Book of Abstracts

Maxim Bichuch (Johns Hopkins University)
The Learning Premium

We find equilibrium stock prices and interest rates in a representative-agent model with uncertain dividends? growth, gradually revealed by dividends themselves, where asset prices are rational – reflect current information and anticipate the impact of future knowledge on future prices. In addition to the usual premium for risk, stock returns include a learning premium, which reflects the expected change in prices from new information. In the long run, the learning premium vanishes, as prices and interest rates converge to their counterparts in the standard setting with known growth. The model explains the increase in price-dividend ratios of the past century if both relative risk aversion and elasticity of intertemporal substitution are above one. (Joint work with Paolo Guasoni)

Agostino Capponi (Columbia University)
Bail-Ins and Bail-Outs: Incentives, Connectivity, and Systemic Stability

We develop a framework to analyze the stability of an interbank network, in which subsidized bail-ins or public bailouts can be coordinated to stop financial contagion. Banks are willing to contribute to a subsidized bail-in only if the social planner?s threat to not bail out insolvent banks is credible. We show that the credibility of the threat exhibits a phase transition: for small shocks, the threat is more credible in a more densely connected network, whereas for large shocks, the threat is more credible in sparsely connected networks. The optimal bail-in plan requires lower taxpayer contributions in more sparsely connected networks. This raises social welfare and makes a sparsely connected network socially preferable over a more densely connected network, even if the densely connected network is more stable in the absence of intervention. (Joint work with Benjamin Bernard and Joseph Stiglitz)

Peter Cotton (J.P. Morgan)
Trading Illiquid Goods: Market Making as a Sequence of Sealed-Bid Auctions, with Analytic Results

We provide analytic results for the optimal control problem faced by a market maker who can only obtain and dispose of inventory via a sequence of sealed-bid auctions. Under the assumption that the best competing response is exponentially distributed around a commonly discerned fair market price we examine properties of the market maker's optimal behavior. We show that simple adjustments to skew and width accommodate customer arrival imbalance. We derive a straightforward relationship between the market marker's fill probability and direct holding costs. A simple formula for optimal bidding in terms of inventory cost is presented. We present the results as a perturbation of an improvement to a "linear skew, constant width" (CWLS) market making heuristic.

Jianqing Fan (Princeton University)
Robust High-dimensional Volatility Matrix Estimation for High-Frequency Factor Model

High-frequency financial data allow us to estimate large volatility matrices with relatively short time horizon. Many novel statistical methods have been introduced to address large volatility matrix estimation problems from a high-dimensional Ito process with micro-structure noise contamination. Their asymptotic theories require sub-Gaussian or some finite high-order moments assumptions. These assumptions are at odd with the heavy tail phenomenon that is pandemic in financial stock returns and new procedures are needed to mitigate the influence of heavy tails. In this paper, we introduce the Huber loss function with a diverging threshold to develop a robust realized volatility estimation. We show that it has the sub-Gaussian concentration around the conditional expected volatility with only finite fourth moments. With the proposed robust estimator as input, we further regularize it by using the principal orthogonal component thresholding (POET) procedure to estimate the large volatility matrix that admits an approximate factor structure. We establish the asymptotic theories for such low-rank plus sparse matrices. The simulation study is conducted to check the finite sample performance of the proposed estimation methods. (Joint work with Dongguy Kim)

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Siddhartha Dalal (AIG)
Transforming Insurance Industry Using Data Science

Mark D. Flood (Office of Financial Research, US Treasury)
Topological Approaches to Financial Network Complexity

Complexity is often cited as a fundamental factor affecting financial system efficiency and stability, but these conversations frequently fail to define "complexity" precisely. In two papers, we develop network complexity measures grounded in basic graph theory and algebraic topology. To make them useful, it is important to ground the measurement tools in specific economic issues. In one paper, we develop a collection of related measures that capture the coordination challenges that arise in unwinding a large network of financial obligations. We derive formal results for core-periphery networks, which are commonplace in large interbank dealer markets. In a second paper, we develop measures of the extent of jurisdictional overlap that can complicate the resolution of large bank holding companies (BHCs). BHCs are structured into intricate ownership hierarchies involving hundreds or even thousands of legal entities, where each subsidiary has its own legal form, assets, liabilities, managerial goals, and supervisory authorities. We propose metrics that focus on the graph quotient relative to certain partitions on the set of subsidiaries, such as charter type and regulatory jurisdiction. We illustrate the process with a case study of one large U.S. BHC.

