Final Project Report

Professional Certificate in Algo-Trading, Theory and Practice

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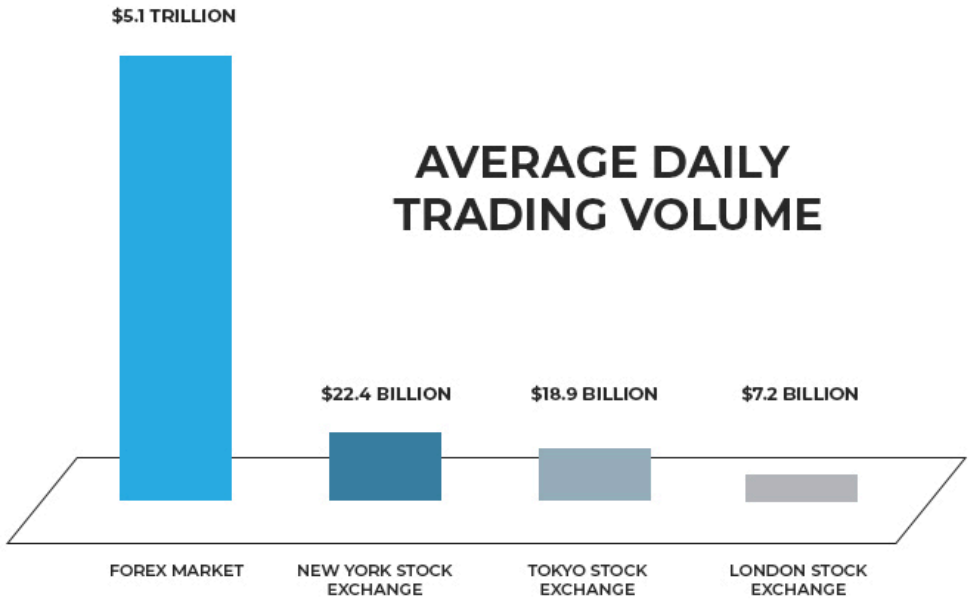
1. Identify, Decide, Manage Risk, Rebalance Portfolio

1.1 Market Identification - The Forex Market

Team members have moderately high risk tolerance and limited forex trading experience.

(1) High Trading Volume



A large trading volume is advantageous to retail investors with moderately high risk appetites. High trading volume coincides with heightened market volatility. This provides more trading opportunities for retail investors like us who are seeking to capitalize on short-term price fluctuations to generate higher returns through active trading strategies.

(2) Broad Market Participation

Key players in the forex market include Central Banks, Commercial Banks, Investment Management Firms, Hedge Funds, Institutional Investors, and Retail Forex Brokers.

The presence of numerous market participants increases liquidity as the likelihood of matching buy and sell orders is enhanced. This leads to faster order execution, narrower bid-ask spreads, and reduced price slippages - enabling us to enter and exit positions at our desired fill prices.

(3) Market Dynamic and Price Volatility

Different participants bring a diverse range of unique objectives, strategies, and influence to the market, contributing to its dynamic nature. Periods of price volatility are profit opportunities.

(4) Regulatory Environment and Market Access

The forex market operates 24 hours a day, five days a week, spanning major financial centers across different time zones. This allows us to participate in forex trading from anywhere in the world, anytime on most days of the week. Aligning our trading schedules to our work schedules can be done with more ease.

The presence of well-established regulatory oversight ensures fair and transparent trading practices. This serves as a form of protection for independent retail investors like us.

1.2 Choice of Instruments

Focus on liquidity, volatility, and correlation to justify our selection of currency pairs.

Currency Pairs:

EUR/USD, USD/JPY, GBP/USD, USD/CHF, AUD/JPY

(1) Liquidity

We selected currency pairs like *EUR/USD, USD/JPY, and GBP/USD* as they are widely traded and offer ample liquidity, making them suitable for retail investors like us with limited forex trading experience.

(2) Volatility

The currency pairs that we have chosen, which are known for their lower volatility compared to exotic pairs, suit our risk tolerance, as we favor risk but prefer to avoid excessive fluctuations in prices.

(3) Diversification and Risk Mitigation

We chose pairs with strong correlations to enhance diversification and mitigate risk. For example, *USD/CHF* was chosen due to its negative correlation with *EUR/USD,* providing potential hedging opportunities and reducing overall portfolio volatility.

1.3 Description of Strategy

1.3.1 Mean Reversion Strategy using Bollinger Bands

Several strategies that were suitable for forex trading were considered in the beginning, namely: ***Momentum Trading*** [1]***, Breakout Trading*** [2], ***Mean Reversion*** [3], ***Arbitrage Trading*** [4]***,*** and ***Event-Driven Trading*** [5]***.***

We decided to go with the *Mean Reversion strategy* because of its simplicity and reliability in range-bound markets, and clear entry and exit signals provided by indicators like Bollinger Bands.

