Trading strategy developing and backtesting, based on the correlation between oil price, energy and transportation sector

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1) Introduction

1.1) Overview

The purpose of this report is to outline trading strategies development and backtesting approaches based on the correlation between oil price, the energy sector, and the transportation sector. Oil price fluctuations can have a significant impact on the performance of companies within these sectors, as they heavily rely on oil for their service operations, transportation and consumer demand needs. This correlation creates opportunities for traders to capitalize on the oil price market movements and generate profitable trading signals.

This idea inspires me to determine if this approach can provide more robust market neutrality for the portfolio and generate trading signals for tickers related to these sectors by delving into the intricacies of this correlation and exploring how it can be leveraged to develop an effective trading strategy.

1.2) Objective

The objective of this project is to quantify and capitalize on the correlation between oil price movements and their impact on the energy and transportation sectors. By identifying and analyzing these correlations, the strategy aims to generate signals that can be used to make informed trading decisions.

2) Methodology

2.1) Rationale

The rationale for developing a trading strategy based on the correlation between oil price, energy, and transportation sectors is rooted in the understanding of how changes in oil price can influence the performance of these sectors.

Energy Sector:

When the price of oil rises, companies involved in the production and sale of oil, such as Exxon Mobil (XOM), stand to benefit. The increase in oil price positively impacts their expected earnings per share (EPS) as it indicates a higher profit for their products. By identifying and capitalizing on this correlation, the strategy can generate signals to invest in energy sector tickers, such as XOM, during periods of rising oil prices.

Electric Vehicle Sector:

A rise in oil prices can also have a positive impact on the electric vehicle sector, as consumers may be less inclined to purchase traditional vehicles that require expensive fuel. This shift in consumer behavior can drive the demand for electric vehicles, benefiting companies like Tesla (TSLA). By recognizing this correlation, the strategy can generate signals to invest in electric vehicle tickers, such as TSLA, when oil prices are on the rise.

Transportation Sector:

Conversely, the transportation sector, including airlines and cruise companies like American Airlines Group (AAL) and Carnival Corporation (CCL), can be negatively affected by rising oil prices. These industries heavily rely on oil for their operations, and increased fuel costs can hinder their expected EPS. By understanding this correlation, the strategy can generate signals to avoid or short tickers in the transportation sector during periods of increasing oil prices.

2.2) Feature Engineering

This part will emphasize how to feature and transform oil price data to interpret the market trend. It is crucial to quantify the movement of oil price and determine whether it is considered expensive or cheap, uptrend or downtrend, in order to process the generation of buy and sell signals for energy and transportation sector tickers based on their correlation to oil price.

Daily Return of USO

When the close price today is dropped, the oil price is considered as “cheap” and in the downtrend relatively, vice versa.

Extrema Classification of USO Price

When the high price is classified as local maxima, the oil price is considered in the downtrend relatively, vice versa.

Simple Moving Average of USO Close Price

When the close price is below the SMA10 of close price with 10 window size, the oil price is considered as “cheap” and in the downtrend relatively, vice versa.

Simple Moving Average of USO Open Price

When the open price is below the SMA of open price with 10 window size, the oil price is considered as “cheap” and in the downtrend on that day, vice versa.

Gap between USO Open price and USO Close Price

When there is a downward gap (today's open price is lower than yesterday's close price), the oil price is considered as “cheap” and in the downtrend on that day, vice versa.

The cosideration of oil price is “cheap” or in a relatively downtrend suggests that transportation sectors may benefit from the expected drop in the oil price, and the profitability of energy sectors may be hampered by this. Conversely, when the oil price is considered expensive or has an upward movement, it may suggest a selling opportunity for tickers in the transportation sector and buying opportunity for tickers in the energy sector.
Through this feature engineering, a signal is generated to open position at open price and close position at close price and each signal is not generated by the use of future data. For example, if the USO close price today is dropped, a signal will be generated to long position at tomorrow's open price and close position at tomorrow's close price for tickets in the transportation sector. If the USO is observed to have a downward gap, a signal will be generated to short position at tomorrow's open price and close position at tomorrow's close price for tickets in the energy sector.

