

# The Science of Technical Analysis

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# Status Quo

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- **Efficient markets**

Lefevre (1874)

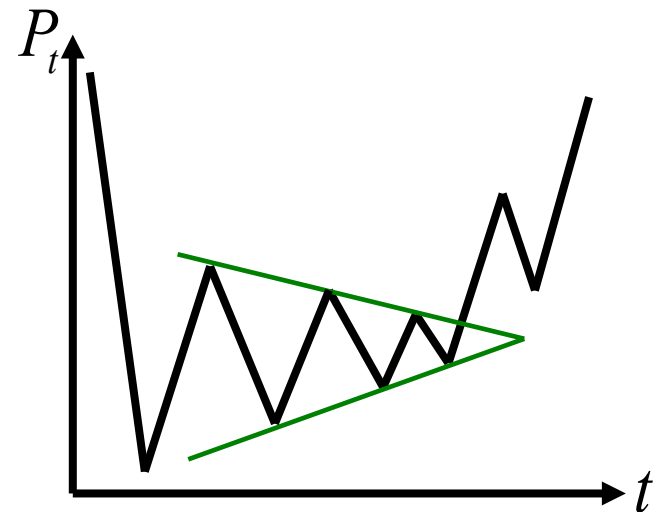
Bachelier (1900)

Fama (1965)

Samuelson (1965)

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

- **Technical analysis**



- Large gap between academics and practitioners

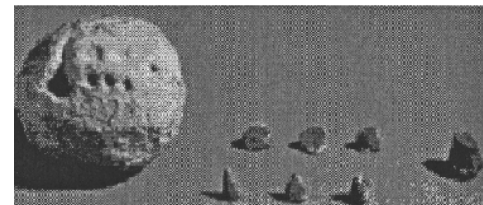
# Broad Study of Technical Analysis

[H. Lo 2003-present]

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- Past

Historical study: Place in context



*The Evolution of Technical Analysis*, Lo H. 2010

- Present

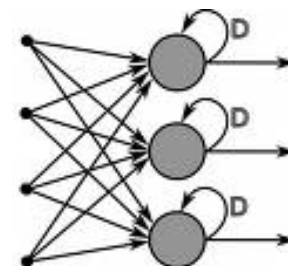
Interviews with practitioners: Understand what it is

*The Heretics of Finance*, Lo H. 2009



- Future

Science: Standardize and extend



*Quantitative Approach to Technical Analysis*, Lo H. to appear

# Outline

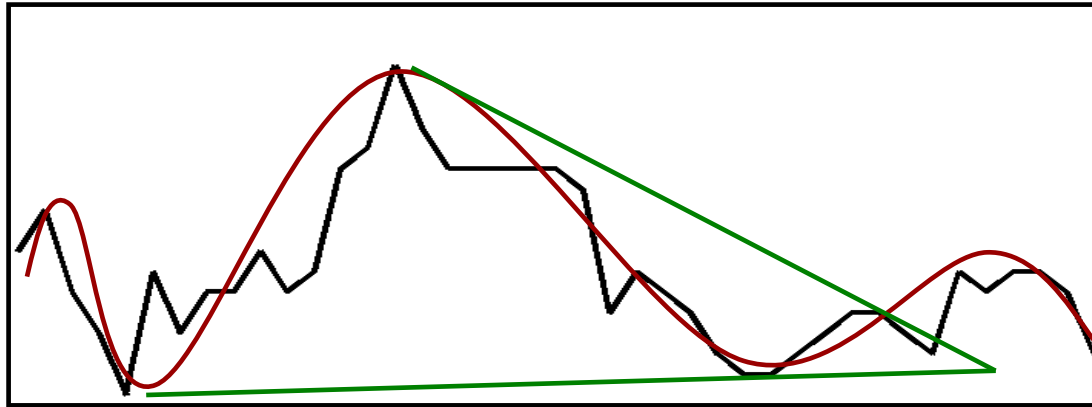
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- Standardize: Make precise
- Extend: New indicators

# Standardization

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- 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]

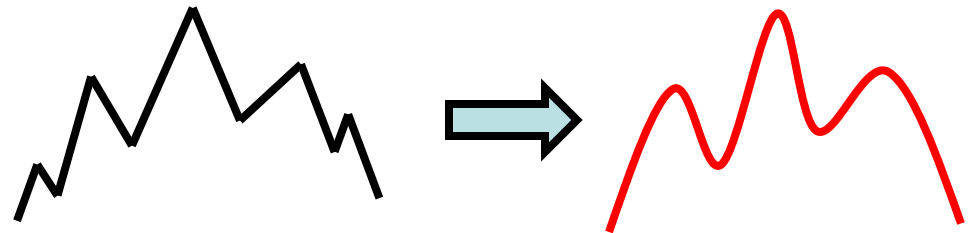
# Foundations of Technical Analysis

Lo Mamaysky Wang '00, *Journal of Finance*

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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

