Analysis and calibration of mean-reversal strategies on capital markets

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Motivation and Context

Mean Reversion Strategy

Trading strategies based on the assumption that prices of financial instruments return to an equilibrium value (moving average) after temporary deviations

Optimal moving average (MA) length depends on market volatility

Lack of universal formula for predicting optimal MA without extensive testing

Lo & MacKinlay (2018), López de Prado (2020)

Research Question and Hypothesis

Research Question

Can we derive a generalized formula for calculating optimal moving average length based solely on the volatility of a financial instrument?

Hypothesis H_0

Currency pairs with lower volatility exhibit more stable results in mean reversion strategy and allow for more efficient moving average calibration

Methodology

Data & Instruments

Hourly data, 5-10 years
FX pairs, commodities, indices
10+ instruments

Strategy

MA ± K × σ bands
Long/Short on deviation
Exit on return to MA

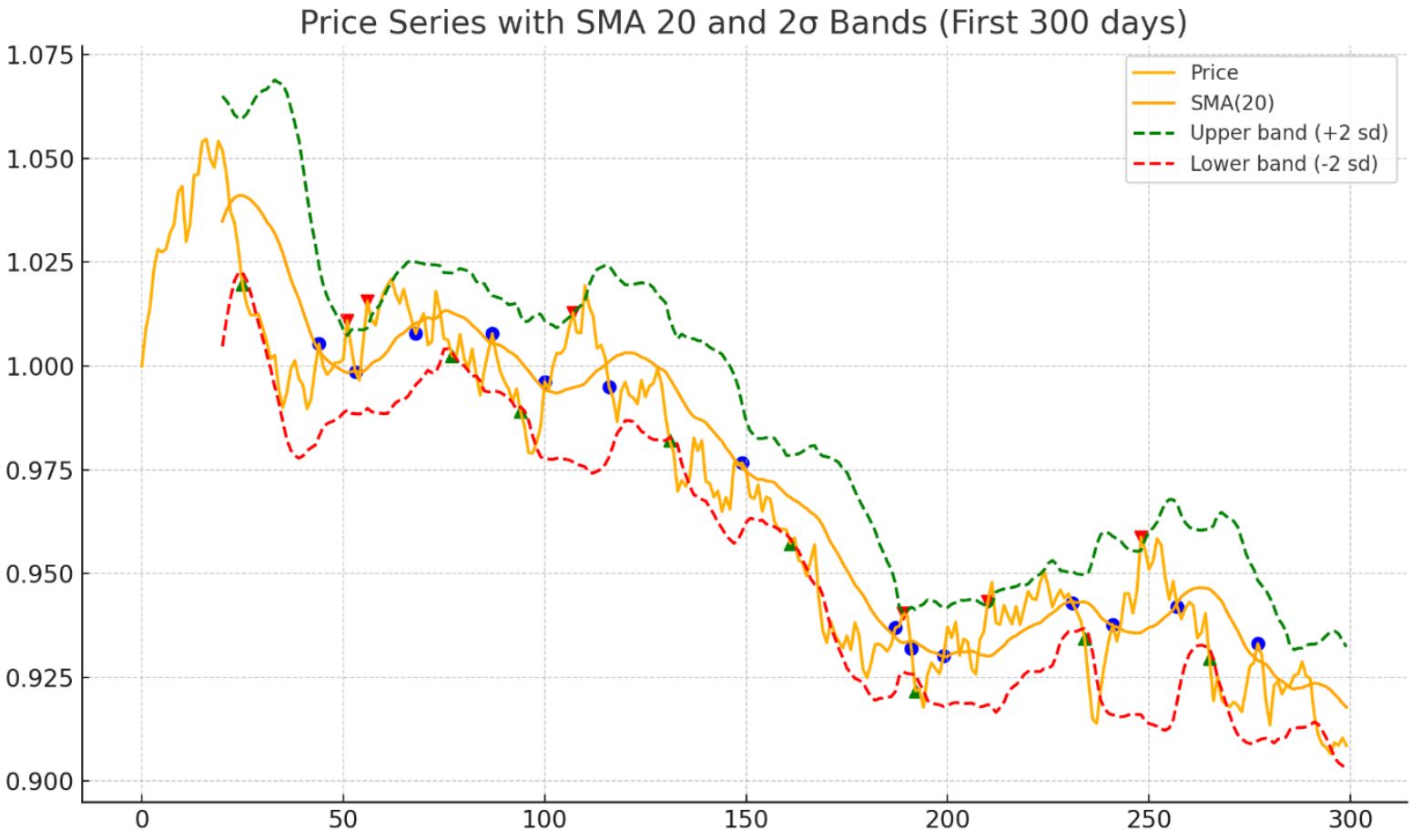
Tested Parameters

MA: 30-200 hours

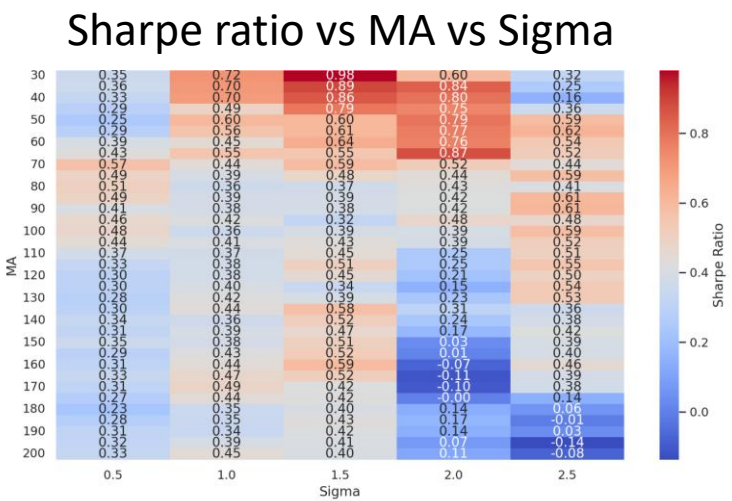
K: 0.5-2.5

Sharpe Ratio, AvgReturn
DS, Max Drawdown

EViews implementation, >600 parameter combinations


Price Series with SMA 20 and 2σ Bands (First 300 days)
Price
SMA(20)
Upper band (+2 sd)
Lower band (-2 sd)
1.075
1.050
1.025
1.000
0.975
0.950
0.925
0.900
0
50
100
150
200
250
300

Results: Sharpe Ratio by MA and Sigma



Key Findings

Optimum at MA 35-50

Sigma (K) = 1.5-2.0

Max Sharpe ≈ 1.0-1.4

Interpretation

Highest Sharpe ratios achieved with relatively shorter moving averages and medium K values

Directional Success

DS ≈ 50-51% – statistically real but not dominant

Color scale: red = higher Sharpe, blue = lower Sharpe

Results by Market Volatility

Low Volatility

Major FX pairs (~5-8% p.a.)

Sharpe: 1.0-1.4 ✓

Max DD: ~15%

DS: ~51%

Annual return: 10-13% p.a.

Medium Volatility

Minor FX pairs (~10-15% p.a.)

Sharpe: 0.8-1.1

Max DD: 20-25%

DS: ~50%

Annual return: single digits %

Commodities, indices (>30% p.a.)