3) Result

Strategy of Simple Moving Average of USO Close Price for CCL (Cruise Sector)

Implement steps

1, Calculate the SMA10 of USO close price at today close time

2, If the close price is above SMA10, open a short position at tomorrow open price and flat the position of tomorrow close price, vice versa

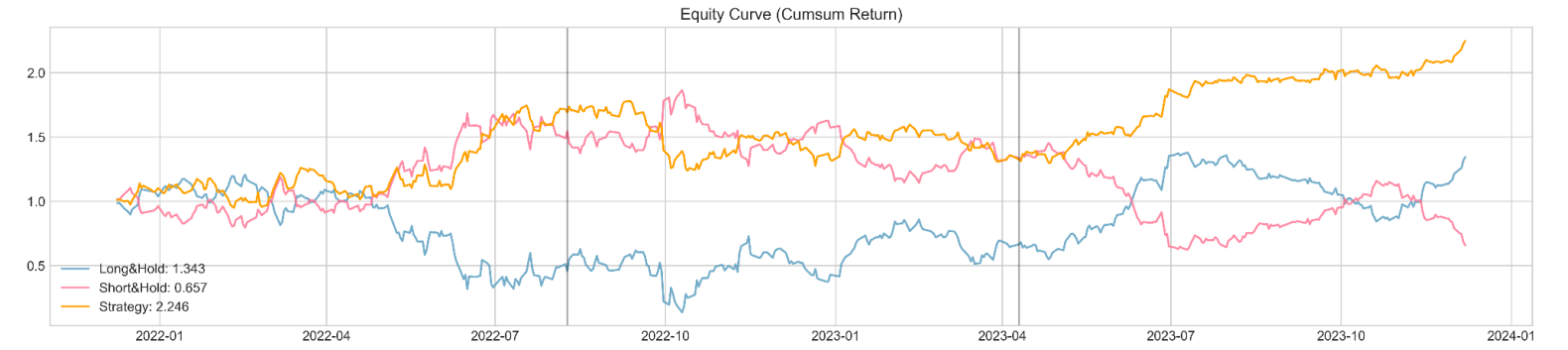
3, Backtesting the performance base on the above signals generation

Performance Metrics of the backtesting

Sharpe Ratio: 1.16

Long/Short Ratio: 0.86

The strategy has been able to achieve a favorable risk-adjusted return. The strategy is not biased towards either a bull or bear market and either long or short position which provides the potential to generate returns in different market conditions.



Performance Statistics

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calmar_ratio: 1.64313	time_under_water: 0.90239	maximum_drawdown: 0.30426

Strategy of Simple Moving Average of USO Open Price for XOM (Energy Sector)

Implement steps

1, Calculate the SMA10 of USO open price at today open time

2, If the open price is above SMA10, open a long position at today open price and flat the position of today close price, vice versa

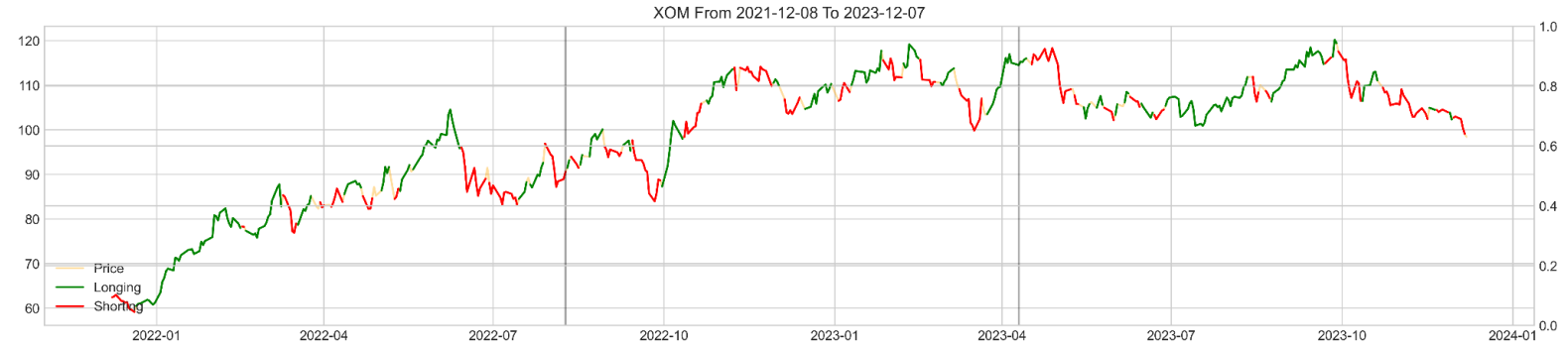
3, Backtesting the performance base on the above signals generation

