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MSOM Society Student Paper Competition: Abstracts of 2017 Winners

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The journal is pleased to publish the abstracts of the six finalists of the 2017 Manufacturing and Service Operations Management Society's student paper competition.

The 2017 prize committee was chaired by Saravanan Kesavan (University of North Carolina at Chapel Hill), Lauren Lu (University of North Carolina at Chapel Hill), and Nicos Savva (London Business School). The other committee members were Elodie Adida, Vishal Agrawal, Mazhar Arikan, Atalay Atasü, Nitin Bakshi, Gah-Yi Ban, Bob Batt, Elena Belavina, Kostas Bimpikis, Fernanda Bravo, Robert Bray, Li Chen, Xin Chen, Ying-Ju Chen, Soo-Haeng Cho, So Yeon Chun, Florin Ciocan, Ruomeng Cui, Kaitlin Daniels, Seyed Emadi, Liu Fang, Kris Ferreira, Santiago Gallino, Xiting Gong, Manu Goyal, Jose Guarjado, Bin Hu, Ming Hu, Dan Iancu, Nitish Jain, Stefanus Jasin, Diwas KC, Bora Keskin, Song-Hee Kim, Mümin Kurtuluş, Guoming Lai, Cuihong Li, Daniel Lin, Ilan Lobel, Mengshi Lu, Vidya Mani, Mili Mehrotra, Toni Moreno, Suresh Muthulingam, Karthik Natarajan, Adem Orsdemir, Anton Ovchinnikov, Yiangos Papanastasiou, Chris Parker, Olga Perdikaki, Anyan Qi, Soroush Saghaian, Özge Şahin, Burhan Sandıkçı, Bill Schmidt, Stephen Shechter, Pengyi Shi, Hummy Song, Brad Staats, Nur Sunar, Nicos Trichakis, John Turner, Misic Velibor, Ruxian Wang, Shouqiang Wang, Luo Wei, Yehua Wei, Owen Wu, Wenqiang Xiao, Linwei Xin, Alex Yang, Nan Yang, Dennis Zhang, Renyue Zhang, Yao Zhao, Yong-Pin Zhou, and Leon Zhu.

The 2017 prize winners are as follows:

First Prize

Truthful Mechanisms for Medical Surplus Product Allocation
Can Zhang, Georgia Institute of Technology

Second Prize

Robust Dual Sourcing Inventory Management: Optimality of Capped Dual Index Policies
Jiankun Sun, Northwestern University

Finalists (in alphabetical order according to the author's last name):

Mallows-Smoothed Distribution over Rankings Approach for Modeling Choice
Antoine Désir, Columbia University

An Examination of Early Transfers to the ICU Based on a Physiologic Risk Score
Wenqi Hu, Columbia Business School

An IV Tree Approach for Personalized Health Care Outcome Analysis
Guihua Wang, University of Michigan

Risky Suppliers or Risky Supply Chains? An Empirical Analysis of Sub-tier Supply Network Structure on Firm Risk in the High-Tech Sector
Yixin (Iris) Wang, University of Michigan

Truthful Mechanisms for Medical Surplus Product Allocation

Can Zhang

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Advisors: Atalay Atasü, Georgia Institute of Technology; Turgay Ayer, Georgia Institute of Technology; Beril Toktay, Georgia Institute of Technology

We analyze a resource allocation problem faced by Medical Surplus Recovery Organizations (MSROs) that recover medical surplus products to fulfill the needs of under-served healthcare facilities in developing countries. Due to the uncertain, uncontrollable supply and limited information about recipient needs, delivering the right product to the right recipient in MSRO supply chains is particularly challenging. The objective of this study is to identify strategies to improve MSROs' value provision capability. In particular, we propose a mechanism design approach, and determine which recipient to serve at each shipping opportunity based on recipients' reported preference rankings of different products. We find that when MSRO inventory information is shared with recipients, the only truthful mechanism is random selection among recipients, which defeats the purpose of eliciting information. Consequently, we propose two operational strategies to improve MSROs' value provision: (i) not sharing MSRO inventory information with recipients; and (ii) withholding information regarding other recipients. We characterize the set of truthful mechanisms under each setting, and show that eliminating inventory and competitor information provision both improve MSROs' value provision. Further, we investigate the value of cardinal mechanisms where recipients report their valuations. We show that in our setting, eliciting valuations has no value added beyond eliciting rankings under a wide class of implementable mechanisms. Finally, we present a calibrated numerical study based on historical data from a partner MSRO, and show that a strategy consisting of a ranking-based mechanism in conjunction with eliminating inventory and competitor information can significantly improve MSROs' value provision.

Robust Dual Sourcing Inventory Management: Optimality of Capped Dual Index Policies

Jiankun Sun

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Advisor: Jan A. Van Mieghem, Northwestern University

We provide closed-form solutions to a robust optimization model for inventory management with two supply sources or modes with general lead times. The fast source is more expensive than the slow source. While the optimal stochastic policy for non-consecutive

lead times has been unknown for over 50 years, we prove that the optimal robust policy is a dual index, dual base-stock policy that constrains or caps the slow order. Optimality is established in a rolling horizon model that can accommodate nonstationary demand. As the lead time difference grows, the capped dual index policy increasingly smoothes slow orders and, for stationary demand, converges to the tailored base surge policy, which places a constant slow order and has been shown to be asymptotically optimal. In an extensive simulation study, the capped dual index policy performs as well as, and can even outperform, the best heuristics presented in the stochastic inventory literature.

