

Denham Quantitative Management, LP

Building a Quantitative Hedge Fund

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CSO, Denham Quantitative Management

Content:

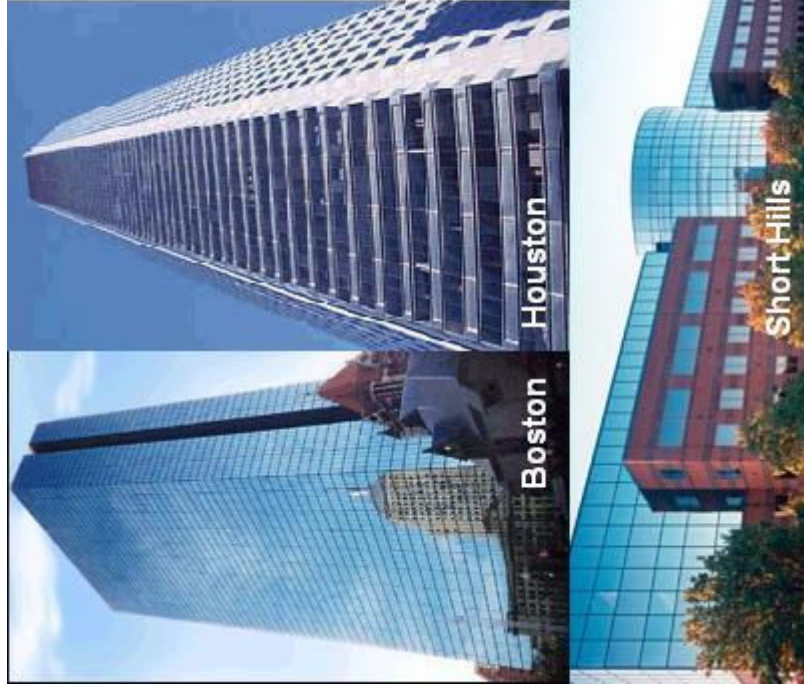
1. What is Denham Quantitative Management?
2. Efficient Market Hypothesis
 - a) Conceptual context for our work.
 - b) Econophysics.
 - c) Why you won't get useful algorithms in this talk.
3. What is a Quantitative Hedge Fund?
4. An Illustrative (but Useless) Example
5. How is the System Set Up?
6. Computation, Data, Back Testing, and Paper Trading
7. Why Isn't Everybody Doing This?

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Section 1

What is Denham Quantitative Management?

Our parent company is Denham Capital Management.



DCM is global energy- and commodities-focused private investment firm with over \$4.3 billion in invested and committed capital.

We are a development project within Denham Capital Management.

- DQM is focused on trading of public equities (stocks and futures).
- We do not perform fundamental analysis.
- Our methods are based on new mathematics and are computationally intensive.
- Fundamental advances have been made both in trade signaling and in portfolio composition theory.
- Our research in this area has been ongoing for over 4 years.
- This project was brought into DCM in July 2007.
- DCM provides much business infrastructure as well as funding.
- We anticipate that much of our trading will be done at high frequency and will be highly automated.
- We are planning our launch into the market early in 2009.

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Section 2

Efficient Market Hypothesis

Efficient Market Hypothesis

Strong Form:

All relevant information is reflected in the price of equities.

Bachelier, 1900
Cootner, 1964
Fama, 1965

- ⇒ Remaining price motions are described by a Brownian random walk (martingale).
- ⇒ Algorithms to “beat the market” are not possible.

This has been the conventional wisdom through most of the 70's and 80's.

Efficient Market Hypothesis (cont.)

Weak Form:

Excess returns cannot be generated using strategies based on historical share prices.

- ⇒ Remaining price motions are described by a Brownian random walk (martingale)
- ⇒ Algorithms to “beat the market” are not possible.

However, other information can potentially lead to excess returns.

Efficient Market Hypothesis (cont.)

Criticisms of EMH:

- Investors are not rational. (Behavioral finance)
 - Investors are not unbiased.
 - Investors are not equally risk-averse.
 - There is no evidence for the contention that people are more rational in the aggregate than individually.
- Information does not affect all of the market at the same time.
- Other information comes into play in price determination in addition to historical prices.
- *etc.*

Efficient Market Hypothesis (cont.)

Working Hypothesis:

EMH is approximately true, but there are exceptions occurring episodically for particular equities. There are tradeable opportunities in the exceptions to EMH.

Heretic's View:

It's just another d****d time series!

- Bob Hohlfeld
summer of 2005

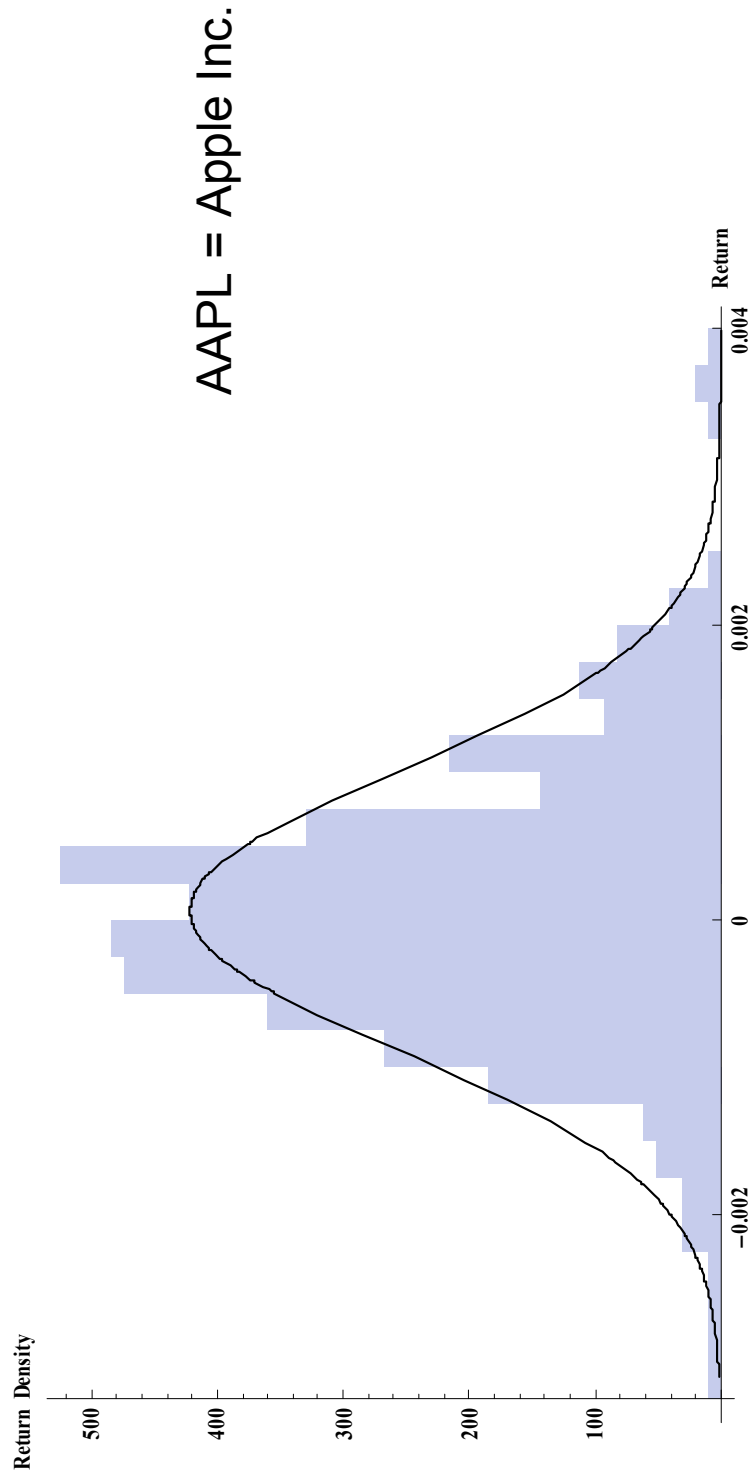
Other real-world signals are intermittent and have low SNR.
Why do you expect anything different in quantitative finance?

Chaos

- Applied to finance by Farmer and other workers.
- Suggests fundamental unpredictability as time progresses.
 - Lyapunov exponents.
- Dimension of the strange attractor is at least 6.
 - ⇒ The amount of data to characterize the attractor is prohibitive.
- Time scales are relevant here. When EMH was first formulated, positions in the stock market lasted days to months.
- In the current standards of high frequency finance, positions last minutes to a small number of days.

