Technical Report: Pairs Trading Strategy on Indian Oil & Gas Equities

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1. Strategy Overview

Objective: Implement a market-neutral statistical arbitrage (pairs trading) strategy on Indian Oil & Gas equities over the last 5 years, capturing mean-reversion in cointegrated stock pairs.

Key Components:

1. **Pair Selection**: Identify strongly correlated, cointegrated pairs within the Oil & Gas sector using:
    - **Pearson Correlation** (ρ > 0.8)
    - **Engle–Granger Cointegration Test** (p-value < 0.05)
2. **Spread & Z-Score**:
    - **Hedge Ratio** (β) estimated via OLS regression: $s_t = A_t - \beta B_t - \alpha$
    - **Z-Score**: rolling (window = 30 days) standardized spread: $z_t = (s_t - \mu)/\sigma$
3. **Trade Signals**:
    - **Entry**: long when $z_t \leq -entry_{threshold}$, short when $z_t \geq entry_{threshold}$
    - **Exit**: close when spread reverts inside $\pm exit_{threshold}$, or if stop-loss (10%) or maximum holding (20 days) triggers.
4. **Execution & Risk Controls**:
    - **Dollar-neutral sizing**: equal capital per leg (₹50k each).
    - **Transaction costs & slippage**: 0.1% + 0.1% per round-trip.
    - **Liquidity filter**: minimum average daily volume ≥ 1,000,000 shares.
5. **Benchmarks**:

- Compare against **Sensex 30** (^BSESN) and **Nifty 50** (^NSEI).

2. Results & Interpretation (for BPCL - PETRONET pair)

2.1 Performance Metrics

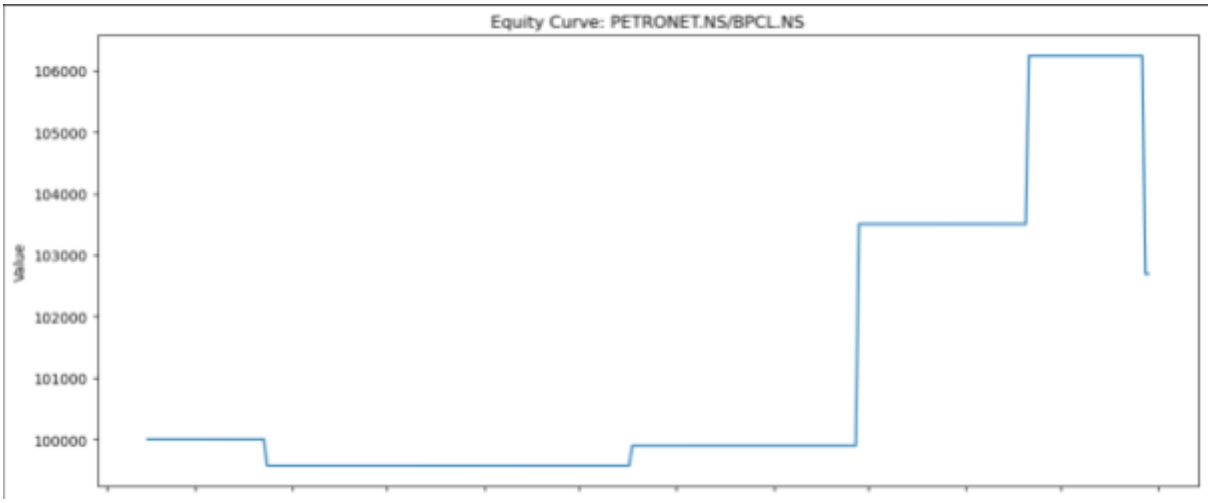
Metric	Value
Cumulative Return (%)	2.69
Annualized Return (%)	3.09
Sharpe Ratio	0.54
Sortino Ratio	0.17
Max Drawdown (%)	3.34
Win Rate (%)	0.60
Profit Factor	1.68
Cumulative vs Sensex (%)	-15.67
Cumulative vs Nifty (%)	-18.51
Info Ratio vs Sensex	-1.44
Info Ratio vs Nifty	-1.67

Interpretation:

- The strategy underperformed in comparison to Sensex/Nifty.
- The Sharpe and Sortino ratios are positive, meaning the strategy is mildly profitable.
- Maximum drawdown is low, remains within risk tolerance.
- Profit factor is decent.

3. Visualizations

3.1 Equity Curve



3.2 Z-Score & Trade Signals

4. Resources & References

1. **Online Articles & Tutorials**:
    - QuantStart: Pairs Trading in Python
    - Investopedia: Statistical Arbitrage
    - Quantinsti: Pairs trading for beginners
2. **Libraries & APIs**:
    - **Python**: pandas, numpy, statsmodels, yfinance, matplotlib

- **Data Sources**: Yahoo Finance, NSEpy

5. Potential Improvements

- **Dynamic Thresholds**: adapt entry/exit z-thresholds via optimization
- **Volatility Scaling**: adjust capital per pair based on spread volatility.
- **Machine Learning**: integrate sentiment or alternative data as additional signals.
- **Robustness Checks**: Monte Carlo simulations, etc.