(1) Entry Signal - Buy Trade

- Mean Reversion strategy with the use of Bollinger Bands as the technical indicator of choice for market entry signals.
- Lower Bollinger Band set at a negative multiple (e.g. -2) of standard deviation from the moving average. If the price drops below the lower band, execute purchase.
- For Risk Management:
    - Stop Loss : a negative multiple (e.g. -3) of standard deviation from the moving average, below the lower BB. When price hits stop loss, execute a sell market order to close the buy trade and limit loss.

[1] *Identifies and trades in the direction of established market trends, aiming to capitalize on momentum.*
[2] *Enters trades when the price breaks above or below a significant level of support or resistance, expecting the price to continue moving in the breakout direction.*
[3] *Capitalizes on the tendency of prices to revert to their mean or average levels after periods of deviation.*
[4] *Exploits price discrepancies between related assets or markets to generate risk-free profits.*
[5] *Capitalizes on market reactions to specific events such as earning reports, economic data releases, or geopolitical developments.*

(2) Exit Signal - Sell Trade

- Mean Reversion strategy with the use of Bollinger Bands as the technical indicator of choice for market exit signals.
- Upper Bollinger Band set at a multiple of standard deviation from the moving average. If price exceeds the upper band, liquidate position.

However, it is important to note that Bollinger Bands by itself does not always give accurate buy and sell signals. For instance, during a strong trend, the trader runs the risk of placing trades on the wrong side of the move because the indicator can flash overbought and oversold signals too soon. As a remedy, a trader can look at the overall direction of price and then only take trade signals that align with the momentum.

- If the trend is bearish, only take short positions when the upper band is tagged. The lower band can still be used as an exit point if desired, but a new long position will not be executed since that would buck the trend.

- If the trend is bullish, only take long positions when the lower band is tagged. The upper band can still be used as an exit point if desired, but a new short position will not be executed since that would go against the current.

Momentum Trading would complement the *Mean Reversion strategy*, but it will not hold weight by itself. It is our opinion that Forex currencies typically do not keep trending. Instead, they oscillate around a certain price level. Hence technical indicators that monitor trends may not be the most suitable when setting up conditions for the execution of buy/sell/hold decisions.

Breakout Trading [6], *Arbitrage Trading* [7], and *Event-Driven Trading* [8] *strategies* were not selected due to reasons stated in the footnotes.

1.3.2 Model Training Approach

Due to limitations imposed by our QuantConnect accounts, which restrict testing to 10,000 orders, and recognizing that forex market conditions tend to be more volatile in earlier periods, we opted to train our model using data from January 1, 2017, to January 1, 2020. This timeframe provided a substantial period for testing our strategy.

Additionally, we varied key parameters such as the lookback period (used in computing moving averages), standard deviation multiplier (applied to calculate upper and lower Bollinger Bands), and stop loss multiplier. We then identified the optimal parameter combination for backtesting by selecting the set that yielded the highest Sharpe ratio during the training phase.

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[6] *Breakout Trading can capture large profits during significant price movements and are more suitable for capturing market conditions that are highly volatile i.e., when trading exotic currency pairs. False breakouts are also very common, leading to losses if not properly managed. Precise timing and risk management are required to avoid false signals and whipsaws. As novices in forex trading, this is not the best strategy for us.*

[7] *Arbitrage Trading offers the potential for consistent profits without directional market risk. It can also be automated and executed rapidly using algorithmic trading. However, sophisticated technology and access to multiple markets are required. Profit opportunities may also be short-lived and highly competitive. As novices in forex trading, this is not the best strategy for us.*

[8] *Event-Driven Trading only provides opportunities for high-impact trades when there are clear catalysts. However setting up the conditions for buy/sell/hold decisions can be challenging due to the multi-faceted nature of market reactions to events. While some events may appear to have clear catalysts, the interconnectedness of various factors can lead to unexpected outcomes. For instance, when the FED hiked interest rates a total of 11 times between March 2022 and January 2024. This event might seem like a clear catalyst for buying the USD due to potential for higher yields. However, the market reaction did not unfold as expected after every single rate hike due other concurrent factors. The unpredictable nature of an event-driven approach leads to more risk than we are prepared to manage.*

Below is a table listing the different combinations of parameters we tested along with their corresponding Sharpe ratios:

Lookback Period (hours)	*Standard Deviation Multiplier*	*Stop Loss Multiplier*	*Return*	*Sharpe Ratio*
20	*1.5*	*2.5*	*-11.75%*	*-1.835*
20	*2*	*3*	*-7.47%*	*-1.482*
20	*3*	*4*	*-10.07%*	*-1.739*
50	*1.5*	*2.5*	*-3.72%*	*-1.135*
50	*2*	*3*	*-2.69%*	*-1.044*
50	*3*	*4*	*-1.26%*	*-0.968*
75	*1.5*	*2.5*	*-6.02%*	*-1.336*
75	*2*	*3*	*-4.05%*	*-1.197*
75	*3*	*4*	*-2.28%*	*-0.994*

