

Technical Analysis: Past, Present, and Future

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Status Quo

- **Efficient markets**

Lefevre (1874)

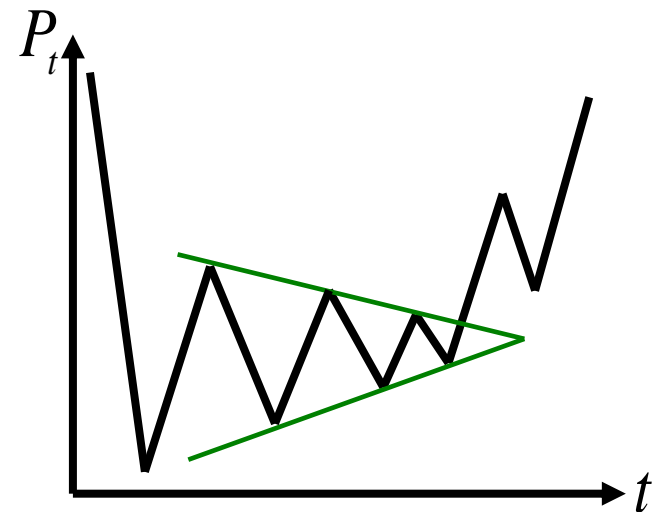
Bachelier (1900)

Fama (1965)

Samuelson (1965)

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

- **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

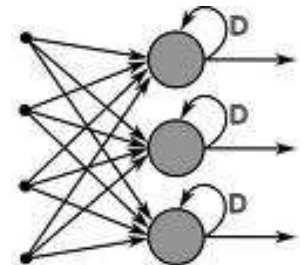
The Heretics of Finance, Lo H. 2009



■ Future

Science: Standardization and extensions

Quantitative Approach to Technical Analysis, Lo H. to appear



Outline

- Past: History
- Present: Interviews
- Future: Science



From Technical Analysis...

- **7th c. BC Babylon:** Evidence from price diaries
Intraday prices recorded when volatility is high [Slotky '97]

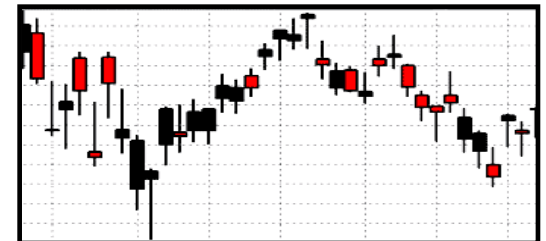
- **17th c. Holland:** *Confusion de Confusiones*
[de la Vega]

“For on this point we are all alike;
when the prices rise, we think they
will run away from us.”



- **18th c. Japan:** *The Fountain of Gold*
[Homma]

“When all are bearish, there is
a cause for prices to rise.”



...to Behavioral Finance

- **19th c. China:** *Essential Business*

[Wang Bingyuan]

“When goods become extremely expensive, then they must become inexpensive again.”



- **20th c. USA:** *The Wall Street Journal*

[Dow]

“It is a bull period as long as the average of one high point exceeds that of previous high points.”



- **1955:** *A Behavioral Model of Rational Choice*

[Herbert Simon]

“Rational behavior compatible with computational capacities”

Outline

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In the Words of Masters

- On market inefficiency

Raschke: Let's take the Renaissance Medallion Fund. What more proof do you need?

Weinstein: I don't know of any successful traders who don't acknowledge that charts and trends are helpful.

In the Words of Masters

- On behavioral finance

Acampora: That's the problem—it's not with what we do, it's how we say it.

Murphy: Academics are now basically copying what we do, renaming it, and trying to take credit for it.

In the Words of Masters

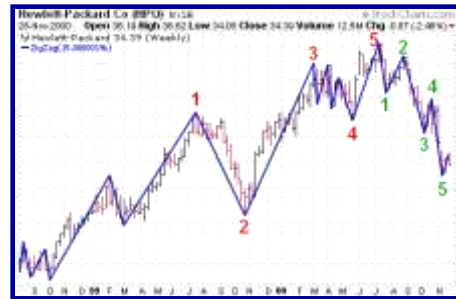
- On changing markets

Dudack: There is a greater amount of noise in daily market action today, primarily generated by hedge-fund managers. We need to measure the market differently.