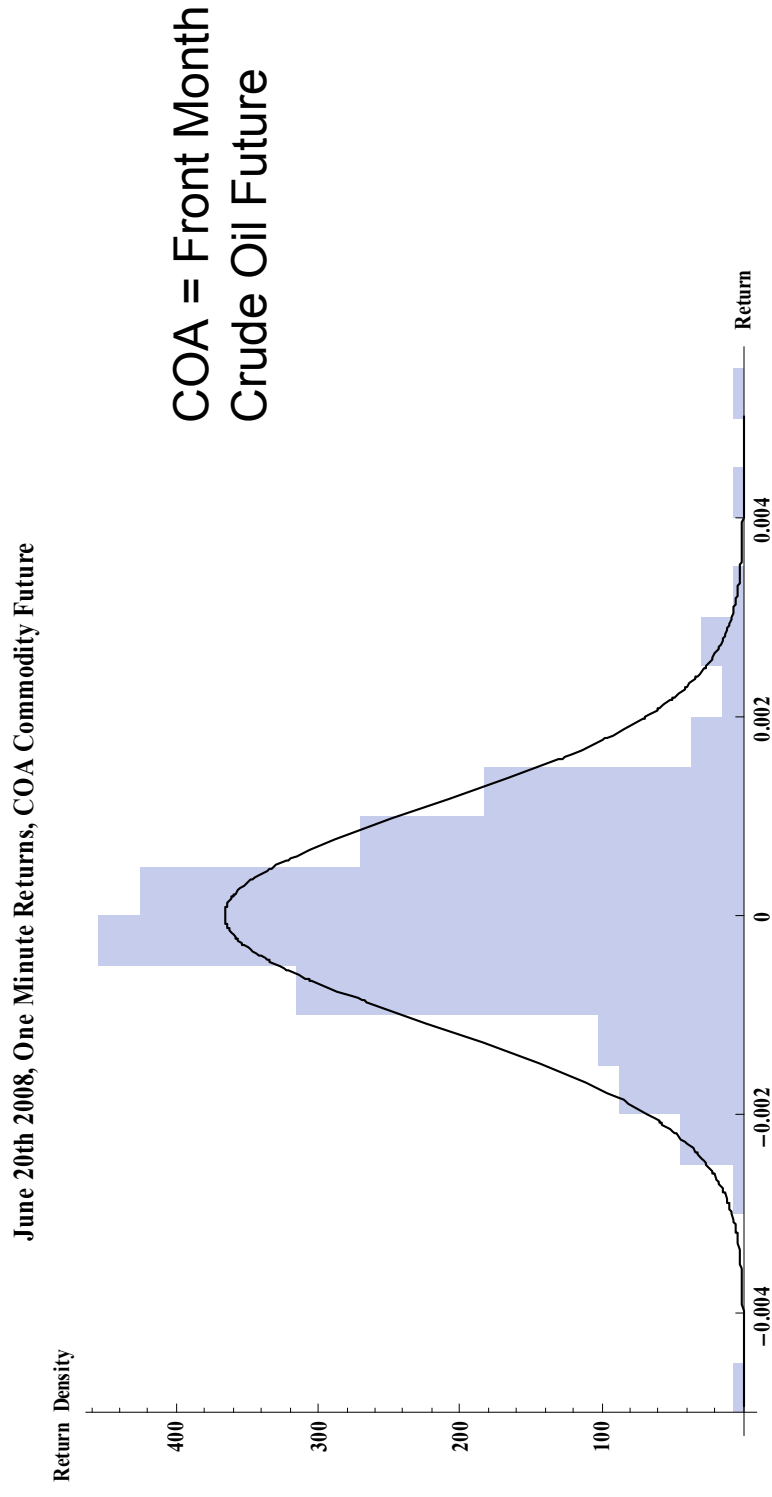
Fat Tails

June 20th 2008, One Minute Returns, AAPL Common Stock



Note that the histogram is kurtotic (central condensation), and also exhibits non-Gaussian (fat) tails.

Fat Tails (cont.)



Again the distribution is kurtotic and fat-tailed.
This behavior is characteristic over time scales of minutes to years and various asset classes.

Econophysics

Many of the ideas in quantitative finance are developed from physics and various physical sciences.

Why is this so?

Philosophical explanation:

Markets obey principles reflecting transfer of information and “energy” like other physical systems. Econophysics is natural.

Economic explanation:

“Refugees” from other disciplines have brought their accustomed tools to quantitative finance.

“Cynical” explanation:

There are only a half dozen useful differential equations anyway.
- Guido Sandri, 2008

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Section 3

What is a Quantitative Hedge Fund?

What is a quantitative hedge fund?

- A “hedge fund” is simply a fund that can take long and short positions.
- Fundamental analysis
 - Examine P/E ratios, accounting measures, econometric indicators, etc. to determine firm’s “true” value.
 - Buys undervalued equities and shorts overvalued equities.
- Technical analysis
 - Examines price histories and other public information.
 - Performs calculations to determine expected excursions in price driving trading strategies.
 - Spans the range from the simple “chartists” to the state of the mathematical art.

What is a quantitative hedge fund?

- Examples of quantitative hedge funds:
 - Renaissance Technologies
 - D.E. Shaw
 - Highview Global Macro, LTD
 - Denham Quantitative Management

Trading strategies on equities that are:

- Publicly traded
- Liquid
- Amenable to modeling

- from “Secret World of Jim Simons”
Institutional Investor Magazine, Nov. 2000

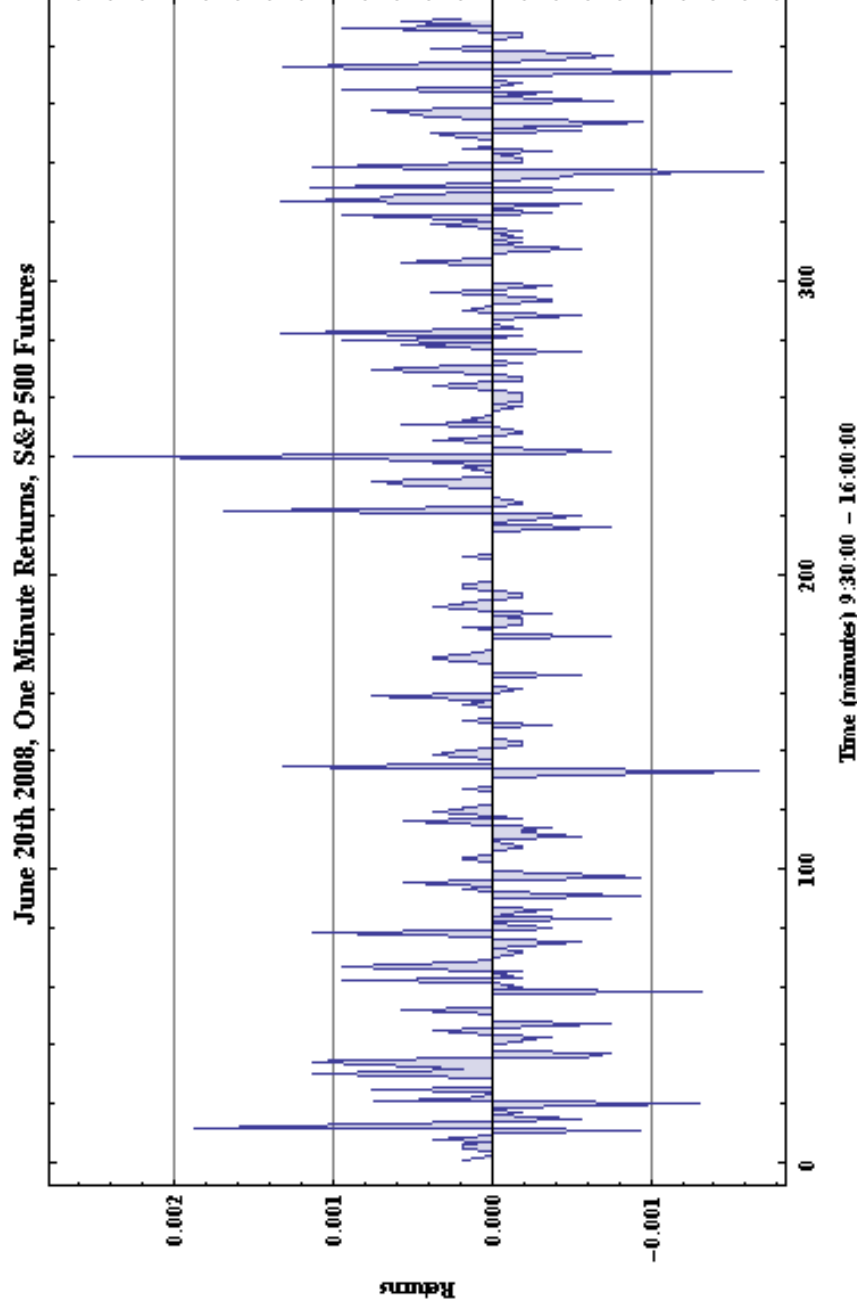
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Section 4

