"Portfolio optimization and Trading Strategies: a simulation approach"

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Workshop on Agent-based Modelling and Policy-Making

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Introduction

- **Portfolio Selection Theory**

  Harry Markowitz (1952)

  CAPM – Sharpe

  Maximization of a portfolio performance index → Sharpe ratio

- **Agent-Based Models in Financial markets**

  Complex system

Sharpe ratio optimization

- **Markowitzian caveats**

  all wealth is allocated

  informative set ⟶ available data

  no interaction

- **Multi-period optimization problem**

12 Heterogeneous strategies

$$argmax_x \quad \frac{E(\boldsymbol{r}_T \cdot \boldsymbol{x}_T)}{sd(\boldsymbol{r}_T \cdot \boldsymbol{x}_T)}$$

$subject\ to$:

$$(1 + \boldsymbol{r}_t \cdot \boldsymbol{x}_t) \cdot W_{t-1} = W_t \qquad t = 1, \dots, T$$

$$x_t \cdot e = 1 \qquad t = 1, \dots, T$$

Fundamentalist

Fundamental value:

$$FV_t = FV_{t-1} + D_t$$

Expectation:

$$p^{exp} = FV_t + \theta_F$$

$$\begin{cases} p_t^{\exp} > p_t^{mkt} \longrightarrow \text{BUY} \\ p_t^{\exp} < p_t^{mkt} \longrightarrow \text{SELL} \end{cases}$$

Chartist

Murphy (1999)

Momentum trader

Expectation:

$$p^{exp} = p_t \pm (p_t - RV_t)$$

$$RV_t = \frac{1}{S}\sum_{j=t-S}^{t} p_j$$

Moving Average Convergence Divergence

Murphy (1999)

$$MACD = EMA^{12d} - EMA^{26d}$$

$$EMA_t^d = EMA_{t-1}^d + w(p_t - EMA_{t-1}^d)$$

$$w = \frac{2}{d+1}$$

MACD-BASIC

$$\begin{cases} MACD > 0 \longrightarrow \text{BUY} \\ MACD < 0 \longrightarrow \text{SELL} \end{cases}$$

MACD-PLUS

$$\begin{cases} MACD > EMA^{9d} \longrightarrow \text{BUY} \\ MACD < EMA^{9d} \longrightarrow \text{SELL} \end{cases}$$

MACD-DIVERGENCE

$$\begin{cases} \alpha_S < 0 \wedge \alpha_M > 0 \longrightarrow \text{BUY} \\ \alpha_S > 0 \wedge \alpha_M < 0 \longrightarrow \text{SELL} \end{cases}$$

Crossover

Murphy (1999)

$$\begin{cases} EMA^{26d} < min(EMA^{20d};\ EMA^{12d}) \longrightarrow \text{BUY} \\ EMA^{26d} > max(EMA^{20d};\ EMA^{12d}) \longrightarrow \text{SELL} \end{cases}$$

RSI

Murphy (1999)

Relative Strength Index (Wilder)

$$RSI = 100 - \left(\frac{100}{1 + RS}\right)$$

Comparison between the trend of the RSI series referred to the entire original price series and the trend of the RSI series referred to a given interval of observation

Stochastica

Murphy (1999)

$$K = 100 \cdot \frac{C - L5}{H5 - L5}$$

$$D = 100 \cdot \frac{H3}{L3}$$

$$\left\{ \begin{array}{c} K > 80 \wedge D > 80 \\ 20 < K < 80 \wedge D > 80 \\ K > 80 \wedge 20 < D < 80 \end{array} \right. \qquad \left\{ \begin{array}{c} 20 < K < 80 \wedge 20 < D < 80 \\ K < 20 \wedge 20 < D < 80 \\ 20 < K < 80 \wedge D < 20 \\ K < 20 \wedge D < 20 \end{array} \right.$$

BUY **SELL**

ROC

Murphy (1999)