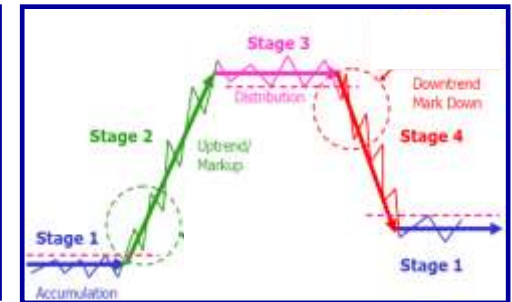
Deemer: I am convinced that the Rydex funds reflect the hedge-fund trading activity which is the driving force in the market.

Interviews

- Topics: Beginnings, style, favorite patterns
- Historical value
- Variety of methods...



Elliott wave



Weinstein's

- ...but ultimately converge to basics: patterns

Outline

- Past: History
- Present: Interviews
- Future: Science
Theory
Standardization
Extensions



Theoretical Framework

- Bounded rationality:
limited resources

[Simon '55]

Hard to make rigorous,
but **intuitive**

- Efficient markets: price
changes are **random**

[Fama, Samuelson '65]

Rigorous model,
but **counterintuitive**

- Are stock returns really a coin flip?



What is Randomness?

- Which sequence is random?



$S_1 = H, H, H, H, H, H, H, H, H, H$

$S_2 = T, H, T, H, H, T, H, T, T, T$

- Paradox: $\text{Prob}(S_1) = \text{Prob}(S_2) = 1/2^{10}$
- Solution: Ask what **looks**, **not is** random
 \Rightarrow **behavioral** randomness

From Randomness to Finance

- Randomness Theory

Classical (1812):
expectations

Behavioral (1960-now):
computationally
bounded algorithms

- Finance Theory

Classical (1874-1965):
efficient markets

Behavioral (1955-now):
bounded rationality

Future: **Computational market efficiency** [H. Lo Viola '09]

Outline

- Past: History
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Theory
Standardization: Video game
Extensions



