University of Bergamo/Georgia Institute of Technology

Fall 2016 Workshop

Groseclose Advisory Boardroom, Room 402

29 August – 2 September 2016

Workshop Program

Monday 29 August 2016, Deterministic Optimization

Workshop Chair: Santanu Dey

1. Time: 9:00 – 10:25
   Speaker: George Lan
   Title: Introduction to stochastic gradient descent.
   Abstract: We provide a brief introduction to stochastic gradient descent (SGD) methods, including mirror-descent stochastic approximation and accelerated stochastic approximation, for solving both convex and nonconvex problems. We show that these methods have evolved into popular algorithms for machine learning, including deep learning.

2. Time: 10:35 – 12:00
   Speaker: Natashia Boland
   Title: Multiobjective Integer Programming
   Abstract: In the last few years, there has been increased interest in algorithms for solving general multiobjective integer linear programs, especially those with a small number of objectives (2 or 3). The aim of these algorithms is to find the complete efficient frontier: the points at which no one objective can be improved without worsening another. Such problems are of great interest in many fields, where trade-offs must be made, between, for example, reliability and cost, or environmental impact and quality of service, or quality of life and cost of treatment. Decision-makers wish to see the efficient frontier in order to select a desirable trade-off point, since the efficient frontier identifies the set of trade-offs that are achievable. This talk provides an introduction to the concepts of multiobjective integer linear programming, and gives an overview of recent algorithms, with an emphasis on algorithms that operate in the space of the objectives (criterion space), rather than in the space of the decision variables. While the latter have great potential, algorithms that operate in the criterion space can exploit the power of modern integer programming solvers, and have, to date, proved most effective.

3. Time: 12:00 – 13:30
   Lunch

4. Time: 13:30 – 14:00
   Speaker: Roberto Pinto
   Title: A derivative free method for a profit satisfying objective problem
   Abstract: The talk discusses a rationing problem with a profit satisficing objective in a company operating many retail stores through a centralized procurement. General rationing problems arise when the available stock or capacity cannot guarantee the possibility to satisfy the demand in full, and different decisions about the allocation of the available resources may lead to different profit results. Therefore, the appropriate allocation of the stock or capacity can have a substantial impact on the companys profit. Unlike other works in the rationing area, the talk considers a profit satisficing objective, which entails maximizing the probability of achieving a pre-specified profit target. This type of objective is sometimes preferable to maximizing the expected profit. The problem is modelled in an analytical form, for which closed-form solutions can be hard to compute. Thus, the conditions for achieving the satisficing objective are discussed, and two heuristic procedures are compared: one exploiting the structure of the problem and resulting in a greedy, marginal unit allocation; the other, based on the Nelder Mead derivative-free method.

5. Time: 14:00 – 14:30
   Speaker: Andy Sun
   Title: Optimal Power flow problem
   Abstract: The AC optimal power flow (OPF) problem is a key optimization problem in the area of electrical power systems operations. We compare the strength of linear programing (LP), second order cone programming (SOCP) and semi-definite relaxations (SDP) of two formulations of the OPF formulation. Then we present a few families of cutting-planes to strengthen the (standard) SOCP relaxation of this problem. The strengthened SOCP relaxation is incomparable to the (standard) SDP relaxation. Extensive computational experiments show that these relaxations have numerous advantages over existing convex relaxations in the literature: (i) their solution quality is extremely close to that of the SDP relaxations and consistently outperforms previously proposed convex quadratic relaxations of the OPF problem, and (ii) in terms of computation times, the strengthened SOCP relaxations can be solved an order of magnitude faster than standard SDP relaxations.