An Illustrative (but Useless) Example

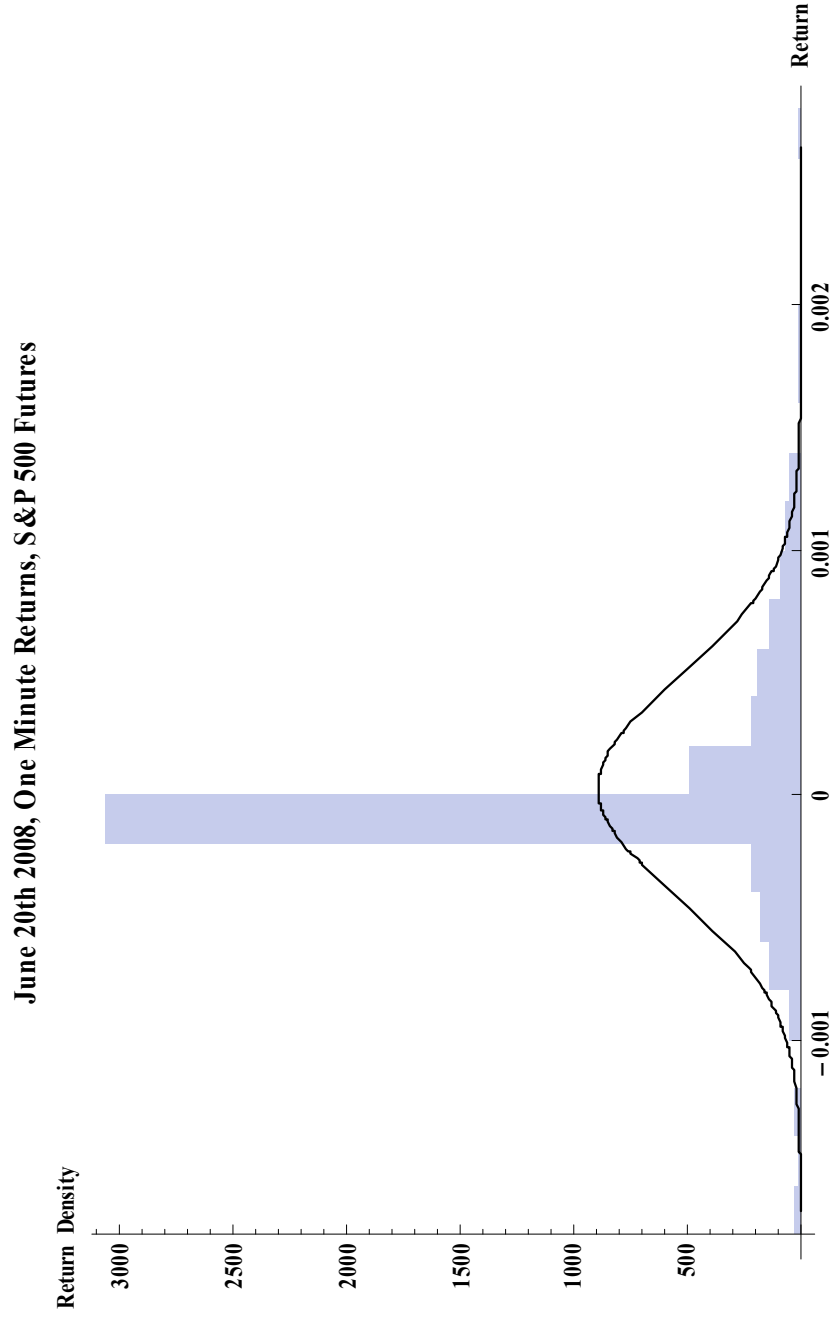
An Illustrative (but Useless) Example (cont.)

First examine “the market”, SP500 futures:



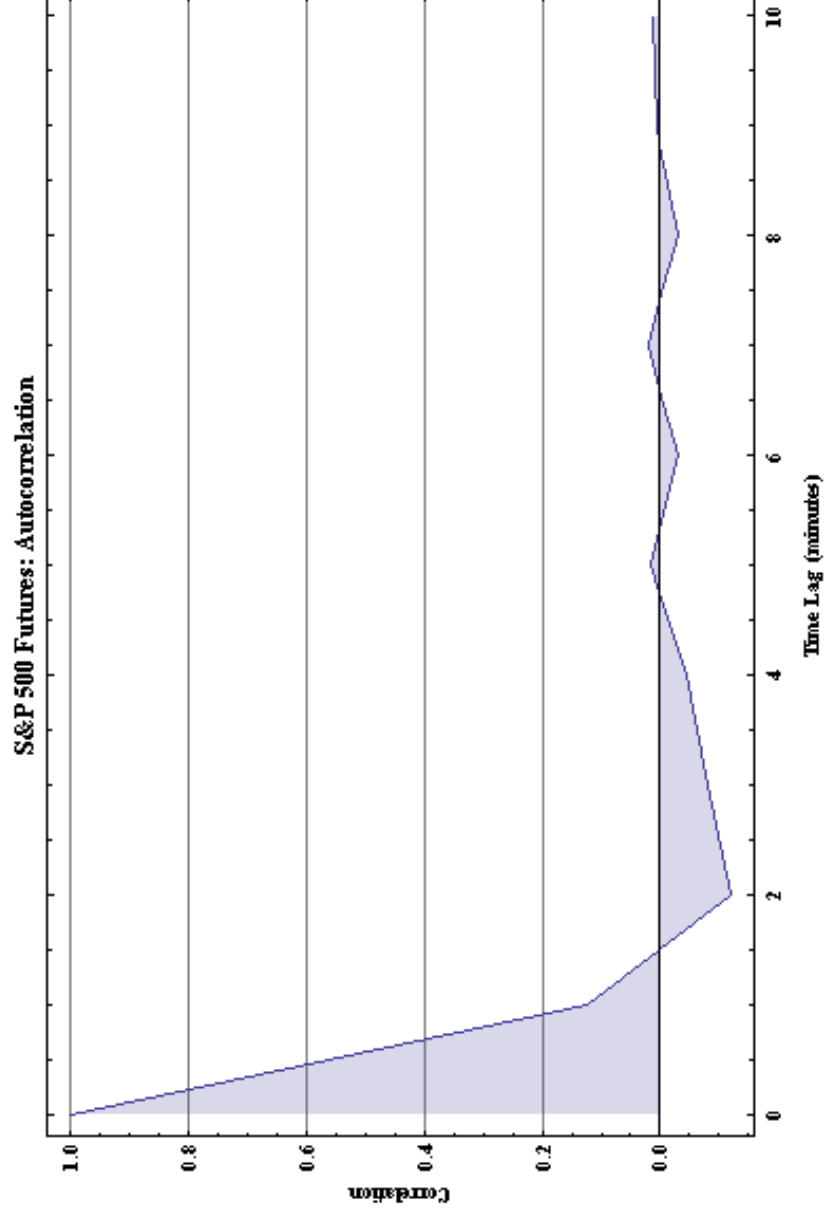
An Illustrative (but Useless) Example (cont.)

SP500 futures:



An Illustrative (but Useless) Example (cont.)

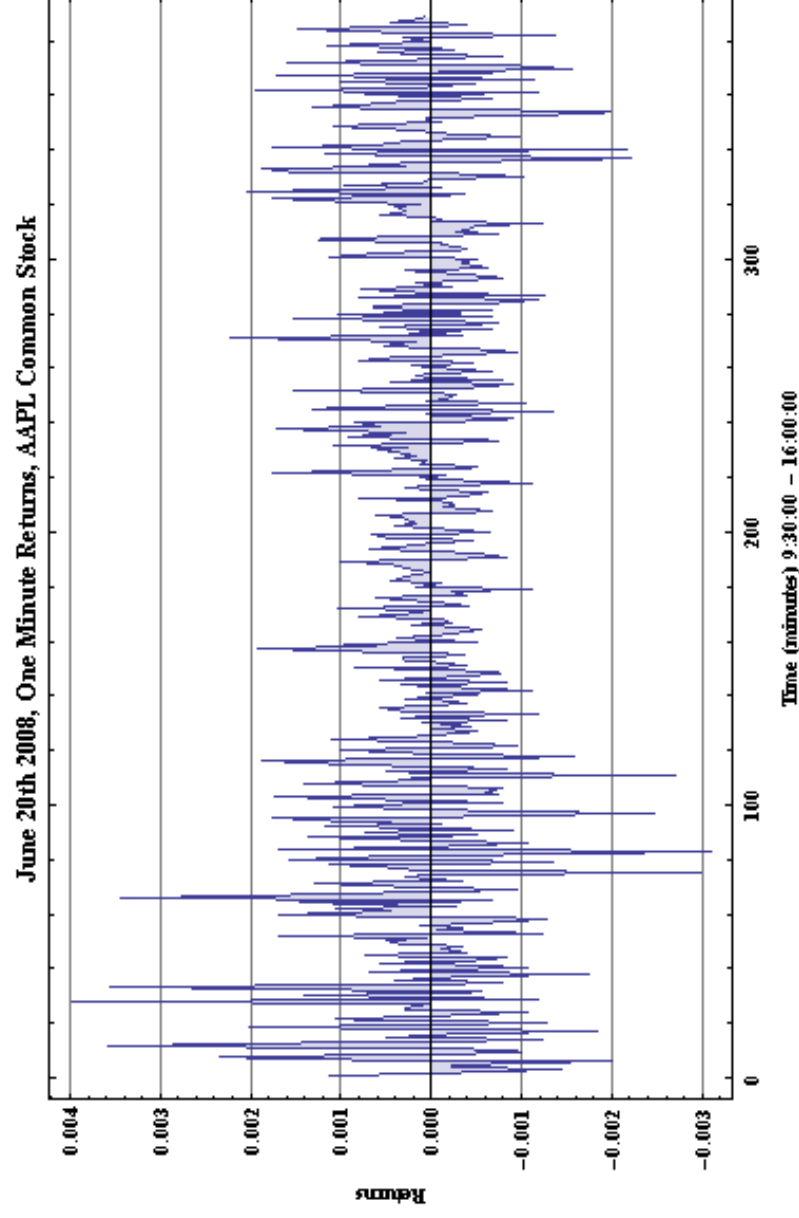
SP500 futures:



The value of the futures contract holds for about 1 minute and anti-correlates for a couple minutes thereafter.

