

Problems that keep me awake at night

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Setting a Baseline



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@__paleologo · Apr 2

I am going to a conference this week. And I must go, since I am speaking.

So, honest question: have you EVER been to a conference that you did NOT regret attending?

No.

53.3%

Yes.

46.7%

120 votes · Final results



3



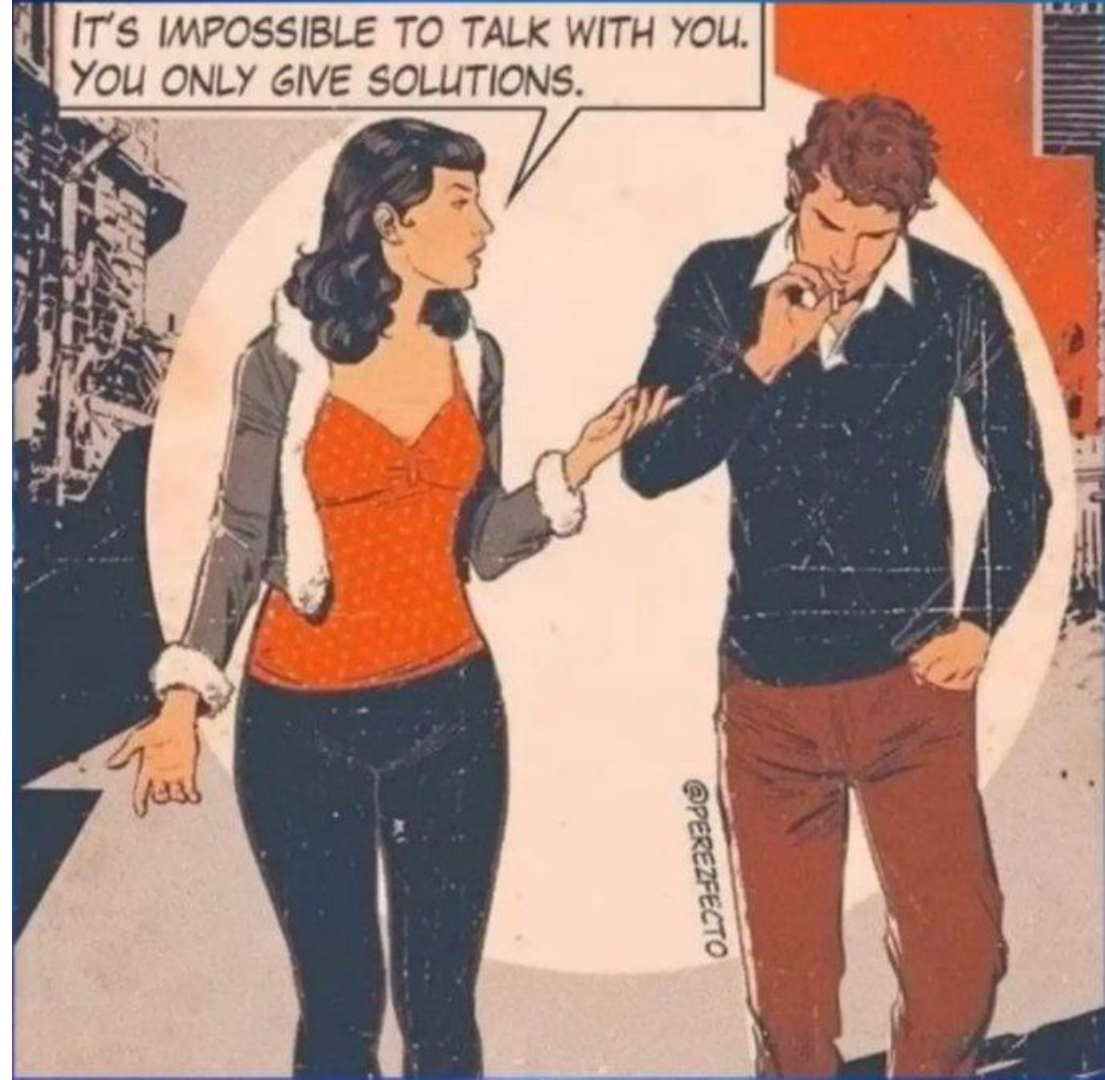
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1.9K



