**Pairs Trading Algorithm Backtesting Report**

**Introduction**

This report provides an analysis of a pairs trading algorithm applied to ONGC and ZOMATO stocks (picked by using an algorithm which finds the most cointegrated stocks) from January 2022 to April 2024. Pairs trading is a market-neutral strategy that involves matching a long position with a short position in two correlated stocks to exploit market inefficiencies. This report includes key performance metrics, risk analysis, and recommendations based on the algorithm's performance over the specified period.

**Portfolio Overview**

* **Initial Portfolio Value Taken:** ₹100,000
* **Final Portfolio Value Calculated by the algorithm:** ₹121399.99
* **Total Return:** 21.4%
* **Period:** January 2022 - April 2024

**Cumulative Returns**

The cumulative returns graph below illustrates the performance of the portfolio over the backtesting period. It highlights the changes in the portfolio's value, showcasing periods of both growth and drawdowns.

A graph with numbers and lines

Description automatically generated

**Key Performance Metrics**

**Total Return**

Total Return = 21.4%

**Annualized Return (CAGR)**

Given the period of approximately 2.25 years:

Annualized Return = ((121399.99/100,000) ^ (1/2.25) − 1) × 100=0.09%

**Standard Deviation (Volatility)**

The standard deviation measures the volatility of the portfolio's returns.

Standard Deviation = 0.033

**Sharpe Ratio**

The Sharpe ratio measures the risk-adjusted return of the portfolio. Assuming a risk-free rate of 2% per annum:

Sharpe Ratio = (Annualized Return – Risk Free Rate) / (std of portfolio’s returns)

Sharpe Ratio = 2.69

**Maximum Drawdown**

Maximum drawdown measures the largest peak-to-trough decline in the portfolio's value. Based on the cumulative returns graph, identify the highest drop. Therefore:

Maximum Drawdown = -0.031

**Sortino Ratio**

The Sortino ratio differentiates harmful volatility from overall volatility by using the standard deviation of negative asset returns.

Sortino Ratio = (Annualized Return – Risk Free Rate)/Downside Deviation

Sortino Ratio = 28.77

**Calmar Ratio**

The Calmar ratio measures the annualized return of the portfolio compared to its maximum drawdown:

Calmar Ratio = (Annualized Return)/Maximum Drawdown

Calmar Ratio = -2.899

**Beta**

Beta measures the portfolio's sensitivity to market movements.

Beta = 0.547

**Alpha**

Alpha measures the portfolio's excess return over the benchmark index. Assuming we have the benchmark return and beta:

Alpha = Annualized Return − (Risk Free Rate + Beta × (Benchmark Return−Risk Free Rate))

Assuming a benchmark return of 5%: Alpha = 0.0535

**Risk Analysis**

* **Volatility:** The portfolio showed moderate volatility with a standard deviation of 0.033, indicating relatively stable returns over the period.
* **Drawdown Risk:** The maximum drawdown was 3.1%, which represents the largest drop from peak to trough in the portfolio's value. This level of drawdown is considered manageable.
* **Sharpe Ratio:** With a Sharpe ratio of 2.69, the portfolio achieved strong risk-adjusted returns, significantly outperforming the risk-free rate when accounting for volatility.
* **Sortino Ratio:** The Sortino ratio of 28.77 highlights exceptional management of downside risk, demonstrating a very strong return per unit of downside deviation.
* **Calmar Ratio:** A Calmar ratio of -2.899 suggests that while the portfolio’s annualized return was positive, it was not sufficiently high to compensate for the drawdown risk. This indicates a need for improved drawdown risk management.
* **Beta and Alpha:** A beta of 0.547 indicates that the portfolio was less sensitive to market movements compared to the benchmark. Additionally, a positive alpha of 0.0535 shows that the portfolio outperformed the benchmark index after adjusting for risk.

**Conclusion**

* **Performance:** The portfolio achieved a total return of 21.4% over 2.25 years, equating to an annualized return of 0.09%.
* **Risk-Adjusted Performance:** Positive Sharpe and Sortino ratios indicate that the portfolio’s returns justified the level of risk taken.
* **Drawdown Risk:** The portfolio experienced a 3.1% maximum drawdown, underscoring the importance of continued risk management efforts.
* **Market Sensitivity:** The portfolio exhibited lower sensitivity to market movements (beta < 1) and achieved positive excess returns (alpha).

**Final Recommendations**

* **Risk Management:** Implement stop-loss strategies to effectively manage and minimize drawdowns.
* **Diversification:** Consider diversifying into additional pairs to spread risk and reduce overall portfolio volatility.
* **Review Strategy:** Continually review and adjust the trading algorithm to sustain and improve excess returns.
* **Performance Monitoring:** Regularly monitor the portfolio and make adjustments as needed to align with evolving market conditions and enhance performance.