# Team projects and references
# of the new research program
# of the Canada Research Chair in Risk Management

Georges Dionne

## Research projects with collaborators and PhD students

- **The first three projects will be realized with Gabriel Yergeau, a PhD student in finance.**

*Dynamic Inventory management*: The starting point will be the model of Ait-Sahalia and Saglam (2014) to determine an optimal quoting policy for a high frequency market maker active in different exchanges. The model will be embedded in a trading strategy with risk management features and will maximize market exposure. The resulting algorithm will be emulated in a microsecond environment for many stocks. The model will examine the empirical impact of the trading algorithm on market quality, market stability, and liquidity. Speed is important to gain time priority and to avoid being picked up while displaying stale quotes, so the effect of latency on profitability will be investigated.

*Auctions*: As discussed above**,** call auctions are considered a potential solution to the alleged speed advantage problem of high-frequency traders. Using public information during Xetra call auction phases, the imprints of trading algorithms will be identified. The algorithms will be grouped into categories according to their goals. This approach will lead to a preliminary diagnosis of the impact of trading algorithms on the price discovery process and of the depth and resilience of the undisclosed auction order book. An extension will be to develop an algorithm that will identify HFTs where such identity is not available. This allows us to qualify the impact of different high-frequency trading algorithms.and can help the regulator curb reprehensible behaviors.

*Interlisting and arbitrage*: Stock exchanges are using different market models while public firms commonly employ interlisting. Controlling for different exchanges' characteristics simultaneously, various dimensions of HFT will be analyzed: arbitrage, liquidity, granularity of the limit order book, bid-ask spread, presence of high-frequency traders, behavior during periods of high stress, and trading commissions. Special attention will be paid to potential benefits related to arbitrage and to asymmetric information, including adverse selection in HF markets.

- **The next two projects will be part of Yann Bilodeau's PhD thesis, supervised by G Dionne.**

*LOB event arrival analysis and forecast*: The main research question is: Do HFT practices alter the dynamics of financial markets? To answer this question, we will focus on LOB event arrivals. A model describing the multilevel LOB arrival dynamics for different stocks will be developed. This will be done by extending the works of Bowsher (2007), Bacry et al. (2013) and Lallouache and Challet (2016), who use multivariate Hawkes point processes. The model will let us analyze the evolution of market participants' behavior over different time periods. The LOB dynamic model will be very useful to forecast behaviors in that it will account for market reaction to different types of events. As Abergel and Jedidi (2015) assert, Hawkes process-based limit order book models have desirable characteristics over the long term.

*HF portfolio analysis*: Portfolio selection has always been an omnipresent topic in finance. There are no portfolio models in the HFT environment. Bilodeau's second project will analyze high frequency data usage in a portfolio management context. The main step will consist in developing and applying a consistent methodology for irregularly spaced data dependency representation such as that developed by Aït-Sahalia et al. (2010), Barndorff-Nielsen et al. (2011) or Hautsch et al. (2010).

- **A PhD candidate in finance, Stéphane Galzin will work on pricing. He is supervised by G. Dionne.**

*Price dynamics*: The advent of algorithmic trading and the technological evolutions in terms of latency have led recent studies to focus on stock price dynamics. The price models used for many of these studies are derived from a latent Itô process supplemented by a "microstructure noise" component (Zhou, 1996). More recent papers have examined price processes derived from the mechanics of LOB (Abergel, A. Jedidi, 2011, Smith et al, 2003, Oomen, 2007). The advantage of this type of modelling is that the microstructure is inherent to the process, instead of being somewhat artificially added to a latent variable. A number of drawbacks remain that need to be addressed in future research. The main extensions that will be considered in this project concern the consideration of liquidity fragmentation in the LOB, the price dynamics related to intraday seasonality, and the development of optimizing high frequency execution algorithms.

- **Two projects on LOB. The first one with X Zhou, UQAM, and Tolga Cenesizoglu, HEC Montréal.**

*Interaction between quoting and trading*: How trading activity and quoting activity interrelate and how market activities evolve and react to an exogenous shock over the short-term and long-term are questions still not well studied (O'Hara, JFE, 2015). Our access to different HFT exchanges and open LOB data will provide an excellent opportunity to establish a comprehensive understanding of these interactions. This project is the first to examine the effect of trade on the different dimensions of LOB dynamics. Trading volumes, durations and volatility will be considered as measures of trading activity. By modeling the simultaneous and causal effects between trading activity and quoting activity, our empirical evidence might provide guidance to a new generation of theoretical models on HFT, and contribute empirical evidence from different datasets. In practice, our economic modeling and empirical results could be of interest to traders, portfolio managers and market regulators.

- **The second project is conducted with Maria Pacurar, Dalhousie University, and X Zhou, UQAM.**

*Information in the LOB and equity trading*: The goal is to investigate the informativeness of the LOB through its impact on trading for different assets as opposed to resampling the data at regularly spaced time intervals. The first part of the research program focuses on how the high-frequency dynamics of the LOB influence the trading of a particular stock on a transaction-by-transaction basis: What are the effects of the state of the LOB on future durations between consecutives trades, on future market order sizes and on future returns and volatility? Which variables describing the LOB have the highest impact on future trading activity? Can one exploit the identified statistical relationships between the LOB variables and the trading activity variables to make profits? Do the identified relationships change during crisis periods? The second part of the project will extend the analysis to multimarket trading (e.g., Canadian stocks cross-listed in the U.S.).