Real People Have Problems



"It's Not That I Smart. It's That I Stay With Problems Longer" -A.Einstein

- A.Einstein had been thinking about General Relativity for years. He picked up the right tool (Differential Geometry) in 1912
- H.Simon learned math in his late 20s, well into his 40s, based on his needs
- F.Black and M.Scholes knew no Stochastic Calculus in 1967-8...
- ...And so on
- Their problems vastly preceded their choice of technique

/imagine being a person lying in bed having seven hard mathematical finance problems that keep them awake at night thinking



More Baselineing from our AI Overlords

 You

Can you list seven open problems that arise in actual investment? They should meet these criteria:

1. At least in principle, must have room for elegant models.
2. Need to be sufficiently well-defined. "What are the essential ingredients of a hedge fund platform" does not cut it.
3. Solving each will have a direct impact on profits.
4. Either the first word on something, or at least on something that is not actually even close to being solved yet.

Sure, here are seven open problems in mathematical finance that meet your criteria:

1. **Risk-based asset allocation:** Develop a model that can optimally allocate assets based on risk factors, such as volatility and correlation.
2. **High-frequency trading:** Develop a model that can predict and optimize trading strategies in high-frequency markets.
3. **Portfolio optimization with non-linear constraints:** Develop a model that can optimize portfolio construction with non-linear constraints, such as regulatory requirements or risk limits.
4. **Credit risk modeling:** Develop a model that can accurately predict credit risk and potential defaults in a portfolio.
5. **Derivative pricing with complex underlying assets:** Develop a model that can accurately price derivatives with underlying assets that exhibit complex behaviors, such as volatility smiles.
6. **Optimal execution strategies:** Develop a model that can optimize trading execution strategies to minimize costs and market impact.
7. **Systemic risk analysis:** Develop a model that can analyze and predict systemic risk in financial markets, including contagion effects and cascading failures.

These problems have room for elegant models, are well-defined, have a direct impact on profits, and are either new or not yet solved.

7:27 AM

 ChatGPT

Certainly! Here are seven open problems in investment that meet the criteria you've outlined:

1. **Market Microstructure Modeling:** Developing more accurate models to understand the dynamics of order flow, price formation, and market impact in high-frequency trading environments. Solving this problem could lead to more effective algorithmic trading strategies and better risk management techniques.
2. **Factor Investing:** Determining the optimal combination of factors (such as value, momentum, size, quality, etc.) that drive asset returns across different market conditions and time periods. Developing robust factor models could improve portfolio construction and enhance risk-adjusted returns.
3. **Portfolio Optimization with Transaction Costs:** Creating efficient algorithms for portfolio rebalancing that explicitly account for transaction costs, market impact, and liquidity constraints. Solving this problem could lead to more realistic portfolio construction techniques that minimize trading expenses and improve overall performance.
4. **Behavioral Finance Integration:** Integrating insights from behavioral finance into quantitative models to better understand and predict investor behavior, market anomalies, and sentiment-driven movements. Developing hybrid models that combine traditional financial theory with behavioral insights could provide more accurate forecasts and enhance risk management strategies.
5. **Tail Risk Hedging:** Designing effective strategies to hedge against extreme market events (tail risk) while minimizing the cost of insurance premiums. Solving this problem could help investors protect their portfolios during periods of market stress and enhance overall risk management practices.
6. **Machine Learning Interpretability:** Developing interpretable machine learning models for investment decision-making to understand the rationale behind model predictions and enhance transparency in the investment process. Solving this problem could improve trust in AI-driven investment strategies and facilitate better collaboration between human experts and automated systems.
7. **Dynamic Asset Allocation in Uncertain Environments:** Designing adaptive asset allocation strategies that can dynamically adjust to changing market conditions, economic regimes, and geopolitical events in real-time. Solving this problem could help investors navigate uncertainty more effectively and capture opportunities across diverse market environments.

