LASSE HEJE PEDERSEN

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**STATISTICS AND INVESTMENTS**

➢ EFFICIENTLY INEFFICIENT

    – what does it mean?

➢ HOW SMART MONEY INVESTS
   & MARKET PRICES ARE DETERMINED

    – The economic problem
    – The statistical problem



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**EFFICIENTLY INEFFICIENT**

HOW SMART MONEY INVESTS &
MARKET PRICES ARE DETERMINED
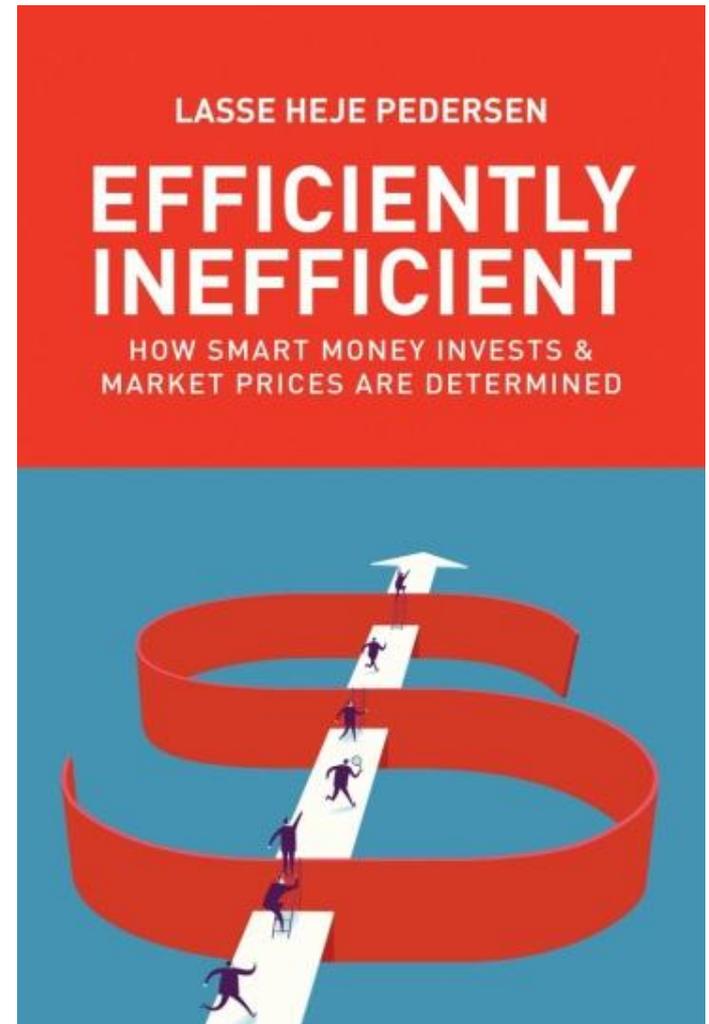
➢ Market efficiency: at the heart of financial economics

➢ Nobel Prize 2013 awarded to Eugene Fama, Lars Hansen, and Robert Shiller "for their empirical analysis of asset prices"

**Markets are <u>efficiently inefficient</u>**

➤ Markets must be
- **inefficient enough** that active investors are compensated for their costs
- **efficient enough** to discourage additional active investing

➤ Said differently
- **You must be efficient to beat the market by exploiting its inefficiencies**

➤ Investment implications

| Market Efficiency | Investment Implications |
| --- | --- |
| Efficient market hypothesis | Passive investing |
| Inefficient market | Active investing |
| Efficiently inefficient markets | Active investing by those with comparative advantage |

➤ <u>Economic problem</u>

$$\max_{x} \mathrm{E}_t(W_{t+1}) - \frac{\gamma}{2}\mathrm{var}_t(W_{t+1})$$

where the wealth $W$ depends on the portfolio $x$

$$W_{t+1} = x_t^1(1+R_{t+1}^1) +\ldots+ x_t^S(1+R_{t+1}^S) + (W_t - \sum x_t^S)(1+R_t^f)$$

$$= x_t^1(R_{t+1}^1 - R_t^f) +\ldots+ x_t^S(R_{t+1}^S - R_t^f) + W_t(1+R_t^f)$$

➤ <u>Equivalently</u>

$$\max_{x} x'\mu_t - \frac{\gamma}{2}x'\Omega_t x$$

with

$$\mu_t = \mathrm{E}_t(R_{t+1}^1 - R_t^f, \ldots, R_{t+1}^S - R_t^f)'$$

$$\Omega_t = \mathrm{var}_t(R_{t+1}^1 - R_t^f, \ldots, R_{t+1}^S - R_t^f)$$

➤ <u>Solution:</u>

$$x = \frac{1}{\gamma}\Omega_t^{-1}\mu_t$$

➤ <u>Complications</u>: transaction costs, position limits, other measures of risk, dynamics, …

➤ Recall
$$\mu_t = \quad \text{E}(R^1_{t+1} - R^f_t, \ldots, R^S_{t+1} - R^f_t \mid \text{all data available at time } t)\text{'}$$

$$\Omega_t = \text{var}(R^1_{t+1} - R^f_t, \ldots, R^S_{t+1} - R^f_t \mid \text{all data available at time } t)$$