An Illustrative (but Useless) Example (cont.)

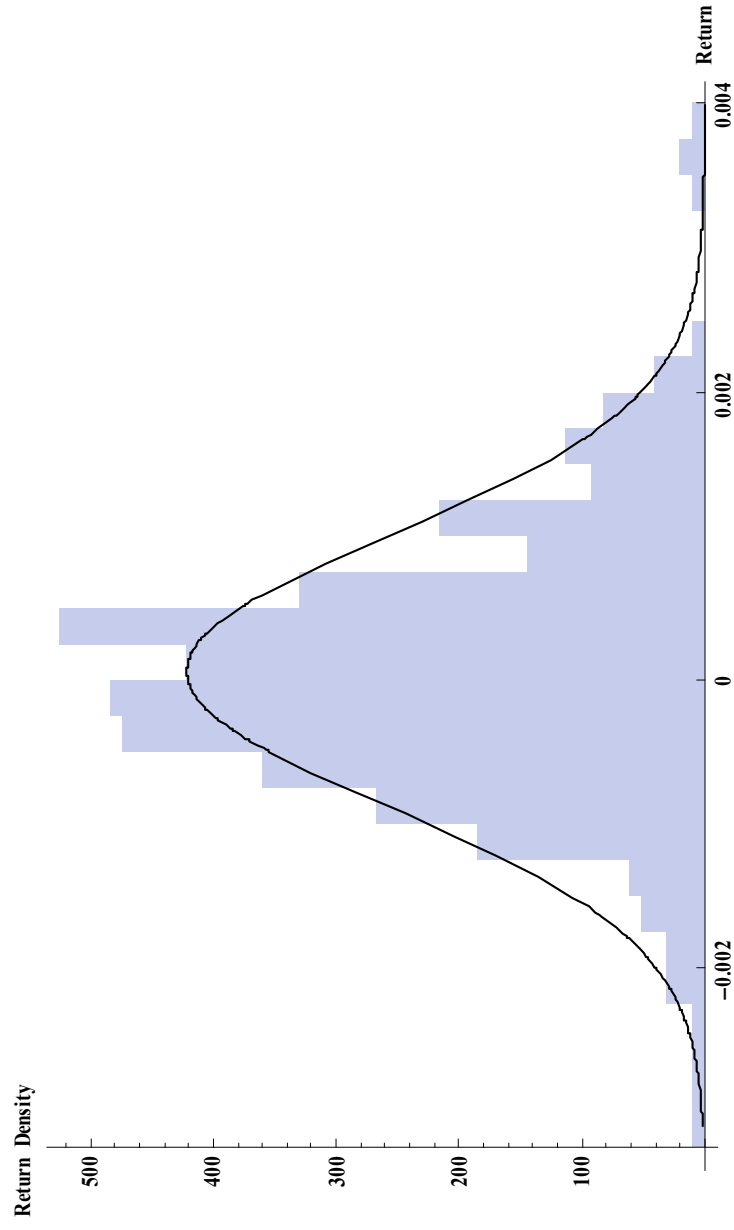
AAPL, a liquid equity:



An Illustrative (but Useless) Example (cont.)

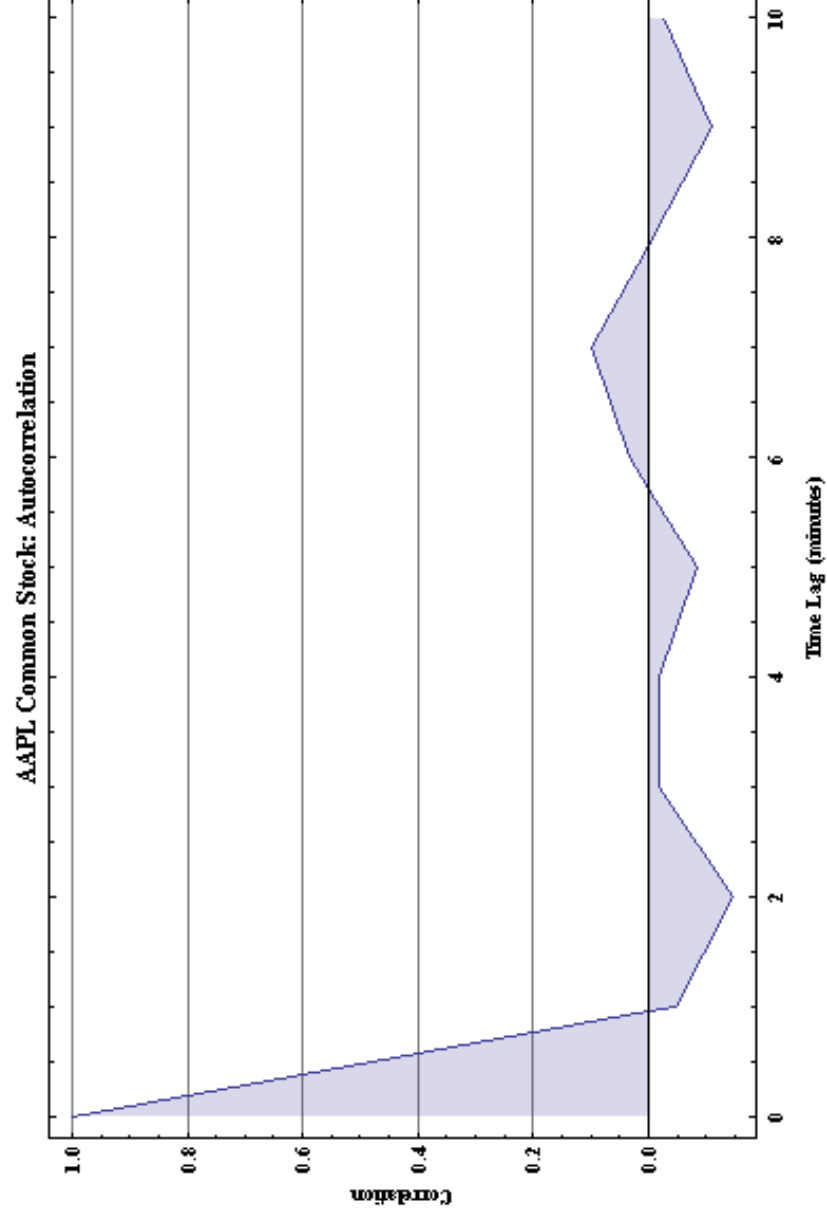
AAPL, a liquid equity:

June 20th 2008, One Minute Returns, AAPL Common Stock



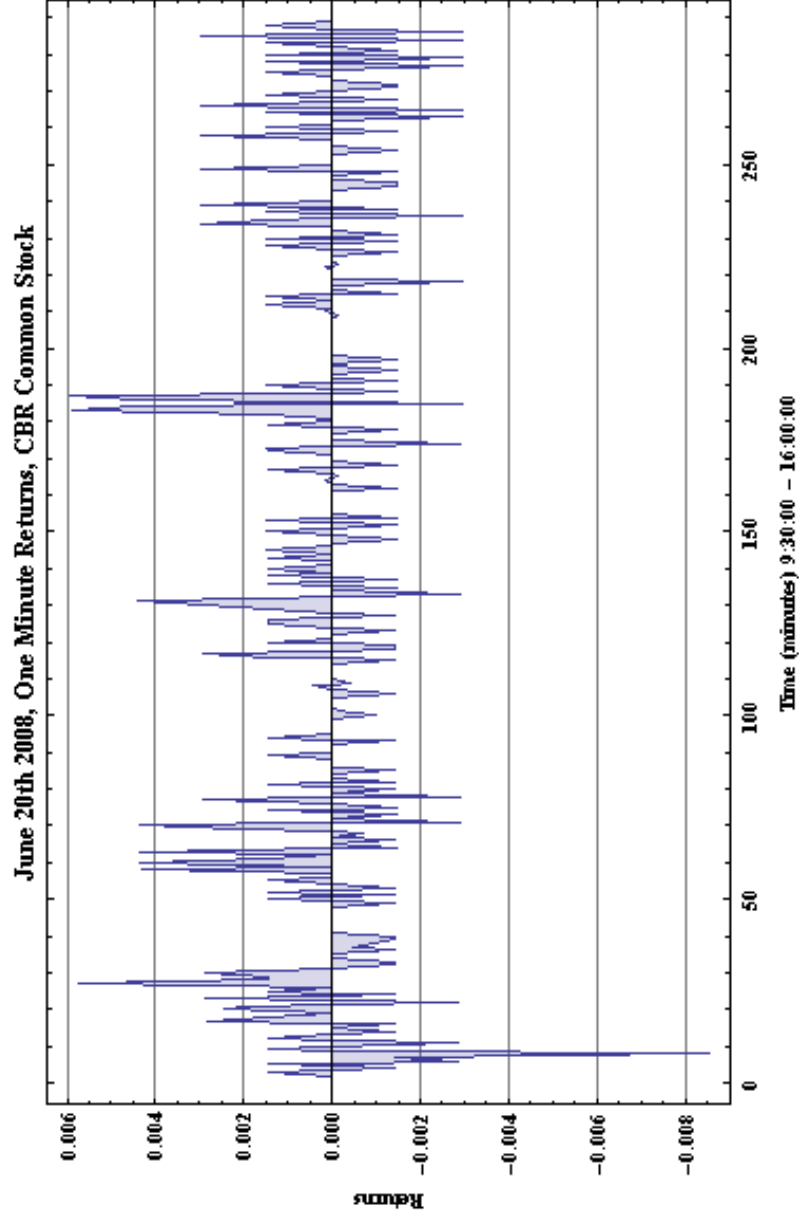
An Illustrative (but Useless) Example (cont.)

