



Quant Focus

Technical Analysis in Statistical Arbitrage II: Stochastic Oscillator

Sep 26, 2024

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Figure 1 : An Example of the Stochastic Oscillator



Source: TradingView, Binance, Presto Research

Summary

- The stochastic oscillator is a widely used technical analysis tool for identifying overbought and oversold conditions, as well as potential trend reversals.
 - To capture mean-reversion opportunities, two reversion alphas based on the stochastic oscillator are introduced: one that utilizes the %K line and the other that uses crossovers.
 - Backtesting demonstrates consistent performance for both alphas, though further refinement is required for practical application.
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Introduction

In the world of quantitative trading, statistical arbitrage (StatArb or Stat Arb) is one of the popular strategies, especially for exploiting statistical mispricing in related financial instruments, such as stocks, cryptocurrencies, commodities, and other assets. One of the key tools in a trader's arsenal for identifying these opportunities is technical analysis, where the stochastic oscillator is widely used to identify overbought and oversold conditions, as well as changes in bullish and bearish trends, making it a valuable component of the StatArb toolkit.

This article delves into the mechanics of the stochastic oscillator and its applications in creating StatArb alphas. We explore how this indicator, which compares an asset's closing price to its price range over a specified period, can be employed creatively to generate trading signals. By understanding its core principles, such as overbought and oversold levels and bullish and bearish crossovers, traders can harness the stochastic oscillator to develop alpha formulas.

We provide practical examples of how the stochastic oscillator can be leveraged to create two types of reversion alphas: one based on the raw %K values and another based on the crossovers between the %K and %D lines. Through backtesting results, we demonstrate the effectiveness of these alphas in capturing mean-reversion opportunities while maintaining a balanced risk profile. Ultimately, this article aims to inspire traders to think beyond the traditional uses of technical indicators, encouraging innovative applications to capture unique patterns and anomalies in the market.

Understanding the Stochastic Oscillator

The stochastic oscillator is a momentum indicator that compares an asset's closing price to its price range over a specific period. It consists of two lines: the %K line, which represents the current closing price relative to the high-low range, and the %D line, a moving average of the %K line. The oscillator ranges from 0 to 100, with readings above 80 indicating overbought conditions and readings below 20 indicating oversold conditions.

Formula:

$$\%K(w, s) = \frac{C - \text{SMA}(L(w), s)}{\text{SMA}(H(w), s) + \text{SMA}(L(w), s)}$$

, where $L(w)$ is the lowest price and $H(w)$ is the highest price over the chosen lookback window, w , and C is the closing price. $\text{SMA}(x, s)$ is the function that calculates the simple moving average of x over the period s .

The other line, $\%D(w, s, p)$, is a simple moving average of $\%K(w, s)$ for another period p :

$$\%D(w, s, p) = \text{SMA}(\%K(w, s), p)$$

An example of the stochastic oscillator applied to an ETH chart is shown in Figure 1, where the indicators are plotted below the price candle chart. In the figure, the orange and purple lines represent the %K and %D lines, respectively.

Interpreting the Stochastic Oscillator

Overbought and Oversold Levels

- **Overbought:** When the %K line is above 80, it suggests the asset may be overbought, suggesting a possible correction or price pullback.
- **Oversold:** When the %K line is below 20, it suggests the asset may be oversold, indicating a potential for a price rebound or upward reversal.

Crossovers

- **Bullish Crossover:** When the %K line crosses above the %D line, it can be considered a buy signal, suggesting upward momentum.
- **Bearish Crossover:** When the %K line crosses below the %D line, it can be seen as a sell signal, indicating downward momentum.

Developing Alphas

Creating StatArb alphas using technical indicators does not necessarily imply adhering strictly to their standard interpretations. Instead, it requires a creative approach from the trader. The key lies in thinking beyond traditional uses and exploring how these indicators can be creatively combined, modified, or adapted to capture unique patterns and anomalies in the market that others might overlook.