➤ <u>Statistical problem:</u>

Estimate expected excess returns $\hat{\mu}_t$ and risk $\widehat{\Omega}_t$

➤ <u>Data:</u>
  – The history of stock prices and returns (starting in 1926 in the US, e.g.)
  – All accounting information at all dates, earnings, book values, dividends, …
  – Global macro data
  – Possibly helpful structure: economic theory

➤ <u>Initial considerations</u>
  – Given that prices are close to Brownian motions with time-varying drift and volatility:
  – Using high-frequency data gets us a good estimate of the risk $\widehat{\Omega}_t$ (monthly, daily, hourly, 5 minutes)
  – Excess returns $\hat{\mu}_t$ are difficult: require long time series to recover $E(\hat{\mu}_t)$ and $\hat{\mu}_t$ much harder

# INVESTMENT APPROACH VS. USEFULNESS OF STATISTICS

| INVESTMENT PROBLEM | COMMON APPROACH | Time horizon |
|---|---|---|
| **Strategic asset allocation** | Economics, long-term means | *Long-term* |
| **Tactical asset allocation** | Economics, judgement | |
| **Security selection** | Economics, statistics | |
| **Statistical arbitrage** | Arbitrage relations, <span style="color:red">statistics</span> | |
| **High-frequency trading** | <span style="color:red">Statistics</span>, engineering | *Short-term* |

# HOW DO YOU BEAT THE MARKET?

## Investment Strategies

### Equity Strategies
(Chapter 6)

- Discretionary Long-Short Equity (Chapter 7)
- Short Bias (Chapter 8)
- Quant Equity (Chapter 9)

### Macro Strategies
(Chapter 10)

- Global Macro (Chapter 11)
- Managed Futures (Chapter 12)

### Arbitrage Strategies
(Chapter 13)

- Fixed Income Arb. (Chapter 14)
- Convertible Bond Arb. (Chapter 15)
- Event-Driven Arb. (Chapter 16)
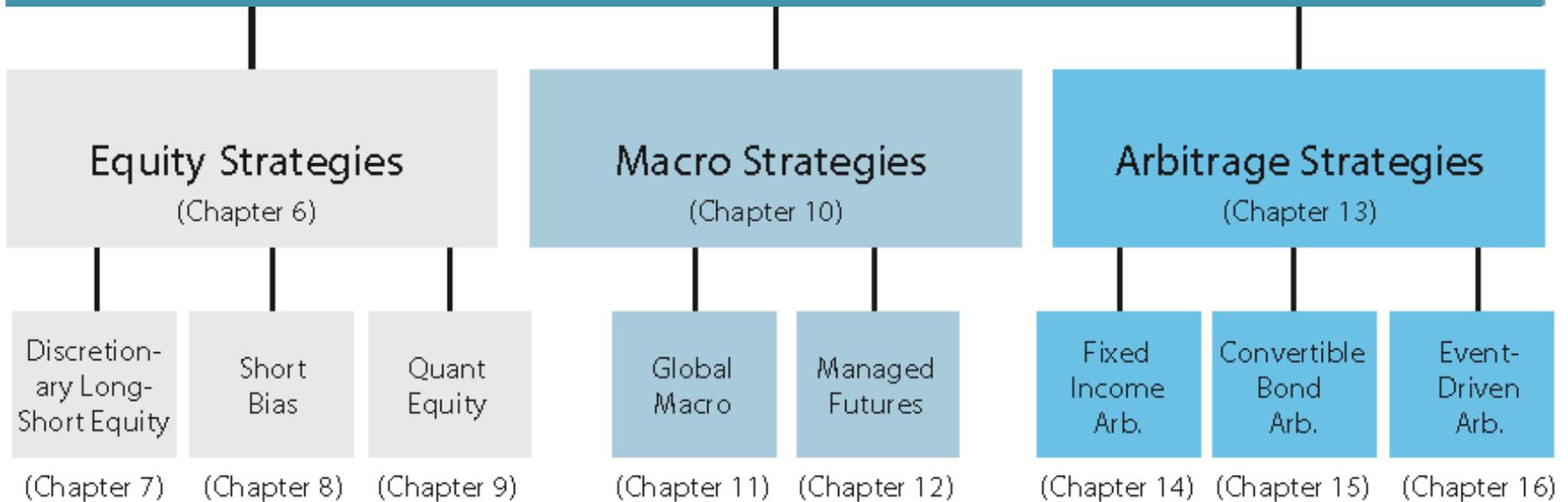
Ainslie    Chanos    Asness    Soros    Harding    Scholes    Griffin    Paulson

**JULIAN ROBERTSON**
FOUNDER & FORMER CEO, TIGER MANAGEMENT

We are really trying to look out two or three years in every industry in which we invest, trying to identify who's winning and losing

**Lee Ainslie**
Maverick Capital

1. **First and foremost, the quality of management**
   - Neostar: management ended up bankrupting what should have been a great opportunity
2. **Second is the quality of the business**
   - persistence of cash flows, drivers and sustainability of growth
   - talking to competitors, suppliers, and customers, many members of management
3. **Finally, valuation**
   - sustainable free cash flow to enterprise value

