SMU SINGAPORE MANAGEMENT UNIVERSITY | Lee Kong Chian School of Business

Operations Management Summer Camp 2024

Date: Friday, 16 August 2024

Venue: Singapore Management University
Lee Kong Chian School of Business
Level 2, Seminar Room (SR) 2.1

Programme	
9.30am - 10.00am	**Registration** (outside SR 2.1) **Morning Refreshment** @ Catering area 2A/2B, near SR 2.8, Level 2
10.00am - 10.15am	**Opening address**
10.15am - 11.15am	**Paper 1** Presenter: **Zhaowei SHE, Singapore Management University** Discussant: **Hessam BAVAFA, University of Wisconsin-Madison** **Title:** **The "Netflix Model": A New Payment Model for Asymptomatic Disease Management** Abstract: Several U.S. state governments (e.g., Louisiana and Washington) have recently entered Netflix-style contracts with pharmaceutical companies (Gilead and AbbVie). In these contracts, the state Medicaid programs make a fixed lump-sum payment to a drug manufacturer in exchange for unlimited access to hepatitis C virus (HCV) drugs for their Medicaid patients. We analyze these Netflix-style contracts from a mechanism design perspective. Our analysis reveals that under perfect information, Netflix-style contracts guarantee a

	market efficiency gain over traditional payment-per-prescription (PPP) models. Specifically, these contracts lead to an increase in treatment rates and pharmaceutical companies' revenue, while maintaining the same or lower average price per DAA therapy course in general. However, the asymptomatic nature of HCV introduces significant uncertainty in patient willingness to participate in screening (WTS), leading to imperfect information about the potential number of treatments needed. In this context, we demonstrate that Netflix-style contracts may not increase HCV treatment rates but may incur higher DAA therapy costs for the payer. We further characterize critical thresholds of WTS uncertainty below which different Netflix-style contracts can still increase market efficiency and HCV treatment rates. Finally, we calibrated our model using the Medicaid State Drug Utilization Database (SDUD) and a validated HCV microsimulation model for all 50 U.S. states. This calibration exercise provides state-specific policy recommendations for U.S. government agencies considering the implementation of Netflix-style contracts. More broadly, this study offers insights for healthcare policymakers and payers on the conditions under which Netflix-style contracts can effectively improve public health outcomes and market efficiency in pharmaceutical procurement.
11.15am - 12.15pm	**Paper 2** Presenter: **Leon Liang XU, Singapore Management University** Discussant: **Jussi KEPPO, National University of Singapore** **Title:** **Regulating Adaptive Medical Artificial Intelligence: Can Less Review Lead to More Compliance?** Abstract: As of May 2024, the U.S. Food and Drug Administration (FDA) has approved 882 medical artificial intelligence (AI) devices. Despite the potential for continual learning, the current regulatory framework freezes AI algorithms after approval, requiring new submissions for updates. This is to ensure the medical AI developers' compliance with Good Machine Learning Practices (GMLP). However, such a regulatory framework imposes significant administrative burdens on both the developer and regulator, hindering AI algorithms' ability to learn from new data. Alternatively, the FDA proposes an emerging Predetermined Change Control Plans (PCCP) framework, which allows developers to outline future changes during initial submissions and exempts

	approved changes from regulatory review. Yet, the impact of the absence of reclearance remains unknown. In this paper, we model the strategic interaction between a developer and regulator under the current regulatory framework and PCCP. The developer can decide whether to follow or deviate from GMLP in the development and retraining of the AI algorithm, and the regulator reviews the market clearance application for its approval decision. Our analysis shows that reclearance is most valuable when regulatory review can effectively detect noncompliance or when efficacy improvements from retraining are unlikely. Otherwise, reclearance may be of limited benefit or may even be counterproductive, making PCCP a more attractive regulatory framework. Our results also show that adaptive algorithms offer advantages over frozen algorithms in terms of improved device efficiency and compliance. Surprisingly, these advantages are particularly high when regulatory oversight has limited ability to detect noncompliance. Our paper highlights the critical balance between regulatory oversight and the flexibility needed to harness the adaptive capabilities of medical AI.
12.15pm - 1.15pm	**Lunch** @ Catering area 2A/2B, near SR 2.8, Level 2
1.15pm – 2.15pm	**Paper 3** Presenter: **Yini GAO, Singapore Management University** Discussant: **John BIRGE, The University of Chicago** **Title:** **The Value of Flexible Response in Defense Resource Allocation** Abstract: This paper explores the role of flexible response in defense resource allocation games. Specifically, we consider a two-player zero-sum game in which both players allocate limited resources over multiple locations, and the defender can respond by reallocating a portion of the resources according to a redeployment network. The payoff depends on the final allocation profiles of both players. This study aims to investigate how different levels of flexibility in the redeployment network affect equilibrium strategies and game payoffs. Solving the game is computationally challenging due to the large-dimensional action space with the exponential number of pure strategies and inherent correlations among allocations at multiple locations. We show that for any

