

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

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Introduction

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Agenda

I would like to present a (biased) selection of topics which may be (or may have been) of interest to applied mathematicians and may be valuable in applied translation to practitioners in financial management and investment research.

Survey of Topics

- Information asymmetry
- Lévy Stable processes
- Emergent “bubbles”
- Investment “breadth”
- Pro-cyclicality
- Multi-period “coherence”
- Slowly-varying parameters

Information asymmetry

- Active vs. Passive investment management
- Systematic (β) vs. Specific (α) exposures
- CAPM says P/L from specific exposure is a martingale; active management begs to differ
- Examples: arbitrage, privileged information
- What can be said about distribution of outcomes?

Lévy Stable processes

- Abbreviated Def.: any distribution subject to a central limit theorem is Lévy Stable
- Turns out to be a four-parameter family
- Limiting examples are Normal & Cauchy
- 99% quantile range from 2.3 to 31.8
- 99% standard conditional expectation ranges from 0.027 to ∞

Emergent “bubbles”

- Detecting imbalances
- Modeling collapses
- Regime shifts?
- Agent models?
- Nash equilibrium based on 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”
- But what about relative bets?
- Perhaps some insight from Brinson’s combinatoric attribution

Pro-cyclicality

- Topic of great interest to banking regulators, e.g. BIS Financial Stability Institute
- Positive feedback from collective adverse behavior in the face of crisis
- Example: Value-at-Risk for setting minimum capital requirements

Multi-period “coherence”

- Seminal paper by Artzner (1998)
- Axioms for Coherence
 - translation invariance, subadditivity, positive homogeneity, and monotonicity
- Example: Albanese’s default risk counterexample
- Recent working paper of Heath et. al.

Slowly-varying parameters

- Examples: estimating historical covariances for risk modeling; the Hull-White time transformation