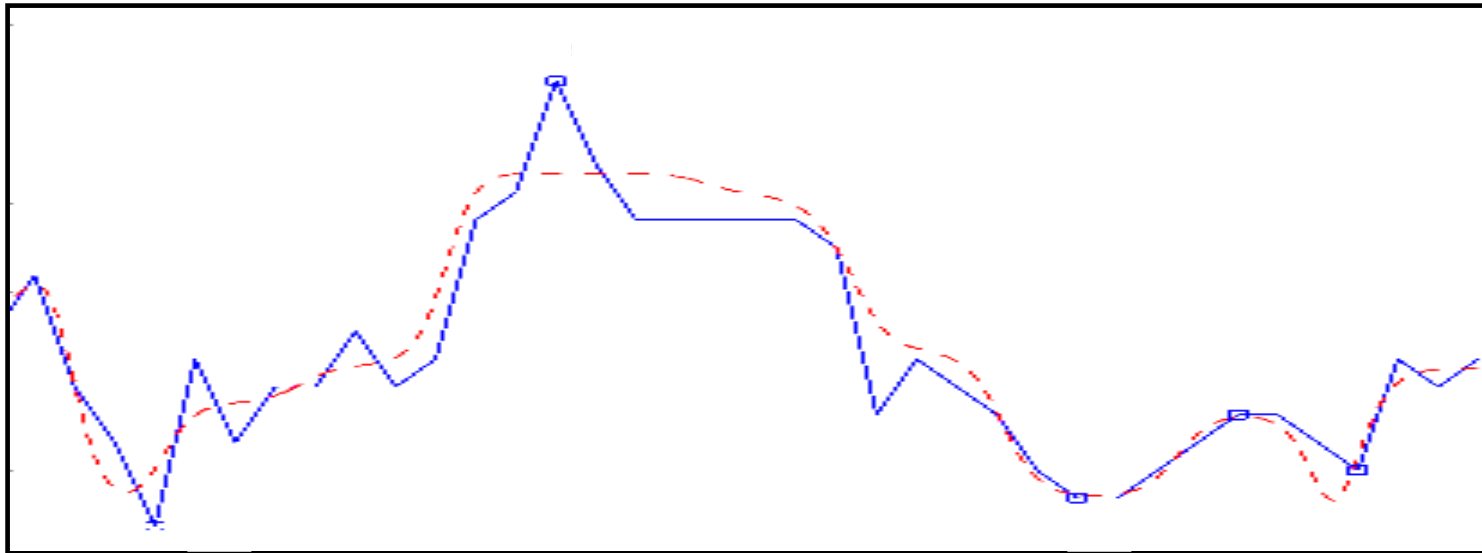
# Our Work

H. '07, MIT Ph.D. Thesis

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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