6. Time: 14:45 – 15:15
   Speaker: Maria-Teresa Vespucci
   Title: Optimal operation of medium-voltage AC networks with distributed generation and storage devices
   Abstact: A Distribution System Operator (DSO) will be in charge of operating power distribution networks, in order to compensate generation-load imbalances with respect to a previously determined scheduling, while guaranteeing constraints on currents in lines for security and voltages at nodes for power quality. Internal (i.e. owned by DSO) regulation resources will be electricity storage devices and on-load tap changers. DSO's external regulation resources (i.e. owned by third parties) will be the dispatch of active and reactive power of generation plants and the exchange of active and reactive power

with the high voltage transmission network. Costs associated to the use of internal regulation resources reflect device deterioration; costs associated to the use of external regulation resources are to be defined by the Regulator, so as to allow a technically efficient operation of the network. The optimal redispatch minimizes the total costs for using internal and external resources, constrained by power flow equations, balance equation for the batteries and local control constraints. Active losses are also considered and penalized in the objective function. The problem is modeled by using a non linear sparse formulation and solved using a primal-dual interior point method. The procedure allows finding efficient configurations of the network and can be used as a simulation tool by the Regulator to analyze the impact of different costs associated to external regulation resources.

7. Time: 15:15 – 15:45
   Speaker: Santanu S. Dey
   Title: Aggregation-based cutting-planes for packing and covering integer programs
   Abstract: We study the strength of Chvatal-Gomory (CG) cuts and more generally aggregation cuts for packing and covering integer programs (IPs). Aggregation cuts are obtained as follows: Given an IP formulation, we first generate a single implied inequality using aggregation of the original constraints, then obtain the integer hull of the set defined by this single inequality with variable bounds, and finally use the inequalities describing the integer hull as cutting-planes. Our first main result is to show that for packing and covering IPs, the CG and aggregation closures can be 2-approximated by simply generating the respective closures for each of the original formulation constraints, without using any aggregations. On the other hand, we use computational experiments to show that aggregation cuts can be arbitrarily stronger than cuts from individual constraints for general IPs. The proof of the above stated results for the case of covering IPs with bounds require the development of some new structural results, which may be of independent interest. Finally, we examine the strength of cuts based on k different aggregation inequalities simultaneously, the so-called multi-row cuts, and show that every packing or covering IP with a large integrality gap also has a large k-aggregation closure rank. In particular, this rank is always at least of the order of the logarithm of the integrality gap.

8. Time: 16:00 – 16:30
   Speaker: Renato Monteiro
   Title:

9. Time: 16:30 – 17:30
   Speaker: Merve Bodur
   Title: Decomposition for loosely coupled integer programs: A multiobjective perspective
   Abstract: We consider integer programming (IP) problems consisting of (possibly a large number of) interrelated subsystems and a small number of coupling constraints which link blocks of variables that correspond to different subsystems. Such problems are called loosely coupled or nearly-decomposable. Motivated by recent developments

in multiobjective programming (MOP), we develop a MOP-based decomposition algorithm to solve loosely coupled IPs. More specifically, we reformulate the problem in such a way that it can be decomposed into a (resource-directive) master problem and a set of MOP subproblems. The proposed algorithm is a column generation algorithm. However, it is based on a new lower bounding problem (which is an IP), and considers a more structured (and usually smaller) set of columns than a traditional column generation algorithm. We provide preliminary computational results on instances with knapsack structure in the subsystems, demonstrating the potential benefits of our approach.

Tuesday 30 August 2016, Probability and Risk

Workshop Chair: David Goldberg

1. Time: 9:00 – 12:00
   Speakers: David Goldberg and Yilun Chen
   Title: Tutorial on multi-arm bandits

2. Time: 12:00 – 14:00
   Lunch

3. Time: 14:00 – 16:00
   Speakers: David Goldberg and Yilun Chen
   Title: Tutorial on multi-arm bandits

4. Time: 16:00 – 17:00
   Speaker: Maria Teresa Vespucci
   Title: Stochastic models for power generation capacity expansion
   Abstract: The power generation capacity expansion problem of a price-taker power producer over a multi-year time horizon is the problem of choosing among thermal power plants and power plants using renewable energy sources (RES), while taking into account regulatory constraints on CO_2 emissions, incentives to generation from RES and risk due to fuel price volatility which affects the variable costs of power generation. Risk neutral and risk averse stochastic mixed integer models are developed that determine the number of new power plants for each chosen technology as well as the years in which the construction of the new power plants is to begin. The solution allows determining the evolution of the power producers generation system along the time period, such that the expected total profit is maximized along the time period, with revenues from sale of electricity and of Green Certificates and costs for the annual debt repayment of new power plants, purchase costs of CO_2 emission permits and of Green Certificates, fixed and variable production costs of new power plants and of power plants owned by the producer at the beginning of the planning period.

