

The Science of Technical Analysis

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Status Quo

- **Efficient markets**

Lefevre (1874)

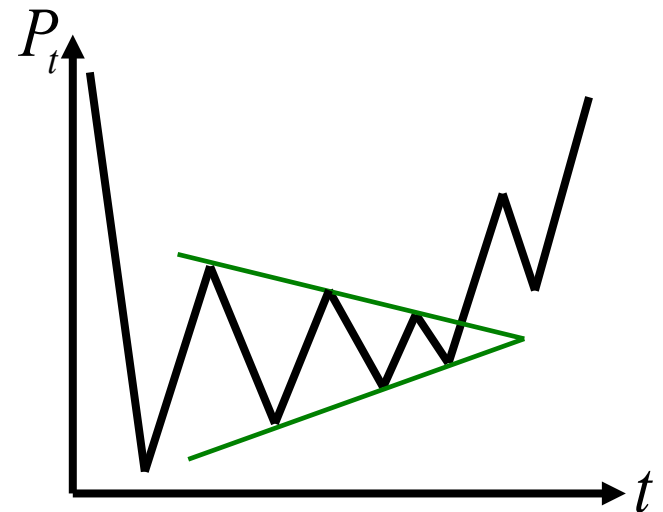
Bachelier (1900)

Fama (1965)

Samuelson (1965)

$$E \left[\Delta^n Y (T, t) \right] \equiv 0$$

- **Technical analysis**



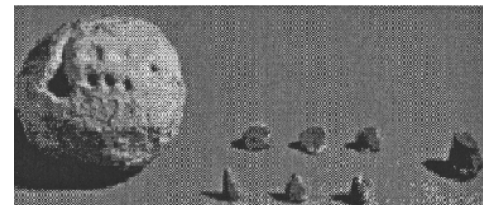
- Large gap between academics and practitioners

Broad Study of Technical Analysis

[H. Lo 2003-present]

- Past

Historical study: Place in context



The Evolution of Technical Analysis, Lo H. 2010

- Present

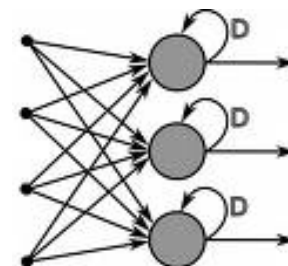
Interviews with practitioners: Understand what it is

The Heretics of Finance, Lo H. 2009



- Future

Science: Standardize and extend



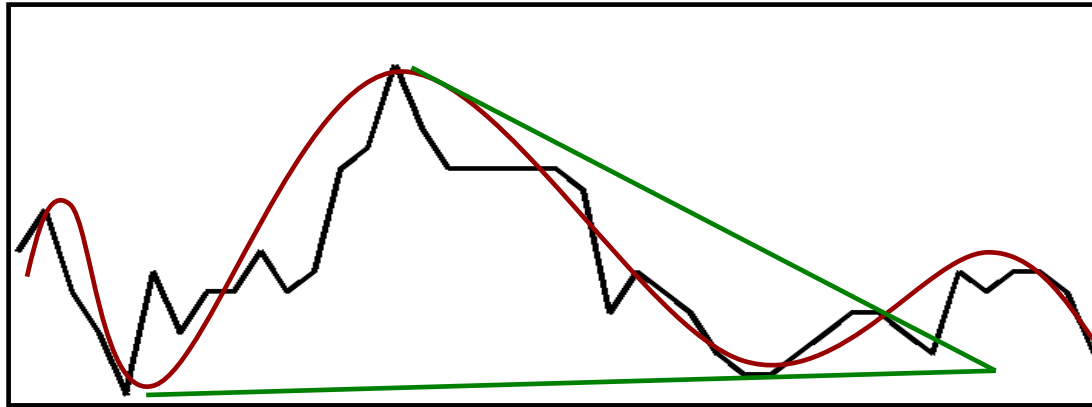
Quantitative Approach to Technical Analysis, Lo H. to appear

Outline

- Standardize: Make precise
- Extend: New indicators

Standardization

- Visual pattern recognition is subjective:



Head & Shoulders (HS) or **Triangle Bottom** (TBOT)?