# SHORT SELLING

**A star has fallen**
Enron share price, $

Shorted Nov. 2000

Source: Thomson Financial Datastream
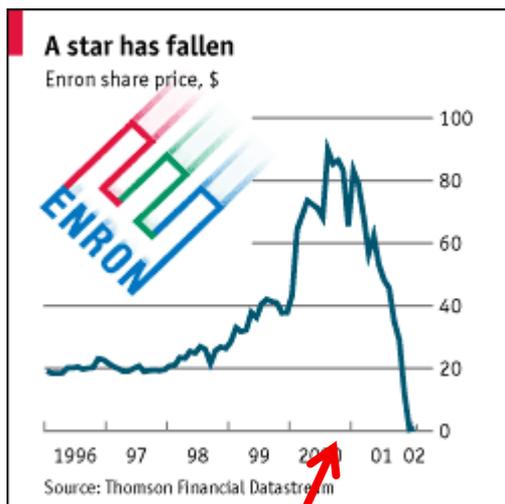
**James Chanos**
Kynikos Associates

Our interest in Enron was piqued
- "gain-on-sale" accounting
- mismatch of cost of capital and return on inv.
- cryptic disclosure re. "related party transactions"
- large amount of selling by senior executives
- analysts at Wall Street firms: "trust me" story

Difficulties to short-selling:
- The market generally goes up
- You have to borrow the share
- You have less advantageous tax treatment
- No one likes you
    → good short sellers are born, not made
But all these difficulties create the opportunity

Of the major financial frauds of the past 25 years, almost every single one of them has been uncovered by an internal whistle blower, a journalist, or a short seller. Not outside auditors. Not outside counsel. Not law enforcement.
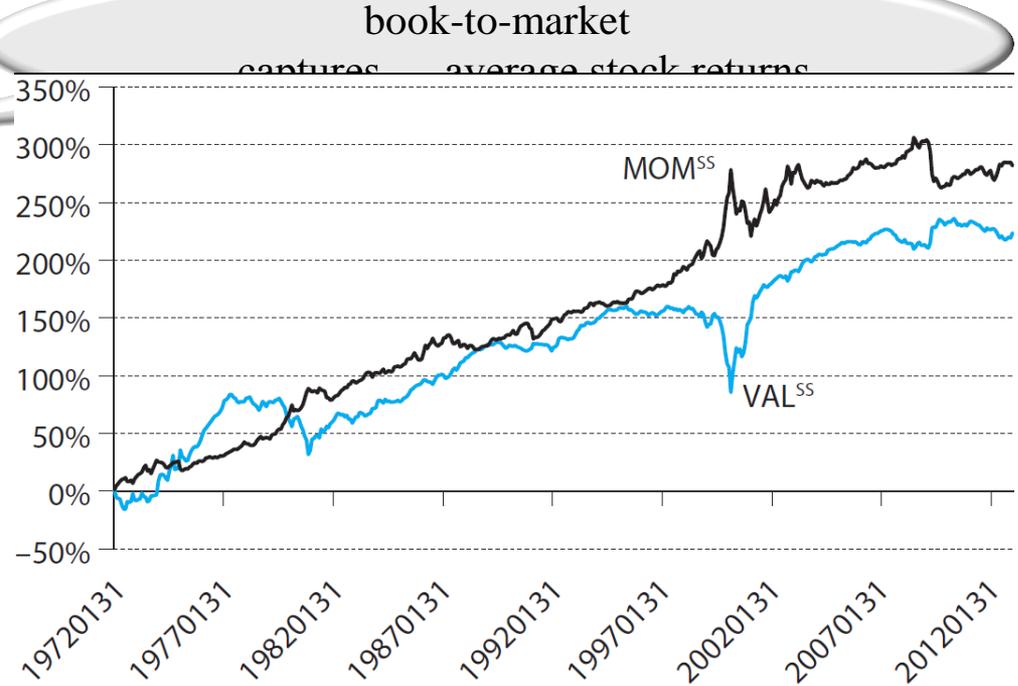
➤ Time-series regression

$$R_{t+1} = a + bF_t + \varepsilon_{t+1}$$

Regression coefficient = profit of a timing strategy based on $F$

$$\hat{b} = \frac{\sum_t (F_t - \bar{F})R_{t+1}}{\sum_t (F_t - \bar{F})^2} = \sum_{t=1}^{T} x_t R_{t+1}$$

Almost equivalent to sorting returns over time based on $F$

➤ Cross-sectional panel regression

$$R_{t+1}^i = a + bF_t^i + \varepsilon_{t+1}^i$$

Regression coefficient = profit of a security-selection strategy based on $F$

$$\hat{b}_t = \frac{\sum_i (F_t^i - \bar{F}_t)R_{t+1}^i}{\sum_i (F_t^i - \bar{F}_t)^2} = \sum_i x_t^i R_{t+1}^i$$

Average coefficient = Fama–MacBeth (1973) estimate

$$\hat{b} = \frac{1}{T}\sum_{t=1}^{T} \hat{b}_t \qquad \hat{\sigma} = \sqrt{\frac{1}{T-1}\sum_{t=1}^{T}(\hat{b}_t - \hat{b})^2} \qquad t-\text{statistic} = \sqrt{T}\,\frac{\hat{b}}{\hat{\sigma}} = \sqrt{T}\ \text{SR}$$