5. Time: 16:00 – 17:00
   Speaker: Giorgio Consigli
   Title: Multiperiod risk measures and dynamic risk control in finance
   Abstract: Medium to long-term investment management problems are often formulated as dynamic portfolio selection problems, in which investment decisions are allowed to change over time. Such choice becomes standard in presence of time- and state-dependent constraints. Due to market frictions such as trading costs and regulatory as well as tax constraints, furthermore, dynamic decision problems are increasingly formulated as discrete, multi-stage, rather than continuous time, control problems. Key to the achievement of an effective risk control are the properties of the adopted risk measure over multiple periods. Compared to a static situation, as we see in the seminar, it is not a trivial task to establish suitable multi-period risk measures which satisfy reasonable and practically relevant properties. The talk will review the state of the art on multi-period risk measures and their inclusion in optimal portfolio selection problems. We see that, due to their complexity, dynamic measures have been

considered only occasionally in multi-stage problems to date. A relevant stream of research has gone indeed into the construction and theoretical properties of multi-period risk measures. Alternative formulations and mathematical properties of a qualified set of existing risk measures will be considered first, before introducing three classes of multi-period risk functions based on the canonical distinction between *terminal wealth*, *additive* and *recursive* risk measures. Only dynamic risk measures in discrete time are considered. Forcing a bit mathematical convention the terms *multi-period* and *dynamic* (risk measure) will be used interchangeably to highlight that despite the discrete-time approximation, underlying time is actually evolving continuously. The application of multi-period risk measures to multi-stage portfolio selection models is discussed in the second part of the talk before providing a brief summary and point out open research problems.

Wednesday 31 August 2016, Stochastic Optimization

Workshop Chair: Anton Kleywegt

1. Time: 08:30 – 09:30
   Speaker: Alexander Shapiro
   Title: Stochastic Programming tutorial
   Abstract: Optimization problems involving stochastic models occur in almost all areas of science and engineering, such as telecommunications, medicine, and finance. This tutorial focuses on optimization problems involving uncertain parameters and discusses theoretical foundations and recent advances in the area of stochastic programming.

2. Time: 09:45 – 10:45
   Speaker: Anton Kleywegt
   Title: Distributionally Robust Stochastic Optimization tutorial
   Abstract: There are various approaches to optimization under uncertainty. The robust optimization approach specifies constraints that must be satisfied for all values of the uncertain variables in a chosen uncertainty set. This is a reasonable approach for many applications, but in other applications it has several shortcomings, such as being overly conservative (it hedges against the worst possible outcome of the uncertain variables in the chosen uncertainty set), being very sensitive to the somewhat arbitrary choice of uncertainty set, and not taking into account available data that have some relevance for which future values of the uncertain variables to hedge against. The stochastic optimization approach models uncertain variables as random variables with known probability distributions. In practice the true probability distribution may not be known, and in some problems there will not be multiple replications of the same random variable (for example, for each presidential election in the USA there will be only one future realization) so that the notion of a true probability distribution does not even apply. Distributionally robust stochastic optimization is an approach to optimization under uncertainty in which one hedges against a set of probability distributions, possibly taking into account available data. This seems to be a reasonable approach to optimization under uncertainty for many applications. The tutorial will discuss various types of distributionally robust stochastic optimization. This is joint work with Rui Gao.

3. Time: 11:00 – 12:00
   Speaker: Shabbir Ahmed
   Title: Stochastic integer programming tutorial or Chance constrained stochastic programming tutorial

4. Time: 12:00 – 13:30
   Lunch

5. Time: 13:30 – 14:00
   Speaker: Francesca Maggioni
   Title: Worst-case analysis of Rolling Horizon Approach in Multistage Stochastic Programming: a Transportation Procurement Problem

Abstract: In this talk we consider a worst-case analysis of the Rolling horizon approach, a heuristic approach frequently used to solve multistage stochastic programming models applied to the stochastic multistage fixed charge transportation problem. In this problem a producer has to ship an uncertain load to a customer within a deadline. At each time period, a fixed transportation price can be paid to buy a transportation capacity. If the transportation capacity is used, the supplier also pays an uncertain unit transportation price. A unit inventory cost is charged for the quantity that remains to be sent. The aim is to determine the transportation capacities to buy and the quantity to send at each time period in order to minimize the expected total cost. We prove that this problem is NP-hard, we propose a multistage stochastic optimization model formulation, and we determine optimal policies for particular cases. Theoretical and numerical results show that the Rolling horizon approach can be very suboptimal in the worst case if used to solve the NP-hard problem, while finite bounds exist for the polynomially solvable cases. This is a joint work with Luca Bertazzi.