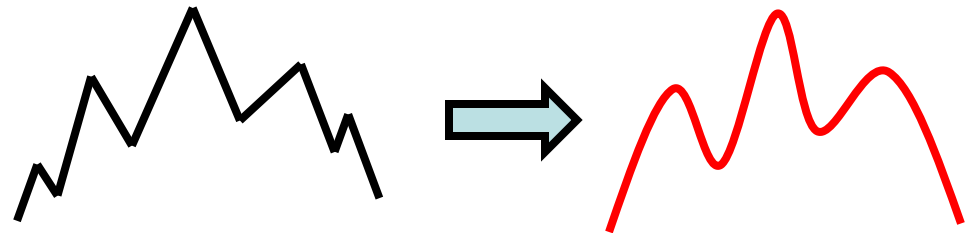
- Quantitative theory [Levy '71, Kirkpatrick Dahlquist '06, Aronson '07; Lo Mamaysky Wang '00, H. '07]

Foundations of Technical Analysis

Lo Mamaysky Wang '00, *Journal of Finance*

Standardize and evaluate technical analysis:

- Smoothing the data
 - Kernel regression



- Pattern recognition:

Consider 10 patterns: HS, TBOT, BBOT, ...

Define patterns as sequences of local extrema

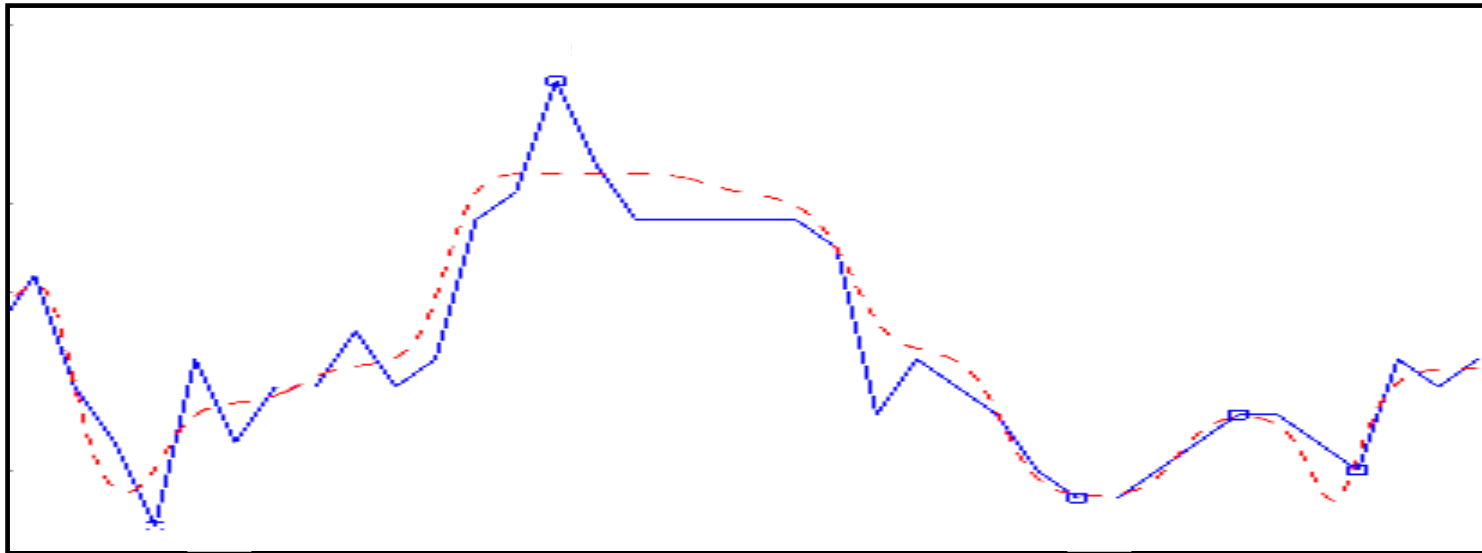
- Statistical evaluation \Rightarrow patterns are informative