Almost equivalent to sorting security returns at a given time based on their characteristics $F$
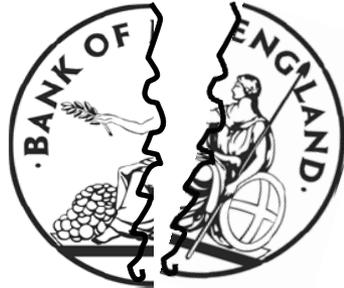
➢ Simple regression evidence

$$r_t^s / \sigma_{t-1}^s = \alpha + \beta_h r_{t-h}^s / \sigma_{t-h-1}^s + \varepsilon_t^s$$
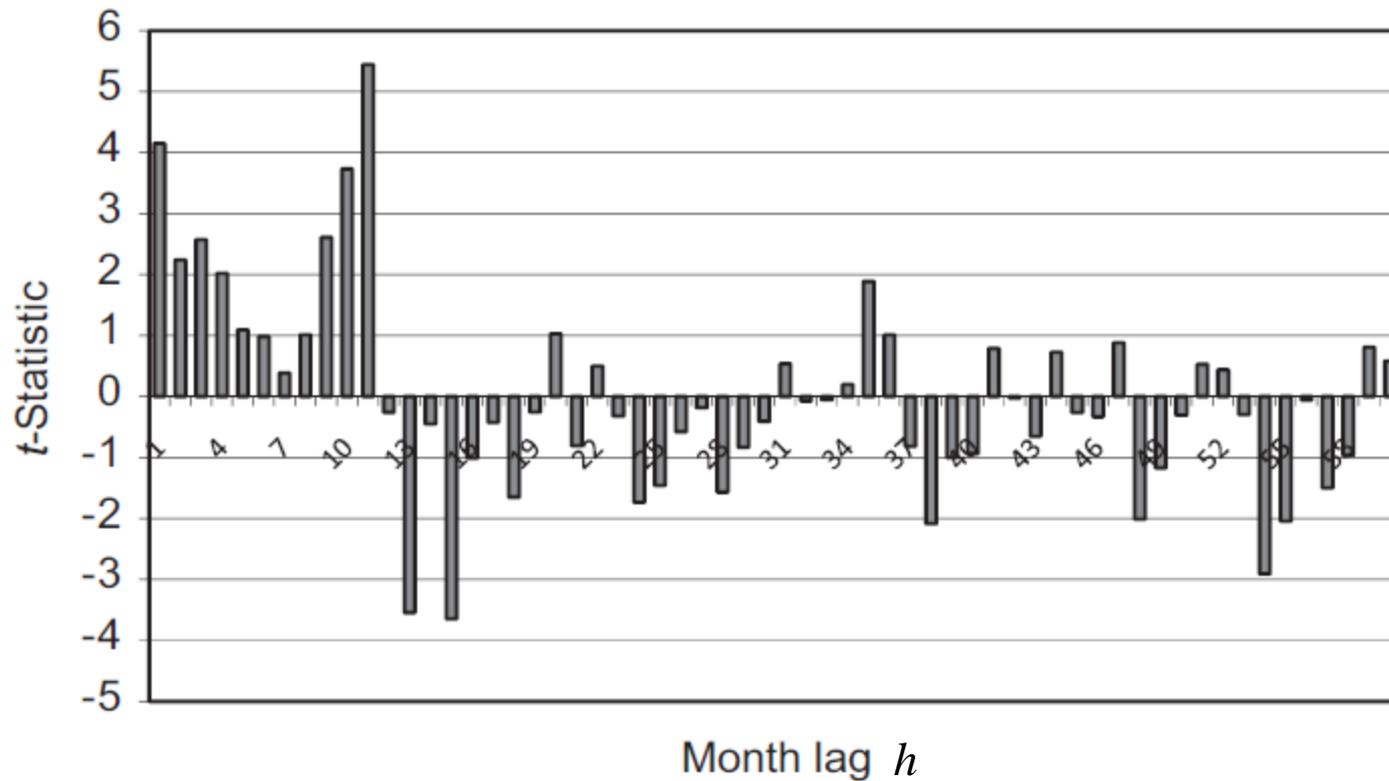