6. Time: 14:00 – 14:30
   Speaker: Enlu Zhou
   Title: Computing Dual Bounds in Dynamic Programming
   Abstract: I will talk about the information relaxation approach and the associated duality theory in dynamic programming. Based on the theory, we have developed a few computational approaches to computing dual bounds on the value function for a given sub-optimal policy. In particular I will focus on two recent works: 1) a practical information relaxation approach for weakly coupled dynamic programs; 2) an efficient regression approach for general dynamic programs.

7. Time: 14:45 – 15:15
   Speaker: Jikai Zou
   Title: Nested Decomposition of Multistage Stochastic Integer Programs with Binary State Variables
   Abstract: We propose a valid nested decomposition algorithm for multistage stochastic integer programming problems when the state variables are binary. We prove finite convergence of the algorithm as long as the cuts satisfy some sufficient conditions. We discuss the use of well known Benders and integer optimality cuts within this algorithm, and introduce new cuts derived from a Lagrangian relaxation corresponding to a reformulation of the problem where local copies of state variables are introduced. We propose a stochastic variant of this algorithm and prove its finite convergence with probability one. Numerical experiment on a large-scale generation expansion planning problem will be presented.

8. Time: 15:15 – 15:45
   Speaker: Weijun Xie
   Title: Nonanticipative duality, relaxations, and formulations for chance-constrained stochastic programs
   Abstract: We propose two new Lagrangian dual problems for chance-con-strained stochastic programs based on relaxing nonanticipativity constraints. We compare the strength of the proposed dual bounds and demonstrate that they are superior to the

bound obtained from the continuous relaxation of a standard mixed-integer programming (MIP) formulation. For a given dual solution, the associated Lagrangian relaxation bounds can be calculated by solving a set of single scenario subproblems and then solving a single knapsack problem. We also derive two new primal MIP formulations and demonstrate that for chance-constrained linear programs, the continuous relaxations of these formulations yield bounds equal to the proposed dual bounds. We propose a new heuristic method and two new exact algorithms based on these duals and formulations. The first exact algorithm applies to chance-constrained binary programs, and uses either of the proposed dual bounds in concert with cuts that eliminate solutions found by the subproblems. The second exact method is a branch-and-cut algorithm for solving either of the primal formulations. Our computational results indicate that the proposed dual bounds and heuristic solutions can be obtained efficiently, and the gaps between the best dual bounds and the heuristic solutions are small. This is joint work with Shabbir Ahmed, James Luedtke and Yongjia Song.

9. Time: 16:00 – 16:30
   Speaker: Kevin Ryan
   Title: Optimization Driven Scenario Grouping
   Abstract: Scenario decomposition algorithms for stochastic programs compute bounds by dualizing all nonanticipativity constraints and solving individual scenario problems. We develop an optimization problem that selects a set of nonanticipativity constraints to re-enforce, placing scenarios into 'groups'. We show that the proposed grouping problem is NP-hard in general, identify a polynomially solvable case, and present a mixed integer programming formulation. Its effectiveness is demonstrated on a set of standard test instances for two-stage 0-1 stochastic programs. The idea is extended to propose a finitely convergent algorithm for two-stage stochastic programs with a finite feasible region.