	redeployment network, the game is NP-hard when the payoff function is the auction contest success function (CSF). When the payoff function satisfies a concavity property, the game can be equivalently characterized by conic programs. To explore the value of flexible redeployment in improving defense performance, we first show that a sparse network structure called an "expander" exhibits superior performance that can approach the performance of fully flexible networks, particularly with classic auction CSF. When the payoff function satisfies the concavity condition, we consider special cases of the game under a k-chain redeployment network with lottery payoff, flow-maximizing payoff, and hinge-type payoff. Closed-form solutions are derived for these special cases. The closed-form solutions reveal that flexibility does not provide significant benefits in contrast to the results established in the classic process flexibility literature that considers an exogenous stochastic environment. This underscores the limiting effect of an adversarial context on the value of flexibility, suggesting that the strategic intelligence of the opponent can significantly diminish the advantages of a sparse structure. We apply the conic program framework to a numerical case study motivated by "Mosaic Warfare games", a novel warfare strategy that features fractionated, heterogeneous, and recomposable military platforms in contrast to traditional multi-functional large platforms. The solutions of the conic program provide insights into the role of flexible recomposition in this context.
2.15pm – 3.15pm	**Paper 4 -** Presenter: **Onur BOYABATLI, Singapore Management University** Discussant: **Xiaole WU, Fudan University** **Title:** **Stochastic Capacity Investment in the Presence of Production Resource Disruption and Its Implications for Hedging** Abstract: In practice, manufacturing firms face a number of uncertainties while choosing their capacity investment levels. Besides the uncertainty in product demand, capacity investment may also be subject to uncertainty in the availability of production resources (such as operating budget or energy) and these resources may become constraining in the production stage. This paper studies a

	manufacturing firm's capacity investment decision under demand and production resource uncertainties. To counteract against the production resource uncertainty, the firm can rely on hedging instruments at the time of capacity investment to engineer the availability of production resource in the production stage. We consider the case where the firm decides on the forward contract volume to sell which corresponds to deciding on the (proportional) allocation between a deterministic production resource and an uncertain production resource which has an expected value equalling the former. In other words, consistent with practice, hedging decision does not change the mean production resource but alters its variability. We characterize the joint optimal capacity investment and hedging decisions of the firm. We identify correlation between demand and production resource uncertainty and the capacity investment cost as the key drivers of the optimal hedging portfolio. In particular, when the correlation is non-positive, the firm always fully hedges and production resource uncertainty is inconsequential for the firm. When the correlation is positive, full hedging is optimal only when capacity investment cost is sufficiently high. Otherwise, the firm chooses a partial hedging policy. Interestingly, the optimal partial hedge is chosen in such a way that there is no effect of production resource variability on the firm's profitability or capacity investment decision. We also find that the firm may optimally choose not to hedge at all, specifically, when the correlation is sufficiently high and the capacity investment cost is sufficiently low. With optimal hedging the firm always benefits from a higher production resource variability and a higher correlation. We put forward important managerial implications on how a local versus global supply chain disruption affects the firm.
3.15pm - 3.45pm	**Tea Break** @ Catering area 2A, near SR 2.8, Level 2
3.45pm - 4.45pm	**Paper 5** Presenter: **Meichun LIN, Singapore Management University** Discussant: **Karthik NATARAJAN, Singapore University of Technology and Design** **Title:** **Two-Sided Pricing and Learning with Inventory Constraints** Abstract: Motivated by online used-car platforms, we study pricing decisions for

	purchasing and selling a product in a two-sided market. With uncertainty from both supply and demand, a platform sequentially adjusts purchase and selling prices to maximize profit while satisfying inventory constraints. Moreover, the platform does not know in advance how supply and demand depend on the prices. The pricing decisions should account for learning of the supply and demand functions in addition to the two sides of uncertainty and inventory constraints. We study first pricing for the demand side with uncertain supply and then the two-sided pricing problem. For each problem, we start with the clairvoyant's problem with known supply and demand functions. We show that a fixed-price policy is asymptotically optimal and establish a bound on its performance loss from the optimal policy. Our bound suggests that we can target the fixed-price policy rather than the state-dependent optimal policy when the supply and demand functions are unknown. By exploiting properties of the fixed-price policy, we propose a pricing algorithm that learns the optimal fixed price(s) and achieves the best possible performance when the planning horizon is large. Our work provides insights into how the platform can manage demand and supply in the presence of the two sides of uncertainty. When the demand and supply functions are known, a simple fixed-price policy can be implemented with a small performance loss. Given limited information on supply and demand, our pricing algorithm is easy to implement and sheds light on how to balance the trade-off between two sides of learning and profit maximization (earning)
4.45pm - 5.00pm	**Concluding Remarks**

