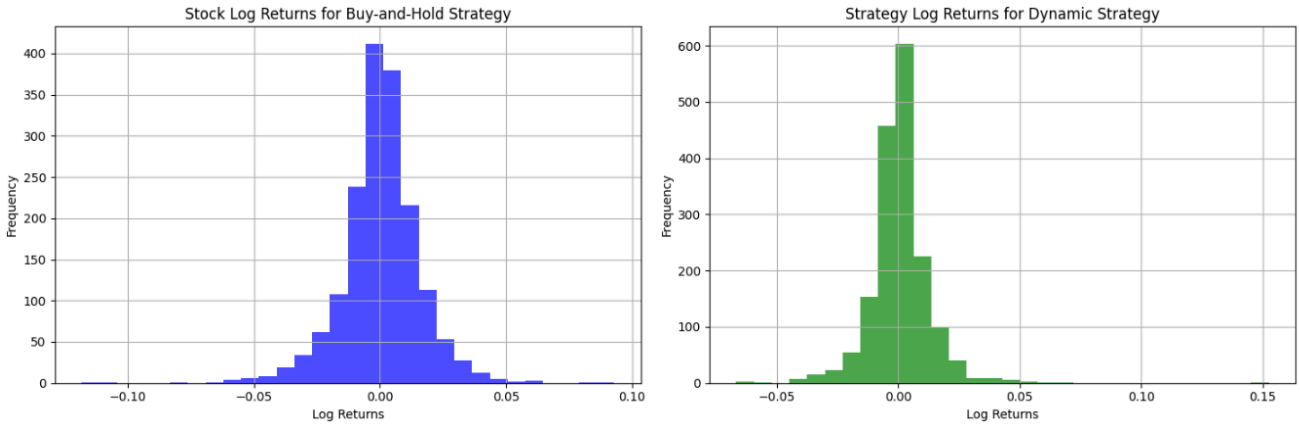

Figure 1: Log Returns Comparison for Train Set

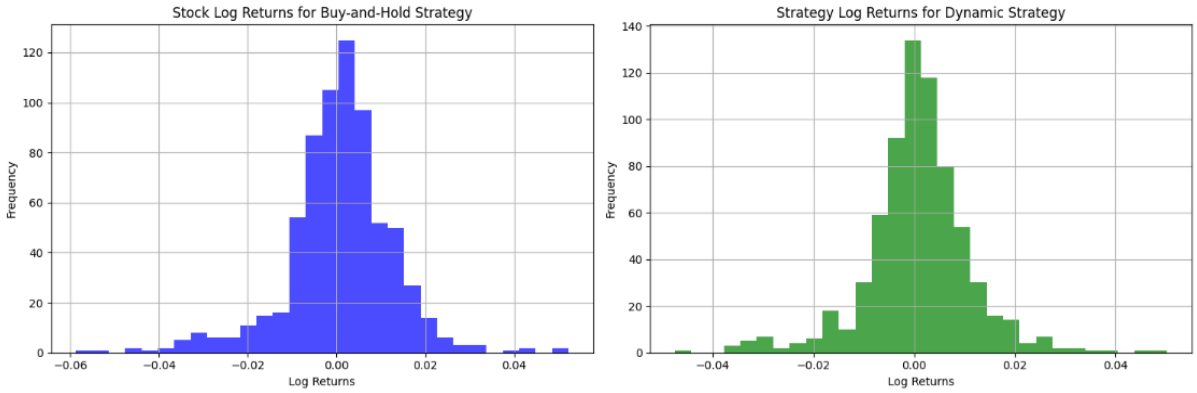

Figure 2: Log Returns Comparison for Test Set

For both the train and test periods, the Dynamic Strategy appears to generate more consistent returns, with reduced volatility and a high frequency of small, stable gains or losses. This is beneficial for risk-conscious investors, as it minimises exposure to extreme returns. The Buy-and-Hold strategy has a more volatile profile with a greater spread of returns, leading to larger fluctuations in daily performance. While this can lead to higher potential gains, it also comes with increased risk and exposure to large losses. The Dynamic Strategy outperforms in terms of stability and risk management, while the Buy-and-Hold strategy demonstrates higher variability and potential for both higher gains and losses.