10. Time: 16:30 – 17:00
    Speaker: Francesca Maggioni
    Title: Guaranteed Bounds and Approximations in Multistage Stochastic Programs
    Abstract: In this paper we study several methods to obtain lower and upper bounds for multistage stochastic programs. In general, multistage stochastic optimization problems are formulated on the basis of continuous distributions for the random parameters. Such "infinite" problems are practically impossible to solve as they are formulated and finite tree approximations are used as proxies. In this talk, we demonstrate how one can find guaranteed bounds, i.e. finite tree models, for which the optimal values give upper and lower bounds for the optimal values of the infinite problem. Moreover, our method allows also to construct solutions for the infinite problem, which are nearly optimal in the sense that their objective value is close to the optimal value of the infinite problem and can even be made arbitrarily close by making the approximating trees bushier. We consider approximations in the first order stochastic sense and in the convex order sense and demonstrate their use in a multistage risk-averse production problem. This is a joint work with Georg Pflug.

11. Time: 17:00 – 17:30

Speaker: Rui Gao
Title: Stochastic Optimization for Distributed System Design

Thursday 1 September 2016, Robust Optimization

Workshop Chair: Andy Sun

1. Time: 9:00 – 12:00
   Speaker: Andy Sun
   Title: Tutorial on Robust Optimization

2. Time: 12:00 – 14:00
   Lunch

3. Time: 14:00 – 15:00
   Speaker: Huan Xu
   Title: All Learning is Robust
   Abstract: Controlling overfitting is a long standing topic of study in machine learning. Regularization is a commonly used technique to control overfitting where a penalty is added to the cost function (typically the classification or regression error). The success of regularization in a host of different algorithms is usually interpreted as coming from penalizing the complexity of the resulting decision rules favoring simple rules. In this talk we propose a different perspective to learning base on robust optimization. That is, assuming that each sample corrupted by a certain disturbance, we find the best decision under the most adversarial perturbation. We show that a special choice of the perturbation exactly recovers the solution obtained by penalizing complexity via regularization. Both Support Vector Machines and Lasso can be re-derived from a robust optimization perspective. The equivalence relationship between regularization and robustness gives a physical interpretation of the regularization process. Moreover, it helps us explain from a robustness point of view why support vector machines are statistically consistent, and why Lasso produces sparse solutions. Generalizing these results we use the robustness perspective to derive new algorithms in new domains that have both favorable statistical and computational properties. We finally argue that robustness is a necessary and sufficient condition for consistency of learning algorithms and in fact every useful learning algorithm must possess some robustness properties.

4. Time: 16:00 – 17:00
   Speaker: Andy Sun
   Title: Robust optimization in Energy Systems
   Abstract: I will present some recent work on modeling uncertainty in the electric energy systems concerning renewable integration and flexible demand. The talk will discuss two-stage and multistage robust optimization models for the unit commitment problem, the economic dispatch problem, and a long-term planning problem. Affine decision rules and constraint/column generation methods are developed for the solution of these challenging large-scale optimization problems.

Friday 2 September 2016, Financial Optimization

Workshop Chair: Narayanan Jayaraman

1. Time: 09:00 – 10:30
   Speaker: Giorgio Consigli
   Title: Asset-Liability Management for Institutional Investors: foundations and two case studies for P&C insurers and pension funds
   Abstract: The theory and practice of asset-liability management (ALM) for financial intermediaries and institutional investors (mainly OECD-based) has undergone a remarkable evolution over the last two decades as a result of new market-based international accounting rules (IAS) and risk management frameworks (Basel II and III, Solvency II). More recently increasing financial instability (2008-...) and unprecedented low interest rates have further stressed insurance companies' and pension funds' solvency equilibria. In this lecture we present the key elements of modern ALM theory specifically for a global property and casualty (P/C) insurer and for an occupational (second pillar) pension fund (P/F). After revising a set of common features, namely related to the definition of capital-at-risk, risk capital employment and consumption, and market-based asset and liability valuation, we analyze two case studies corresponding to real-world developments by a global insurance company. An ALM model designed to support optimal strategic planning by a P/C portfolio manager and a defined benefit (DB) P/F manager [3] is presented. This class of ALM problems is naturally formulated as a long-term multi-stage stochastic program (MSP) [1, 4, 5] with stochastic elements affecting both assets and liabilities.