Our Work

H. '07, MIT Ph.D. Thesis

Study robustness of [Lo et al. '00] results:

- Use **neural networks** to smooth the data
Parameters based on interviews with practitioners
40-observations rolling window, 7 - 18 nodes



Our Work

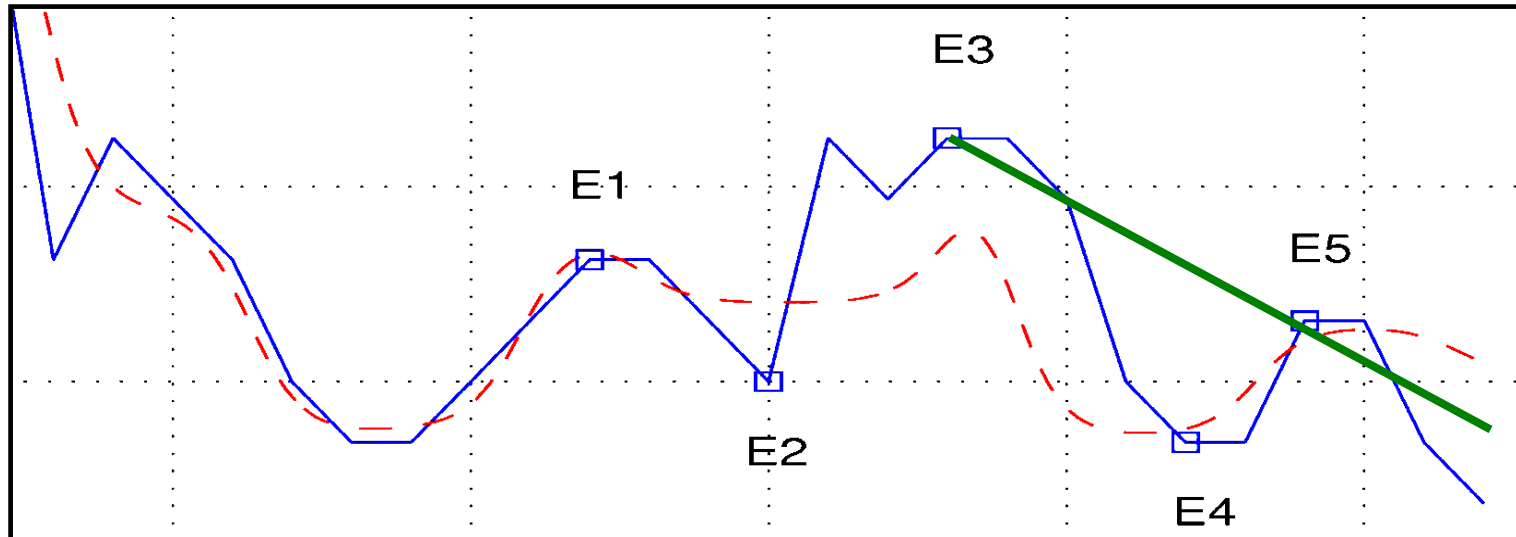
H. '07, MIT Ph.D. Thesis

- Formalize patterns as sequence of extrema

E.g. Head & Shoulders ,

$\exists E_1, \dots, E_5 : E_1 \text{ max.} \ \& \ E_3 > E_1 \ \& \ E_3 > E_5 \ \& \ E_1 \sim E_5 \ \& \ E_2 \sim E_4$

- Pattern Variations: Ends when **neckline** is broken



Goodness-of-Fit Diagnostics

- Other work: Profitability evaluation
[Pruitt White '88; Chang Osler '94;...]
- Our approach: Gauge pattern information content
Compare returns and post-pattern returns
- Entire sample of returns: R_t

Post-pattern returns:

$R_t^{\text{HS}} := \{ R_t : \text{Head-and-shoulders ended at time } t-1 \}$

Test $R_t \sim R_t^{\text{HS}} \Rightarrow \text{Head-and-shoulders informative}$

Our Results

- Goodness-of-fit diagnostics:

| Pattern | Decile | | | | | | | | | | Q |
|--------------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| HS | 12.0 | 13.2 | 8.8 | 7.0 | 8.2 | 14.0 | 4.7 | 8.2 | 10.9 | 13.0 | 63.58 |
| <i>p-val</i> | 0.072 | 0.004 | 0.263 | 0.007 | 0.109 | 0.000 | 0.000 | 0.109 | 0.409 | 0.006 | 0.000 |
| TBOT | 13.5 | 8.6 | 6.5 | 5.0 | 9.4 | 22.9 | 7.9 | 6.0 | 7.3 | 12.9 | 215.16 |
| <i>p-val</i> | 0.001 | 0.180 | 0.001 | 0.000 | 0.590 | 0.000 | 0.043 | 0.000 | 0.009 | 0.005 | 0.000 |
| BBOT | 12.0 | 6.9 | 6.2 | 10.2 | 7.2 | 17.3 | 13.9 | 6.0 | 8.5 | 11.8 | 71.61 |
| <i>p-val</i> | 0.114 | 0.013 | 0.002 | 0.856 | 0.028 | 0.000 | 0.002 | 0.001 | 0.223 | 0.149 | 0.000 |
| ⋮ | | | | | | | | | | | |

- Conclusion: All patterns are informative
 - Regardless of smoothing, pattern variant
- Results in accord with [Lo et al. '00]

Outline

- Standardize: Make precise
- Extend:
New indicators for 130/30 funds and hedge funds

Extensions

- Technical indicators should evolve with markets
- Recall: “The Rydex funds reflect hedge-fund activity which is the driving force in the market.” (Deemer)
- **New (first)** indicators for hedge funds [[H. Lo '07](#)] and **130/30 funds** [[H. Lo Patel '09](#)]

130/30 Funds

- Assets in 130/30 funds at \$50 billion in 2007
- 130/30 vs. long-only:
new risks (shorting, leverage), new premia
- Can 130/30 be captured passively?
- We create **transparent, algorithmic** portfolio with 130/30 risk exposures => **index**, no alpha