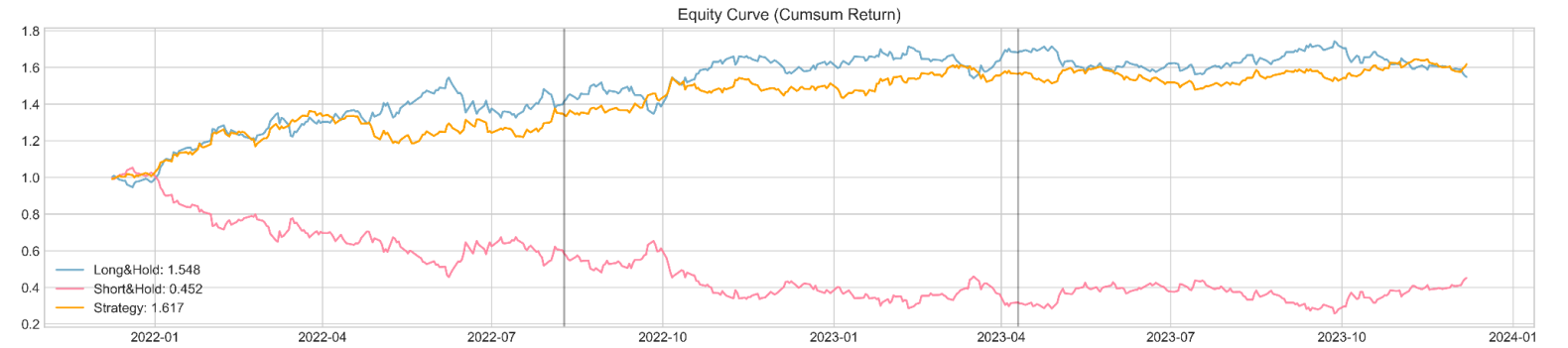
Performance Metrics of the backtesting

Sharpe Ratio: 1.27

Long/Short Ratio: 1.25

The strategy has also been able to achieve a good risk-adjusted return without long short bias. However, the strategy is not informative compared to a strong hold strategy.





Performance Statistics

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win_rate: 0.5259	sharpe_ratio: 1.26915	sortino_ratio: 2.03491
calmar_ratio: 2.10733	time_under_water: 0.89442	maximum_drawdown: 0.12923

Strategy of USO Gap Price for AAL (Airline Sector)

Implement steps

1, Calculate the gap between today open price and yesterday close price of USO at open time

2, If the gap price is greater than 0, open a short position at today open price and flat the position of today close price, vice versa

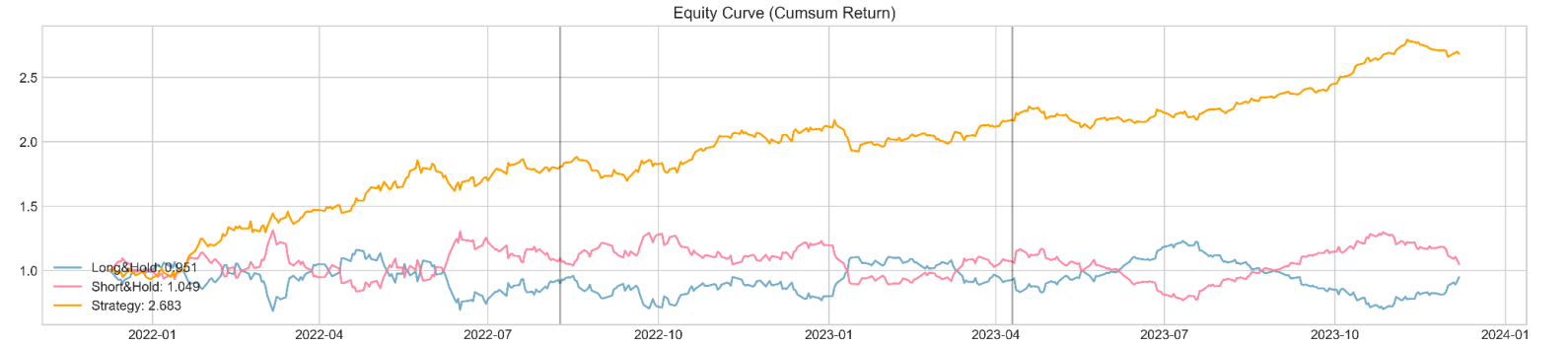
3, Backtesting the performance base on the above signals generation