Helyette Geman (Johns Hopkins University and Birkbeck, University of London)
High Frequency Trading in Commodity Markets

Paul Glasserman (Columbia University)
Does Unusual News Forecast Market Stress?

We find that an increase in the "unusualness" of news with negative sentiment predicts an increase in stock market volatility. Similarly, unusual positive news forecasts lower volatility. Our analysis is based on more than 360,000 articles on 50 large financial companies, published in 1996–2014. Unusualness interacted with sentiment forecasts volatility – at both the company-specific and aggregate level – several months into the future. Furthermore, unusual news is reflected in volatility more slowly at the aggregate than at the company-specific level. The observed behavior of volatility in our analysis can be explained by attention constraints on investors. (Joint work with Harry Mamaysky)

John Sang Jin Kang (University of Western Ontario)
Moment-Based Density Approximation Methodologies with Actuarial Applications

Several advances in connection with certain aspects of distribution theory and its applications are proposed. First, we focus on heavy-tailed distributions, such as the Pareto, Student-t and Cauchy, which only possess a finite number of moments, if any. We suggest applying the Esscher transform to such distributions, which then enables one to make use of an accurate moment-based density approximation methodology. This involves solving

systems of equations that are explicitly provided for the univariate and bivariate cases. A symmetrization technique is also proposed to address instances wherein the methodology can only be applied to truncated distributions that are defined on the positive half-line. As well, we are introducing a novel technique ensuring that the polynomial adjustments being made to appropriately selected base density functions remain positive and differentiable so that the resulting functions be bona fide densities. It is also explained that one can utilize the proposed approach in the context of density estimation, in which case sample moment are employed in lieu of exacts moments. Several illustrative examples involving actuarial data sets will be presented. (Joint work with Serge B. Provost and Jiandong Ren)

Yuming Kuang (Stanford University)
Adaptive Particle Filters in Hidden Markov Models: A New Approach and its Applications

Particle filters, also known as sequential Monte Carlo methods have been widely used to solve the latent state filtering problem in nonlinear hidden Markov model (HMM). In this thesis, we propose a new methodological advancement, adaptive particle filter, for joint parameter estimation and latent state filtering of HMM. Adaptive particle filter is a hybrid algorithm that merges particle filters and a new MCMC scheme, sequential substitution, to provide an efficient estimate for function of the posterior distribution of parameter and latent state, and further give estimator of its standard error. We establish the asymptotic normality of the estimate for the function and the consistency of the standard error estimator. In the case of a long sequence of HMM, we propose the Markov chain restart strategy which enables the particle filters method for newly proposed parameter atoms at time $t+\delta_t$ to start at time t by utilize the approximation of posterior distribution at time t. Markov chain restart greatly reduces the computation cost of adaptive particle filters and makes it feasible to perform more sequential substitution iterations for long sequence of HMM. We demonstrate the effectiveness of adaptive particle filters and Markov chain restart strategy with simulation results on examples of HMM. As an application in finance and econometrics, we apply our approach on parameter estimation and latent volatility filtering for the jump-diffusion models using the asset returns and option prices.

Albert S. "Pete" Kyle (University of Maryland)
Dimensional Analysis, Leverage Neutrality, and Market Microstructure Invariance

This paper combines dimensional analysis, leverage neutrality, and a principle of market microstructure invariance to derive scaling laws expressing transaction costs functions, bid-ask spreads, bet sizes, number of bets, and other financial variables in terms of dollar trading volume and volatility. The scaling laws are illustrated using data on bid-ask spreads and number of trades for Russian and U.S. stocks. These scaling laws provide practical metrics for risk managers and traders; scientific benchmarks for evaluating controversial issues related to high frequency trading, market crashes, and liquidity measurement; and guidelines for designing policies in the aftermath of financial crisis.

