

# Order Book Alpha Extensions

*One-Page Summary*

## Key Questions Addressed

Theme	Question
Self-Alpha Feedback	Whether dynamically adjusting alpha based on remaining inventory improves execution efficiency and trade path structure
Ensemble Coupling	Whether mean-field-inspired coupling based on market-wide behavior reduces execution cost while preserving convexity
Real Data Applicability	Whether the extended model performs robustly when applied to real equity market data (AAPL intraday)

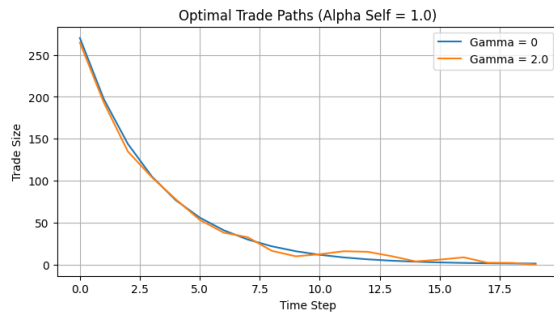
## Conceptual Ideas Proposed

- Convex optimization framework extending Almgren-Chriss by introducing self-alpha feedback and ensemble coupling terms
- Self-alpha modeled as a linear function of remaining inventory, capturing informational decay and execution fatigue
- Ensemble coupling implemented via mean-field approximations using synthetic agent counts and real-market proxies (signed volume)
- Statistical physics analogy connecting self-impact to internal fields and ensemble coupling to mean-field effects
- Parameter grids explored systematically for  $\gamma$  (ensemble coupling strength) and self-alpha magnitudes

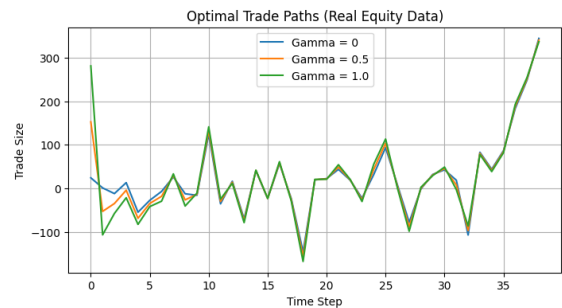
## Key Results

- Synthetic experiments show monotonic execution cost reduction with increasing  $\gamma$ , while self-alpha strength governs trade path stability
- Real market data experiments on AAPL 5-minute bars confirm similar cost-reduction trends, with higher trade path variability due to noisier alpha signals
- Convexity and tractability preserved across all tested configurations, supporting potential real-world application

## Illustrative Figures



Synthetic Data: Trade path adjustment under varying  $\gamma$  (Self Alpha = 1.0)



Real Equity Data (AAPL): Trade path adjustment under varying  $\gamma$