Performance Metrics of the backtesting

Sharpe Ratio: 2.14

Long/Short Ratio: 0.79

The strategy has a good ability to generate profits while managing risk effectively with high market neutrality



Performance Statistics

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annualized_return: 0.63945	total_return: 1.68253	total_return_long: 0.78223
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hit_rate: 0.56275	expected_return_hit: 0.02042	expected_return_miss: -0.0185
win_rate: 0.55378	sharpe_ratio: 2.14435	sortino_ratio: 3.45874
calmar_ratio: 4.98813	time_under_water: 0.80279	maximum_drawdown: 0.12819

Strategy of USO Price Extrema for LI (Electrical Vehicle Sector)

Implement steps

1, Classifying if the local maxima or minima exist, ie: if USO today high price is lower than yesterday high price, maxima is detected, vice versa

2, If the local maxima is detected today, open a long position at today close price at close time, then flat and open an opposite position when local minima is detected, vice versa.

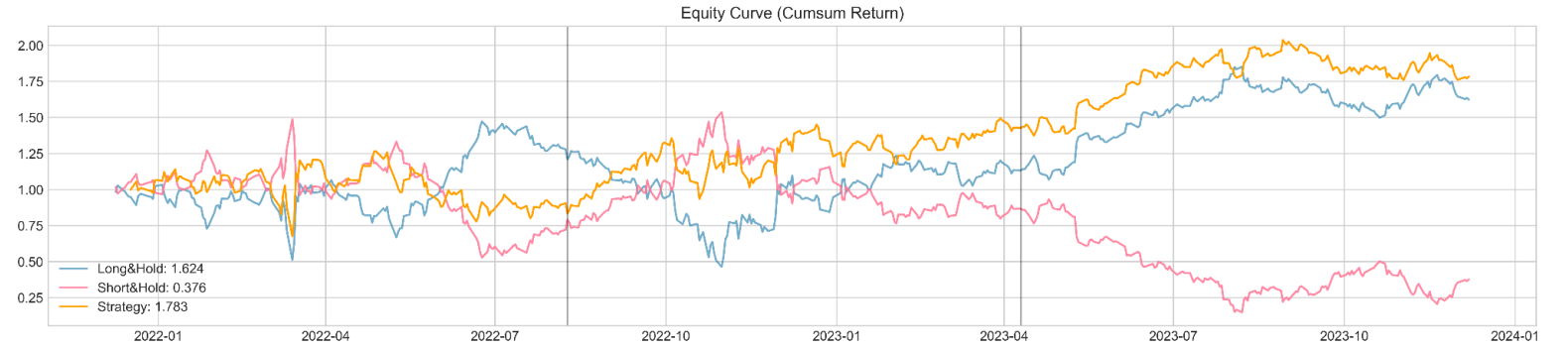
3, Backtesting the performance base on the above signals generation

Performance Metrics of the backtesting

Sharpe Ratio: 0.55

Long/Short Ratio: 1.14

The strategy can generate profit but is not informative compared to a strong hold strategy.



Performance Statistics

start: 2021-12-08 00:00:00	end: 2023-12-07 00:00:00	len_timeframe: 503
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long_short_ratio: 1.14224	holding_ratio: 1.0	expected_return: 0.00158
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expected_return_long: 0.00275	total_return_short: 0.05484	expected_return_short: 0.00024
hit_rate: 0.50605	expected_return_hit: 0.03299	expected_return_miss: -0.03061
win_rate: 0.50605	sharpe_ratio: 0.55184	sortino_ratio: 0.85646
calmar_ratio: 0.82158	time_under_water: 0.90524	maximum_drawdown: 0.40911

Strategy of USO Daily Return for TSLA (Electrical Vehicle Sector)

Implement steps

1, Check USO today's close price percentage change.