Rate of Change

$$ROC = \frac{V}{V_x}$$

$$\left\{ \begin{array}{l} ROC \geq 1 + c \longrightarrow \textbf{BUY} \\ ROC < 1 + c \longrightarrow \textbf{SELL} \end{array} \right.$$

Random

No portfolio optimization strategy

Econometric forecasting

OLS estimation

- Linear:

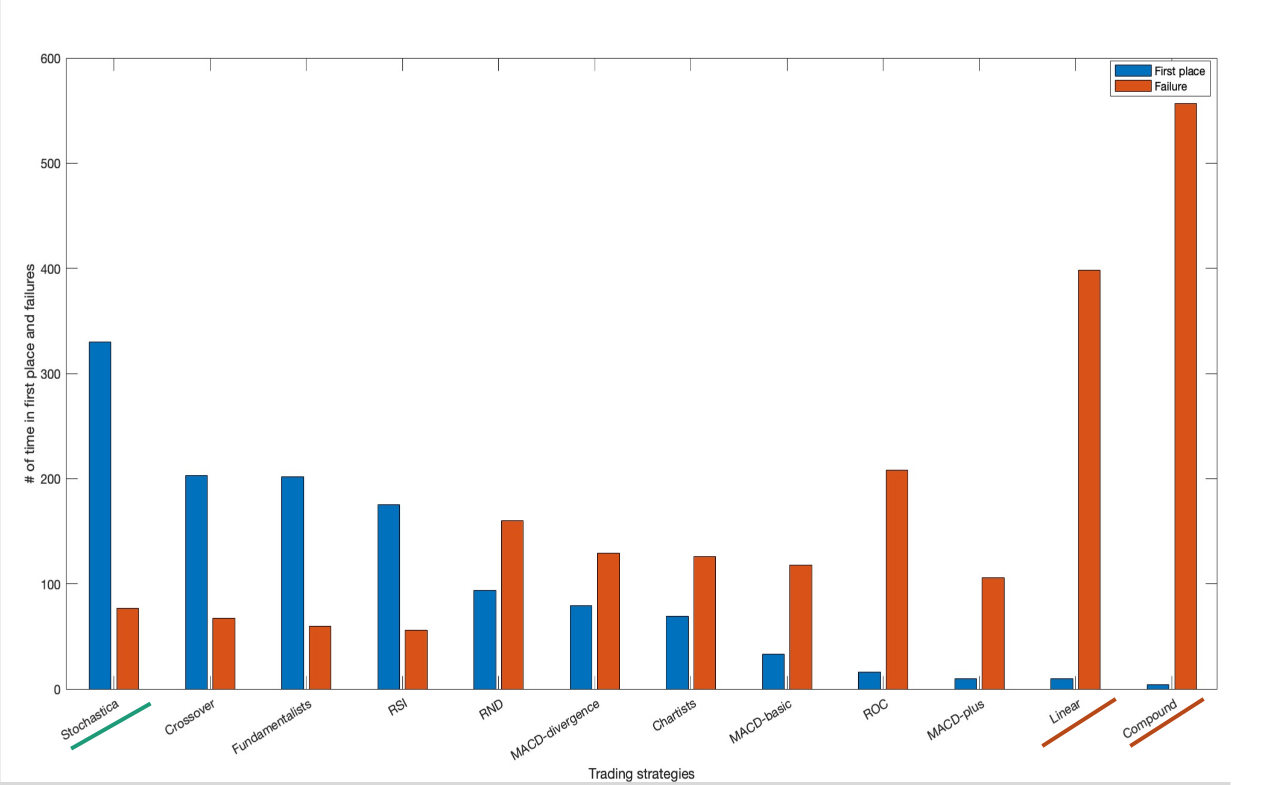
$$Y = a + b \cdot t$$

- Compound:

$$Y = c \cdot d^t$$

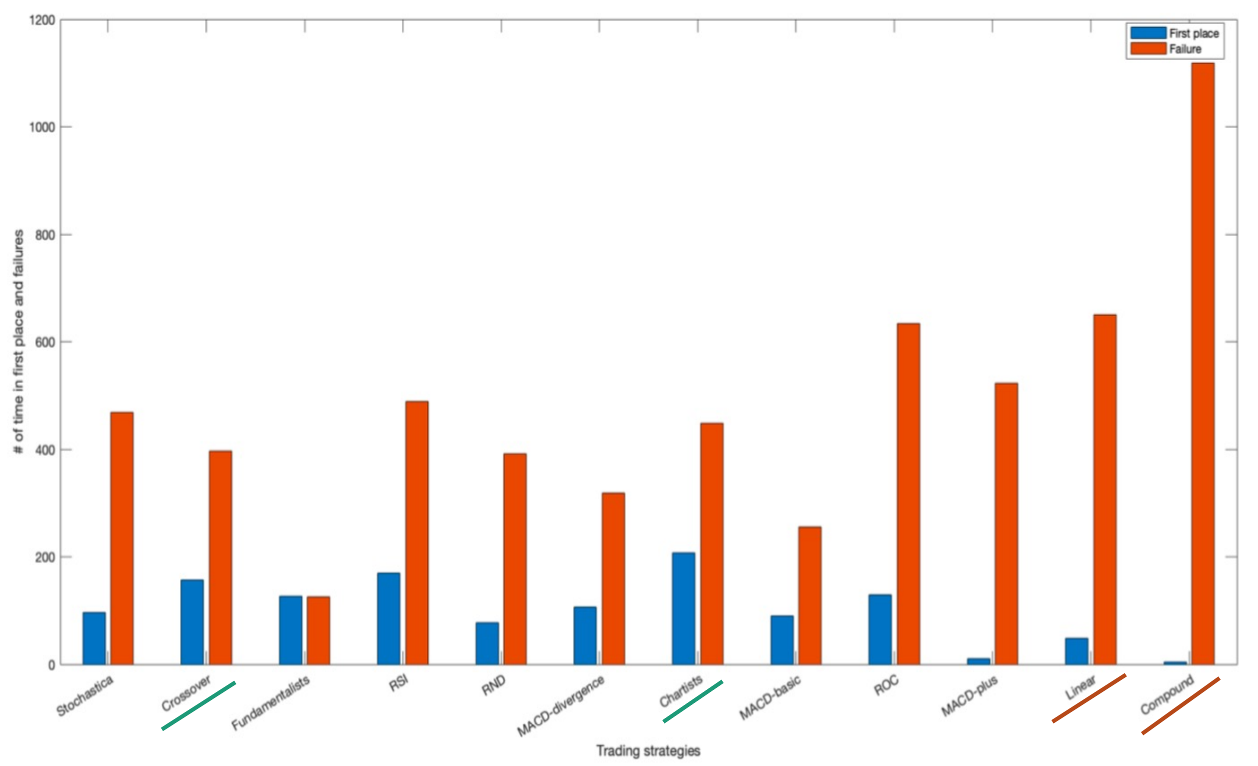
Results: Ranking

- 50 assets
- 12 heterogeneous traders
- 250 $ of initial money
- 1225 portfolios



