Systemic Risk Management of Risky Supply Chains in China

Executive Summary

Economically motivated adulteration (EMA) of food supply chains presents a major threat to public health, and, more generally, on the public trust in the integrity of the food system. Improved capabilities to predict and monitor risk will inform core risk management decisions by firms and regulatory bodies. Tools that allow design and implementation of robust interventions to proactively mitigate risks could have a major and longstanding positive impact local food systems in China and globally.

The collaborative program described herein aims to address two fundamental gaps in the current systems. The first gap is that food supply chains lack transparency and the corresponding risk drivers are not well understood, identified or monitored. In particular, food supply chains are typically complex and opaque, especially their upstream parts, where most food adulteration, particularly EMA, occurs. The second gap is the economics of food testing. Current capabilities include either expensive lab-based tests which are slow but quantitative or rapid kits with low accuracy, with low throughput. This situation leads to very sparse testing of food supply chains that cannot meet the monitoring need in areas with large volume of transactions.

The program leverages supply chain analytics, artificial intelligence (AI), testing and sensing technologies and is focused on developing systemic tools, approaches and collaborations in the following areas:

(i) Integrated large-scale databases of food safety-related data that enable the development of various predictive risk models, tools and scores/indicators;

(ii) Predictive risk tools and supply chain analyses that inform the risk-based allocation of scarce food inspection resources as well as other intervention by regulatory organizations and industry stakeholders;

(iii) Risk-based models and scoring tools that enable the understanding and monitoring of risk at the local (prefecture) level in China to inform policy enforcement strategies, as well as supply chains and sourcing decisions by industry stakeholders;

(iv) Visualization tools that aim to provide users an interactive view of food safety tests, outcomes, and the supply chain.

(v) The development of techno-operational approaches and concepts to integrate newly developed rapid testing platforms and analytics to more proactively and effectively monitor risks in wholesale markets in China (and potentially other locations in the supply chain);

(vi) Industry outreach that will facilitate cross-industry sharing of data, as well as best practices, in China and beyond.

In the first 18 months, we have made significant progress on areas listed below:

1. Successfully created a comprehensive database of national and local food inspection records and developed a robust automated architecture for data scraping, cleaning and integration.
2. Developed a farm database in Zhejiang

3. Created a regulatory database of transparency for each prefecture, based on automated text recognition algorithms applied to government websites, and developed multiple scores to assess the regulatory strength at the prefecture level.
4. Through supply chain analytics, our work with these data has already yielded several important insights. For instance, we found that wholesale markets are a key consolidation point in the supply chain and optimal allocation of testing resources coupled with advanced testing capabilities for wholesale markets could significantly improve food safety. We also developed a model that predicts high-risk manufacturers to inform targeted testing. These insights will allow government and industry stakeholders to effectively allocate resources to high-risk points in the supply chain and proactively mitigate food safety risks.

The program will continue to grow our engagement with Chinese collaborators and seeks to form an industry-government-academia collaborative consortium. The consortia aim to help industry to identify and disseminate best practices and further improve risk models through the confidential collection and analysis of industry experience.

We look forward to meeting with DRC to share more information about predictive risk models and testing tools that we are developing and explore how these tools can be adapted to match needs.

About our team

The program is based on research conducted by a multidisciplinary team of faculty from three schools at MIT (Engineering, Management and Sciences), as well as on extensive collaborations between the MIT team and Chinese organizations, including universities, research institutes, companies and governmental organizations. The program in China builds upon research expertise and experience that the MIT team developed in a multi-year project with the U.S. FDA.

This program is partially supported by the Walmart Foundation and is one of the first two projects affiliated with the Walmart Food Safety Collaboration Center in Beijing.

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MIT Team – 2019 March Hong Kong Visit

The current MIT team includes seven principal investigators, four PhD students, three data technicians, working along with three postdoctoral associates and research scientists. The team, who has been working together for five years, is multidisciplinary and spans a range of expertise including supply chain management, analytics and machine learning, China economics and regulatory environment, food science, chemistry, biology, bio manufacturing, and chemical engineering. Seven team members are native Chinese speakers, which allows the team to interact with Chinese collaborators and process data from Chinese sources.

Stacy Springs is the Senior Director of Programs at the Center for Biomedical Innovation and the Executive Director of the Food Safety Initiative at the Sloan School of Management. She manages a portfolio of collaborative sponsored research and educational initiatives, including two pre-competitive consortia focused on 1) innovation in biopharmaceutical manufacturing, including science, technology, business and policy innovation, and 2) risk management of adventitious agent contamination in biopharmaceutical manufacturing.

Retsef Levi is the J. Spencer Standish (1945) Professor of Operations Management at the MIT Sloan School of Management. His research is focused on the design of analytical data-driven decision support models and tools addressing complex business and system design decisions under uncertainty in areas, such as health and healthcare management, supply chain, procurement and inventory management, revenue management, pricing optimization and logistics.

Yasheng Huang is the International Program Professor in Chinese Economy and Business and a Professor of Global Economics and Management at the MIT Sloan School of Management. He is also an Associate Dean at MIT Sloan School of Management. His research focuses on a range of projects including higher education in China, production of scientific knowledge in China, on entrepreneurship, and on Foreign Direct Investment.

Yanchong (Karen) Zheng is an Associate Professor of Operations Management at the MIT Sloan School of Management. Her research studies fundamental and emerging operations management problems with a critical lens on the behavioral factors impacting human decisions, particularly in information-rich environments. Her research employs a methodology that integrates theoretical modeling of operations management problems with empirical investigation of human behavior.

Charles (Charley) Swofford is a postdoctoral associate in the Sinskey Lab at MIT. His current research interests lie in the interface between engineering and biology, focusing on developing synthetic biology tools for industrial and clinical applications. Specifically, his current research involves creating a single integrated platform that can address food and water contaminants in a low cost, widely deployable nanosensor array.

Lu Chen is a research scientist in the Center for Biomedical Innovation at MIT. Her current research focus on the analysis of risk factors for economic motivated adulteration in major food supply chains, as well as the profiling of drugs used in poultry farming that might contribute to jerky pet treat incidents in the US.

Nicholas Renegar is a 3rd year PhD student at the MIT Operations Research Center, advised by Professor Retsef Levi. His research interests include supply chain analytics, optimization, food safety, healthcare, and internet advertising. Before MIT, he received his BA in Mathematics and BSc in Operations Research from Cornell University.

Jennifer Gao is a research associate at the MIT Sloan School of Management. She received her B.S. from Purdue University in Actuarial Science and Applied Statistics with honor degree, and completed her M.A. at Columbia University Graduate School of Arts and Sciences. Her current research focus on the analysis of Chinese economy and the government regulatory of food safety industry.