 Copilot

Certainly! Here are **seven open problems** in the field of investment that meet the specified criteria:

1. **Algorithmic Trading Strategies:** Developing elegant and robust trading algorithms that can consistently outperform the market remains an ongoing challenge. These models need to adapt to changing market conditions, handle large volumes of data, and account for transaction costs.
2. **Portfolio Optimization with Constraints:** While portfolio optimization models exist, incorporating real-world constraints (such as transaction costs, liquidity, and regulatory restrictions) elegantly remains a challenge. Balancing risk and return while adhering to these constraints is crucial.
3. **Behavioral Finance Models:** Understanding and modeling investor behavior is essential. Behavioral biases impact decision-making, leading to suboptimal investment choices. Creating elegant models that account for cognitive biases and emotional factors is an ongoing pursuit.
4. **Risk Management for Complex Derivatives:** As financial markets evolve, complex derivatives (e.g., credit default swaps, collateralized debt obligations) continue to pose challenges. Developing models to accurately assess and manage risks associated with these instruments is critical.
5. **Factor-Based Investing:** While factor-based strategies (e.g., value, momentum, quality) have gained popularity, refining these models and identifying new factors remains an open problem. Elegant factor models that consistently generate alpha are sought after.
6. **Predictive Asset Pricing Models:** The quest for a unified asset pricing model that explains cross-sectional returns across various asset classes continues. Solving this problem would revolutionize portfolio construction and risk management.
7. **Quantitative ESG Integration:** Integrating environmental, social, and governance (ESG) factors into investment models elegantly is an ongoing challenge. Developing robust ESG metrics and understanding their impact on returns remains an area of active research.

Remember that these problems are multifaceted, and their solutions require collaboration between mathematicians, economists, and practitioners. While progress has been made, the pursuit of elegant models and impactful solutions in investment remains an exciting journey [1](#) [2](#) [3](#) [4](#).

Criteria for Inclusion

1. **Personal taste.** At least in principle, must have room for elegant models.
2. **Tractability.** Needs to be sufficiently well-defined. "What are the essential ingredients of a hedge fund platform" does not cut it.
3. **\$Impact.** Solving each will have a *direct* impact on profits.
4. **Novelty.** Either the first word on something, or at least on something that is not actually even close to being solved yet.

How to think about these problems? Heuristic: as a researcher, be an experimental physicist, or (2nd best) a theoretical physicist. Don't have a problem for mathematical physicists or mathematicians.

(Some of) My Problems

1. How to Model Flows per Strategy Class

The problem: we think of "alpha" as being driven by behavioral mispricing and/or compensation for risk. Returns are also driven by OPT (Other People Trading). This has structural, predictable, features. "Your flow is my (lack of) alpha"

Examples: Index rebalancing, arbitrage trades, end-of-month institutional flows, liquidity provisioning affecting L/S equity

Questions: 1. Data? 2. Models? Can they be incorporated into factor models? And 3. integrate this with analyst forecasts

2. Crowding

The problem: Industry concentration and consolidation in recent years. Every investment style has maybe an effective size 50 participants. Not price takers anymore. Everyone is an imperfect copy of everyone else. *Crowding is not a factor.* Crowding is endogenous.

Examples: Equity, long-short and systematic.

Questions: 1. How to model this beyond 13F, SI, and made-up factors? 2. Are strategy-class returns just compensation for risk? 3. Asset characteristic or participant characteristic?

3. Signal Combination

The problem: Should you combine alphas or portfolios? Very important for decentralization and scaling.

Examples: Hedge funds internal capture systematic/discretionary, aggregation of analyst sleeves in a PM's multi-analyst team.

Questions: 1. Are they the same? 2. Impact of t-costs? Can one prove that under any trading policy combining signal is an improvement?

4. An Effective Backtesting Protocol

The problem: Historical data reuse, and a lack of a solid test protocol, are major causes of failure.

Examples: Any systematic strategy and increasingly discretionary equities.