One effective method for enhancing alpha generation involves integrating multiple technical indicators into a single alpha, leveraging the strengths and filtering out the weaknesses of each. By doing so, traders can develop more robust and dynamic alphas that respond more accurately to complex market conditions. However, for the purposes of this article, the focus will be on demonstrating how to build alphas using one particular technical indicator: the stochastic oscillator.

The goal here is to inspire traders by presenting simple yet effective alpha formulas that rely solely on the stochastic oscillator. By delving into its uses and interpretations, we hope to illustrate how even a single indicator, when applied creatively and thoughtfully, can serve as a powerful tool for generating alphas in StatArb.

The target universe consists of the top 50 most liquid assets, all within the Binance USDⓈ-M market, with a target time interval of 5 minutes.

Reversion Alpha Using %K

This alpha is based on the concept of mean reversion, typically associated with overbought and oversold conditions. However, rather than relying on predefined thresholds for these conditions, this alpha takes a more straightforward approach by using the raw value of the %K line itself as the primary signal for reversion.

The alpha formula is expressed as:

```
alpha := scale(indneutralize(cs_winsorize_percentile(-%K(144, 6), 0.1),
                          IndClass.universe), 2e6)
```

Here, the formula utilizes several steps to refine the signal:

- **-%K(144, 6)**: The %K line, calculated over a 144-interval (12 hours) lookback with a smoothing window of 6, is negated to capture reversion.
- **cs_winsorize_percentile**: This function applies percentile-based winsorization to the %K line value, thereby minimizing the impact of outliers.
- **indneutralize**: This step adjusts the winsorized values by neutralizing them across the whole universe (IndClass.universe), removing long or short exposure.
- **scale**: Finally, scale the signal to have the fixed GMV of 2e6.

Reversion Alpha Using Crossovers

This alpha leverages the concept of crossovers between the %K and %D lines of the stochastic oscillator to identify potential mean-reversion opportunities. The idea is straightforward: the more the %K line crosses above the %D line, the stronger the signal for a long position. Conversely, when the %K line crosses below the %D line, it indicates a stronger signal for a short position.

The alpha formula is constructed as follows:

```
alpha := scale(indneutralize(cs_winsorize_percentile(%D(144, 6, 6) - %K(144,
                          6), 0.1), IndClass.universe), 2e6)
```

Here's a breakdown of the components in the formula:

- **%D(144, 6, 6) - %K(144, 6)**: This expression calculates the difference between the smoothed %D line (with parameters 144, 6, 6) and the %K line (with parameters 144, 6). The greater the difference, the stronger the signal for either a long or short position.
- **cs_winsorize_percentile, indneutralize, scale**: These steps serve the same purpose described in the reversion alpha using %K. For a more detailed explanation of these functions, please refer to:

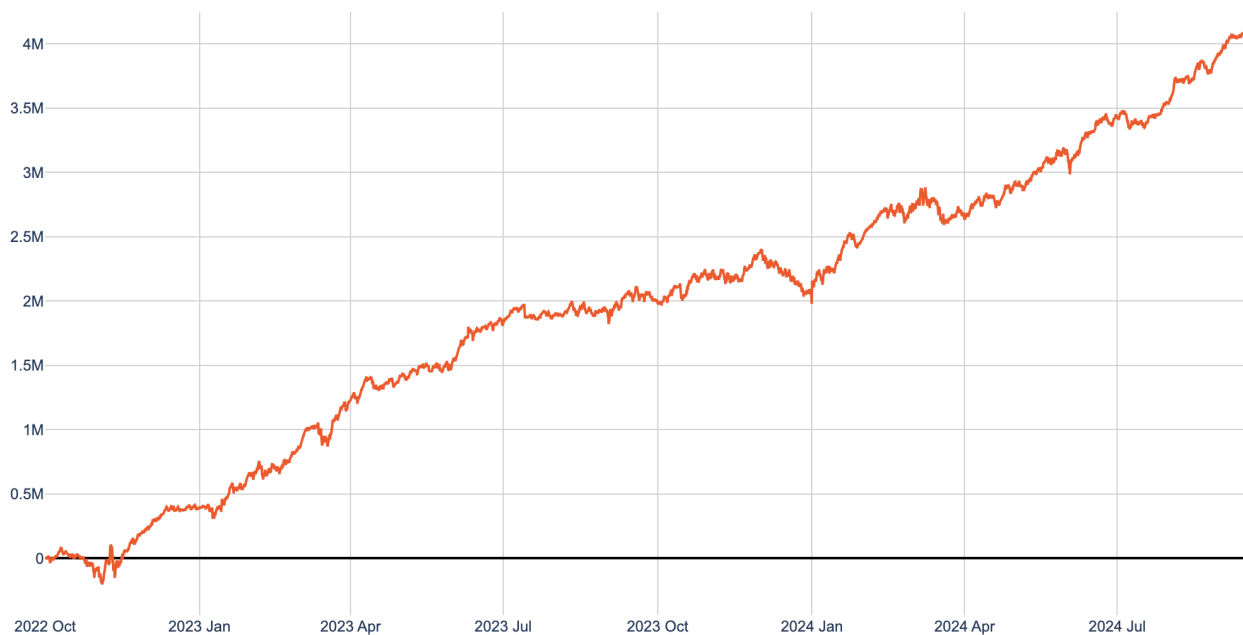
[Technical Analysis in Statistical Arbitrage I: Fibonacci Retracement | Presto Research \(prestolabs.io\)](https://prestolabs.io/Technical-Analysis-in-Statistical-Arbitrage-I-Fibonacci-Retracement/)

By focusing on the intensity of bullish and bearish crossovers, this alpha seeks to capture subtle shifts in trends, providing a refined approach to mean-reversion trading in a StatArb framework.

Simulation Results

The simulation result for the reversion alpha using the %K line shows consistent performance, as detailed in Figure 2 and Table 1, with good risk-adjusted returns and a moderate win ratio. These findings indicate that the alpha effectively captures mean-reversion opportunities while maintaining a balanced risk profile.

Figure 2 : Simulation Results of Reversion Alpha Using %K



Source: Presto Research

Table 1 : Stats of Reversion Alpha Using %K

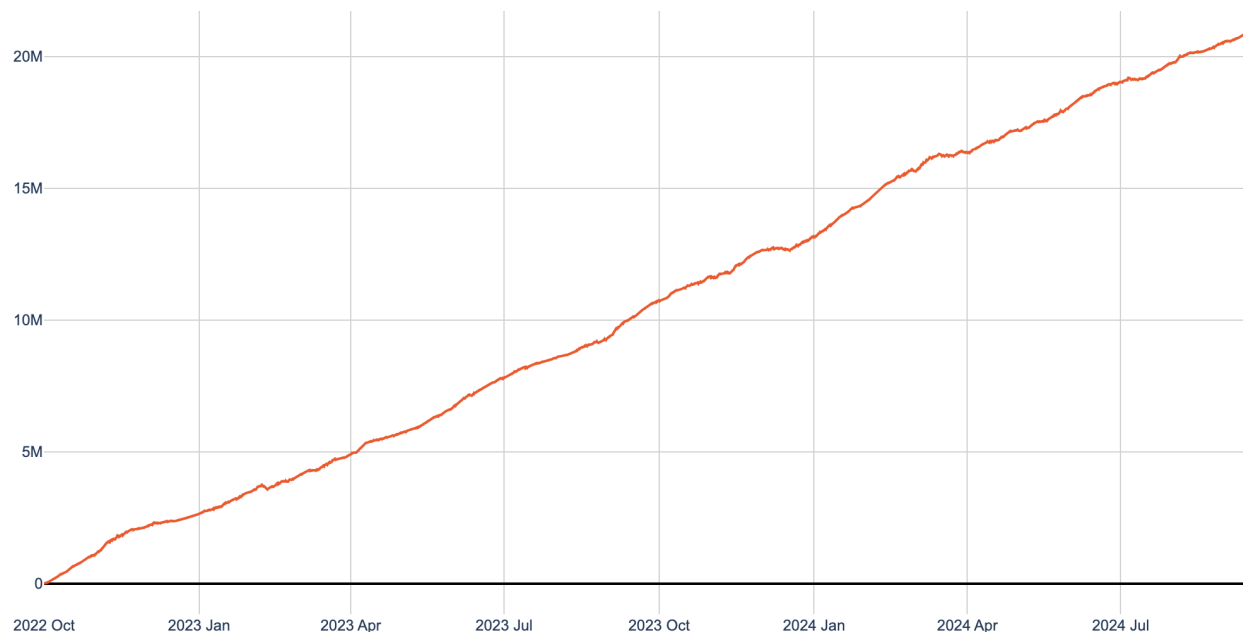
	GMV	Return (%)	Sharpe	MDD (%)	Daily Win Ratio (%)	Daily Turnover (%)	Return/Trade (bp)
20221001-20230101	1.98E+06	78.56	2.92	14.72	59.78	3872.93	0.56
20230101-20230701	2.00E+06	144.84	5.91	9.36	63.54	3855.58	1.03
20230701-20240101	2.00E+06	27.58	1.08	21.28	55.98	3555.09	0.21
20240101-20240701	2.00E+06	132.58	4.60	14.64	67.03	3751.28	0.97
20240701-20240915	2.00E+06	149.94	7.07	7.47	63.16	4141.60	0.99
Total	2.00E+06	103.61	4.00	21.31	61.54	3784.68	0.75