AAPL, a liquid equity:



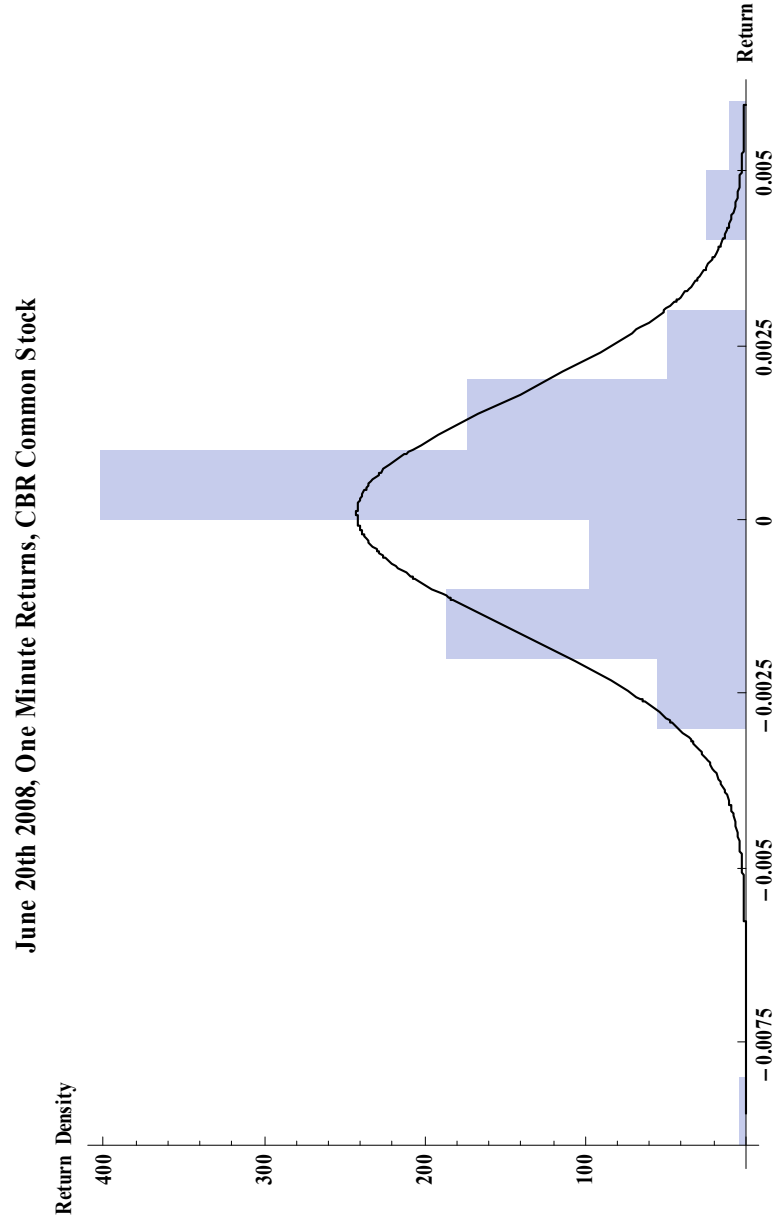
An Illustrative (but Useless) Example (cont.)

CBR, a illiquid equity:



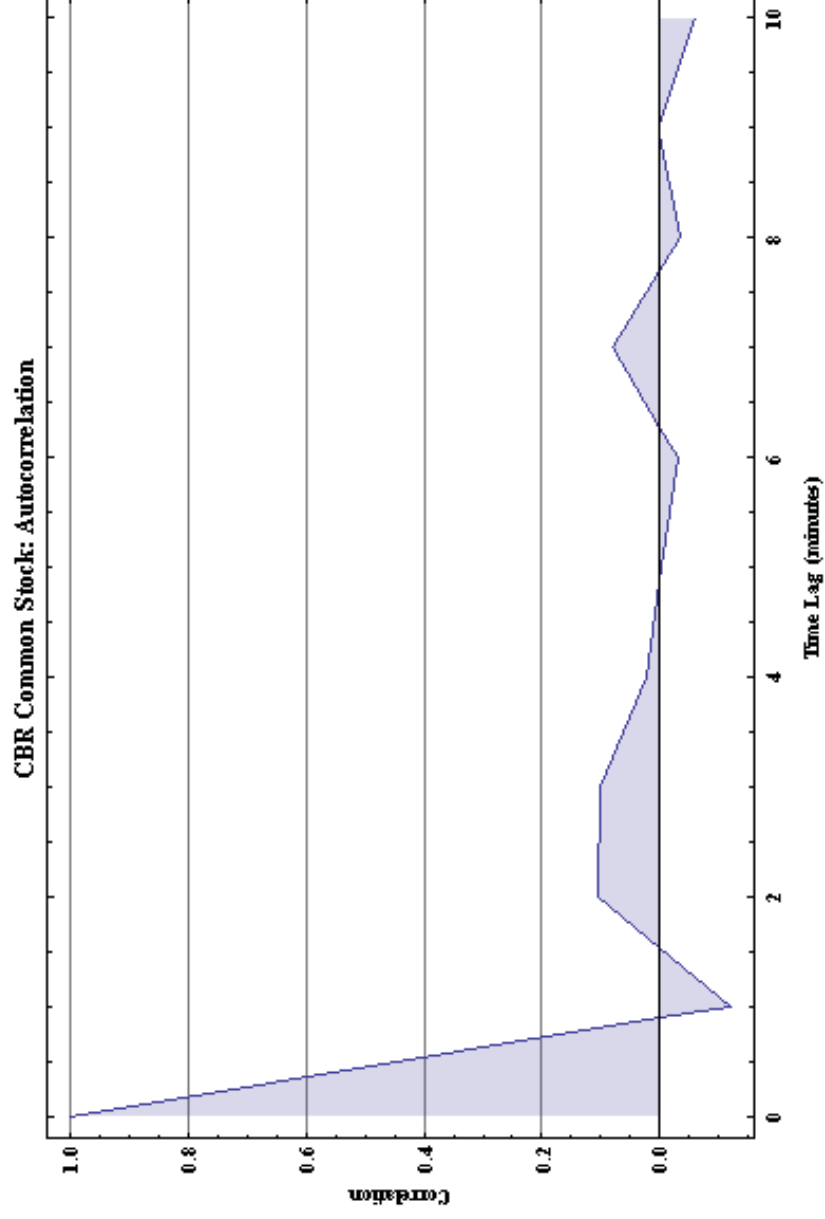
An Illustrative (but Useless) Example (cont.)

CBR, a illiquid equity:



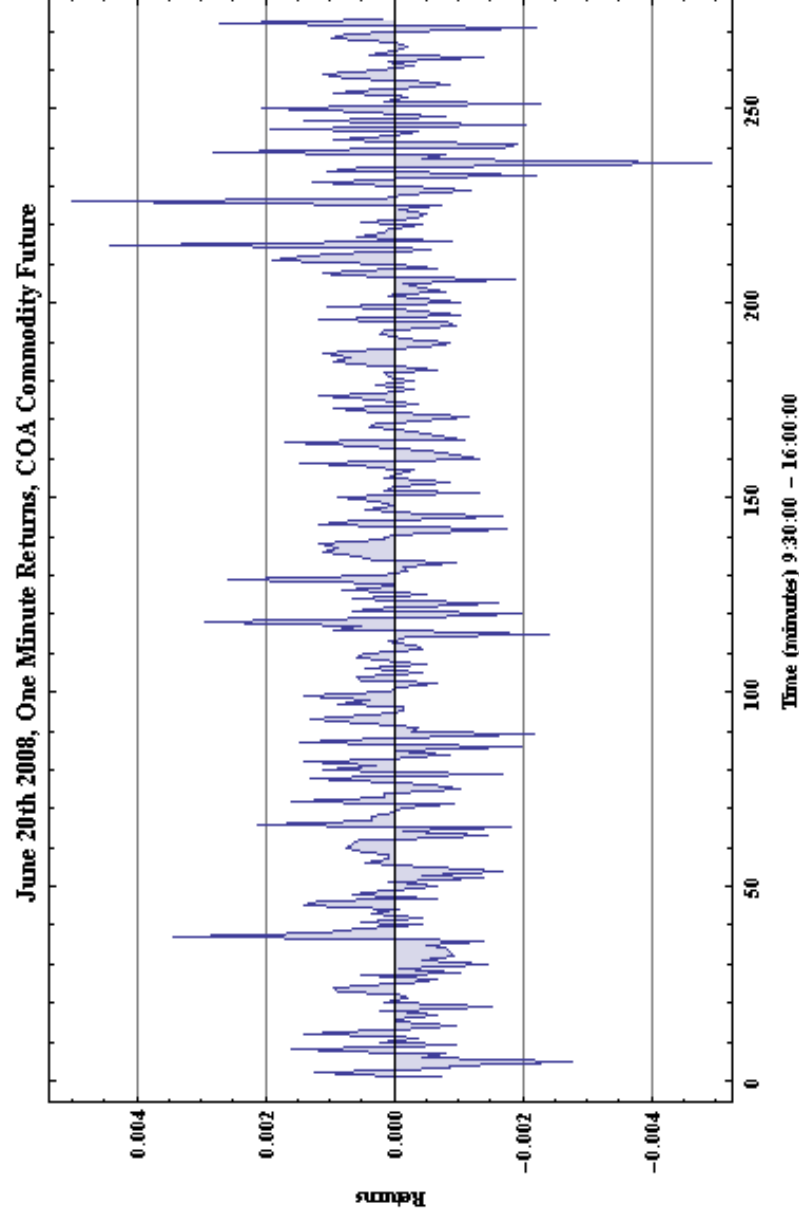
An Illustrative (but Useless) Example (cont.)

CBR, a illiquid equity:



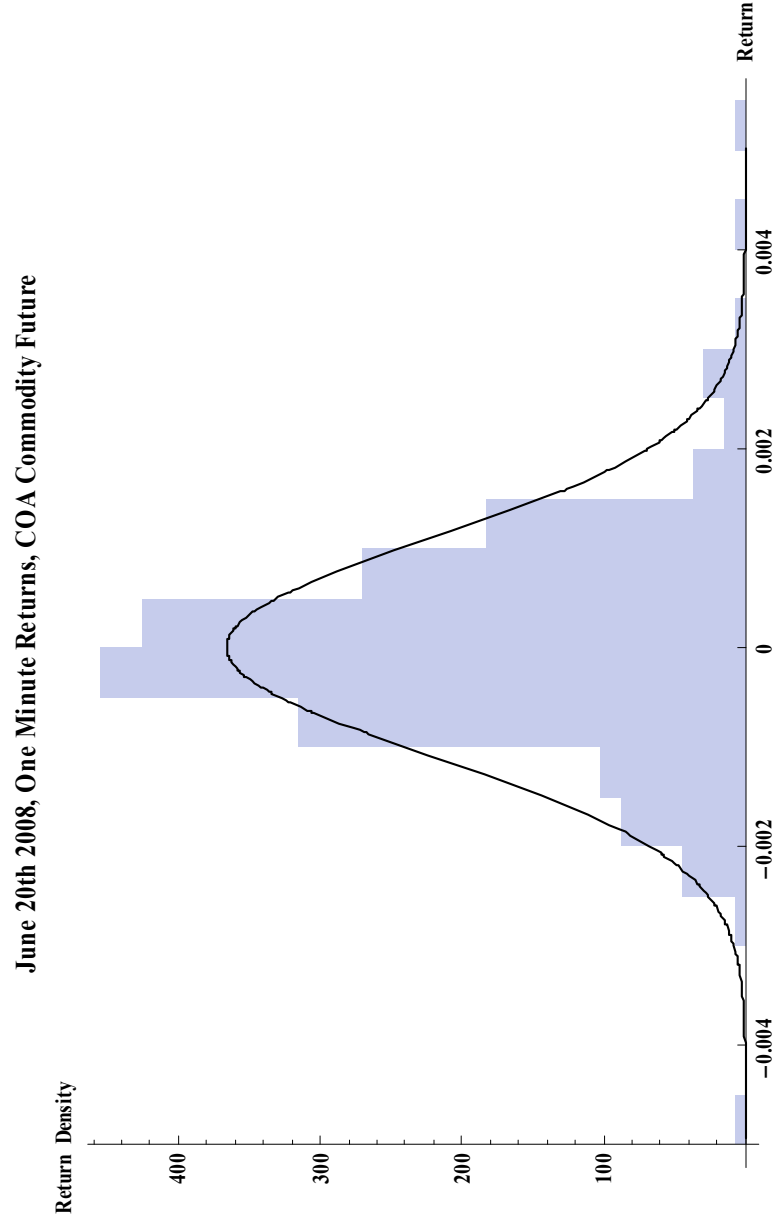
An Illustrative (but Useless) Example (cont.)

COA, a commodity future:



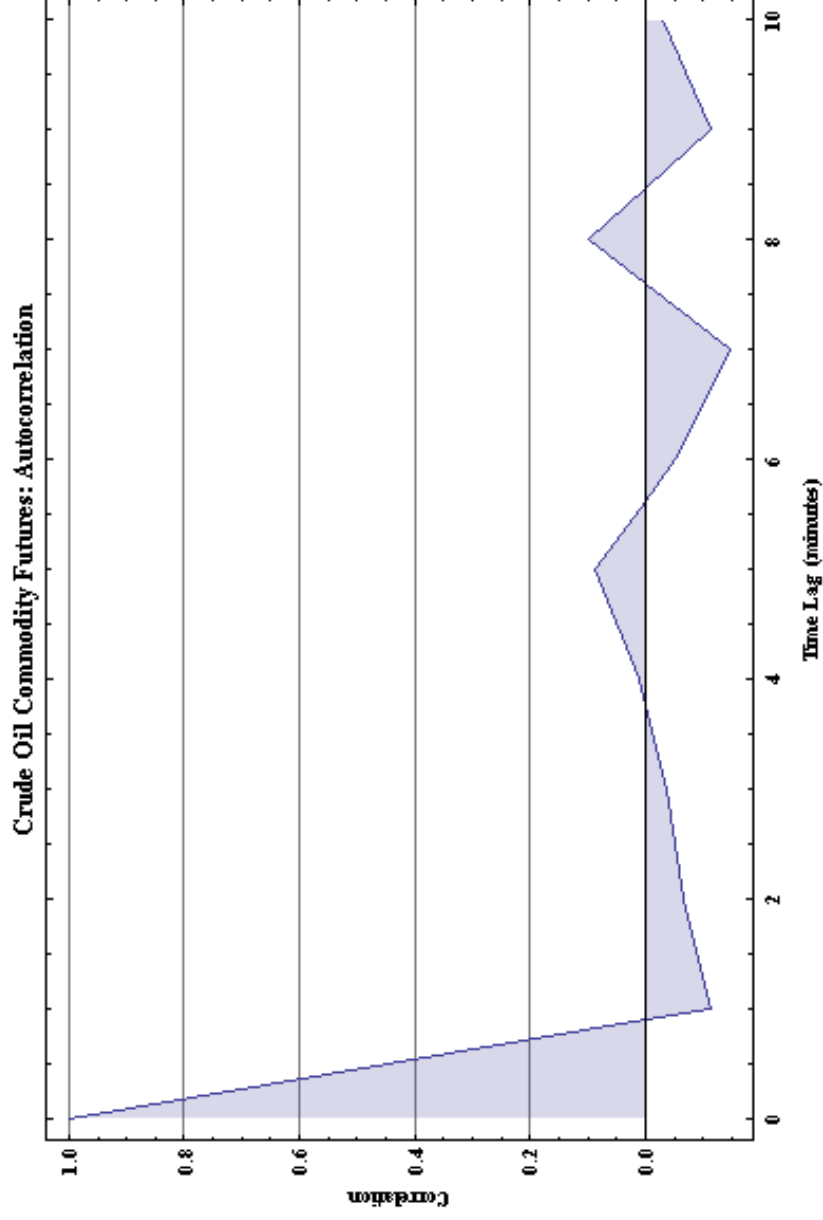
An Illustrative (but Useless) Example (cont.)

COA, a commodity future:



An Illustrative (but Useless) Example (cont.)

COA, a commodity future:



An Illustrative (but Useless) Example (cont.)

“Trading strategy”:

1. If return is positive, take the stock long for the next minute.
(If the return is negative, take the stock short for the next minute.)
2. If you are aggressive, take the stock short (long) for the next minute.
3. Exit the position.

But this won't work, the transaction costs will wipe out your returns!