   The P/C case study develops from the evidence that increasing competition and record P/C insurance claims reported by global players in recent years [2] have indeed generated remarkable pressures on the financial stability of P/C divisions within insurance firms, leading to increased technical reserves and higher capital requirements. At the same time investment management divisions have expanded, reinforcing the role of insurers as institutional investors competing in fixed-income and equity markets with other players such as pension and mutual funds. The Solvency II regulatory agreement [9] forced an historic change towards risk-based capital allocation measures for insurance companies as a whole. The complex interaction between investment and insurance operational constraints motivates a multi-objective strategy based on a short-term profit target and longer term risk-adjusted return goals. In the case study we derive an optimal asset allocation policy over a 10 year planning horizon with the inclusion of liability constraints generated by an ongoing P/C business [6, 7]. The investment universe includes fixed income and equity asset classes as well as real estate and alternative investments.

   Relative to the P/C case study, the P/F presents an additional degree of complexity due to a typically longer planning horizon and A-L risk exposure. Increasingly PFs operating in the second pension pillar of advanced economies are also constrained to monitor their risk capital exposure over time. PF ALM theory originally developed from the challenges associated with the modeling of liability streams typically extended over several decades. Those streams carry relevant risks to the PF manager. On the

liability side, indeed, a DB PF manager mainly faces three relevant risk sources: inflation risk, interest rate risk and longevity risk [3]. The value of the pension fund liability, or DB obligation (DBO), is computed as the discounted value of all expected pension payments and will depend on the evolution of the yield curve over the decision horizon. Such exposure is typically compensated for hedging purposes by fixed-income holdings in the asset portfolio. Longevity risk comes into the picture because upon determination of individuals' benefits through an annuity, the PF manager needs to assume a future life length that might underestimate passive members' actual future life duration. Such phenomenon is attracting increasing interest by actuarial studies. To trace more accurately pension payments we consider in this case a scenario tree structure in which decision stages are combined with non-decision annual stages aimed at mapping carefully the evolution of P/F's liabilities. We present a case-study of an underfunded P/F with an initial liquidity shortage and show how a dynamic policy, relying on a set of specific decision criteria is able to gain long-term equilibrium solvency conditions over a 20 year horizon.

References

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[9] European Parliament (2009), Solvency II Directive. http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:335:0001:0155:EN

2. Time: 10:45 – 11:15
   Speaker: Shijie Deng
   Title: Multiple Optimal Stopping Problems and Applications in Finance
   Abstract: Optimal stopping problems arise in a wide range of financial applications. The classical example is the American-style options pricing problem. In energy markets, various structured supply contracts have multiple early-exercising options embedded in them. The pricing of such financial instruments motivates the development of algorithms for solving multiple optimal stopping problems. In this tutorial, we present a couple of algorithms for solving optimal stopping problems and discuss their advantages and needs for future improvements.

3. Time: 11:15 – 11:45
   Speaker: Sebastiano Vitali
   Title: Stress-testing of pension fund ALM models with stochastic dominance constraints
   Abstract: The main goal of a pension fund manager is sustainability. We propose an Asset and Liability Management (ALM) model structured as a multi-stage stochastic programming problem adopting a discrete scenario tree and a multi-objective function. Among other constraints, we consider the second order stochastic dominance with respect to a market portfolio. To protect the pension fund from shocks we test the inclusion of hedge financial contracts in the form of put options. Numerical results show that we can efficiently manage the pension fund satisfying liquidity, return, sponsors extraordinary contribution and funding gap targets. We test sensitivity to put option strikes and to stochastic dominance constraints inclusion. This is joint work with Vittorio Moriggia and Miloš Kopa.

4. Time: 11:45 – 13:00
   Lunch

5. Time: 13:00 – 13:30
   Speaker: Narayanan Jayaraman
   Title: Does Combining the CEO and Chair Roles Cause Poor Firm Performance?
   Abstract: Considerable disagreement exists over the merits of CEO-Chair duality. We show that firms, depending on their attributes, follow different duality strategies: while some never or always combine CEO-chair positions, others follow a pass-the-baton (PTB) strategy, with chair-promotion conditional on firm performance. We evaluate duality by focusing on the PTB sample. We propose and test a learning model in which the title of board-chair is optimally awarded to retain talented CEOs. As predicted by this model, PTB firms exhibit performance decline following CEO chair-appointment. Underperformance disappears when an appropriate counterfactual is employed. Further, supportive of model — and counter to agency-type explanations

— chair-promotions are more likely when boards are independent and, furthermore, increase in post-combination compensation is unrelated to managerial power. Overall, CEO-duality does not harm — and may even promote — shareholder interests. Co-authored with Vikram Nanda, and Chip Ryan.