1.3.3 Finalized Strategy

Final parameter combination:

Lookback Period (hours)	*Standard Deviation Multiplier*	*Stop Loss Multiplier*
50	*3*	*4*

1.4 Risk Management

1.4.1 Stop Loss

In our strategy, we incorporated a stop loss mechanism set at -4 times of the standard deviation from the moving average for each currency pair. When the price of a currency pair hit the stop loss threshold, we executed a sell market order to close the buy trade and mitigate potential losses.

1.4.2 Diversification

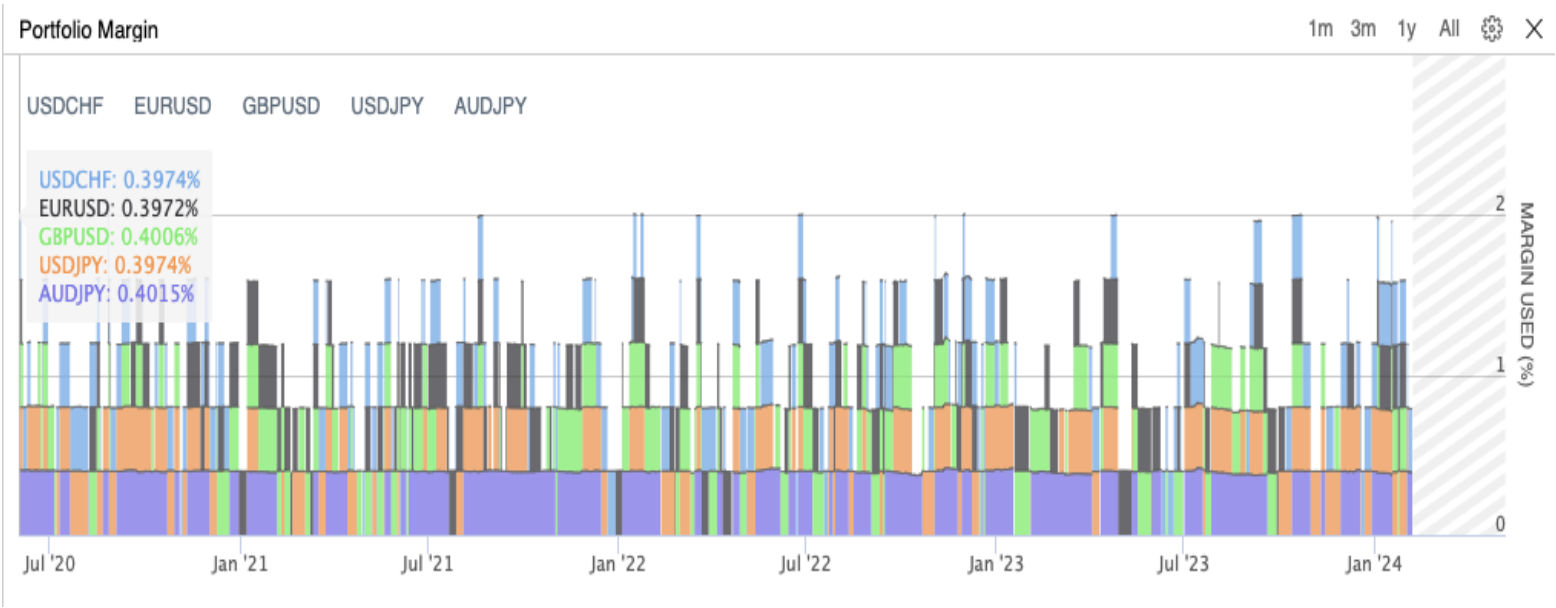
By diversifying across multiple currency pairs, we reduced exposure to the risks associated with a specific currency or economic region. Funds were allocated to different currency pairs (i.e., *EUR/USD*, *USD/JPY*) that may have uncorrelated price movements. That way, we avoid relying too heavily on the performance of a single asset. When one market experiences a downturn, we will still be able to capitalize on favorable trends in another to mitigate the extent of our losses.

1.5 Rebalance Portfolio

1.5.1 Periodic Re-Adjustments via Entry & Exit of Each Currency Pair

Our strategy implemented a portfolio rebalancing approach using the Bollinger Bands mean reversion strategy for each currency pair. We initiated buy or sell positions based on the price movement relative to the Bollinger Bands for each pair.