➢ Filtering methods

Sharpe ratio of 12-month trend strategy
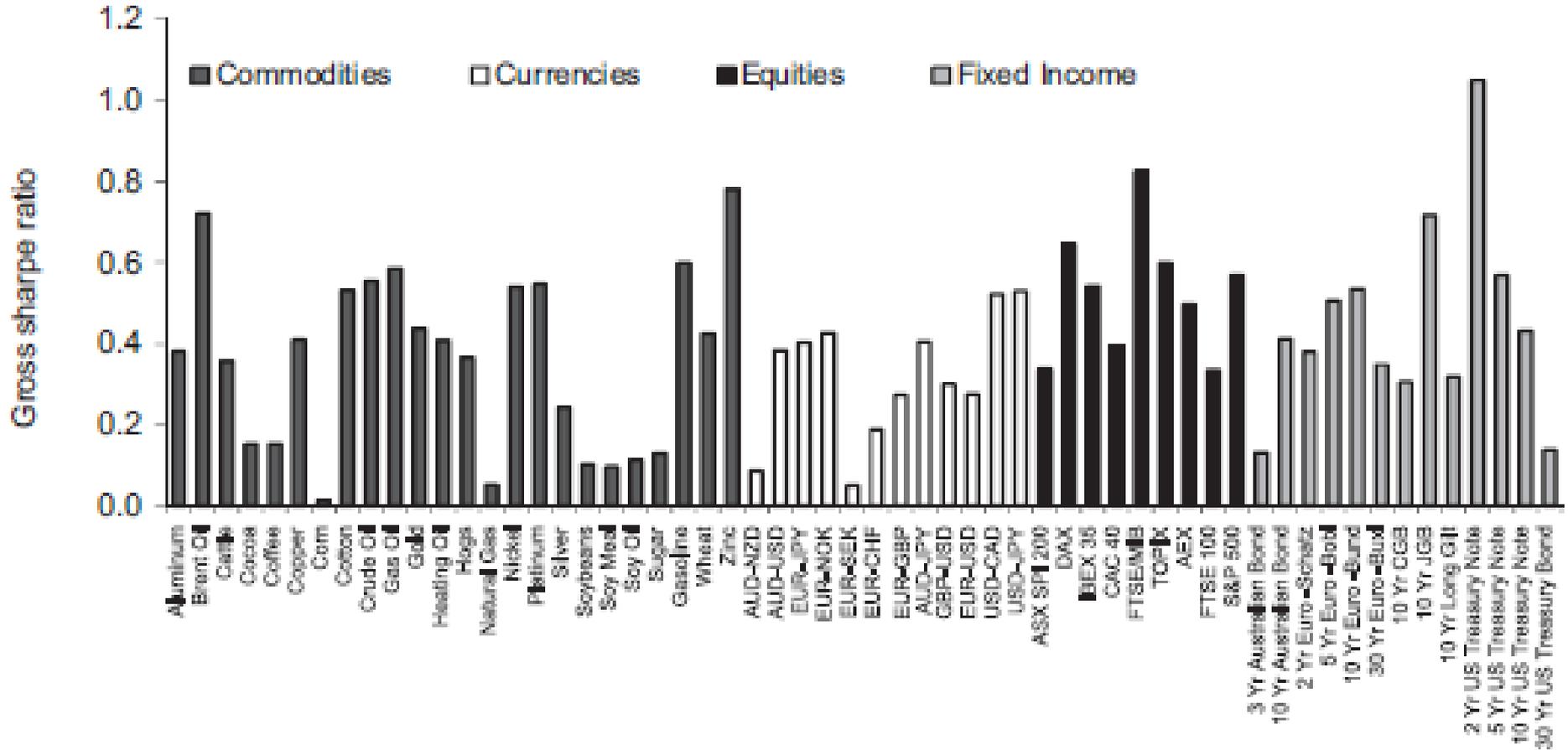
**John A. Paulson**
Paulson & Co.
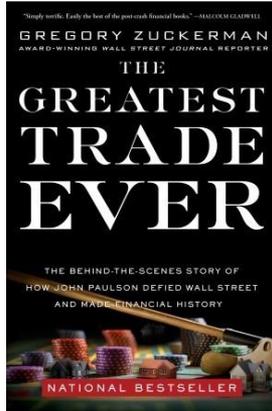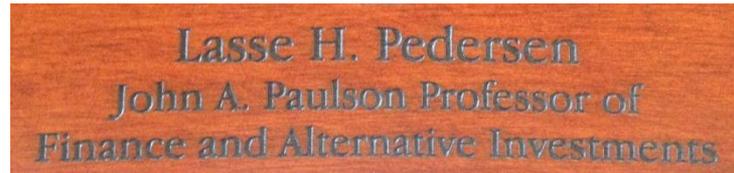
it's not a game for the faint of heart

Could someone else pay a higher price?

Valuation: what multiple of EBITDA?

How's the growth?

What other acquisitions in this sector?
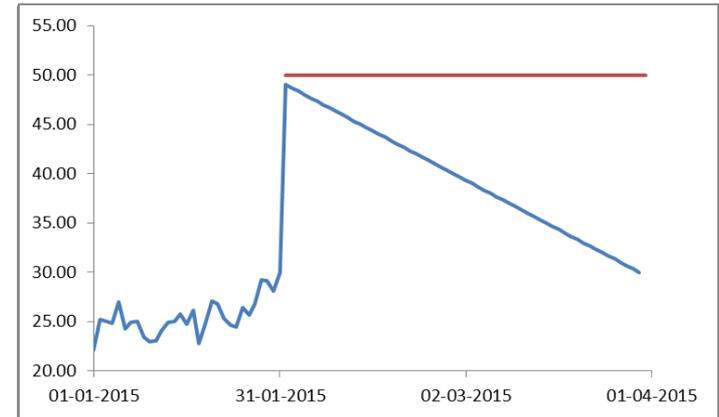
# CONVERTIBLE ARBITRAGE