2, If the return is greater than 0, open a long position at tomorrow open price and flat the position at tomorrow close price

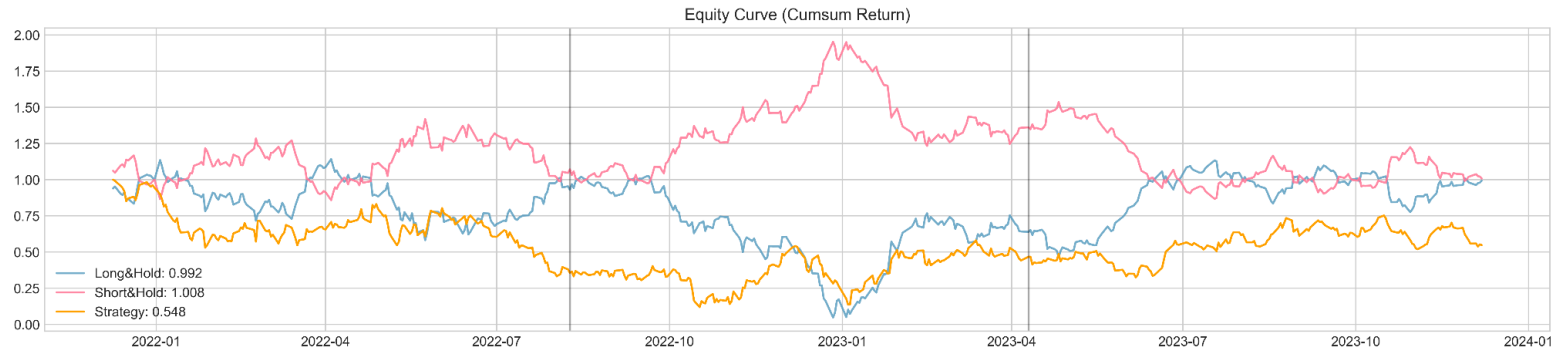
3, Backtesting the performance base on the above signals generation

Performance Metrics of the backtesting

Sharpe Ratio: -0.43

Long/Short Ratio: 1.21

The strategy cannot generate profit consistently and is not informative compared to a strong hold strategy.



Performance Statistics

start: 2021-12-08 00:00:00	end: 2023-12-07 00:00:00	len_timeframe: 503
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annualized_return: -0.26001	total_return: -0.45176	total_return_long: -0.30606
expected_return_long: -0.00112	total_return_short: -0.1457	expected_return_short: -0.00064
hit_rate: 0.49	expected_return_hit: 0.02531	expected_return_miss: -0.02609
win_rate: 0.48805	sharpe_ratio: -0.43001	sortino_ratio: -0.6844
calmar_ratio: -0.29533	time_under_water: 0.99801	maximum_drawdown: 0.88042

Strategy of USO Gap Price for SNDR (Transportation Sector)

Implement steps

1, Calculate the gap between today open price and yesterday close price of USO at open time

2, If the gap price is greater than 0, open a short position at today open price and flat the position of today close price, vice versa

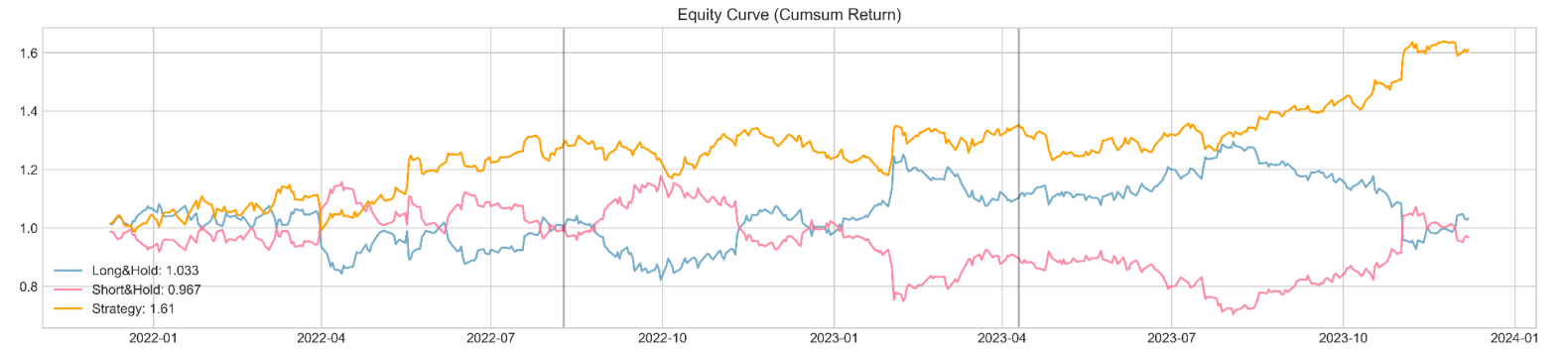
3, Backtesting the performance base on the above signals generation

Performance Metrics of the backtesting

Sharpe Ratio: 1.15

Long/Short Ratio: 0.79

The strategy exhibits strong profitability while effectively managing risk and its balanced long/short ratio indicate the strategy to perform well across diverse market conditions.



