

WHERE DID WE COME FROM
and
WHERE ARE WE GOING?

Presidential Address
Bachelier World Congress
London 2008

Steven E. Shreve
Department of Mathematical Sciences
Carnegie Mellon University

Disclaimer

To prepare a **Presidential Address** is a daunting task because it should be ... well ...

Presidential.

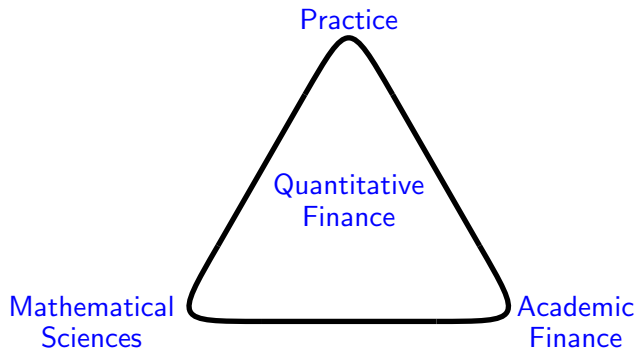
Last month the President of the United States made his farewell tour of Europe, and upon meeting Pope Benedict XVI he said

“Your eminence, you’re lookin’ good.”

Being Presidential is not so difficult any more.

Three cultures

In order to understand the origins of quantitative finance and to hazard a guess where it might be going, it is necessary to understand its **three cultures**.



I will try to describe quantitative finance by describing the extreme points.

Practice

First Extreme Assertion.

The practice of finance drives the whole activity.

The practice of finance creates demand for:

- ▶ Mathematics
- ▶ Technology
- ▶ People

Practice: Demand for mathematics

“The London buyer of options is accustomed to ‘trade against his options’ to a much greater extent than the New Yorker, and trading of this character calls for *quite complicated calculations* that would puzzle and confuse the average American stock speculator ...”

Samuel A. Nelson
The ABC of Options and Arbitrage
New York
1904

Practice: Demand for mathematics

“While many financial institutions exude vast power, they are highly vulnerable because it is hard to patent their ideas.”

Gillian Tett
Financial Times
May 30, 2008

Corollary

Financial institutions must constantly be seeking new ideas. Many of these are mathematical.

Practice: Demand for mathematics

“I got the biggest kick out of hearing those options traders routinely talk about hedge ratios and deltas, partial differential equations, and stochastic differential equations.”

Robert Merton talking about the state of options markets a year after Black-Scholes and Merton were published.

Quoted by Peter Bernstein in *Capital Ideas*.

Practice: Demand for mathematics

- ▶ Fundamental Theorems of Asset Pricing
- ▶ Optional decomposition of supermartingales
- ▶ Evolution of yield curves on a manifold

- ▶ Change of numeraire and market models for interest rates
- ▶ Monte-Carlo simulation for American options
- ▶ Coherent and convex risk measures

- ▶ Stochastic volatility modeling
- ▶ Renewed interest in Lévy processes
- ▶ Renewed interest in fractional Brownian motion

Practice: Demand for technology

“There are three rival cable companies in London From 3 PM, which means 10 AM in New York, messages pour into these offices at the rate of many hundreds an hour and are flashed with inconceivable rapidity over the wires from London via Ireland and Canada to New York.... This speed in the transmission of orders enables the arbitrageur to secure his profits.”

Samuel A. Nelson
The ABC of Options and Arbitrage
New York
1904

Practice: Demand for technology

Wall Street is exploring the use of graphics processing units found in video games to speed up options analytics and other math-intensive applications.

Ivy Schmerken
Finance Tech
June 18, 2008

“A major international hedgefund with significant assets under management is searching for a quantitative research analyst. The focus of the role will involve developing and refining an algorithmic trading engine that is used to place trades using an electronic order book.

Posted on
Quant Finance Jobs.com
May 2008

Practice: Demand for people

“I’ve always said Renaissance’s secret is that it didn’t hire MBAs,”

Elwyn Berlekamp

Director of Renaissance Technology’s
Medallion Fund in 1990, when
it returned 56% on investments.

Quoted in *Bloomberg Markets*,
January 2008.

- ▶ Renaissance Technology is the world’s largest hedge fund.
- ▶ James Simons, the founder and primary owner of Renaissance, won the American Mathematical Society’s Oswald Veblin Prize in Geometry.
- ▶ One-third of the 200 Renaissance employees in its main office hold Ph.D. degrees.

Practice: Demand for people

The first Master's programs in quantitative finance were founded fewer than 15 years ago.

“If we assume the existence of around 75 quant finance programs worldwide, ... we can conclude that slightly fewer than 2,000 quant finance students graduate annually....

Pablo Triana

“The Metamorphosis of Finance Education”

Global Association of Risk Professionals

September/October 2007

Practice: Demand for people

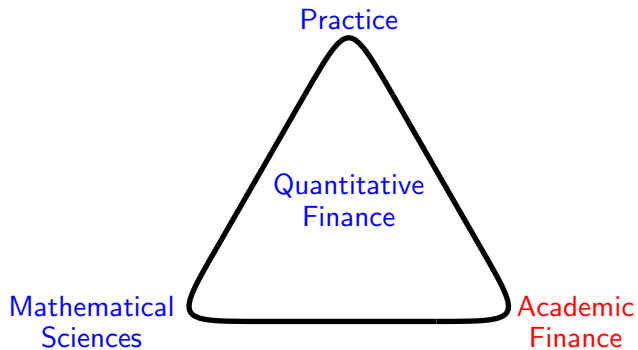
But do all these people find jobs in today's distressed market?

