Technical Analysis: Past, Present, and Future

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MTA Educational Web Series
October 6, 2009
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

\[ P_t \]

\[ t \]
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 [Slotsky ’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

- Past: History
- Present: Interviews
- Future: Science
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.
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...
- ...but ultimately converge to basics: patterns

Elliott wave  Weinstein’s
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?

\[ S_2 = T,H,T,H,H,T,H,T,T,T,T \]

- Paradox: \( \text{Prob}(S_1) = \text{Prob}(S_2) = \frac{1}{2^{10}} \)

- Solution: Ask what looks, not is random
  \[ \Rightarrow \text{behavioral randomness} \]
<table>
<thead>
<tr>
<th>Randomness Theory</th>
<th>Finance Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Classical</strong> (1812): expectations</td>
<td><strong>Classical</strong> (1874-1965): efficient markets</td>
</tr>
<tr>
<td>Behavioral (1960-now): computationally bounded algorithms</td>
<td>Behavioral (1955-now): bounded rationality</td>
</tr>
</tbody>
</table>

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

- Past: History

- Present: Interviews

- Future: Science
  - 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/
Outline

- Past: History

- Present: Interviews

- Future: Science
  - Theory
  - 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]
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** → 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 $\Leftrightarrow$
  $\exists E_1, \ldots, E_5 : E_1 \text{ max.} \& E_3 > E_1 \& E_3 > E_5 \& E_1 \sim E_5 \& E_2 \sim E_4$

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

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

- **Goodness-of-fit diagnostics:**

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

- **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
  \[ R_t = \beta_1 SP500_t + \cdots + \beta_5 CMDTY_t + \epsilon_t \]
  s.t. \[ 1 = \beta_1 + \cdots + \beta_5 \]

- Construct a hedge-fund “clone”
  \[ \tilde{R}_t = \hat{\beta}_1 SP500_t + \cdots + \hat{\beta}_5 CMDTY_t \]
  \[ \hat{R}_t = \tilde{R}_t \times \gamma \]
  \[ \gamma \equiv \sigma(R)/\sigma(\tilde{R}) \]

- 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
Other New Indicators

- 130/30 assets at $50 billion and growing
- CS 130/30 Index, ProShares 130/30 ETF
  

- 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!