Figure 3: Strategy Returns Comparison for Train Set

For the training period, the Dynamic Strategy demonstrates superior performance, ending with significantly higher cumulative capital. This outperformance is particularly evident in the latter part of the period, where the Dynamic Strategy accelerates upward, suggesting it capitalised on favourable market conditions. Throughout, the Dynamic Strategy shows better resilience, recovering faster from drawdowns compared to Buy-and-Hold, indicating effective risk management. Overall, the Dynamic Strategy provides greater capital appreciation and more stable growth, making it a preferable option for investors seeking higher returns with controlled risk.

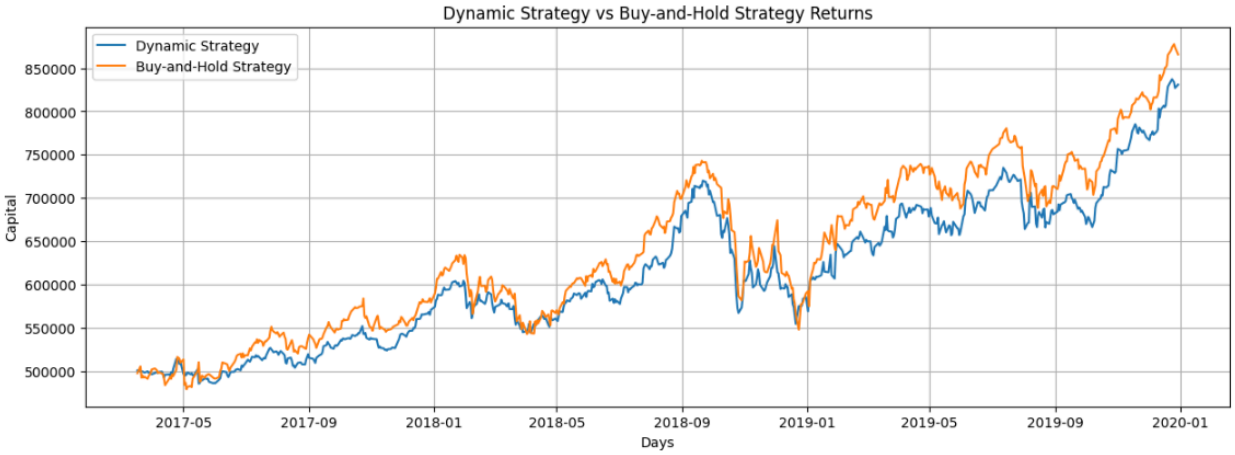

Figure 4: Strategy Returns Comparison for Test Set

For the testing period, the Buy-and-Hold Strategy slightly outperforms in the later stages, maintaining a higher capital level overall. Both strategies experience similar fluctuations and track closely during most periods, though Buy-and-Hold shows greater stability during uptrends. The Buy-and-Hold strategy ultimately acheives higher returns over this period.