- **Collaboration with Manuel Morales, professor at Université de Montréal, N. Pegnard, post-doctorate fellow, and PhD students in mathematics.**

*Simulating the LOB and Optimizing Trading Strategies*: Brokerage firms use optimal strategies by efficiently distributing order volume throughout a given day. This can be done by using an efficient

market simulator capable of reproducing stylized features of the LOB. These engines are often developed in-house and play a strategic role in the decision-making process of an intra-day trading desk dealing with large order volumes. In this project, we propose to develop new market simulator models and their theoretical foundations that allow us to test intra-day and high frequency trading algorithms used by brokerage firms. We focus on zero-intelligence (ZI) models and propose ***efficient*** and ***realistic*** ways of simulating their arrival without focusing on the behavior of the agents creating the events. These two keywords are important when discussing market simulator models because we want our simulator to produce market prices that exhibit observed features and that efficiently simulate events that occur at a high frequency during a day. The algorithms and simulators to be used require very powerful computer clusters capable of parallel computing.

- **Collaboration with Diego Amaya, Cedric Okou and Alexandre Roch, UQAM.**

*Cross-listing analysis of liquidity and price impact*: Limit-order markets have developed into important trading venues, offering a real-time view of the current supply and demand in financial markets. However, financial assets are often cross-listed on various trading venues and exchanges so that a complete assessment of the supply and demand of an asset must be performed across venues. The aim of this work is to characterize the liquidity of a cross-listed asset, to develop a theory for the optimal way to manage liquidity across multiple limit-order markets and to understand its characteristics and determinants. First, we will construct the relevant variables (liquidity measures, realized variances and order imbalances) for cross-listed stocks and investigate their statistical properties. This analysis should reveal liquidity patterns that are specific to each trading venue. Next, we will pool all specific liquidity measures together and study their differences and commonalities. This second step should help us identify the main cross-market liquidity drivers and support the design of a multi-market liquidity management strategy.

- **Collaboration with Bruno Rémillard, HEC Montréal, and PhD students in mathematics.**

*Optimal execution: modeling and estimation*: The problem of execution is to find an optimal way to sell or buy a large amount of shares of a given stock without overly affecting its price. Most of the literature on the subject is about modeling the transaction impact with latent variables, by taking into account the particular structure of the LOB. Our goal is to improve existing models such as the models of Smith et al. (2003) and Cont and de Larrard (2013). In these models, the main building blocks of the LOB are modeled as Poisson processes. To improve these models, one should first replace the Poisson processes by inhomogeneous Poisson processes, where the arrival rate is not constant but depends on time. Even if this seems an elementary improvement, it generates significant technical difficulties; we will have to use the full arsenal of the theory of stochastic processes to be able to tackle this problem and study the properties of the price processes. The second part of this project is to estimate the required parameters that will be a function of time. To estimate the time-dependent parameters, tick-by-tick data over several weeks must be used, either to validate the assumptions about the arrival rates or to estimate all parameters with a given precision level. Access to HFT data is of paramount importance for the application part of the project.

- **LIVaR for HFTs, project in collaboration with X. Zhou and M. Pacurar**

Dionne et al, (2015) have developed a new measure of risk that add liquidity risk from LOB to market risk (LIVaR). The computation of the Value at Risk has two steps: model estimation and model simulation. Estimation takes 1 or 2 hours depending on the number of observations during

a week. Monte Carlo simulations are used to make multi-step forecasts. It takes 8 or 9 hours to simulate 5,000 paths for an interval of one week depending on the stock characteristics. The time needed for the simulation depends on the target interval and number of paths in simulations. However, the simulation time could be longer than the target interval for risk management. The goal of this project is to use ultra-high speed parallel computing and C++ to obtain a measure of risk that will be useful to HFTs and regulators.

- **Two projects on asymmetric information with two PhD students. One with Rami Hedfi, HEC Montréal.**

*Capital formation and HFT*: This study will investigate the informational problems that arise between investors and issuers in the context of HFT trading. Does the presence of HFTs affect adverse selection in the IPO, SEO, and Private Investment in Public Equity (PIPE) markets? Do more informed investors take advantage of their informational position and speed? Does the presence of HFT affect the trade-off between SEO and PIPE financing? Although different papers (Floros et al. 2015 and Billett et al. 2014) emphasize the fact that the participation of more informed investors can alleviate information asymmetry between the issuer and the investors, no one has proposed a formal test of the presence of information asymmetry in these markets. This study introduces a formal test to uncover the informational problem in this market and examines how the presence of HFTs affects the conclusions. The data we plan to buy for PIPES will let us identify multiple issuers over time and to track the investor identity from deal to deal by identifying multiple participants. We will thus test whether more informed participants affect the pricing of capital and the contracting terms compared with transactions in which they do not participate. We already have access to the IPOs and SEOs data from SDC Platinum.

- **The second project with Helmi Jeddidi, HEC Montréal.**

*Asymmetric information in securitization*: This project analyzes information asymmetry in the the bank loan securitization process using a large data set on U.S. mortgages that were privately securitized during the period of 2002 to 2012. In the first part, we propose a test of the presence of information asymmetry in the mortgage securitization process. Our preliminary results from a sample of the whole dataset support the evidence of information asymmetry in the data. Our project will then separate moral hazard from adverse selection in this setting. Our separating analysis is twofold. First, we use the timing of the securitization decision as a key variable that lets us separate moral hazard from adverse selection. Second, we consider the issuer's decision to modify loan terms and conditions as the agent's action (in a principal-agent relationship) that mirrors its effort to avoid the default outcome. We will then look at the best regulation scheme to align the lender's interests with those of the secondary market investors. The data for this project, obtained with previous funding from CFI, contain more than 25 million loan origination records in the US spanning over 20 years. The new data we plan to buy will be an update of the current data that will cover the recent regulatory changes in the USA, which is necessary to analyze the efficiency of this regulation under asymmetric information. The dataset will be updated to 2015.

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