**Ken Griffin**
Citadel

Started to view the markets through the lens of relative value trading

Raised about $265,000 from friends and family to deploy this strategy
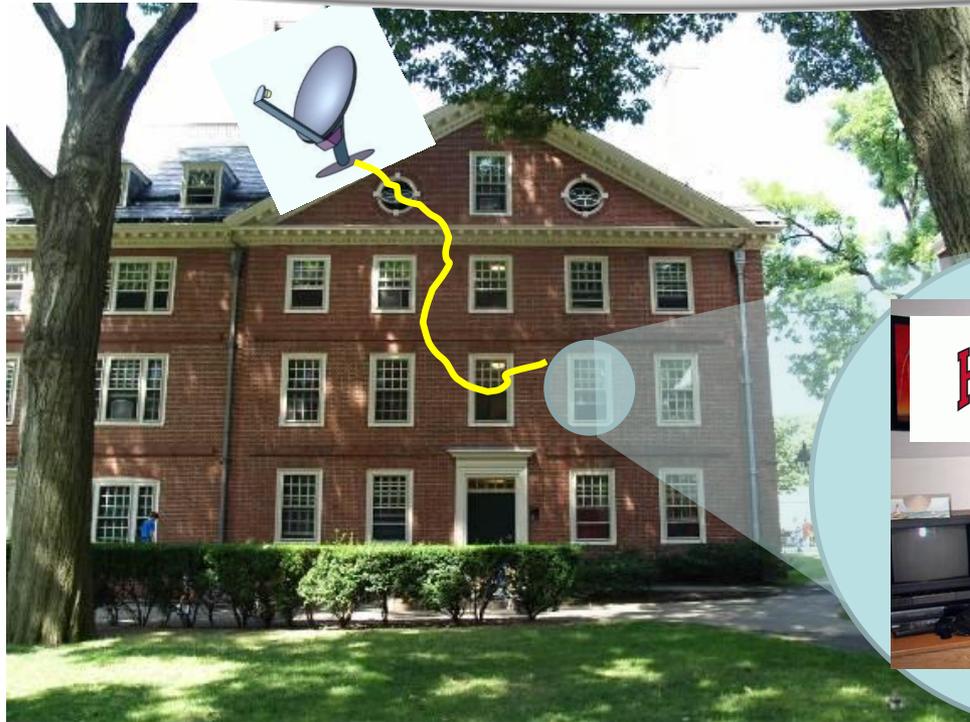
trading securities that are liquid enough that you can take meaningful positions but where you can still be better than others in understanding what defines and drives value

**Myron Scholes**
Nobel Laureate
Prev. LTCM and Platinum Grove
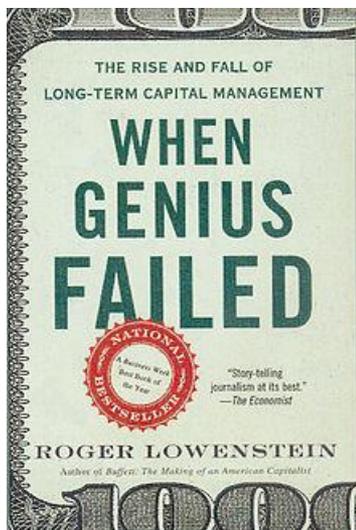
fixed-income arbitrage is intermediating supply and demand imbalances that result from flows in the marketplace

The major question is

- how long before mean reversion occurs and
- to what extent flows will continue

The system is a combination of positive and negative feedback.

# COMMON CHARACTERISTICS AMONG GREAT INVESTORS:
# VALUE AND MOMENTUM

## Country Indices
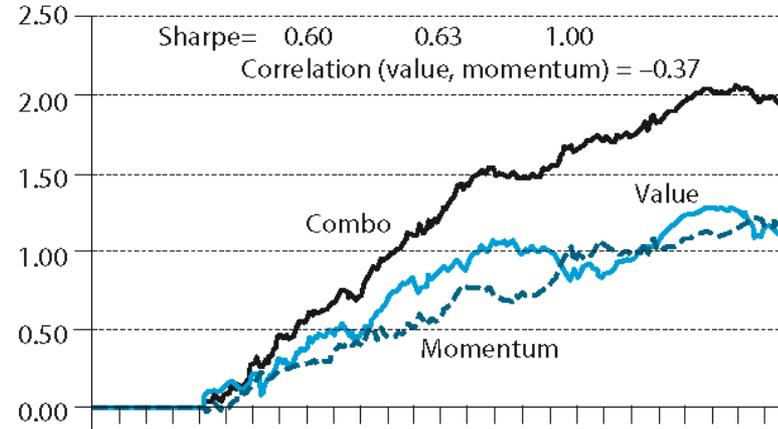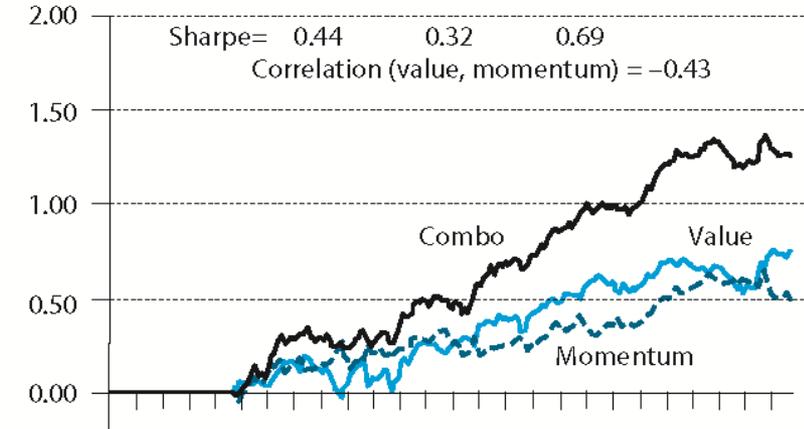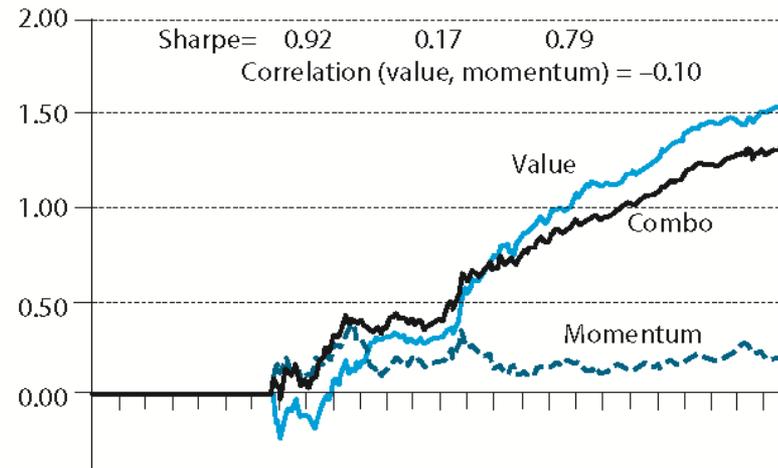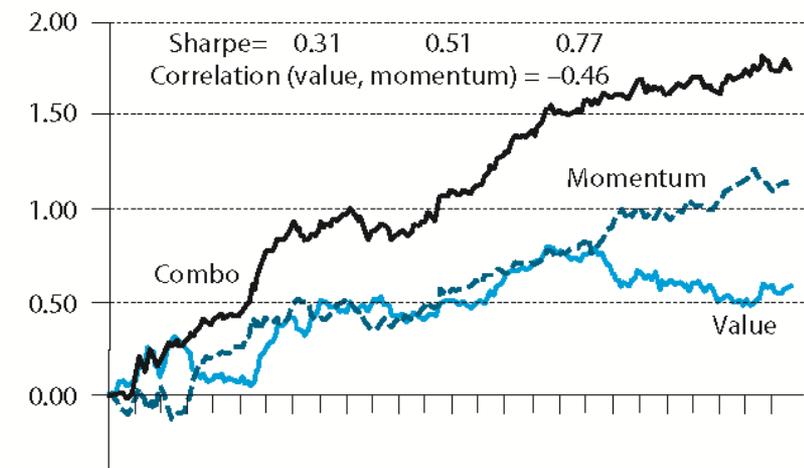
Sharpe=   0.60        0.63        1.00
Correlation (value, momentum) = −0.37