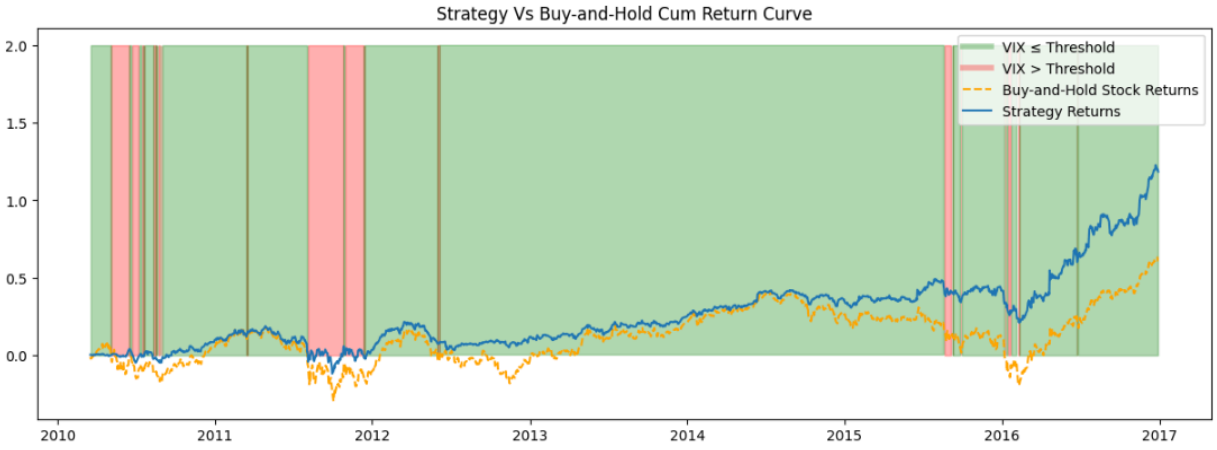

Figure 5: Return Curve for Train Set

This chart shows the cumulative return curve of the Dynamic Strategy versus the Buy-and-Hold Strategy, with market volatility zones indicated by the VIX index.

- VIX ≤ Threshold (Green): Represents periods of lower volatility
- VIX > Threshold (Red): Indicates high volatility periods

For the training period, the Dynamic Strategy maintains a higher cumulative return over most of the period, benefiting from its responsiveness to different volatility conditions. The use of the VIX as a

market condition indicator seems effective, as it helps the Dynamic Strategy adapt and preserve capital during turbulent times while capturing gains in stable periods.

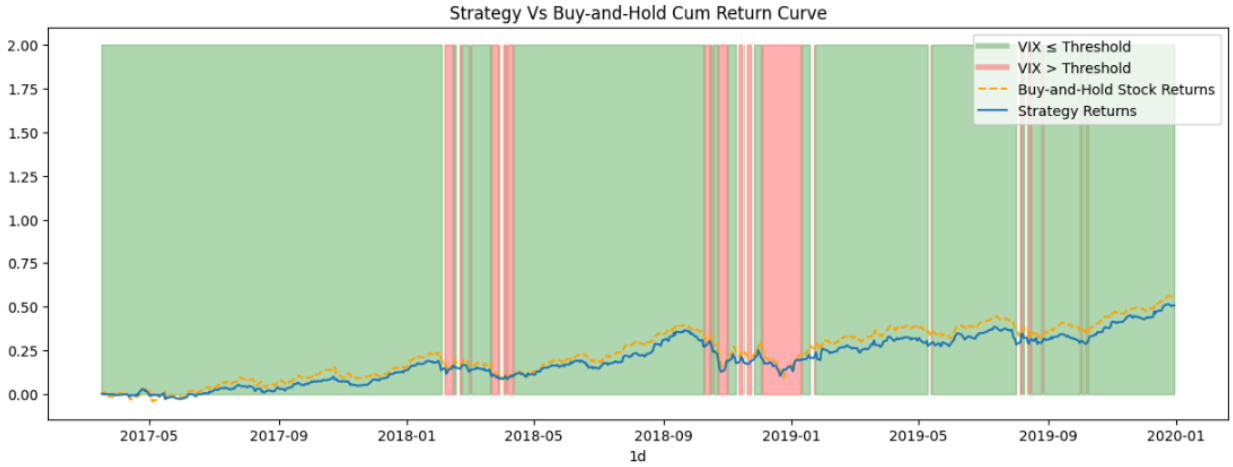

Figure 6: Return Curve for Test Set

For the testing period, the strategies are closely matched, though the Buy-and-Hold Strategy shows a slight cumulative return advantage by the end of the period. The Dynamic Strategy's use of the VIX index allows it to adapt to volatility, preserving capital during market downturns, although it lags slightly in stable uptrend periods. Overall, the Dynamic Strategy effectively manages risk in volatile markets, while Buy-and-Hold capitalises more on sustained uptrends in low-volatility phases.