(Return and Sharpe ratio are annualized)

Source: Presto Research

Figure 3 and Table 2 show the performance of the reversion alpha based on the crossovers between the %K and %D lines of the stochastic oscillator. The alpha demonstrates a steady, linear upward trend, indicating consistent profitability and effective capture of mean-reversion opportunities. However, due to its exceptionally high turnover rate, turnover reduction techniques may need to be applied before deploying it in a production strategy.

Figure 3 : Simulation Results of Reversion Alpha Using Crossovers



Source: Presto Research

Table 2 : Stats of Reversion Alpha Using Crossovers

	GMV	Return (%)	Sharpe	MDD (%)	Daily Win Ratio (%)	Daily Turnover (%)	Return/Trade (bp)
20221001-20230101	1.98E+06	529.44	22.09	5.01	93.48	20534.12	0.71
20230101-20230701	2.00E+06	520.63	24.40	8.85	87.85	20351.15	0.70
20230701-20240101	2.00E+06	527.47	23.26	6.28	90.76	20104.48	0.72
20240101-20240701	2.00E+06	592.00	22.76	4.79	86.81	19862.75	0.82
20240701-20240915	2.00E+06	455.77	23.02	4.06	88.16	19917.48	0.63
Total	2.00E+06	534.64	23.11	8.86	89.51	20139.89	0.73

(Return and Sharpe ratio are annualized)

Source: Presto Research

It is important to note that the simulations for both alphas do not account for transaction costs. These alphas are not intended to serve as standalone strategies; rather, they are designed to be integrated with multiple other alphas to create a tradable strategy. This concept is thoroughly explained in the article: [Optimizing Risk-Adjusted Return in Constructing Portfolios of Alphas | Presto Research \(prestolabs.io\)](https://prestolabs.io/optimizing-risk-adjusted-return-in-constructing-portfolios-of-alphas/)

Conclusion

This article highlights the effectiveness of using the stochastic oscillator in developing alphas for statistical arbitrage. By leveraging either the %K line or the crossovers, we demonstrated two distinct reversion alphas that consistently capture mean-reversion opportunities. The backtesting results confirm their profitability and balanced risk profiles, though they reveal certain practical considerations, such as the need for turnover reduction techniques to enhance deployability in live trading scenarios.

By extending beyond the conventional uses of technical indicators like the stochastic oscillator, this research encourages a more innovative approach to developing alphas, ultimately helping traders uncover unique market patterns and strengthen their strategies.

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