

**Selections from an  
Applied Mathematics Research Agenda  
for the Investments Industry**

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# Agenda

I would like to present an albeit biased selection of topics from asset management and investment research which may be (or may have been) of interest to other practitioners and applied mathematicians.

N.B.: A version of this was presented to the MCIM Industrial Problems seminar in February 2005

# Survey of Topics

- Information asymmetry
- Stable processes
- Emergent “bubbles”
- Investment breadth
- Multi-period coherence
- Liquidity put

# Information asymmetry

- Examples: arbitrage, privileged information
- Systematic ( $\beta$ ) vs. Specific ( $\alpha$ ) exposures
  - CAPM says P/L from specific exposure is a martingale; active management begs to differ
- What can be said about distribution of outcomes?
  - Risk management in a setting of plural densities
- Asset Allocation
  - Black-Litterman model (risk efficiency)
  - Kelly criterion (max log utility)

# Stable processes

- Abbreviated Def.: any distribution subject to a central limit theorem is Stable
- Turns out to be a four-parameter family
  - Limiting examples are Normal & Cauchy
- Risk Management
  - 99% quantile range from  $2.3 \sigma$  to  $31.8 \sigma$
  - Connections to Embrechts' 1d Extreme Value Theory
- Derivatives Pricing
  - Variance-Gamma & CGMY models

# Emergent “bubbles”

- Goals
  - Detecting imbalances
  - Modeling collapses
- Statistics
  - Bi-modal returns
  - Long-term memory
- Models
  - Regime shifts?
  - Anticipating agents?
  - Nash equilibrium of anticipated supply and demand?

# Investment breadth

- Grinold & Kahn's, "Fundamental Law of Active Management": 
$$\underbrace{IR}_{\text{excess return}} = \overbrace{IC}^{\text{skill}} \cdot \sqrt{\underbrace{N}_{\text{breadth}}}$$
- Based on the concept that a manager makes discrete "bets"
- Does this make any sense?
  - It does not in a Markowitz world
  - Is a pair trade one bet or two?

# Multi-period coherence

- Seminal paper by Artzner (1998)
- Axioms for Coherence
  - translation invariance, subadditivity, positive homogeneity, and monotonicity
- Counterexample: Albanese's default risk
- Single period solution usually posed in terms of expectation over an “acceptance set”
- More recent work of Heath et. al.



# Valuing the Liquidity Put

- Market Impact
- Distress Liquidations
- Intramarginal Surplus
  - Capitalization
  - Liquidation value
  - Replacement value
  - Market Value
- Does Discretion Matter?

The End