Combo
Value
Momentum

## Currencies

Sharpe=   0.44        0.32        0.69
Correlation (value, momentum) = −0.43

Combo
Value
Momentum

## Fixed Income

Sharpe=   0.92        0.17        0.79
Correlation (value, momentum) = −0.10

Value
Combo
Momentum

## Commodities

Sharpe=   0.31        0.51        0.77
Correlation (value, momentum) = −0.46

Combo
Momentum
Value

➢ **1000s of hedge funds and active mutual funds**
  – across different markets, continents, asset classes, …

➢ **But, can we summarize the main trading strategies through a few *investment styles*?**
  – method that can be applied across markets
  – based on economics
  – broad long-term evidence
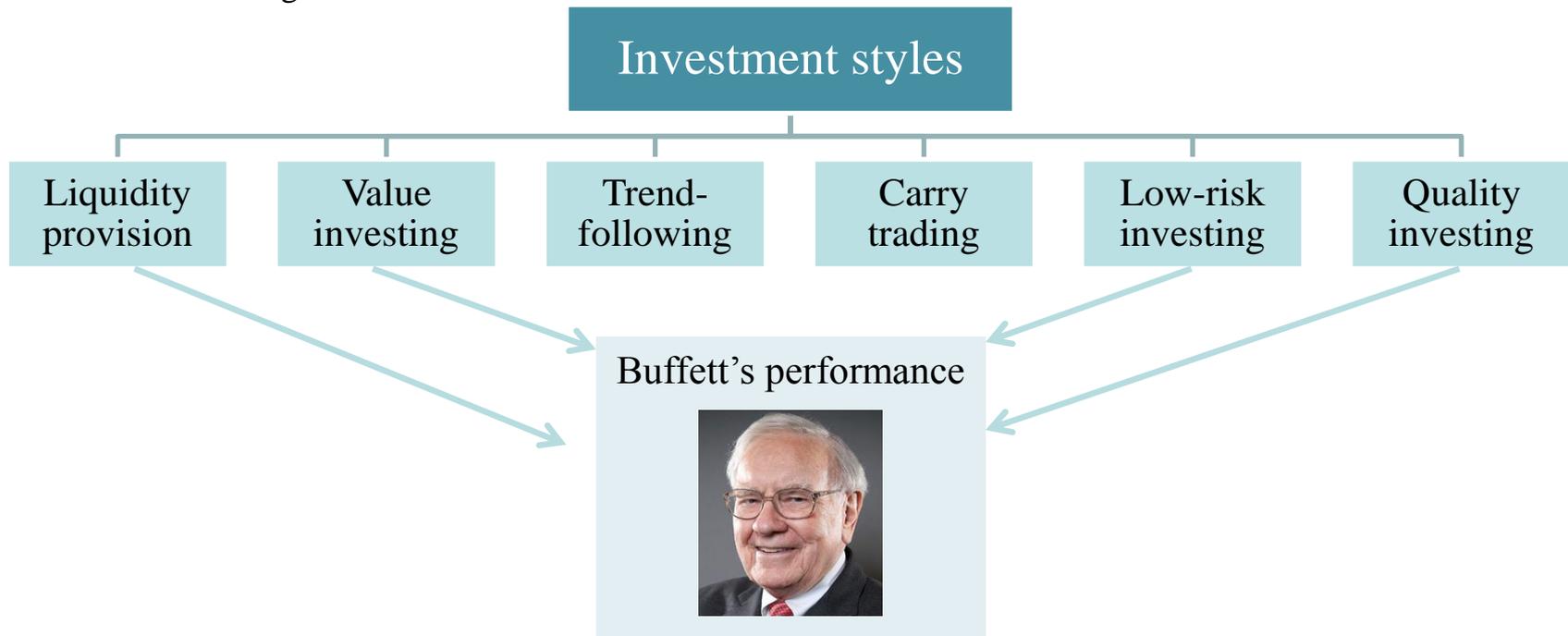
# INVESTMENT STYLES AND WARREN BUFFETT



Legend:
- Berkshire's Public Stocks (from 13F filings)
- Buffett-Style Portfolio for Public Stocks
- Overall stock market (leveraged to same vol.)