Discussants' Profile:

Hessam BAVAFA

Hessam Bavafa is the Wisconsin School of Business Bascom Professor and Associate Professor of Operations and Information Management. He is an affiliate faculty of the Department of Family Medicine and Community Health at the University of Wisconsin School of Medicine and Public Health. His research, based on econometric analysis and stochastic models, has focused on innovative technologies and service delivery models (e.g., telemedicine), people-centric and behavioral factors that affect performance (e.g., fatigue and learning), healthcare resource management (e.g., revenue management of surgical portfolios and panel sizing), and quality management (e.g., pharmaceutical manufacturing).

He is currently serving as a Department Editor for Decision Sciences. He is also an Associate/Senior Editor for Management Science, Manufacturing & Service Operations Management, Production & Operations Management, and Health Care Management Science. His research has been published in academic journals such as Management Science, Operations Research, Manufacturing & Service Operations Management, Production & Operations Management, Journal of Operations Management, Journal of Health Economics, and Annals of Family Medicine.

During his career, Professor Bavafa has worked with leading healthcare organizations such as the University of Pennsylvania Health System, the Provincial Health Services Authority of British Columbia, Veterans Health Administration, University of Wisconsin Hospital and Clinics, and British Columbia Children's Hospital. He held a visiting position as Senior Innovation Strategist at the Penn Medicine Center for Health Care Innovation. Professor Bavafa is also a moderator for the Health & Wellness Stream of the Creative Destruction Lab, which is a nonprofit organization focused on scalable, seed-stage, science- and technology-based startups.

Jussi KEPPO

Professor Jussi Keppo teaches risk management and analytics courses, and directs analytics executive education programs at NUS Business School. He is also the Head of the Department of Analytics & Operations at NUS Business School and Research Director of the Institute of Operations Research and Analytics at NUS. Previously, he taught at the University of Michigan.

He has several publications in the top-tier journals such as Journal of Economic Theory, Review of Economic Studies, Management Science, Operations Research, and Journal of Business on topics such as investment analysis, banking regulation, learning, and strategic incentives. His research has been featured also in numerous business and popular publications, including the Wall Street Journal and Fortune.

Professor Keppo's research has been supported by several Asian, European, and US agencies such as the National Science Foundation. He serves on the editorial boards of Management Science, Operations Research, and Journal of Risk. He has consulted several startups, Fortune 100 companies, and financial institutions.

John BIRGE

John R. Birge studies mathematical modeling of systems under uncertainty, especially for maximizing operational and financial goals using the methodologies of stochastic programming and large-scale optimization. He was first drawn to this area by a need to use mathematics in a useful and practical way. "My research has shown how special problem structure can allow for efficient solution of complex problems of decision making under uncertainty," Birge explains. This research has been supported by the National Science Foundation, the Ford Motor Company, General Motors Corporation, the National Institute of Justice, the Office of Naval Research, the Electric Power Research Institute, and Volkswagen of America. He has published widely and is the recipient of the Best Paper Award from the Japan Society for Industrial and Applied Mathematics, the Institute for Operations Research and the Management Sciences Fellows Award, the Institute of Industrial Engineers Medallion Award and was elected to the National Academy of Engineering.

Xiaole WU

Xiaole Wu is a Professor in the Department of Management Science at the School of Management, Fudan University. She received her PhD in Management from Olin Business School, Washington University in St. Louis in 2011, and bachelor's degree in Industrial Engineering from Tsinghua University in 2006. Her research interests include global supply chain management, risk management, and the interfaces between operations and other disciplines. She has published in *Management Science, Manufacturing and Service Operations Management, Production and Operations Management, Decision Sciences, Energy Economics, Naval Research Logistics, European Journal of Operational Research*, etc. She serves as a Senior Editor at Production and Operations Management, and an Associate Editor at Naval Research Logistics. She is a principle investigator of the National Science Fund for Distinguished Young Scholars and the Major Program of National Natural Science Foundation of China.

Karthik NATARAJAN

Karthik Natarajan is a Professor at the Singapore University of Technology and Design (SUTD). Prior to joining SUTD, he has held faculty positions as the Department of Management Sciences, City University of Hong Kong and at the Department of Mathematics, NUS. His primary research interest is in distributionally robust optimization with a broader focus on operations research and analytics. He serves as an Associate Editor for the journals Operations Research, Management Science, MSOM and Mathematical Programming.

~ Thank you ~