Minisymposium on High Frequency Trading

March 25−26th, 2017

THAW Hall 102, University of Pittsburgh

A. Schedule

	Saturday, March 25th
✻ MORNING SESSION, Chair: Sergey Nadtochiy	
9:00am-10:00am	Sebastian Jaimungal (University of Toronto)
10:00am-10:30am	*Coffee break*
10:30am-11:30am	Kevin Li (Tower research Capital, New York)
11:30pm-1:30pm	*Lunch break*
✻ AFTERNOON SESSION, Chair: Sebastian Jaimungal	
1:30pm-2:30pm	Ciamac Moallemi (Columbia University)
2:30pm-3:00pm	*Coffee break*
3:00pm-4:00pm	Sasha Stoikov (Cornell University)
4:00pm-5:00pm	Dmitry Kramkov (Carnegie Mellon University)

	Sunday, March 26th
✻ MORNING SESSION, Chair: Steven Shreve	
9:00am-10:00am	Agostino Capponi (Columbia University)
10:00am-10:30am	*Coffee break*
10:30am-11:30am	Dobrislav Dobrev (Federal Reserve)
11:30pm-1:30pm	*Lunch break*
✻ AFTERNOON SESSION, Chair: Agostino Capponi	
1:30pm-2:30pm	Sergey Nadtochiy (University of Michigan)
2:30pm-3:00pm	*Coffee break*
3:00pm-4:00pm	Steve Xu (HTG Capital Partners, Chicago)
4:00pm-5:00pm	Steven Shreve (Carnegie Mellon University)

B. Programs

1. Intraday Market Making with Overnight Inventory Costs

Agostino Capponi (Columbia University)

The share of market making conducted by high-frequency trading (HFT) firms has been rising steadily. A distinguishing feature of HFTs is that they trade intraday, ending the day flat. To shed light on the economics of HFTs, and in a departure from existing market making theories, we model an HFT that has access to unlimited leverage intraday but must fund any end-of-day inventory at an exogenously determined cost. Even though the inventory cost only occurs at the end of the day, it impacts intraday price dynamics and generates a negative relation between prices and the HFT's inventory level. As time approaches the end of the trading day, the sensitivity of prices to inventory levels intensifies, making price impact stronger and widening bid-ask spreads. Empirically, we show that these predictions are borne out in the U.S. Treasury market, where bid-ask spreads and price impact tend to rise towards the end of the day. We show that a higher arrival frequency of orders may improve or harm price stability, depending on the severity of the end-of-day inventory cost. A welfare analysis finds that overnight inventory costs have the greatest negative impact in illiquid markets.

2. High-Frequency Cross-Market Trading: Model Free Measurement and Applications

Dobrislav Dobrev (Federal Reserve)

We propose a set of intuitive model-free measures of cross-market trading activity based on publicly available trade and quote data with sufficient time stamp granularity. By virtue of capturing the offset at which co-activity peaks, as well as its magnitude and dispersion, the measures allow us to shed new light on the distinct features of the high-frequency cross-market linkages in US Treasury and equity markets. First, the measures avoid reliance on noisy return series often used in the literature and demonstrate sharp identification of the prevailing lead-lag relationships between trading activity across markets. Second, we show how the measures can be used to examine price impact and liquidity provision in (near) arbitrage linked markets. In particular, we provide new evidence pointing to the fact that price discovery in US Treasury, equity and EUR/USD FX markets primarily takes place in futures rather than cash markets and we give a strong rationale for considering the cross-market price impact between arbitrage linked markets. Finally, we show that our measures of cross-market activity are closely linked with observed market volatility even after controlling for commonly used measures of individual market activity such as trading volume and number of transactions. Overall, our empirical findings suggest that accounting for cross-market trading activity is important when studying volatility and liquidity in US Treasury and equity markets (this is a joint work with Ernst Schaumburg).

3. Trading algorithms with learning in latent alpha models

Sebastian Jaimungal (University of Toronto)

Alpha signals for statistical arbitrage strategies are often driven by latent factors. This paper analyses how to optimally trade with latent factors that cause prices to jump and diffuse. Moreover, we account for the effect of the trader's actions on quoted prices and the prices they receive from trading. Under fairly general assumptions, we demonstrate how the trader can learn the posterior distribution over the latent states, and explicitly solve the latent optimal trading problem. We furthermore develop forward-backward algorithm based on expectation-maximization to calibrate a pure-jump model to historical data, illustrate the efficacy of the optimal strategy through simulations, and compare to strategies which ignore learning in the latent factors (this is a joint work with Philippe Casgrain).