The following visual illustrates the evolution of the portfolio during the backtest period:



2. Results

Backtest period: June 1, 2020 - Current

Key Performance Metrics:

- Sharpe ratio: -0.036
- Return: 11.71%

We have performed backtesting of our strategy on the QuantConnect environment, during the period of June 1, 2020 to now (May 2024), which is approximately 3 years. The strategy achieves a return of 11.71%, generating a net profit of 12.37k USD with an initial portfolio investment of 100k USD. The price-sale ratio (PSR) for the trades is 25.15% overall.

The portfolio has a negative Sharpe ratio of -0.036. Being a negative value, it indicates that the net profit of the portfolio does not overrun the risk-free rate compounded. We refer to a commonly used risk-free rate, SOFR. SOFR was mostly zero during the start of our backtesting period, until March 2022, due to the COVID pandemic. However, it rose rapidly since then, until it stabilized at 5.3% in mid-2023. Under comparison, the compound annual return is 3.05% over the three years of backtesting, which is less than the risk-free rate of the last two years. The variance of this strategy is however small, leading to a relatively large absolute value of Sharpe ratio.

Another highlight is that the drawdown percentage is controlled at 4.8%. We have noticed occasionally large fluctuations of the underlying Forex pairs. With the stop-loss criterion in our

strategy to liquidate our Forex holdings, drawdown is maintained at an acceptable level of under 5%, despite the performance of its compositing assets.

We have demonstrated the equity pricing history along with the monthly return in the figure below.

A relatively complete performance metrics of the backtesting portfolio is listed in the table below.

PSR	25.151%	Sharpe Ratio	-0.036
Total Orders	709	Average Win	0.23%
Average Loss	-0.19%	Compounding Annual Return	3.049%
Drawdown	4.800%	Expectancy	0.179
Start Equity	100000.00	End Equity	111714.24
Net Profit	11.714%	Sortino Ratio	-0.046
Loss Rate	48%	Win Rate	52%
Profit-Loss Ratio	1.25	Alpha	-0.006
Beta	0.054	Annual Standard Deviation	0.029
Annual Variance	0.001	Information Ratio	-0.689
Tracking Error	0.141	Treynor Ratio	-0.019
Total Fees	$0.00	Estimated Strategy Capaci…	$3800000.00
Lowest Capacity Asset	AUDJPY 8G	Portfolio Turnover	10.51%

3. Challenges

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3.1 Selection of Right Indicators

Lack of financial or technical analysis expertise to select the most suitable indicator for trading strategy.

3.2 Optimizing Indicator Utilization

Challenges in effectively utilizing indicators within the trading strategy i.e., parameter optimization (determining standard deviation multipliers for indicators like BB), which will significantly influence strategy outcomes.

3.3 Financial Knowledge and Strategy Development

Lack of adequate financial training leads to struggle with development and refinement of trading strategies. Reliance on simplistic approaches such as buying low and selling high without considering the nuances of market dynamics, risk management, and trade executions. This results in suboptimal performance and vulnerability to market risks.

3.4 Selection of Back-Testing Periods

Struggled to select appropriate historical data period for backtesting and in identifying ideal timeframe for testing strategy, led to suboptimal results.

3.5 Market Conditions and Adaptability

Mean Reversion strategies tend to perform well in range-bound markets but may struggle during trending or volatile conditions. There is a need to adjust strategies or switch to alternative approaches based on changing market dynamics.

5. Opportunities

5.1 Improve Drawdown

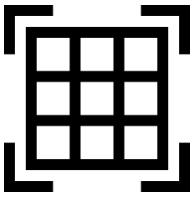
Implement measures to reduce the magnitude and duration of drawdowns in our trading strategy. We can incorporate stricter risk management rules, diversify across uncorrelated assets, and refine entry/exit conditions to avoid extended losing streaks.

5.2 Create Scoring Formula for Portfolio Rebalancing

Develop a quantitative scoring system to determine when and how to rebalance a portfolio based on predefined criteria i.e., asset allocation targets, risk levels, and market conditions. This ensures a systematic approach to portfolio management.

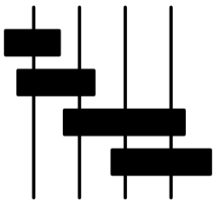
5.3 Selection of Performance Metrics

Choose appropriate performance metrics to evaluate the profitability of our trading strategy. Factors to be considered can include Sharpe Ratio, Maximum Drawdown, Risk-Adjusted Returns, Win-Rate, and Consistency of Returns.



5.4 Automated GridSearchCV to Tune Parameters

Utilize automated optimization techniques like GridSearchCV to systematically search through a specified parameter grid and identify optimal parameter values for the trading strategy. This will enhance performance and robustness.



5.5 Selection of Back-Testing Strategy

Decide on the most suitable backtesting approach based on the trading strategy's objectives, complexity, and historical data available, to validate and refine our strategy under various market conditions. Options include historical backtesting, walk-forward optimization, Monte Carlo simulation, or event-driven backtesting.