Johan Lim (Seoul National University)
High-Dimensional Markowitz Portfolio Optimization Problem: Empirical Comparison of Covariance Matrix Estimators

We compare the performance of recently developed regularized covariance matrix estimators for Markowitz's portfolio optimization, the minimum variance portfolio (MVP) problem in particular. We focus on five estimators that are applied to the MVP problem in the literature, two of which regularize the eigenvalues of the sample covariance matrix while the other three assume sparsity of the true covariance matrix. The comparisons are made with two sets of long-term S&P 500 stock return data that represent two extreme scenarios of active and passive managements. The results show that the MVPs with sparse covariance estimators have a high Sharpe ratio, whereas the naive diversification (also known as uniform portfolio on market share) still works well in view of the wealth growth.

James Lo (University of Maryland, Baltimore County)
Are Empirical Covariance Matrices what Biological Neural Networks Learn?

A computational model of biological neural networks will be presented to answer the above question. It is the only single computational model that answers eight long-standing holy-grail questions in neuroscience and is believed to be the common cortical algorithm long hypothesized. As a learning machine, it is the only one that performs "photographic learning", "real-time learning", and/or "maximal generalization". It is also the only multilayer network (with or without feedback connections) that is capable of unsupervised learning. The computational model provides a large number of research opportunities for understanding the brain, developing intelligent and cognitive machines, processing big data (including those in finance and insurance), and possibly helping find genetic causes of diseases.

Winsome Huei-Wen Teng (National Chiao Tung University)
On a Novel Spherical Monte Carlo Method via Group Representation

Accurate and efficient calculation of d-dimensional integrals for large d is of crucial importance in various scientific disciplines. Via spherical transformation, standard spherical Monte Carlo estimators consist of independent radii and a set of unit vectors uniformly distributed on a unit sphere. A random orthogonal group is used to rotate a set of unit vectors simultaneously, and can be generated by applying the Gram–Schmidt procedure to a $d \times d$ matrix with i.i.d. standard normal random variables as entries. The generation of a random orthogonal group is however computationally demanding. To overcome this problem, this paper proposes a novel spherical Monte Carlo approach via group representation: By constructing a subgroup of the orthogonal groups, the spherical integral is calculated using the group orbit of a random unit vector. In this case, the generation of a random unit vector only needs d i.i.d. standard normal random variable. The proposed method outperforms existing methods in terms of computation efficiency in high-dimensional cases. Theoretical

properties of the proposed subset are provided. Extensive numerical experiments with applications in finance confirm our claims.

I-Ping Tu (Academia Sinica, Taipei)

A Transition Probability Tensor and its Application to Block Chain

A sequence of random variables (states) $\{X_1, X_2, \cdots\}$ can be modeled as a stationary Markov Chain if $P(X_{n+1}|X_1, \cdots, X_n) = P(X_{n+1}|X_n)$ for any integer $n \geq 1$. This can be generalized as a stationary Markov Chain of order m. An mth order Markov Chain is defined as $P(X_{n+m}|X_1, \cdots, X_n, \cdots, X_{n+m-1}) = P(X_{n+m}|X_n, \cdots, X_{n+m-1})$ holds for any $n \geq 1$. An exact solution for the stationary states is usually solved by constructing a first order Markov Chain accordingly which would create a huge number of states. The corresponding transition matrix would be an enormous square matrix with a large proportion of zero values. A tensor representation has been introduced for the transition probability of high order Markov Chain which could succinctly keep the valid probabilities. With some condition, we could exploit the tensor structure to construct a compact transition matrix to solve the stationary states efficiently. We will show a demonstration on calculating the double spending probability under a dynamic difficulty scheme of a Block Chain.