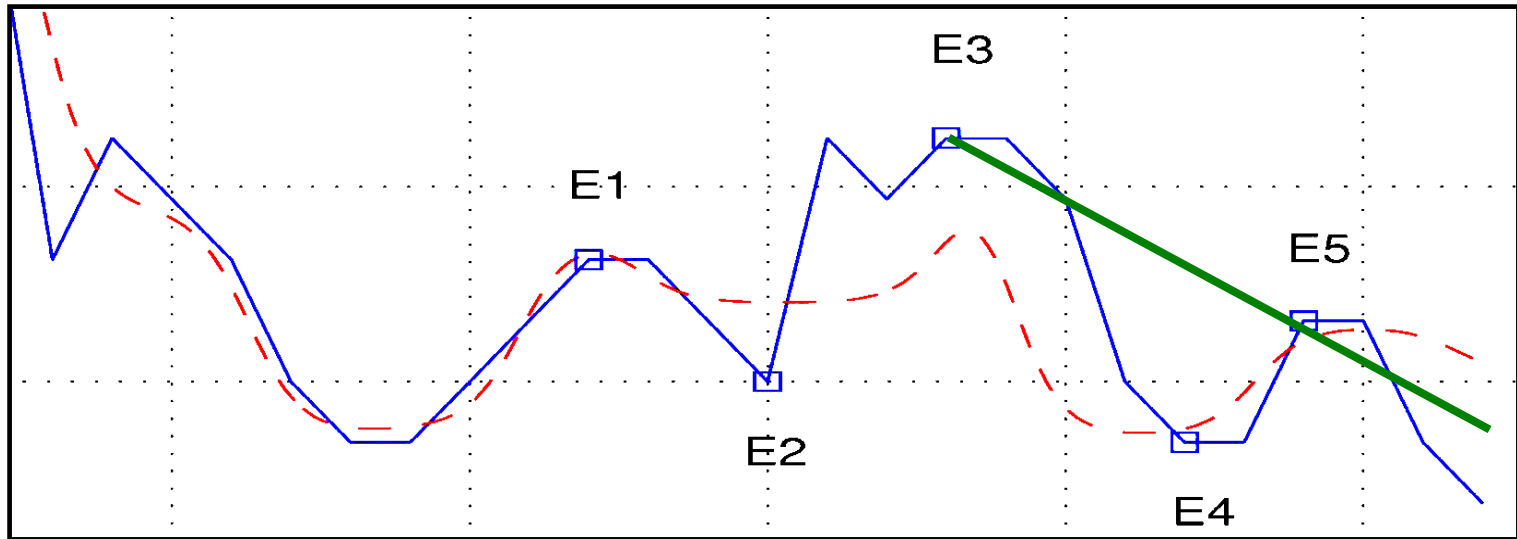
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- Formalize patterns as sequence of extrema

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

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- 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	
<b>HS</b>	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
<b>TBOT</b>	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
<b>BBOT</b>	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

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

# Extensions

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- 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

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- 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

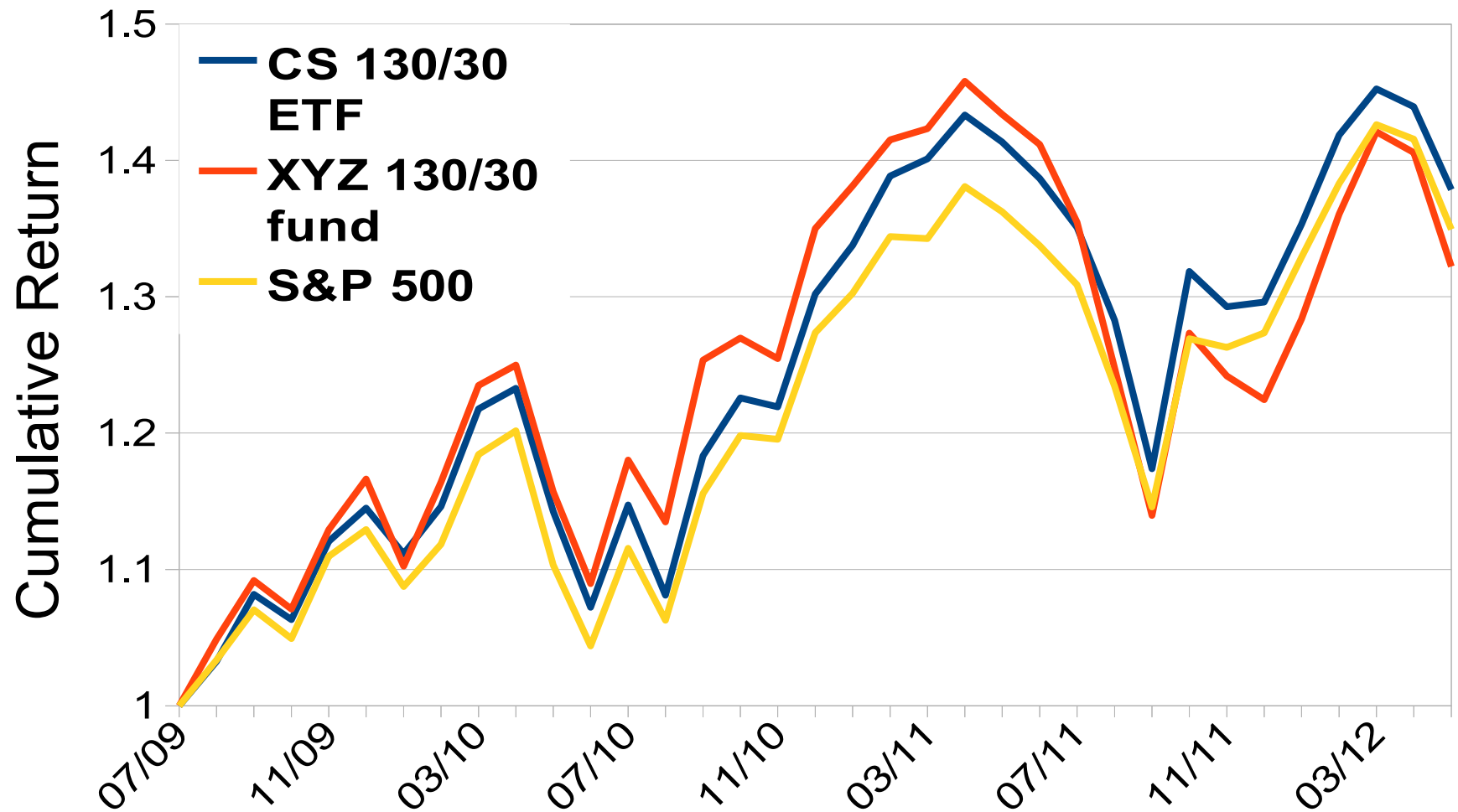
[H. Lo Patel '09, Credit Suisse White Paper]