Mallows-Smoothed Distribution over Rankings Approach for Modeling Choice

Antoine Désir

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Advisors: Vineet Goyal, Columbia University; Srikanth Jagabathula, New York University; Danny Segev, Haifa University

Assortment optimization is an important problem that arises in many applications including retailing and online advertising. The goal in this problem is to determine a revenue/profit maximizing subset of products to offer from a large universe of products when customers exhibit a random substitution behavior. We consider a mixture of Mallows model for demand. This is a "smoothed" generalization of the class of sparse rank-based choice models, designed to overcome some of its key limitations. However, the Mallows distribution has an exponential support size and does not admit a closed-form expression for choice probabilities. We present an efficient procedure to compute the choice probabilities for any assortment under the mixture of Mallows model. Based on this procedure and the structural properties of the distribution, we give a polynomial time approximation scheme (PTAS) for the constrained assortment optimization under a reasonable assumption. In other words, for any constant $\varepsilon \geq 0$, we get a $(1-\varepsilon)$ -approximation in running time that is polynomial in number of products, n and number of segments, K but depends exponentially on $1/\varepsilon$. Our PTAS can handle a large class of constraints on the assortments including cardinality constraints, capacity constraints and matroid constraints. To the best of our knowledge, this is the first efficient algorithm with provably near-optimal performance guarantees for the assortment optimization problem under the Mallows or the mixture of Mallow model in such generality. Furthermore, we give a compact mixed integer program (MIP) that leads to a practical approach for the constrained assortment optimization problem under a general mixture of Mallows model.

An Examination of Early Transfers to the ICU Based on a Physiologic Risk Score

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Advisors: Carri W. Chan, Columbia Business School;
José R. Zubizarreta, Harvard Medical School

Unplanned transfers of patients from general medical-surgical wards to the Intensive Care Unit (ICU) can occur due to unexpected patient deterioration. Such patients tend to have higher mortality rates and longer lengths-of-stay than direct admissions to the ICU. As such, the medical community has invested substantial efforts in the development of patient risk scores with the intent to identify patients at risk of deterioration. In this work, we consider how one such risk score could be used to trigger proactive transfers to the ICU. We utilize a retrospective dataset from 21 Kaiser Permanente Northern California hospitals to estimate the potential benefit of transferring patients to the ICU at various levels of patient risk of deterioration. In order to reduce the sensitivity of our findings to key identification and modeling assumptions, we use a combination of multivariate matching and instrumental variable approaches. Using our empirical results to calibrate a simulation model, we find that proactively transferring the most severe patients could reduce mortality rates and lengths-of-stay without increasing other adverse events; however, proactive transfers should be used judiciously as being too aggressive could increase ICU congestion and degrade quality of care.

An IV Tree Approach for Personalized Health Care Outcome Analysis

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Advisors: Jun Li, University of Michigan;
Wallace J. Hopp, University of Michigan

This study addresses the challenges of generating patient-centric outcome information. Using patient-level data from thirty-five hospitals for six cardiovascular surgeries in New York State, we identify patient groups that exhibit significant differences in outcomes with a recently developed instrumental variable tree approach. We find that outcome differences between hospitals are heterogeneous not only across procedure types, but also along other dimensions such as patient age and comorbidities. For around 80% of patients, the best hospitals indicated by patient-centric information are different than those indicated as best by

population-average information. We compare potential outcomes when patients are treated at the best hospitals based on the two types of information, and estimate that complications could be reduced by 66.7% by using patient-centric information instead of population-average information. We also use our model to illustrate how patient-centric outcome information can enhance pay-for-performance programs offered by payers and guide providers in targeting quality improvement efforts.

Risky Suppliers or Risky Supply Chains? An Empirical Analysis of Sub-tier Supply Network Structure on Firm Risk in the High-Tech Sector

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Advisor(s): Jun Li, University of Michigan;
Ravi Anupindi, University of Michigan

Although past research on supply chain risk management has focused on immediate supply chain connections, propagation of risks can extend beyond a firm's direct linkages. The structure of sub-tier supply network may also aid or prevent such risk propagation. In this paper we focus on a specific aspect of sub-tier network structure, the sharing of tier-2 suppliers, and empirically study its prevalence and quantify its impact. Using firm-level supplier-customer relationship data in the high-tech industry, we find on average 20 percent of tier-2 suppliers are shared by tier-1 suppliers. We also find tier-0 firm risk is positively associated with common tier-2 supplier risk. The association is stronger with a higher degree of commonality. To disentangle the effect of risky supply network structure from risky tier-2 suppliers, we define two network metrics, diamond ratio and cosine commonality score. A 10 percent increase in either metric is associated with around 5 percent increase in tier-0 firm risk. Lastly, using a new source of risk event data, we find firms experience significantly negative abnormal returns when their tier-2 suppliers are located in the event impact area, even though they themselves are not. The magnitude of this impact is much larger when the impacted tier-2 suppliers are heavily shared, similar to the scale of directly impacted firms, though taking longer to materialize. Overall our results reveal existence of substantial supply chain risks due to sub-tier supplier overlapping and highlight the need for firms to increase visibility into their extended supply network.