Y-axis: Cumulative Return (log scale) — $1,00, $10,00, $100,00, $1.000,00

X-axis: 1980, 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010
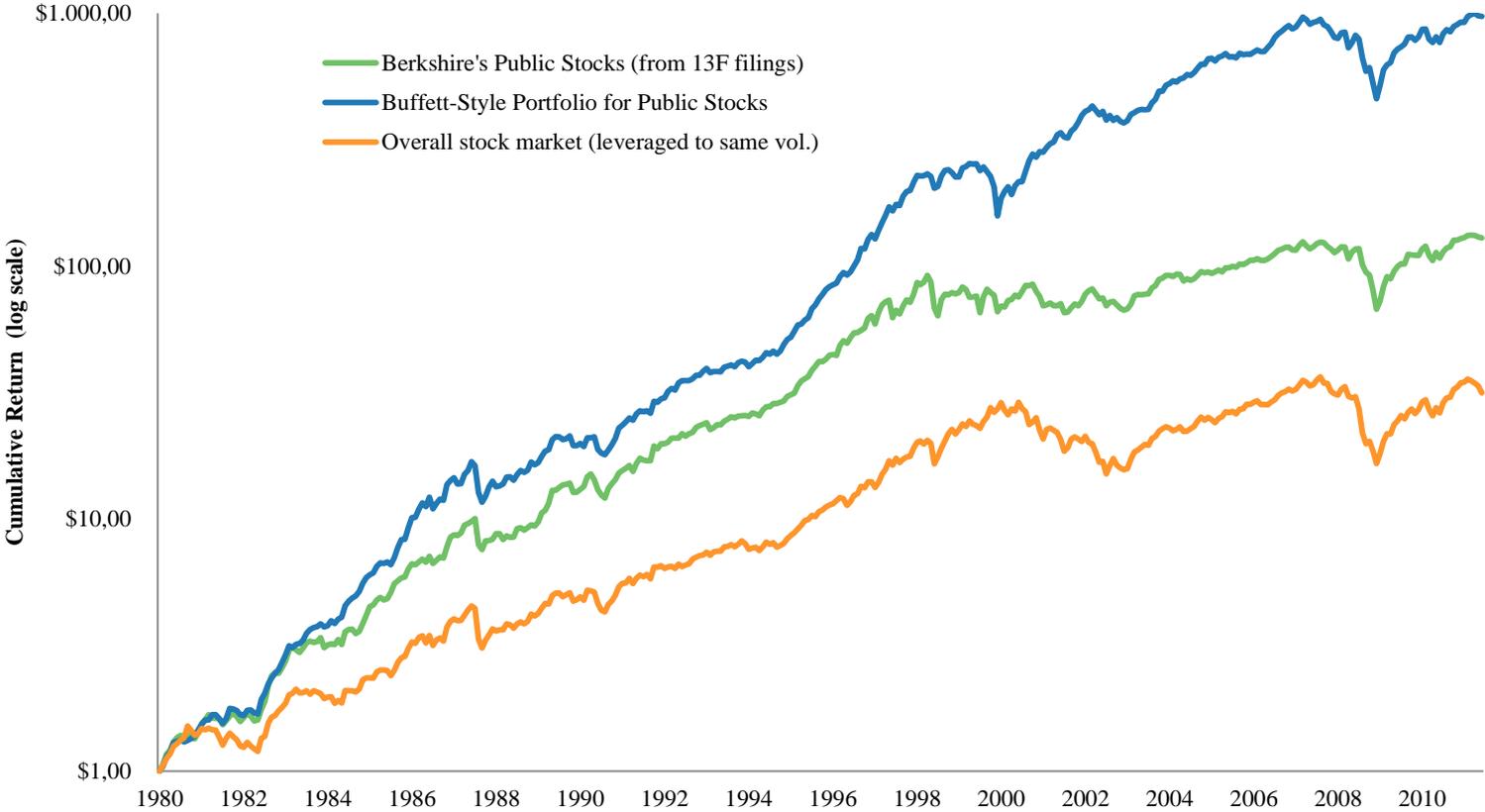
Competition + frictions = **EFFICIENTLY INEFFICIENT** dynamics



**EFFICIENTLY INEFFICIENT** traffic dynamics



**EFFICIENTLY INEFFICIENT** political process
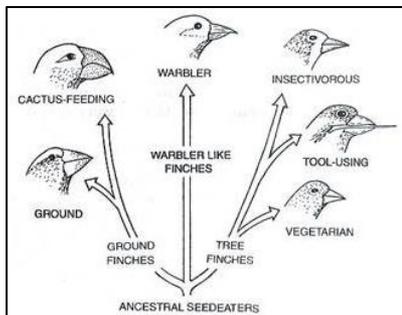


**EFFICIENTLY INEFFICIENT** nature: evolution not converged yet