2.2.3 Performance Metrics

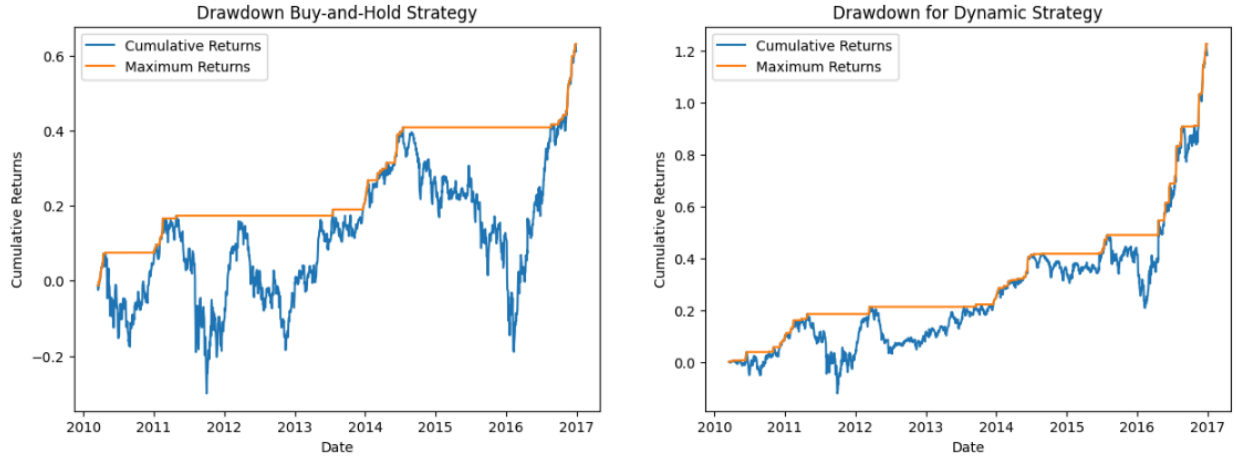

Figure 7: Drawdown Comparison for Train Set

For the training period, we observe that drawdowns are less significant in our strategy as compared to the Buy-and-Hold strategy. The Dynamic Strategy outperforms the Buy-and-Hold Strategy in terms of

drawdown management and capital preservation. It provides more consistent growth with limited exposure to severe drawdowns, which makes it preferable for risk-averse investors. This signifies better risk management and lower risk for our dynamic strategy.

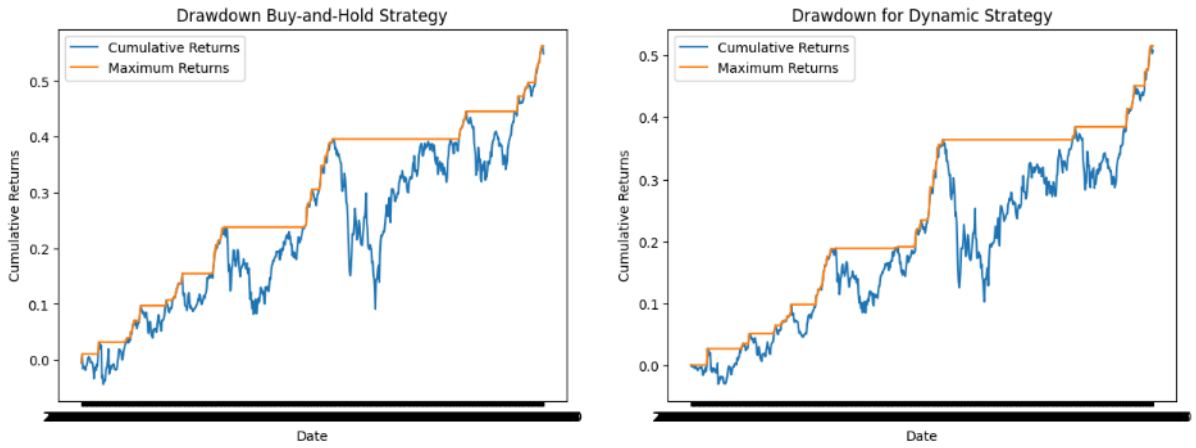

Figure 8: Drawdown Comparison for Test Set

For the testing period, we observe that drawdowns are similar for both strategies.

