Research Statement

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My goal is to understand both theoretically and empirically how the links between firms, financial, physical and technological, affect the business cycle, systemic risk, investor behaviors, and asset pricing.

My work to date can be divided into three parts. The first, focuses on the links by which technological innovation spreads between firms and their implications on the business cycle, asset pricing, and investor behaviors. The second focuses on the financial links created by equity-holding relationships and their implications on systemic risk, corporate finance, governance, and monetary policy. The third, uses machine learning techniques to identify `hidden links' between firms or agents, contracting frictions in the formation of networks, and portfolio management. These projects span several fields – Macroeconomics, Finance, Machine Learning, Theory, and the Chinese Economy.

Project on innovation networks

The speed at which the US economy has recovered from different recessions varies greatly, ranging from months to years. An important question is what drives this slow recovery process. In my job market paper, "Networks and Business Cycles", we show, theoretically and empirically, that the underlying network of knowledge flow on technology and its interactions with production networks and cross-sectional shocks explain a large variation in the recovery speed across recessions in US.

In theory, we develop a dynamic general equilibrium incorporating two networks – production network where firms are linked through input-output, and innovation network where firms are linked through technology. We examine how cross-sectional shocks interact with these networks. In general, we show that these interactions allow us to decompose shocks' effect on future growth into several components. Each component includes its persistence and amplification. The persistence can be fully captured by the eigenvalue distribution of the adjacency matrix for the innovation network. When the innovation network is low rank (i.e., the leading eigenvalue is much larger than the rest in absolute value), the direction of the current cross-sectional shock reveals useful information on the economy's future recovery process. Furthermore, when the leading eigenvalue is large enough, the shock' impact would become extremely persistent.

The amplification can be fully captured by two sufficient statistics - the correlation between the sectoral importance in innovation network and the cross-sectional shock, and the correlation between sectoral importance in innovation and production networks. The slow recovery occurs when the amplification on the persistent component increases sharply.

To evaluate the importance of the channel, we construct a new and comprehensive patent dataset of U.S back to 1911 – patent issuance, transaction, and citation, and the production network back to 1950. We first document a set of new stylized facts in U.S. First, the innovation network is very stable and takes a low rank structure; Second, the structure of the innovation network is special such that the effect of the shock becomes very persistent and is significantly amplified when important sectors in the innovation network are severely hit. Third, the interactions between the innovation and production networks are strong and stable over time. Finally, there is a large variation in sectors' exposure to adversarial shocks across recessions in U.S.

To explain the risk-premium puzzles in financial market. The long-run risk literature assumes that there is a very persistent component in the consumption growth. My job market paper rationalizes a time-varying persistent component in the consumption growth from the perspective of networks. An importance question is whether the networking economy can explain the risk-premium puzzle and several related puzzles in financial markets. Besides, the networked economy allows us to directly examine the cross-sectional implications of the long-run risk. In the progressing paper, "Networks, Long Run Risk, and Asset Pricing", I explore this possibility.

Understanding how agents impound information from the environment is an essential question in economics, closely related to the three power horses in decision making – information, preference, and choice set. The technology links between firms provide us a good chance to study how investors (professional investors like hedge fund managers) incorporate information in decision making. In the working paper, "Networks, Link Complexity, and Cross-Predictability", I provide evidence to show that link complexity significantly hinders investors impounding fundamentally relevant information, leading to a significant cross-predictability. A long-short strategy based on the link-complexity yields a risk-adjusted monthly alpha of 270 basis points.

Project on equity-holding networks

Equity crossholdings are another way in which firms are dependent upon each other. My goal here is to understand how such networks affect firms' decision making, propagation of shocks, firm growth, and monetary policy.

In a joint theoretical work with Rakesh Vohra and Yiqing Xing, "The Network Effects of Agency Conflicts", we develop a flexible model incorporating various types of frictions – default costs, limited liability, interest conflicts, and moral hazards between managers and shareholder – to systematically examine the role of firm-level frictions in amplifying and propagating the shocks. This paper argues the within-firm agency conflicts and not just the network structure, play a crucial role in amplifying or muting the propagation of the shock. Under some conditions, the aggregate effect of an idiosyncratic shock via propagation does not diminish when the agency conflicts within firms are non-negligible. This suggests a potentially important role that corporate governance plays in macro fluctuations.

On the empirical side, I construct a proprietary and dynamic updated dataset covering the universal firms registered in China till 2020 (70 million firms). This comprehensive dataset records detailed information on firm shareholders, outside investment, and historical update. Using the information on the historical shareholders, I construct the dynamic equity-holding networks that can be traced back to 1990.

In a joint work with Yu Shi and Robert Townsend, "Tiered Intermediation in Business Groups", we show that internal capital market in business groups can play the role of financial intermediary and propagate the corporate shareholders' credit supply shocks to the corporate subsidiaries. This intermediation explains a large variation in firms' physical investment. We argue that equity exchange is one channel through which corporate shareholders transmit bank credit supply shocks to the subsidiaries and provide evidence to support the channel.

Firms in the equity-holding network not only benefit from the positive exposure to their parent companies, but also benefit from the network effect either due to relationship financing or equity-financing. In a joint work with Franklin Allen, Junhui Cai, Xian Gu, Jun Qian, and Linda Zhao, "Ownership networks and Firm Growth: What Do Forty Million Companies Tell About Chinese Economy", we examine the effect of firms' position in the equity-holding on firm growth. This work partially decoding the long-standing puzzle about the Chinese Economy – unprecedented economic growth and sluggish developed financial systems.

A significant feature of the Chinese economy is the dominance of State-Owned Enterprises (SOEs). Besides the traditional industrial policies – targeted tax or subsidies, Chinese government leverages the SOEs to implement its policies. Important questions are what motivates SOEs to hold other firms? How does the government control the economy via leveraging the SOEs and what is the impact of such control on the economic efficiency? In our recent work "State-Owned Enterprises in China Revised", we revise the definition of SOEs based on the controlling rights and cash-flow rights using the equity-holding networks and document several important facts. For example, the Chinese government has been shifting from direct control to indirect control. On the one hand, this shift leads to a significant rise in controlling rights over the whole economy, on the other hand, it promotes the efficiency of resource allocation.

To understand the formation of the equity-holding networks, one interesting observation is that the equity-holding link is bilateral that the investor-investee relationship is forged if and only if both parties benefit from the link. When the bargaining cost is high, the equity-holding link may not be forged even if the total payoff is positive. One important question is whether the bilateral link can be efficiently formed and where the bargaining cost comes from.

Project on machine learning

In many cases, networking data is costly to collect and there are large measurement errors on the links between agents or firms. Therefore, I am interested in using machine learning techniques to recover the underlying links between firms or agents to study prediction, portfolio management, and information acquisition in a networked world. In recent work with Junhui Cai, Linda Zhao, Haipeng Shen, and Dan Yang, "Semi-supervised Learning with Network Data" (Invited talk in American Statistical Association, 2021), we develop a model to combine both the information in the observed but noisy links, and the information in the predictive model to boost the estimates of parameters and the network structure.

In a networked economy, firms are linked by various types of links – technology links, equity-holding links, geographical links, supply-customer links etc. How do investors learn information in a networked economy is an important but unexplored question. Can investors efficiently extract information about one company from their linked counterparties? How investors learn in a complicated and dynamically changing networked world? We handle these questions in several progressing papers.