CS 130/30 Index

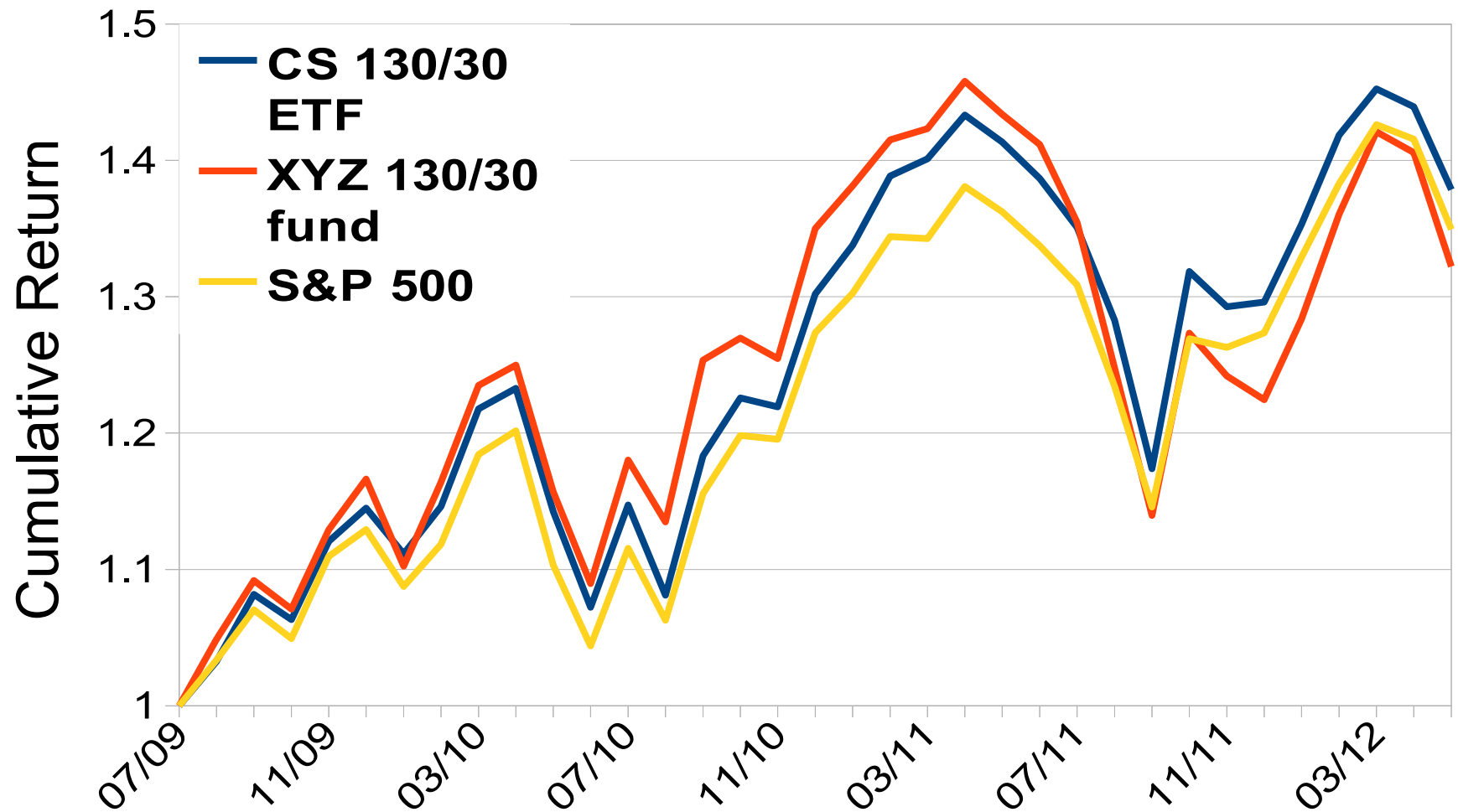
[H. Lo Patel '09, Credit Suisse White Paper]

- **Transparent** factors rank S&P 500 stocks: B/P, RSI...
- Benchmark to S&P 500 ($\beta = 1$, 1–3% tracking error)
- Integrated optimization: Maximize transfer coefficient
130/30 \neq 100/0 (long-only) + 30/30 (market neutral)



CS 130/30 ETF

- Passive 130/30 ETF as index for active funds



Outline

- Standardize: Make precise
- Extend:
New indicators for 130/30 funds and hedge funds

Hedge Funds

- Hedge funds are the driving force of the market
- Price to hedge-fund access:
Secrecy, high fees, routine lock-ups
- Can hedge funds be captured passively?
- We create **transparent, algorithmic** portfolio with hedge-fund-like risk exposures => **index**, no alpha

Our Work

[H. Lo '07, *Journal of Investment Management*]

- There are multiple betas each with its own factor:
stocks, bonds, currencies, commodities, credit
- Express hedge-fund returns in terms of those betas
Use a **linear regression** model
- Other work: [Kat Palaro '05, '06a,b]
Goal is to replicate distribution, not returns

Our Model

- Estimate **linear regression** model

$$R_t = \beta_1 \text{SP500}_t + \dots + \beta_5 \text{CMDTY}_t + \epsilon_t$$

$$\text{s.t. } 1 = \beta_1 + \dots + \beta_5$$

- Construct a hedge-fund “clone”

$$\tilde{R}_t = \hat{\beta}_1 \text{SP500}_t + \dots + \hat{\beta}_5 \text{CMDTY}_t$$