Performance Metrics

	Annual Returns	Annual Std Dev	Sharpe Ratio	Beta	Alpha	Returns on Investment	Max Drawdown	Calmar Ratio	Sortino Ratio	Information Ratio	Treynor Ratio
Buy-and-Hold Strategy	0.094122	0.251128	0.374797	1.343754	-0.072531	0.841150	0.597539	0.157516	0.527958	-0.197031	0.070044
Dynamic Strategy	0.190729	0.195125	0.977470	-0.013063	0.192349	2.269219	0.306728	0.621817	1.556187	0.268079	-14.601016

Figure 9: Performance Metrics for Train Set

For the training period, we observe that the Dynamic Strategy has better ratios in general as compared to the buy and hold strategy. For example, the Dynamic Strategy shows Annual Returns of 19.07% with a Sharpe Ratio of 0.98, significantly outperforming the Buy-and-Hold Strategy (9.41% and 0.37, respectively). This indicates higher risk-adjusted returns in the training period. The Dynamic Strategy also has a lower annual standard deviation and lower max drawdown, signifying better risk management.

	Annual Returns	Annual Std Dev	Sharpe Ratio	Beta	Alpha	Returns on Investment	Max Drawdown	Calmar Ratio	Sortino Ratio	Information Ratio	Treynor Ratio
Buy-and-Hold Strategy	0.217871	0.193889	1.123690	1.158692	0.060752	0.731652	0.304676	0.715089	1.586131	0.676379	0.188032
Dynamic Strategy	0.200024	0.167036	1.197487	0.023820	0.196794	0.661883	0.261074	0.766158	1.745106	0.305641	8.397430

Figure 10: Performance Metrics for Test Set

For the testing period, Annual Returns for the Dynamic Strategy decreased slightly to 20.00% with a Sharpe Ratio of 1.19, while the Buy-and-Hold saw increased returns of 21.79% with a Sharpe Ratio of 1.12. This shows that its returns-to-risk ratio is better as compared to the Buy-and-Hold strategy despite underperforming. It also has a lower annual standard deviation and lower max drawdown, signifying better risk management.

2.3 Weaknesses

Reliance on the VIX Index

One weakness is the strategy relies solely on the VIX index to determine whether a stock is in a volatile period or not. This approach might lead to overgeneralisation since a volatile period determined by the VIX index might not mean that a stock is truly in a volatile period itself. In this case, we are assuming that the VIX index can represent all the stocks we chose but in fact, this might not be the case.

Also, we observe from the charts that there are not many volatile periods for the stocks, meaning we are running our non-volatile strategy most of the time, which does not do much trading since its indicators are more focused on the long-term rather than the short term. In this case, we might be holding the same position for long periods of time with minimal changes. As explained previously, a low VIX might not indicate that the individual stocks are not going through a volatile period by itself, there might be volatility due to company news and more factors. However, we are unable to trade this volatile period as we reference the VIX index only to determine whether all of the stocks are in or out of the volatile period. In this case, we might miss out on potential short-term trading opportunities that we can capitalise on for the individual stocks. Similarly, we are assuming a high VIX means volatile periods for all stocks when, in fact, the stock might not be experiencing much volatility, causing us to apply the wrong strategy at the wrong time.

Method of Executing Stop Loss

Another possible weakness is our execution of stop loss. We adopt the greedy method of entering an opposite position when stop loss is triggered to try and ride on the trend and recover the losses. This approach would work if the trend actually continues after the stop loss is triggered, but there are certainly cases that might not. In the worst-case scenario, where the price goes up and down in a 3-day interval by a huge margin that triggers our stop loss, we would see ourselves go into a losing streak in our volatile strategy since our cooldown period is 3 days for that period.