Definition

- Technical analysis:
Use of historical prices to predict the next price

- Past: Naked eye

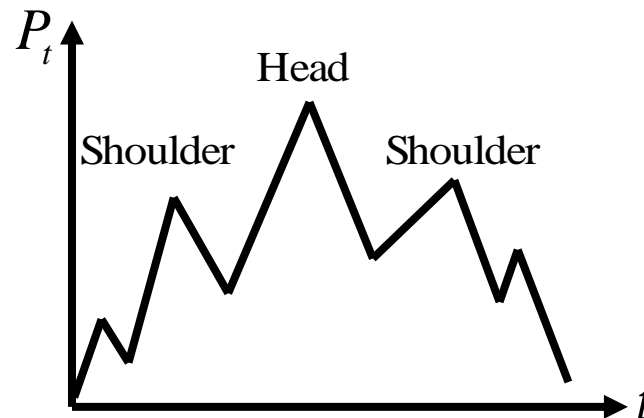


- Future: Statistics



Technical vs. Quantitative Analysis

- **Technical analysis** critics:
Data order shouldn't matter

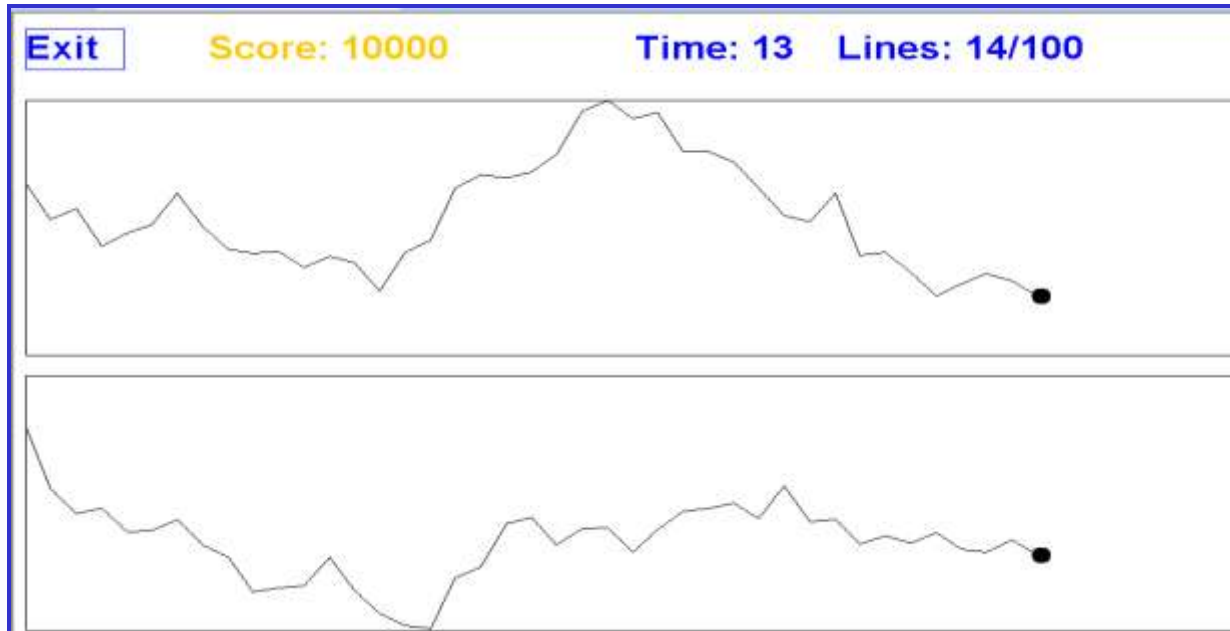


- **Quantitative analysis**: Data order also matters!
Negative return \Rightarrow higher volatility
Rolling-window regressions
...
■ Does order matter?

Does Order Matter?

- Tell market data from randomly permuted data
[H. Lo Viola '09]

Video game **ARORA: A Random Or Real Array**



<http://www.ccs.neu.edu/home/viola/arora/>

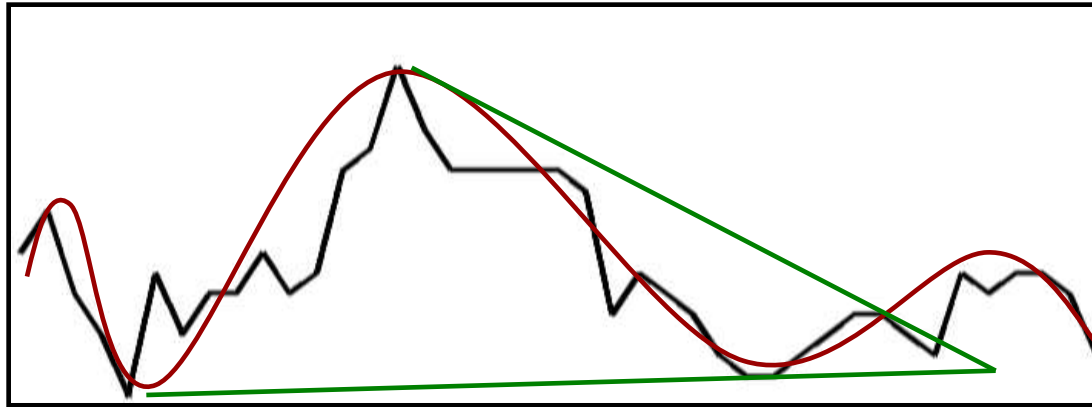
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Standardization: Make precise
Extensions



Standardization

- Visual pattern recognition is subjective:



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

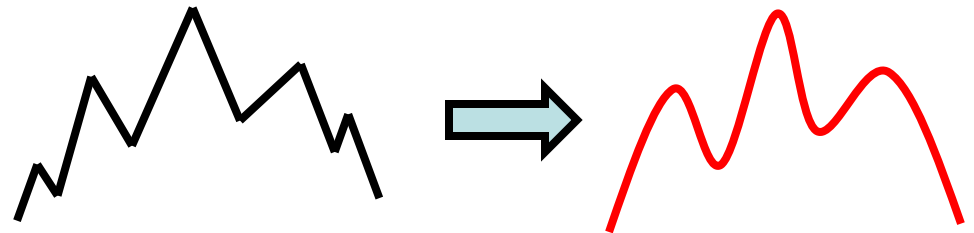
- Quantitative theory [Levy '71, Kirkpatrick Dahlquist '06, Aronson '07; Lo Mamaysky Wang '00, H. '07]

Foundations of Technical Analysis

Lo Mamaysky Wang '00, *Journal of Finance*

Standardize and evaluate technical analysis:

- Smoothing the data
 - Kernel regression



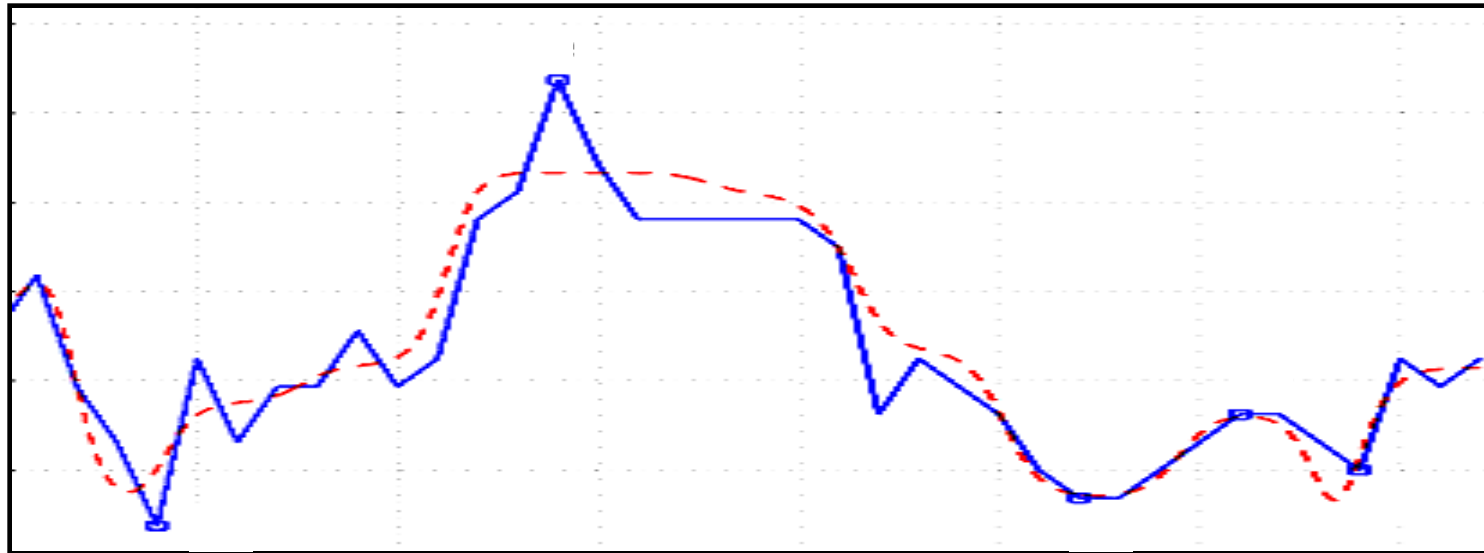
- Pattern recognition:
 - Consider 10 patterns: HS, TBOT, BBOT, ...
 - Define patterns as sequences of local extrema
- Statistical evaluation \Rightarrow patterns are informative