Questions: 1. What are we solving for? Hypothesis testing? Controlling FWER? Uniform haircut on all strategies? 2. Should we keep the testing/holdout separation? What about the holdout reuse?

5. Portfolios from Rankings

The problem: 1. People rank much better than score. Some algorithms too. 2. The rank->score step is often arbitrary. Plus, heavy-tailed returns are not well described by this step.

Examples: Discretionary Equity, Macro.

Questions: 1. How do we describe ranking noise? 2. How do we combine expert rankings? 3. How do we build portfolios?

6. The Impact of Being Wrong on alpha and risk

The problem: Since Michaud (1989) "error maximization" is a commonplace criticism of Mean-Variance Optimization. You get both alpha and covariance matrix wrong. This impacts performance.

Examples: Wherever MVO is used, but also if you use something different.

Questions: 1. What are best the error metrics? 2. Tight lower and upper bounds. 3. Does alpha error really matter more than covariance error? Under what conditions? 4. Impact on portfolio construction and alpha & covariance estimation?

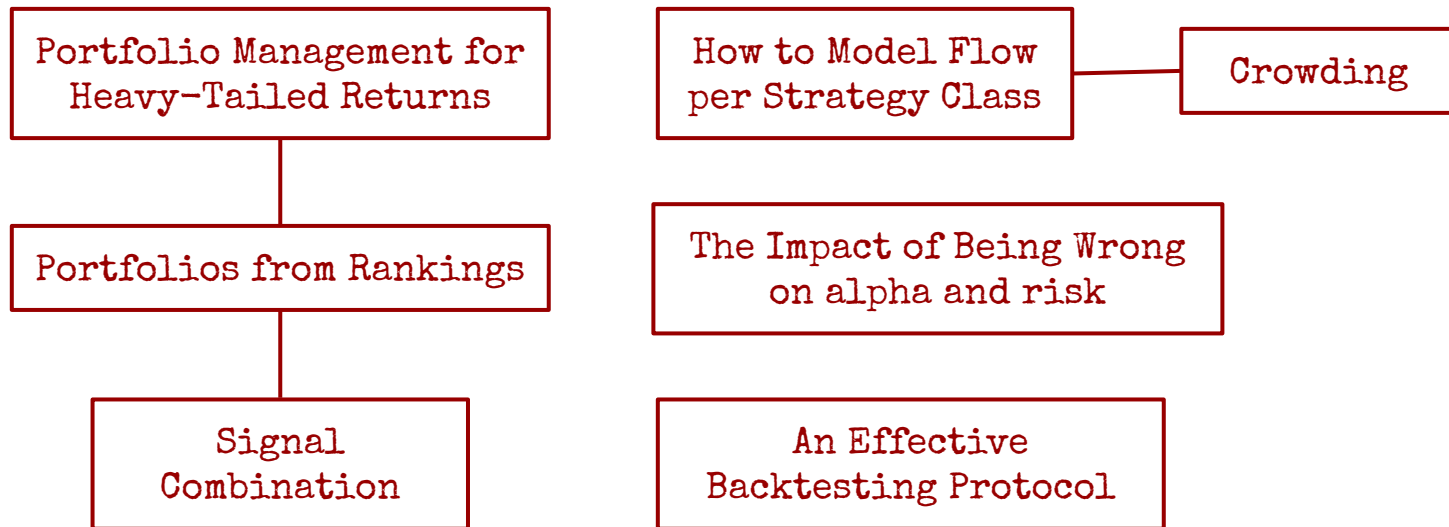
7. Portfolio Management for Heavy-Tailed Returns

The problem: *Everything* is heavy-tailed (except most animals with actual tails). We ignore this at our peril. How should we build such a portfolio?

Examples: 2.5% of PMs are 60% of total HF PnL on a good year. Long-term assets are heavy-tailed. PnL is concentrated even at the PnL level

Questions: 1. Should you diversify more or less? 2. How do you define, measure and use a selection skill metric? 3. Does sizing skill matter?

Relationships Graph



The End