Potential Oversensitivity to Price Changes

Using the EMA indicator for our volatile strategy allows it to be sensitive to price changes, giving us good signals when we are looking for peaks or troughs in the price movement. However, due to the sensitive nature of the indicator, it can easily create false signals since we are only checking the indicator with the past 1 day or data. A shift in another direction for price movement will already trigger this indicator, creating a signal if the RSI is overbought or oversold. While this creates false signals, using more days to confirm our entry can cause us to enter late and miss potential opportunities. Hence, this is a tradeoff we are willing to take.

Overfitting of trading strategy

Our strategy has been optimised with various parameters to ensure that we are able to achieve the best possible return in the training data. However, this has led to us underperforming the buy-and-hold strategy in the test data.

2.4 Strengths

Recency and Relevance of Technical Indicators

One strength of our strategy is the use of quantiles over rolling periods for indicators, enhancing the accuracy of trading signals. For example, to assess whether the RSI level is high, we compare it to the 75th quantile of the past 20 days of RSI; if it is above the 75th quantile, we determine that it is above the threshold, and hence it is considered high. We implemented quantiles for comparing VIX and ATR as well. Using this method, we are more able to make our trading signals more accurate as it is based on recent data rather than data from a long time ago. This is especially important for our short-term trading strategy during volatile periods since we need more recent data comparisons to give good and fast signals.

Dynamic Stop Loss

Another strength of our strategy is the use of dynamic stop loss levels for the volatile and non-volatile periods of our strategy. By doing so, we can better manage risk, especially during the volatile period when price movements are large. During volatile periods, we set stricter stop loss levels, meaning it requires less loss for us to exit our position and trigger stop loss, as compared to non-volatile periods where we choose to take larger losses before triggering stop loss.

Cooldown (Less unneeded trading)

We also utilise a cooldown period to avoid overtrading, thereby reducing transaction costs and unnecessary market exposure. During volatile periods, we set a shorter cooldown period, recognising the need for more rapid position changes. This adaptive approach aligns with the fluctuating pace of market activity in different conditions, enhancing the strategy's resilience across economic cycles.

2.5 Strategy Performance and Improvements

Better Volatility Measurement for Individual Stocks

To reduce the issue of overgeneralization when relying solely on the VIX index to determine when a stock is in a volatile period or otherwise, more stock-specific volatility indicators can be used, such as each stock's historical volatility or beta relative to the S5P500. Using these indicators would provide a better gauge of an individual stock's volatility.

Better Market Indicators

For our current strategy, we utilised VIX index to indicate market sentiments. Moving forward, we could use inflation (CPI) and growth data (GDP) to identify the current economic regimes that the market operates within. By categorising these regimes, we gain a clearer understanding of the prevailing economic conditions. We are then able to tailor our strategy to be profitable within each specific regime, optimising our strategy based on the unique characteristics and risks of each. This ensures that we are able to achieve more consistent profits as our trading approach adapts to shifts in economic conditions better.

Dynamic Cooldown Periods

Additionally, instead of using fixed cooldown periods (3 days for volatile and 10 days for non-volatile), an improvement could be adjusting the cooldown period according to the most recent volatility. For example, ATR could be linked to each stock to allow for shorter cooldowns when volatility is exceptionally high and longer cooldowns when volatility decreases, further refining the responsiveness of our model to stock price changes.

Optimised ATR Multiplier used for Stop-Loss

Another improvement to address the stop-loss levels that are based on a fixed ATR multiplier would be to use historical backtesting to optimise the ATR multiplier for each stock. By running tests with different stop-loss levels, this improvement would allow the identification of optimal conditions that minimise drawdowns and maximise returns.

Time Stop Loss

Incorporating a time-based stop loss, such as exiting a trade after a predetermined period (eg. 5 days) if prices remain stagnant or fail to move in the desired direction. This may bring improvements to our trading strategy as it prevents prolonged exposure to uncertainty and reduces the risk of holding onto unproductive positions. By enforcing this time limit, we minimise emotional biases and avoid the temptation to rely excessively on technical indicators in hopes of a reversal. Additionally, we are able to free up capital more quickly, allowing us to relocate it to new, potentially more profitable opportunities.

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