Our Extension

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 Extension

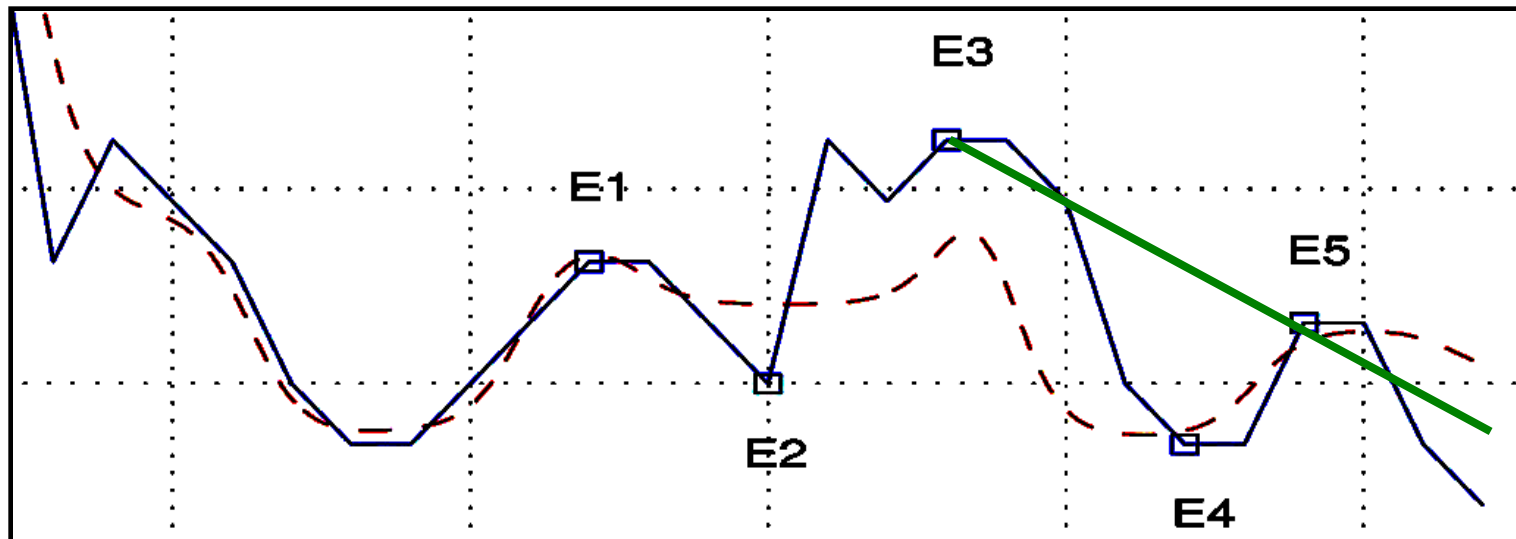
H. '07, MIT Ph.D. Thesis

- Formalize patterns as sequence of extrema

E.g. Head & Shoulders \Leftrightarrow

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

- 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]

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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]

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”

