High-Grade Copper Futures Trading

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COMEX: HGH6

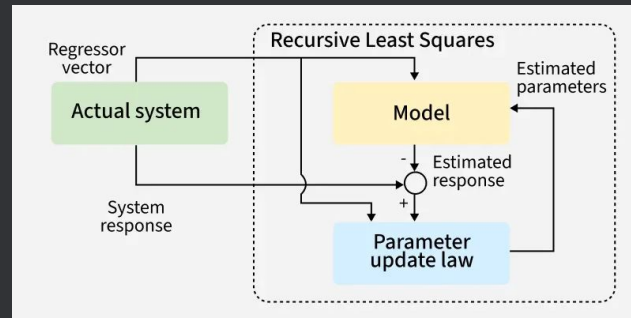# 01 Recursive Least Squares (RLS) & External Markers

> Contrarian mean-reversion strategy: Prices will return to their normal levels over time.

> Copper is highly volatile due to swings in demand for construction/electrification and semiconductor manufacturing, along with fluctuating mining yields.

Trading Strategy

- Predict the next day's copper futures contract prices with an adaptive linear model (RLS). Convert to a position size based on risk tolerance.
- Aggregate mining and construction stock signals (NYSE: FCX, NYSE: CAT)
- St. Louis Fed data reports for Industrial Production (INDPRO) & Total Construction (TLRESCONS) Spending
- RLS Parameters: $\lambda = 0.99$ (forgetting factor, assigned to old data) ~ 100 trading days of memory before data starts to get tossed out.
- Oversold is positive signal, overbought is negative signal
- Shorts overbought conditions (RSI > 70)
- Longs oversold conditions (RSI < 30)

- Mean reversion signals (Z-scores, Bollinger Band position)
- RSI (Relative Strength Index)
- Volatility and distribution (skewness)
- External signals & seasonality: Z-scored returns from mining stocks (supply side) and industrial companies (demand side), plus the dollar and FRED macro data

Backtesting with Historical Futures Contracts

Results

- Performance Metrics
- Total Returns:
  - +15.93% (vs –20% for buy-and-hold) over a 24-year period
  - CAGR: +1.06% per year (low, but safer than holding or following 60-day trends))
  - Sharpe Ratio: 0.23
  - Max Drawdown: –12.5% (vs –63% for buy-and-hold)
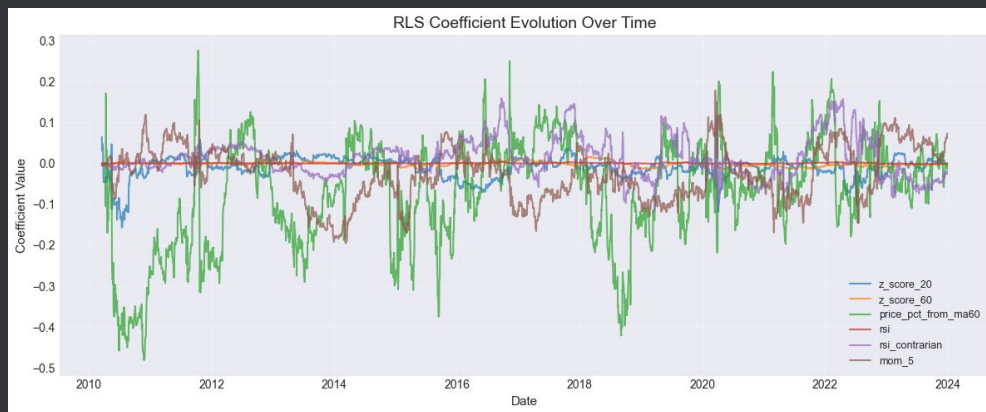 - Annualized Volatility: 5.2% (vs 22.6% for buy-and-hold)

Equity Curves: RLS Strategy vs Baselines (2010-2024)

Model Predictions (top) and Portfolio Position (bottom)

Future Improvements

- Adjust leverage (currently capped at 2.5x for risk)
- Allow more flexibility for short/long ratio within RLS model.
- Backtesting:
  - 3524 days
  - Avg position: 0.010
  - Short days: 1020 (28.9%)
  - Long days: 1152 (32.7%)
  - Neutral days: 1352 (38.4%)
  - Avg turnover: 0.152 (higher than 60-day trend following)

RLS Coefficient Evolution Over Time

▶ Sidenote on RLS + Adaptation

Parameter vector β_t: Current coefficient estimates for all features

Covariance matrix P_t: Uncertainty in parameter estimates

When a new data point *(x_t, y_t)* is obtained from Yahoo Finance, we find:

1. Prediction: $\hat{y}_t = x_t' \beta_{t-1}$

2. Prediction error: $e_t = y_t - \hat{y}_t$

3. Kalman gain: $K_t = P_{t-1} x_t / (\lambda + x_t' P_{t-1} x_t)$

4. Update parameters: $\beta_t = \beta_{t-1} + K_t e_t$

5. Update covariance: $P_t = (P_{t-1} - K_t x_t' P_{t-1}) / \lambda$

(Old data loses 1% of its weight every day)

How much do you buy?

Amount: w_t = clip(pred_t / (gamma * vol_t), -w_max, w_max)

- pred_t: RLS predicted next-day return

- gamma: Risk aversion (1.8)

- vol_t: 60-day realized volatility

- w_max: Maximum leverage (2.5)

Buy/Sell signal threshold:

if abs(pred_t) < 0.002:

  w_t = 0 # No position

Sources (from yfinance Python library):

- Copper Futures (HG=F)

- US Dollar Index (DX-Y.NYB)

- Mining stocks: FCX, SCCO, TECK

- Industrial stocks: CAT, NUE, AA