Performance Statistics

start: 2021-12-08 00:00:00	end: 2023-12-07 00:00:00	len_timeframe: 503
leverage: 1	resolution(hr): 24.0	count_day_tradable_yearly: 252
long_short_ratio: 0.79286	holding_ratio: 1.0	expected_return: 0.00122
annualized_return: 0.26951	total_return: 0.61014	total_return_long: 0.3946
expected_return_long: 0.00178	total_return_short: 0.21554	expected_return_short: 0.00077
hit_rate: 0.54125	expected_return_hit: 0.01262	expected_return_miss: -0.01222
win_rate: 0.53586	sharpe_ratio: 1.15874	sortino_ratio: 1.8166
calmar_ratio: 1.9936	time_under_water: 0.90239	maximum_drawdown: 0.13519

4) Conclusion

Statistics of different sectors (All strategies)

Sharpe Ratio	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
Sector								
Airline	48.0	0.421	0.716	-0.945	-0.079	0.330	0.955	2.160
Cruise	24.0	0.458	0.787	-0.690	-0.324	0.548	1.171	1.488
Electric Vehicle	32.0	-0.124	0.458	-0.988	-0.465	-0.043	0.153	0.704
Energy	56.0	-0.211	0.900	-2.247	-0.870	-0.147	0.537	1.269
Transportation	56.0	0.060	0.717	-2.118	-0.247	0.079	0.577	1.159

The sharpe ratio results for different sectors, including the airline, cruise, electric vehicle, energy, and transportation sectors, provide valuable insights into their risk-adjusted performance. The airline sector demonstrates a positive mean sharpe ratio, indicating that it has generated positive risk-adjusted returns. Similarly, the cruise sector also shows a positive mean sharpe ratio, suggesting successful risk-adjusted performance. However, the electric vehicle sector displays a negative mean sharpe ratio, indicating a lack of positive risk-adjusted returns. The energy sector also shows a negative mean sharpe ratio, suggesting a similar lack of positive risk-adjusted returns. Lastly, the transportation sector has a small positive mean sharpe ratio, indicating slightly positive risk-adjusted returns. Overall, the airline and cruise sectors demonstrate better risk-adjusted performance compared to the electric vehicle, energy, and transportation sectors. However, it is important to consider that performance can vary significantly across individual companies within each sector.

The movement of oil prices has a significant impact on the airline and cruise sectors. The correlation between the two can be attributed to the fact that fuel expenses, which are largely dependent on oil prices, constitute a significant portion of the operating costs for these sectors. As oil prices rise, the cost of fuel increases, which directly increases the marginal cost and affects the profitability of airlines and cruise companies. Consequently, changes in oil prices can be one of the factors to forecast price movement of these sectors.

Statistics of different strategies (filtered by positive return)

Positive Sharpe Ratio	**count**	**mean**	**std**	**min**	**25%**	**50%**	**75%**	**max**
Strategy								
Close Price Return	21.0	0.220	0.173	0.014	0.070	0.210	0.289	0.708
Close vs SMA(Close)	43.0	0.742	0.356	0.063	0.480	0.723	1.016	1.488
Extrema	18.0	0.418	0.241	0.008	0.277	0.447	0.550	0.859
Gap	16.0	1.083	0.573	0.133	0.620	1.076	1.339	2.160
Open vs SMA(Open)	21.0	0.747	0.438	0.096	0.398	0.775	1.102	1.468

The "Gap" and "Close vs SMA(Close)" feature methods have provided the best backtesting results. This indicates that these two strategies have shown promising performance in identifying, classifying, or quantifying the movement of oil prices. By analyzing the price gaps between consecutive trading periods and comparing the closing price of an asset with its simple moving average (SMA), it may be effectively capturing significant price movements and trends in the oil market. Utilizing this information may help in identifying, classifying, or quantifying the movement of oil prices, traders and investors could make informed decisions regarding their positions in the oil market.

However, it is important to note that this backtesting results alone do not guarantee the strategies' future performance in live trading. The strategies should be continuously monitored and adapted to changing market conditions. Therefore, further research, validation, and real-time testing are necessary to determine the strategies' effectiveness and robustness in real-world trading scenarios.

Disclaimer

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