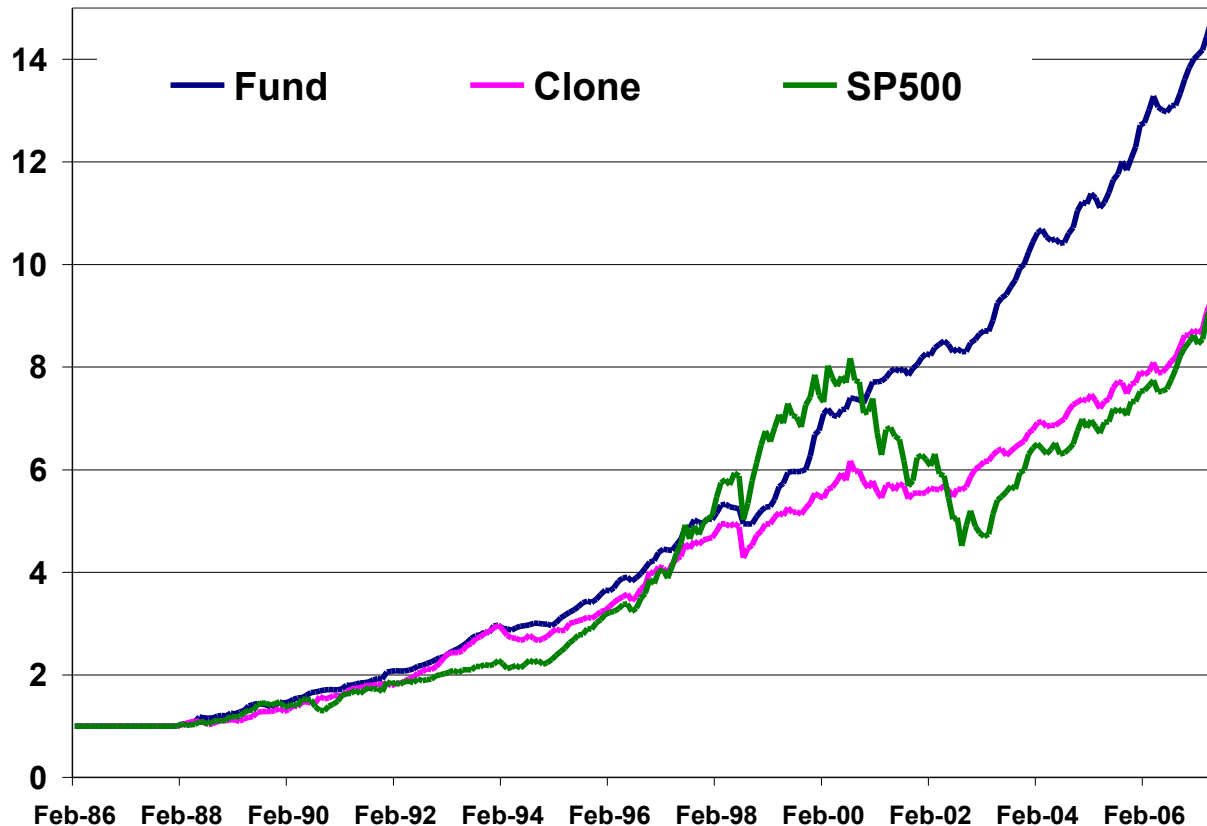
$$\hat{R}_t = \tilde{R}_t \times \gamma$$

$$\gamma \equiv \sigma(R) / \sigma(\tilde{R})$$

- Implement γ via **futures** and $\hat{\beta}_j < 0$ via short sales

Our Results

- Equal-weighted clones as **indicator for hedge funds**
 - 2,700 hedge funds, 20 yrs of monthly data



Conclusion

Science of technical analysis:

- Framework for **standardization** and evaluation of technical indicators [H. '07]
- **Extensions**: New indicators
 - CS 130/30 index [H. Lo Patel '09]
 - Hedge-fund index [H. Lo '07]
 - Transparent algorithm** is next generation of **indicators**

Thank you!