- **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

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



# Hedge Funds

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- 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*]

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- 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

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- 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”

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

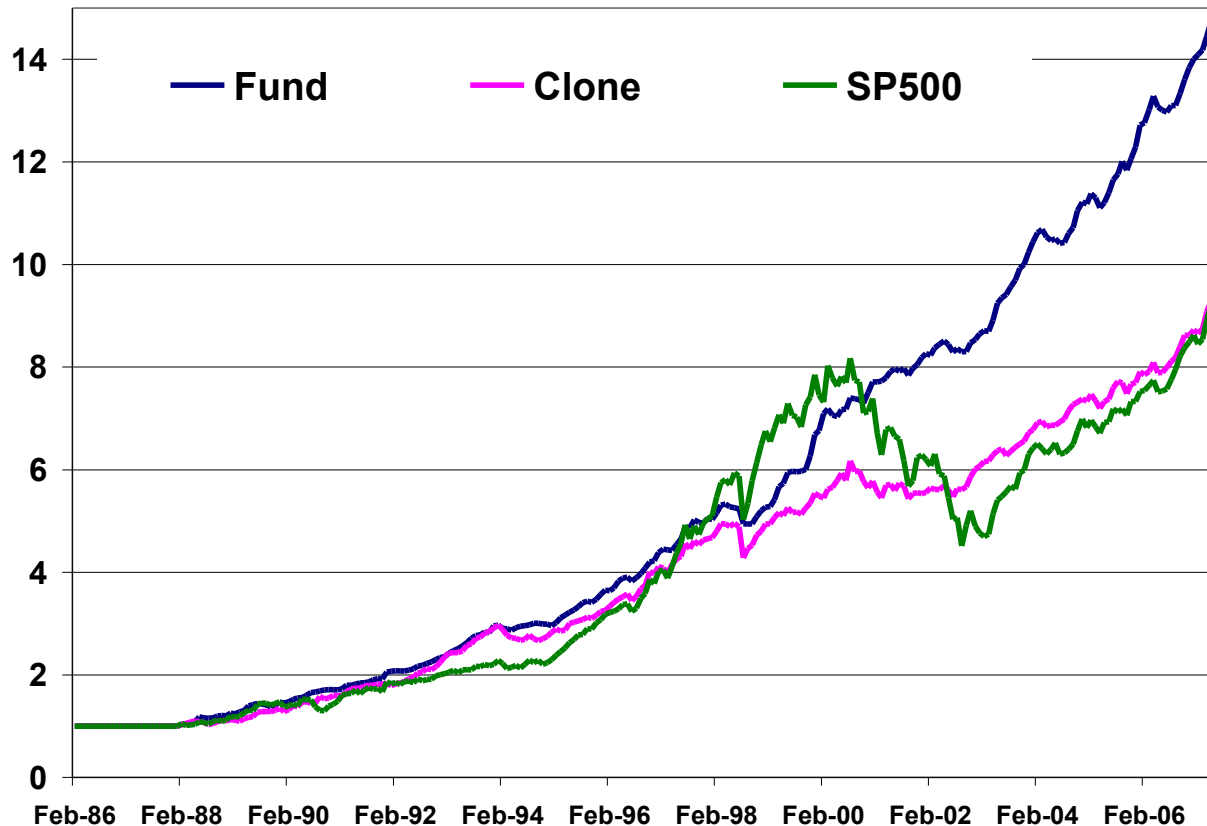
$$\hat{R}_t = \tilde{R}_t \times \gamma$$

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

- Implement  $\gamma$  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

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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!