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

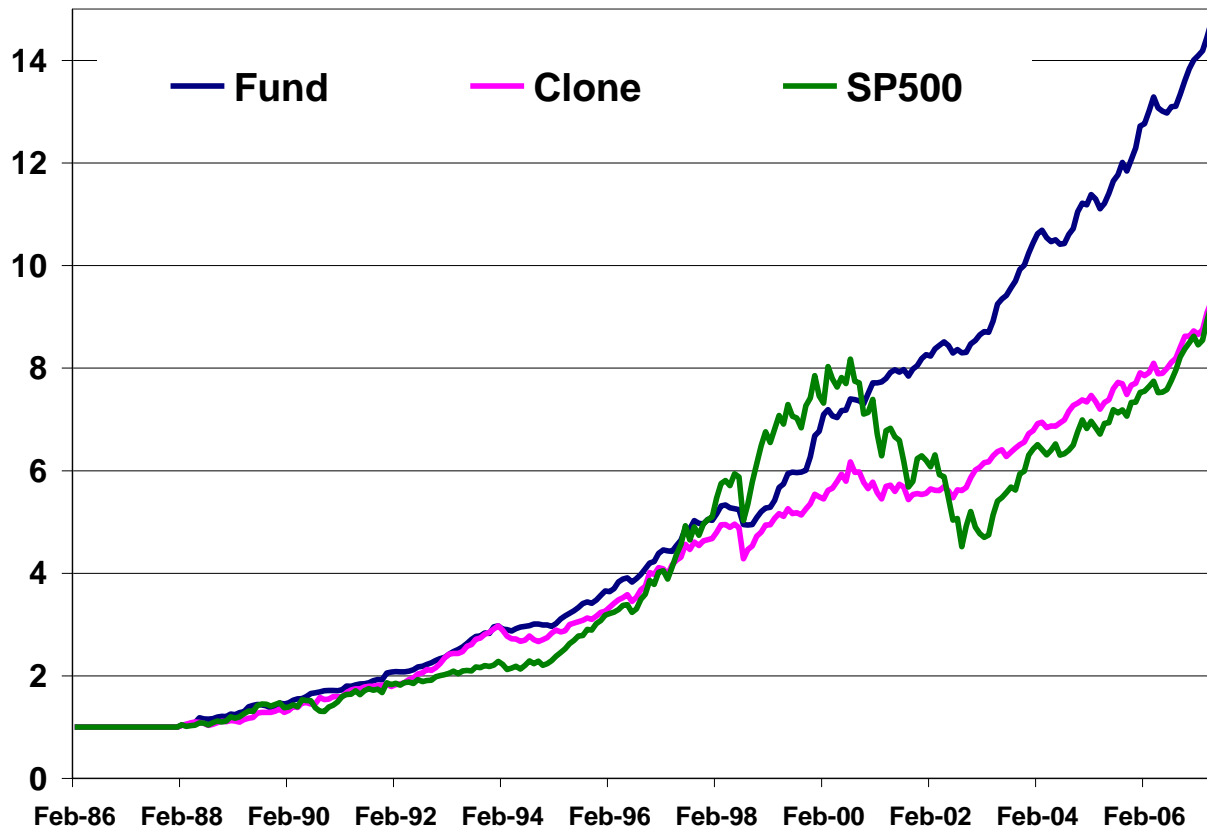
$$\hat{R}_t = \tilde{R}_t \times \gamma$$

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

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

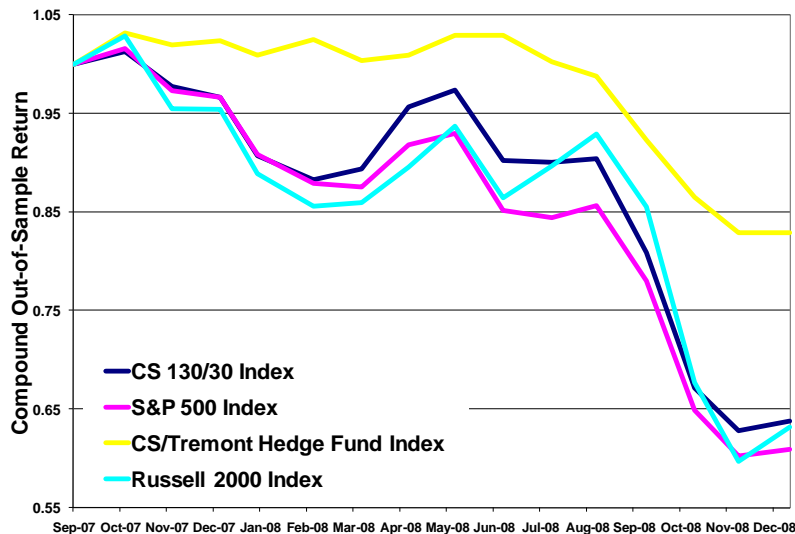
Our Results

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



Other New Indicators

- 130/30 assets at \$50 billion and growing
 - CS 130/30 Index, ProShares 130/30 ETF
- [H. Lo Patel '09, <http://credit-suisse.com/indices/13030>]



- Dynamic indexes are next generation of indicators

Conclusion

Broad study of technical analysis [H. Lo 2003-present]

- Past: A force through history
- Present: Wisdom from the masters
- Future: Theory, standardize, extend



Thank you!