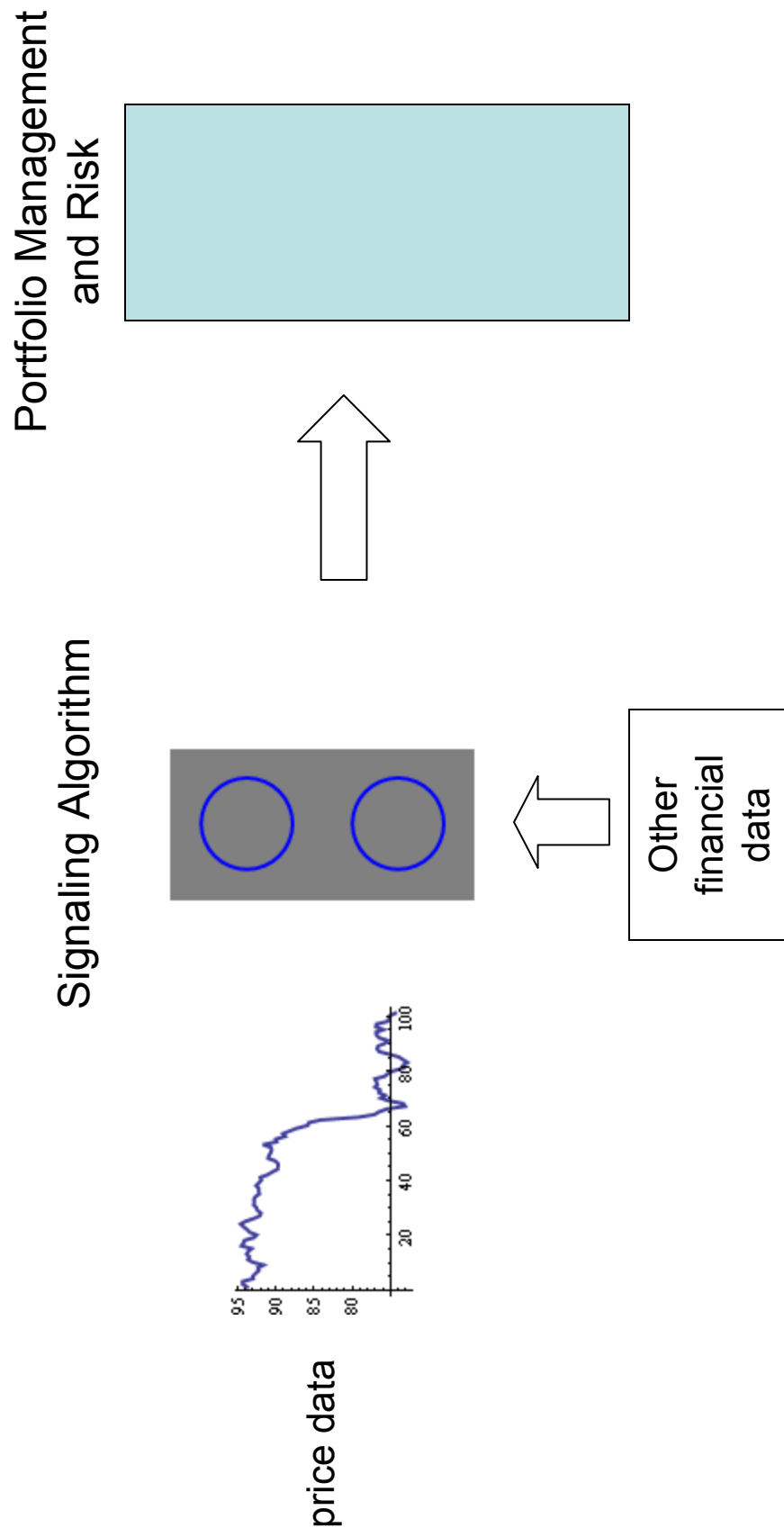
One needs an algorithm with similar mathematical/algorithmic content but higher return to overcome transaction costs and market slippage.

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Section 5

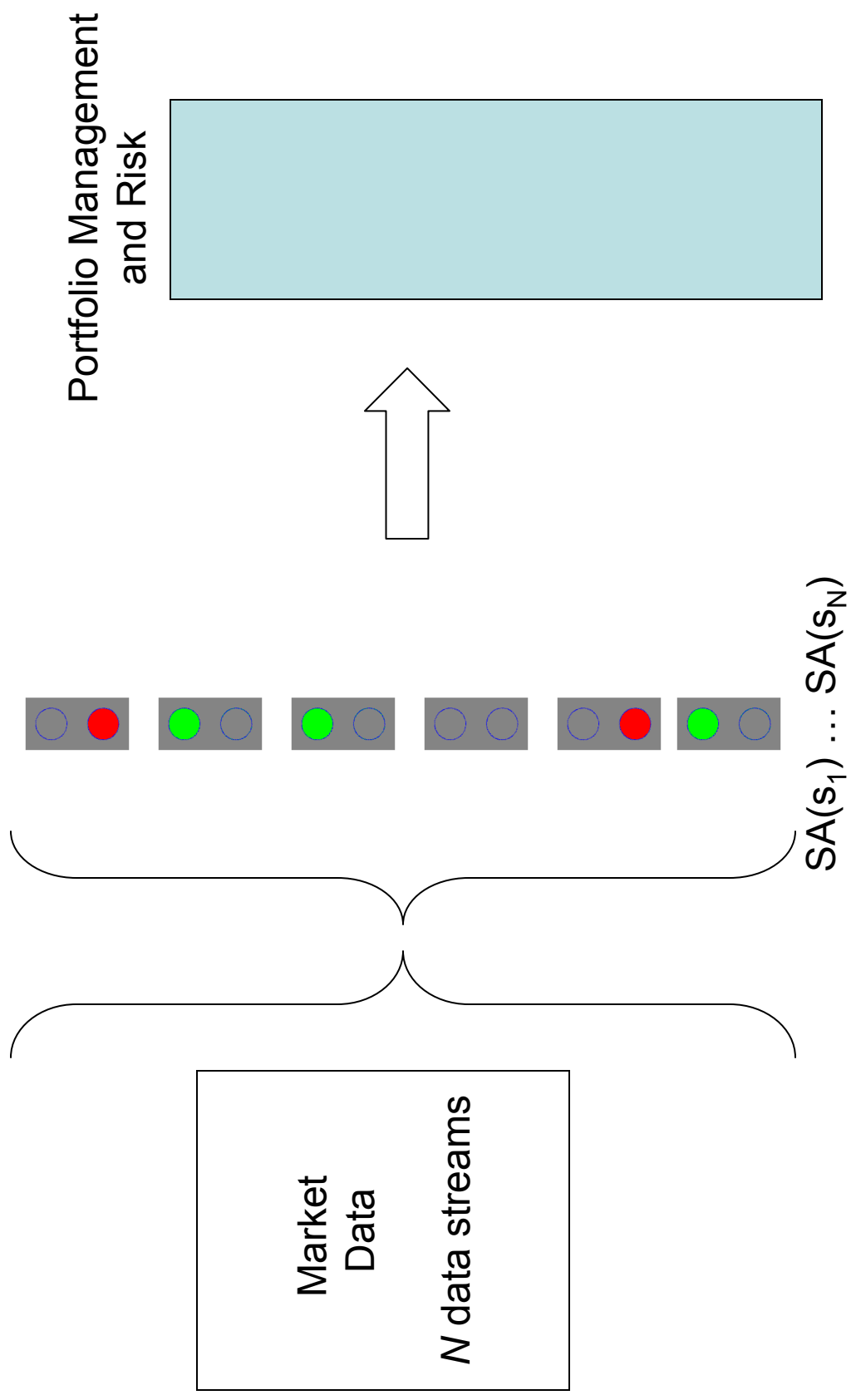
How is the System Set Up?