Sharpe: <0.5 ⚠

Max DD: >30%

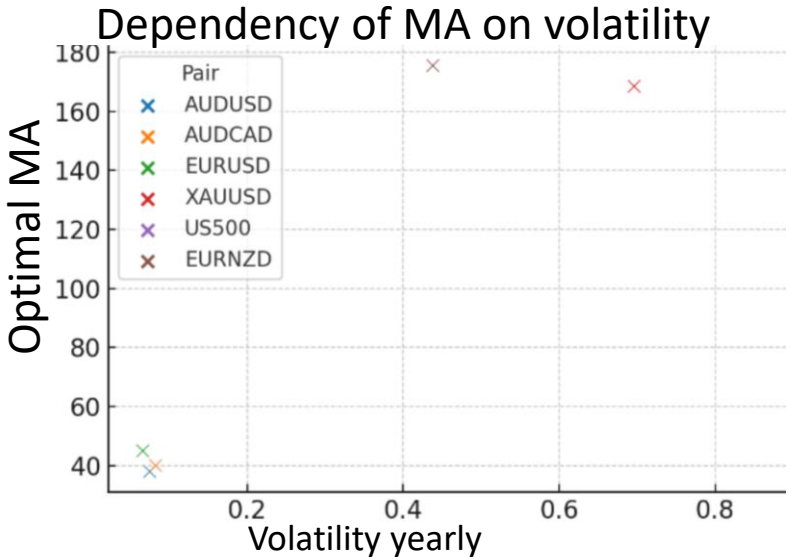
DS: ~50%

Model: 3/σ fails

Hypothesis confirmed: Less volatile markets exhibit more stable mean reversion results with higher Sharpe ratios and lower drawdowns

Tested on 10+ instruments, >600 parameter combinations

Relationship: Optimal MA Length vs Volatility



Empirical Data

Observation: For low volatility, optimal MA is in tens of periods; for high volatility, in hundreds

Currency pair	Length n (days)	Number of trades	Avg profit per trade	Sharpe ratio	Profitable trades(%)	Max. drawdown (%)
EUR/USD	20 days	108	+0,12 %	0,23	69,4 %	-13,8 %
EUR/USD	60 days	84	+0,06 %	0,05	69,0 %	-19,5 %
EUR/USD	120 days	50	+0,17 %	0,07	64,0 %	-21,4 %
USD/JPY	20 days	103	–0,01 %	–0,01	65,0 %	-27,3 %
USD/JPY	60 days	68	+0,73 %	0,57	78,6 %	-12,1 %
USD/JPY	120 days	42	+0,41 %	0,16	71,4 %	-13,7 %

Optimal MA = MA with highest Sharpe ratio for given instrument

Derivation of Predictive Models

Model 1: Simple

$$MAopt = 3 / \sigma$$

Application: Low volatility

Range: $\sigma < 0.10$ (~10% p.a.)

Constant K: ≈ 3.0

Example

EURUSD: $\sigma = 0.066$

$MA = 3 / 0.066 \approx 45$

Model 2: Linear

$$MAopt = a \times \sigma - b$$

Where a = 278.2; b = 21.1

Application: Medium to high volatility

Range: $\sigma \geq 0.10$

R^2: ≈ 0.94

Example

EURNZD: $\sigma = 0.438$

$MA = 278.2 \times 0.438 - 21.1 \approx 100.75$

Linear model derived by least squares method, explains 94% of variability

Comparison of Predictive Models

σ (Volatility)	MA based on 3/σ	MA based on 278.2·σ - 21.1
0.05 (5 %)	60	–7
0.10 (10 %)	30	6
0.20 (20 %)	15	34
0.50 (50 %)	6	118
1.00 (100 %)	3	257

Recommended Approach

σ < 0.10: Use Model 1 (3/σ)

σ ≥ 0.10: Use Model 2 (linear)

Practical Benefit

Eliminates need for extensive testing of hundreds of parameter combinations – just measure volatility

Model 1 underestimates MA for high volatility, Model 2 unreliable for σ < 0.05

Conclusions

Main Findings

Hypothesis confirmed – low-volatility markets more stable. Derived two predictive models (3/σ for σ < 0.10, linear for σ ≥ 0.10). Mean reversion strategy profitable across markets with proper calibration.

Practical Benefits

Fast MA estimation without testing, eliminates overfitting

Scientific Contribution

Generalized formula, empirical confirmation, R^2 = 0.94

Future Research

Multi-factor models, EMA, dynamic ML adaptation

10+ instruments, 5-10 years data, >600 combinations

Thank You

Questions?

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