6. Time: 13:30 – 14:00
   Speaker: Andras Danis
   Title: Impact of Labor Constraints on Firm Investment: Evidence from Right-to-Work Laws
   Abstract: We analyze the impact of staggered introduction of state level Right-to- Work (RTW) laws on corporate investment. Our difference-in-differences estimation shows that RTW law passage is associated with 14.47% higher investment-asset ratio for firms headquartered in the state, with the effect being more pronounced for financially unconstrained firms. We ameliorate endogeneity concerns using a geographic regression discontinuity design. Our evidence is consistent with both a wage channel, where RTW leads to lower wages, and a debt channel, where RTW affects the leverage ratio, which then influences investment. Our results highlight the role of labor constraints in shaping corporate policies. Co-authored with Sudheer Chava and Alex Hsu.

7. Time: 14:00 – 14:30
   Speaker: Teng Zhang
   Title: A Clash of Cultures: The Governance and Valuation Effects of Multiple Corporate Cultures Abstract: This study investigates the effect of multiple corporate cultures on the governance and valuation of a firm. Estimating the cultural distance between the CEO and the board and between the CEO and stakeholders, we find significant effects of both. We find that increased cultural distance is associated with greater CEO turnover, but also with higher firm values. These findings are consistent with the view that greater cultural distance between a CEO and the board results in less empathy and acceptance of the CEO, but such distance also provokes greater monitoring and consequently increased firm value. Co-authored with Steve Ferris and Narayanan Jayaraman.

8. Time: 14:45 – 15:15
   Speaker: Alex Hsu
   Title: Monetary Policy, Volatility Risk, and Return Predictability
   Abstract: Two well-documented empirical observations in the United States economy are a structural break in macroeconomic volatility in the early 1980s, and the predictability of asset returns. We document (i) strong predictive power of several macroeconomic volatility series for stock and bond returns at various horizons, and (ii) a structural break in this predictability around 1980. We develop a long-run risk model with a monetary policy rule to address whether these findings are consistent with changes in the volatility of fundamental shocks, changes in monetary policy, or both. Preliminary results suggest that time-varying volatility in monetary policy shocks induces macroeconomic volatility that predicts asset returns as in the data. This predictability decreases in policy regimes with a strong reaction to inflation as a result of reduced time variation in volatility.

9. Time: 15:15 – 15:45
   Speaker: Chang Liu
   Title: How Does the Stock Market Impact Investor Sentiment? — Evidence from Antidepressant Usage
   Abstract: This study examines the effects of local stock returns on antidepressant usage using the Truven Health MarketScan® individual prescription drug data. There are three main findings. First, a one standard deviation decrease in local stock return increases local investor's antidepressant usage by approximately 0.42 percent, causing 2,773 more prescriptions filled (a medical expense of approximately 2.3 million dollars) in the subsequent weeks than would have been in the absence of the decrease in stock return; in contrast, a stock price increase has no impact on antidepressant usage. Second, the effect of stock returns on antidepressant usage depends on an array of local socioeconomic characteristics. Third, local stock return fluctuations have significant effects on certain physical illnesses that are comorbidities of depression. The results are consistent across a variety of robustness checks.

10. Time: 15:45 – 16:15
    Speaker: Jonathan Clarke
    Title: When Do Analysts Impede Innovation?
    Abstract: We re-examine the impact of analyst coverage on firm innovation and find that the negative relation between analyst coverage and innovation is driven by firms that are poor-quality innovators. In contrast, analysts do not hinder innovation in firms that are efficient innovators. These findings are robust when considering two different identification strategies that control for endogeneity. Our results hold for both innovation output (patents) and innovation input (R&D). Overall, our main findings indicate that analysts curtail wasteful innovation and play a beneficial role in resource allocation in the economy. Co-authored with Nishant Dass and Ajay Patel.