A Signaling Algorithm Processes Financial Time Series Data

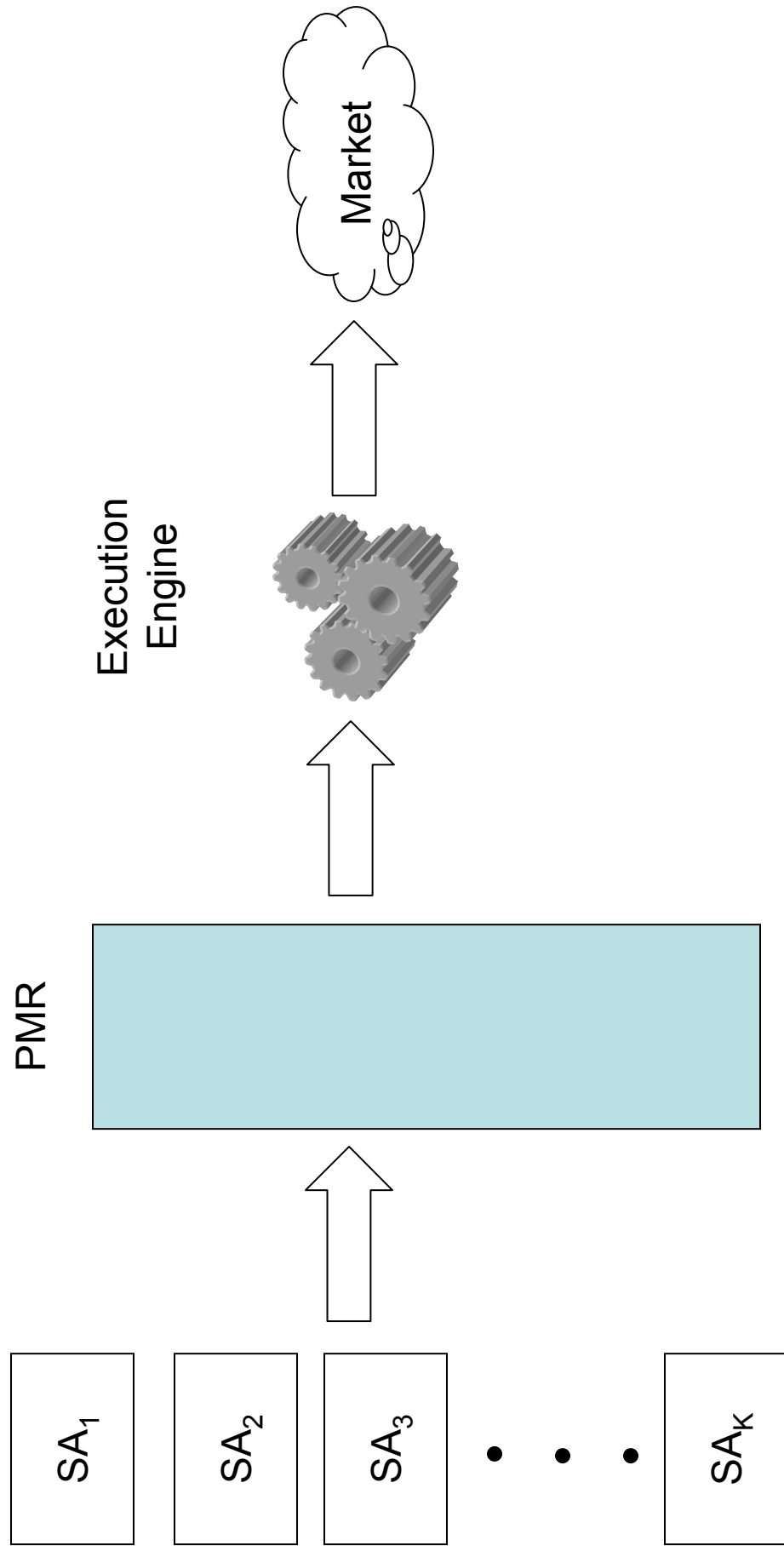


Signaling algorithms pass **long** and **short** trade states to the PMR software.

But in reality multiple signals (different equities) are input to each SA



And at the top level of organization, multiple SAs are operating at once



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Section 6

Computation, Data, Back Testing, and Paper Trading

Computation

- Research and Development system uses 160 cores organized in 4 logical clusters.
- Linux operating system
- Science Team uses mostly gridMathematica.
- Production Engineering Team uses Python and C.
- Operational system will run 24/7 (especially after we open in international markets).
- Computational horsepower is desirable, but often reliability is more desirable.
- Computation is cheaper than HR costs.

Data

- Data is surprisingly expensive (at least I was surprised).
- Maintain 4+ years in our database down to the level of individual transaction (tick) data \Rightarrow few TB in SAN
- Real-time data from the market (2 redundant DS-3 lines, 45 Mbit each)
- Aggregate data approximately 1-2 GB (compressed) for principal U.S. equity markets (NYSE, NASDAQ, AMEX) including all trades on alternate trading venues.
- Minute data (VWAP) used in many algorithms rather than tick data, but still a large database component:
 - 1000 equities \times 400 minutes \times 1000 trading days (4 yrs)
= 400M database rows

Back Test

- Back test is evaluation of algorithm performance over historical data.
- Considerable care is taken to insure that back test is causal and realistic.
- Back test usually involves combinations of signaling and PMR components.
- Back test is the fundamental scientific technique used by the DQM Science Team. We view back test runs as experiments.
- Back test operates within the context of a hypothesis-driven methodology with planning and progress review because some of the back test experiments are expensive.

Paper Trading

- Paper trading is algorithm testing on market data in real time or near real time.
- More advanced paper trading runs incorporate market execution and slippage models as well as interactions with other paper-traded algorithms through the PMR suite.
- Paper trading results are stored in a “lock box” to guarantee their validity and security.
- Successful paper trading is a necessary performance gate before an algorithm is implemented in its final operational form.
- The computational resources required for realistic and useful paper trading approach those of operational trading.

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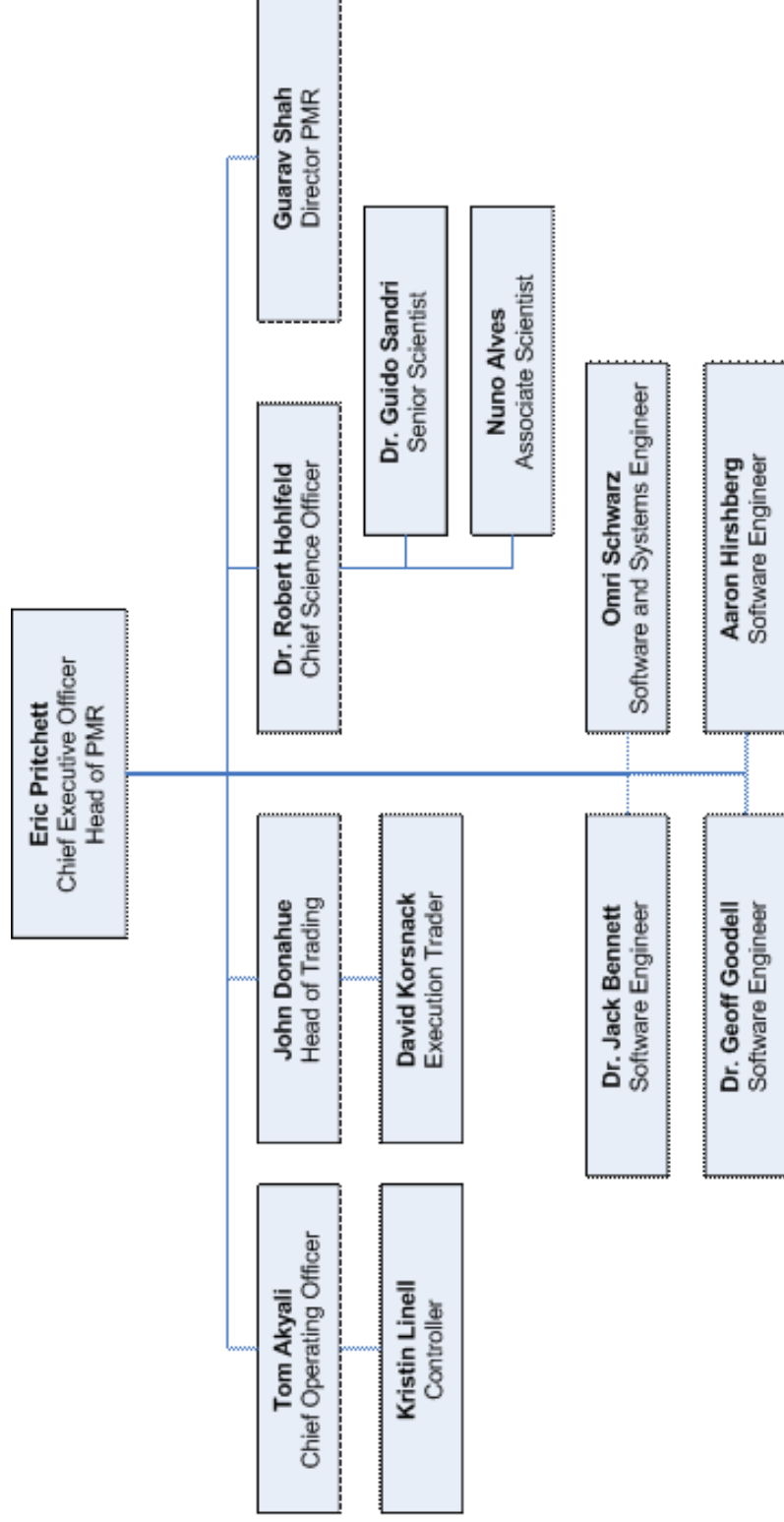
Section 7

Why Isn't Everybody Doing This?

Why Isn't Everybody Doing This?

- New signaling and PMR algorithms require a significant intellectual, time, and monetary investment. (You'll pay your dues working around your kitchen table for a long time.)
- The statistical edge of signaling algorithms is small (EMH is approximately true) ⇒
 - You need a lot of (expensive) data.
 - You need to do a lot of computing.
 - You need to have significant AUM. This is not a day-trading from home endeavor.
 - You need significant business infrastructure. Legal, accounting, HR, investor relations, co-location, DR, ...

Why Isn't Everybody Doing This? (HR)



But there are compensations:

- We are inventing something new and intellectually stimulating.
- We aspire to high standards of scientific methodology and content.
- DQM is a start-up and has a start-up atmosphere.
- Our organizational structure is very flat and this encourages collaborations.
- We have an atmosphere of a high-tech start-up that expects to monetize itself through trading operations.
- We expect to be financially successful.

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