Daily data

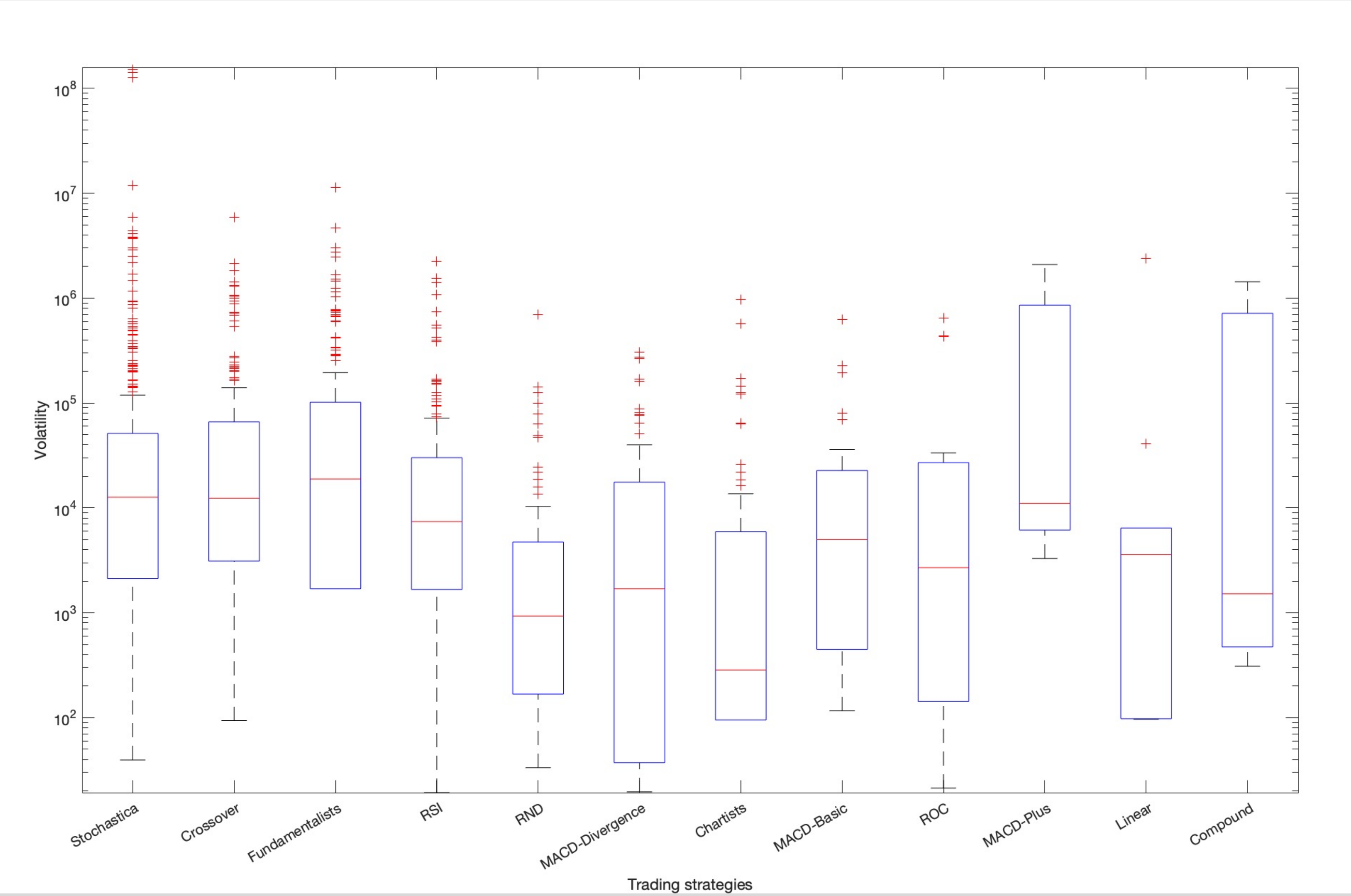
Hourly data



Results: Volatility

The volatility of the best performing strategy has been computed as the standard deviation of the distribution of portfolio values associated to that strategy for all occurrences in which it has ranked first.

This **figure compares the volatility** of all winning strategies



Conclusions

There are no concordant rankings of various strategies at different time lengths resolution.

This provides evidence <u>that optimal strategies are more a desire of investors </u>than actual results

The complexity of the system prevents any forecast and so past trends need not be replicated.

Even best performing strategies manifest wide variability

Variability of results is not simply linked to the goodness of the adopted strategy.

All strategies are uncertain and potentially harmful.

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