

Pairs Trading: Concepts and Applications

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Introduction to Pairs Trading

- ▶ **Definition:** A market-neutral strategy exploiting short-term price deviations between two highly correlated assets.
- ▶ **Objective:** Profit from price convergence while minimizing market risk.
- ▶ **Intuition:** If two assets historically move together, temporary divergences offer trading opportunities.

Core Concept: Cointegration

- ▶ **Definition:** Two non-stationary series $P_A, P_B \sim I(1)$ are cointegrated if a linear combination $P_A - \beta P_B \sim I(0)$.
- ▶ **Mathematical Intuition:** Price spread $S_t = P_A - \beta P_B$ is stationary, implying mean-reverting behavior.
- ▶ **Testing:** Use Engle-Granger or Johansen tests to confirm cointegration.
- ▶ **Example:** Coca-Cola (KO) and PepsiCo (PEP) prices.

Price Spread Model

- ▶ **Spread:** Define $S_t = P_A - \beta P_B$, where β is the hedge ratio from cointegration.
- ▶ **Mean-Reversion:** Assume S_t follows an Ornstein-Uhlenbeck process:

$$dS_t = \theta(\mu - S_t)dt + \sigma dW_t$$

- ▶ **Parameters:** θ : reversion speed, μ : mean, σ : volatility, W_t : Brownian motion.
- ▶ **Intuition:** S_t fluctuates around μ , enabling predictable trading signals.

Trading Logic

- ▶ **Signal Generation:**
 - ▶ If $S_t > \mu + k\sigma$: Sell A , buy B (overvalued A).
 - ▶ If $S_t < \mu - k\sigma$: Buy A , sell B (undervalued A).
 - ▶ Close position when $S_t \approx \mu$.
- ▶ **Intuition:** Profit from spread convergence to μ .
- ▶ **Example:** $\mu = 0$, $\sigma = 1$, $k = 2$. If $S_t = 2.5$, sell KO, buy PEP.

Risk Management

- ▶ **Risks:**
 - ▶ Spread divergence due to fundamental changes.
 - ▶ High transaction costs (commissions, slippage).
- ▶ **Mitigation:**
 - ▶ Set stop-loss to limit losses.
 - ▶ Control leverage to manage volatility.
 - ▶ Monitor cointegration stability.
- ▶ **Intuition:** Balance profit potential with exposure to unexpected shocks.

Practical Applications

- ▶ **Asset Selection:** Stocks (e.g., KO vs. PEP), ETFs, futures.
- ▶ **Data Analysis:** Use historical prices to estimate β , μ , σ .
- ▶ **Machine Learning:** PCA or neural networks to identify pairs or optimize β .
- ▶ **Advantages:** Market-neutral, scalable across asset classes.
- ▶ **Challenges:** Transaction costs, cointegration breakdown.

Comparison with Other Strategies

- ▶ **Pairs Trading vs. Arbitrage:**
 - ▶ Pairs: Statistical, mean-reverting, higher risk.
 - ▶ Arbitrage: Risk-free, deterministic, rare opportunities.
- ▶ **Pairs Trading vs. Trend Following:**
 - ▶ Pairs: Market-neutral, short-term.
 - ▶ Trend: Directional, momentum-based.
- ▶ **Intuition:** Pairs trading leverages statistical relationships, not market trends.

Takeaways

- ▶ Pairs trading exploits cointegrated asset pairs for market-neutral profits.
- ▶ **Cointegration:** Ensures mean-reverting spreads, testable via statistical methods.
- ▶ **Trading Logic:** Buy low, sell high based on spread thresholds.
- ▶ **Risk Management:** Critical to handle divergence and costs.
- ▶ **Applications:** Scalable but requires robust data and execution.
- ▶ Select pairs with strong cointegration and monitor for structural changes.