- ▶ “According to a study by the London-based Securities & Investment Institute, graduate recruitment at the 20 top investment banks is running at 94% of the 2007 level, which, in turn, was well ahead of what it was in 2006.” — Financial Times, June 26, 2008.
- ▶ We are seeing quant finance job growth in Hong Kong and Singapore. There is potential in China and the Middle East.
- ▶ Regulation generates quant finance jobs.
- ▶ Cap-and-trade generates quant finance jobs.
- ▶ Insurance and accounting firms are beginning to hire.
- ▶ 92% of Carnegie Mellon's M.S. in Computational Finance December 2007 graduates were placed by March 2008.
96% of students seeking 2008 summer internships were placed.

Practice: Interface with academia

- ▶ Banks exist to make money, not to prove theorems.
- ▶ A month is a long time for a bank to spend on a research project.
- ▶ If you work on a problem because the bank says it is important, when you finish be prepared to hear them say that they have moved on and something else is more important.
- ▶ Banks must do something *now*, even if there is little theoretical justification, e.g., Value-at-Risk and the normal copula model.
- ▶ Academia has the luxury of letting good ideas germinate and grow to maturity.

Three cultures



Academic finance

Second Extreme Assertion

Mathematics is the language used by finance academics to express insights about finance. Rigorous mathematics is not the method used to derive them.

- ▶ “Proofs” go in the appendix.
- ▶ “Black and Scholes have three proofs in their paper. That says to me that they didn’t believe any of them.” — David Heath

Academic finance

But Black, Scholes and Merton were onto something.

- ▶ Mathematicians cannot afford to dismiss the heuristic arguments of our colleagues in finance.
- ▶ Academic finance is a discipline that takes years to master.
 - ▶ Its own language.
 - ▶ Its own important questions.
 - ▶ Its own criteria for assessment.

Get a co-author.

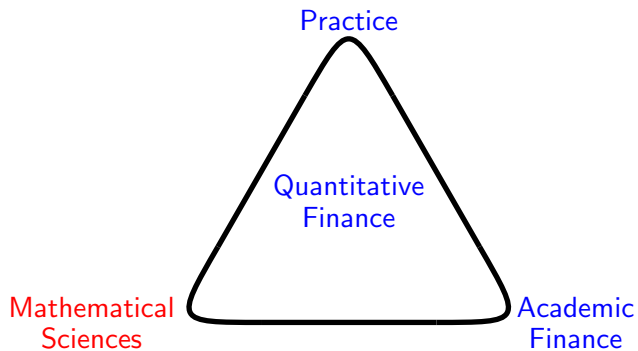
- ▶ Refereeing process: Black-Scholes paper was twice summarily rejected.

Academic finance

Finance faculty can help mathematicians move beyond the trap pricing ever more exotic options.

- ▶ Market microstructure and order book transparency.
- ▶ Equilibrium prices and incomplete markets.
- ▶ Information.
- ▶ Energy and commodities.
- ▶ Asset management.
- ▶ Macroeconomic variables.

Three cultures



Third Extreme Assertion

Mathematicians tend drive out those who would help them.

- ▶ Statistics began in mathematics departments and moved out.
- ▶ Computer Science began in mathematics departments and moved out.
- ▶ Will quantitative finance move out of mathematical science departments?

Mathematics

“Mathematicians love their proofs.” – Dieter Sondermann

- ▶ Mathematicians bring rigor to the party. Rigor is a critical part of quantitative finance.
- ▶ Rigor is not the only part.
- ▶ Model building is a critical part of quantitative finance. Sometimes the appropriate model does not require deep mathematics, e.g., the initial paper on coherent risk measures.
- ▶ **Specialist** – Someone who knows more and more about less and less until ultimately he knows everything about nothing.
- ▶ **Prove theorems, but let your theorems be about something!**

Admonishment to those who evaluate others

Do not become entrapped in disciplinary thinking. This impedes progress.

“Harry, this isn’t a dissertation in economics, and we can’t give you a Ph.D. in economics for a dissertation that’s not economics. It’s not math, it’s not economics, it’s not even business administration.”

Milton Friedman at Harry Markowitz’s
Ph.D. defense.

Reported by Peter Bernstein in
Capital Ideas Evolving.

Where are we going?

Prediction is very hard, especially about the future. — Yogi Berra

But here is my infinitesimal peek into the future.

- ▶ Exotic options of all types demand richer models.
 - ▶ Exotic equity options
 - ▶ Energy and commodity markets
 - ▶ FX and fixed income
 - ▶ Credit
- ▶ Risk measures for dynamic portfolios.
- ▶ Asset management.
 - ▶ Increasingly populated by quants
 - ▶ Hold derivatives as well as stocks and bonds
- ▶ Hedge funds.
 - ▶ Model driven
 - ▶ Data driven

Where are we going?

Prediction is very hard, especially about the future. — Yogi Berra

I am reluctant to predict. Therefore, I will say only

The answer is in your hands.

- ▶ There is demand in industry for our research.
- ▶ There is demand in industry for our students.
- ▶ There is also demand in industry for our faculty!
- ▶ There is the possibility of counter-productive emphasis on disciplinary boundaries.
- ▶ There is also the possibility of continued scientific advance that will fuel the growth of a sustainable global economy, truly a golden age of quantitative finance.

Where are we going?

I end with a cautionary note about the harm that can be caused by too much attention to disciplinary boundaries.

“Too much finance!”

Paul Levy, commenting on the Ph.D. dissertation of our namesake, Louis Bachelier.