Research Statement

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 linkages by which technological innovation spreads between firms and its implication for the business cycles, asset pricing, and investor behaviors. The second focuses on the financial linkages created by equity-holding relationship and its implications for systemic risk, corporate finance, governance, and monetary policy. The third, uses machine learning techniques to identify `hidden links' between firms or agents, identify the contracting frictions in the formation of networks, and the network effects. Under these three projects, my current work spans several fields linked to networks – Macroeconomics, Finance, Machine Learning, Theory, and the Chinese Economy. I am also an expert in big data and especially interested in using huge dataset to reveal a micro channel to support a vivid macro picture.

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. Put differently, what links the short-term business cycles and the long-term growth trend? In my job market paper, "Networks and Business Cycles", we argue, theoretically and empirically, that the underlying network of knowledge flow on technology and its interactions with production networks and cross-sectional shocks explains the large variations in the speed of recovery across recessions in US.

Theoretically, 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 the effects of shocks, even idiosyncratic shocks, 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), 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 impact of the shock would become extremely persistent.

The amplification can be fully captured by two sufficient statistics - the correlation between the centrality in innovation network and shocks, and the correlation between centralities 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 significantly amplified when sectors in the center of the innovation network are severely hit. Finally, there is a large variation in the 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 that whether the networking economy can explain the risk-premium puzzle and several related puzzles in financial markets. In the progressing paper, "Networks, Long Run Risk, and Asset Pricing", I explore this possibility.

Understanding how agents impound information from their environments is the 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 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 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

Besides the physical or technological links, equity crossholding is another way in which firms are dependent upon each other. My goal here is to understand how such networks affects 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

In the empirical work, we 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. Use the information on the historical shareholders, we 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 propagation 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.

A significant feature of the Chinese economy is the dominant existence of State-Owned Enterprises (SOEs), intriguing widely debate in both academics and policy makers. Important questions are what motivates SOEs to hold other firms? how the government controls the economy via leveraging the SOEs? and what is the impact of such controls on 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 the direct controlling to indirect controlling. This shift, on one hand, leads to a significant rise in controlling rights on the whole economy, on the other hand, promotes the efficient allocation of resources.

Project on machine learning

In most cases, the networking data is rare available because: i) the prohibitive collection cost of such dataset; 2) large noise on the linkage between agents or firms due to measure errors or sampling basic. Therefore, I am interested in using machine learning to recover the underlying linkages between firms or agents, and then use the recovered linked to study a sequence of topics – prediction, portfolio management, and information acquisition in linking world. In a recent work with Junhui Cai, Linda Zhao, 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 network economy, firms are linked by various types of links – technology links, equity-holding links, geographical links, supply-customer links etc. How investors learn information in a network economy with multi-links is an important but unexplored question. Can investors efficiently extract information about one company from their linked counterparties? In several works in progress, we examine these topics in detail.

To understand the formation of the equity-holding networks, one challenge is that the equity-holding link is bilateral in the sense that the investor-investee relationship forges if and only if both parties benefit from such links. When the contracting cost is high and the two parties cannot efficiently bargain to reallocate the total payoff, the equity-holding link will not be formed even if the total payoff is positive. In a progressing paper, we model the formation of the investor-investee links to estimate this contracting cost.