4. On "forward" and "backward" models with price impact

Dmitry Kramkov (Carnegie Mellon University)

A typical financial model presumes that the prices of traded securities are not affected by an investors buy and sell orders. From a practical viewpoint, this assumption is justified as long as his trading volume remains small enough to be easily covered by market liquidity. An opposite situation occurs, for instance, when an economic agent has to sell a large block of shares over a short period of time. This and other examples motivate the development of financial models for a large trader, where the dependence of market prices on his strategy, called a price impact or a demand pressure, is taken into account. In this talk, we discuss two models of price impact, "forward" and "backward", which originated in financial economics. A starting point for both models is the postulate that, at any given moment, a price reflects a balance between demand and supply or, more formally, it is an output of an equilibrium. The models differ in the amount of information the market makers have about the strategy of the large trader (this presentations is based on joint papers with Peter Bank and Sergio Pulido).

5. How does High Frequency Trading make profits: Styles and Approaches

Kevin Li (Tower research Capital, New York)

We do a survey of the various successful HFT firms and discuss their styles of trading, what edge they have in propelling the consistent revenues, we then move onto the holding periods/trading frequency of the high frequency firms and discuss the typical features/factors of a high frequency strategy firms are looking at. Finally we will talk about the steps of implementing a HF strategy.

6. A Separation Principle for Dynamic Trading and Portfolio Optimization

Ciamac Moallemi (Columbia University)

We consider multi-period optimal trading or portfolio optimization problems in the presence of predictable returns. Our setting is general in that it allows essentially arbitrary dynamics for returns and return predictions, but requires restrictive assumptions on transaction costs, risk preferences, and trading constraints. When restricted to this setting, we establish that that the term structure of future conditional mean returns is a sufficient statistic for optimal decision making. This provides a separation principle that partitions optimal trading into two natural steps: at each time, (1) conditionally forecast the term structure of future expected returns; and (2) given the forecast term structure, compute the optimal trading decision by solving a single-period, deterministic Markowitz-style mean-variance optimization problem, but with an endogenously determined effective time horizon. Our method is tractable for realistic problems with a large number of assets and many predictive variables over multiple time horizons (this is a joint work with Benjamin Van Roy from Stanford University).

7. Control-Stopping Games for Market Microstructure

Sergey Nadtochiy (University of Michigan)

In this talk, I present a framework for modeling market microstructure based on continuous-time control-stopping games. In this framework, the shape and dynamics of a Limit Order Book (LOB) arise as an outcome of an equilibrium between multiple agents who have different beliefs about the future demand for the asset. These beliefs may change according to the information observed by the agents (e.g. represented by a relevant stochastic factor), implying a change in the shape of the LOB. The proposed framework allows one to see how changes in a relevant information signal affect the LOB. In addition, it can be used to evaluate the consequences of a new regulation, such as a change in the tick size. On the mathematical side, we formulate the problem as a mixed control-stopping game, with a continuum of players. Under certain structural assumptions, the equilibrium problem splits into two parts: a two-dimensional system of Reflected Backward Stochastic Differential Equations and an infinite-dimensional fixed-point equation. Both problems are non-standard. I will discuss in detail the mathematical challenges associated with these problems, will prove the existence of their solutions, and will show how they can be computed in simple examples (this is a joint work with Roman Gayduk).

8. A Diffusion Model for Limit-Order Book Evolution

Steven Shreve (Carnegie Mellon University)

With the movement away from the trading floor to electronic exchanges and the accompanying substantial increase in the volume of order submission has come the need for tractable mathematical models of the evolution of the limit-order book. The problem is inherently high dimensional, and any realistic description of order flows must have them depend on the state of the limit-order book. Poisson process models for the evolution of the limit-order book have been proposed, but the analysis of these is either difficult or impossible. In this talk, we show how diffusion scaling of a simple Poisson model, inspired by queueing theory, can lead to a rich

yet tractable diffusion model for the evolution of the limit-order book. We then show how to compute the probability of up and down price moves and the time between price changes in this model (this is joint work with Chris Almost, John Lehoczky and Xiaofeng Yu).

9. The micro-price

Sasha Stoikov (Cornell University)

The micro-price is a weighted average between the bid and ask prices, where the weight is a simple function of the bid and ask sizes. The micro-price is a good predictor of future mid-price moves and is frequently used by high frequency trading algorithms to make micro-decisions, such as whether to cancel, submit a limit order or a market order. However, not much effort has been made in determining whether the micro-price is a fair or efficient price. We redefine the micro-price as the limit of a sequence of expected mid-prices at future stopping times. We provide conditions for this sequence to converge. Volatility signature plots using this notion of micro-price indicate that our method is an effective method for filtering out microstructure noise.

10. High Frequency Trading Principles

Steve Xu (Hehmeyer LLC, Chicago)

HFT is a highly debated topic just as much as misconceived by media, public and even by many professional market practitioners. Structured often as a proprietary trading business, most HFT trading firms try to remain an ultra-low profile to protect their trade secrets. This mysteriousness does not help their public image, unfortunately, though HFT is more of a result from combining finance, science and engineering than any other investment or trading methods. In this talk, Mr. Xu will demystify what HFT really is, correct some common misconceptions, explain basic principles behind HFT trading, introduce some common HFT strategy types, and explain why, in his mind, HFT has existed, will exist and must exist in one form or another in a free market place.