Wu Zhu

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Education

PhD in Economics, University of Pennsylvania, Expected in 2021
(Asset Pricing, Empirical Corporate Finance and Machine Learning)
Master in Statistics (Joint Dual Major), Department of Stats, Expected in 2021
(Machine Learning and Deep Learning in Networks)
M.A in Economics, CCER, Peking University, 2016
Supervisor: Justin Yifu Lin (Chief Economist &Vice President of World Bank, 2008-2012)
B.S in Materials Physics, University of Science and Technology, Beijing, 2009

Programming and Skills

Python (High Proficiency), R(Proficiency) and Stata (High Proficiency)
First Prize Winners for China National Mathematical Olympics or Modelling Contests (4 Times)

Related Papers

My current research includes two parts -Equity Holding Networks and Innovation Networks (Project Leader) and their interactions with asset pricing and corporate finance, also involve in a big data company in China.

Related Papers on Innovation Networks

1. **Firm-to-Firm Innovation Networks and Cross-Sectional Asset Pricing**
(Preliminary draft is available)
We examine the cross-sectional pricing implications of citing-cited networks using our self-constructed patent datasets from 1920-2015. We first document a highly asymmetric citing-cited network. We further document several anomalies associated with the asymmetric citing-cited innovation networks. 1) Firms with high betweenness centrality at the end of last year earn high average risk-adjusted returns, a long/short strategy yields a monthly alpha of more than 120 basis points with value weights. 2) The return of upstream portfolio has a very strong predictive power on the return of focal firm next month, while the predictability of downstream portfolio is modest. A long-short strategy based on this fact yields a monthly alpha of 200 (145) basis points with equal weights (value weights). Limited investor attention can explain part of the second anomaly but not all.

2. **The Recovery of Financial Crisis - A Perspective from Innovation Network (with Yu Cheng Yang, Applied Math, Princeton)**
(In Progress, preliminary results in empirical and model)
What is the fundamental driving force for the slow recovery of the economy from crisis? In this paper, we justify that when firms in the center of innovation networks are hit severely resulting in a sudden drop in innovation, the downstream firm would learn less from the upstream, leading to a further drop in innovation. Through this cascade, it would take much longer time for recovery. However, if firms in the periphery of the networks are hit severely but the center is less exposure to bad initial shock, the economy can recovery

rapidly. We lend empirical evidence via our self-constructed firm-to-firm innovation networks to support our theory.

Related Papers on Crossholding Networks.

3. **Equity Cross-holding Networks and Transmissions of Banking Sector Shocks, with Yu Shi (IMF) and Robert M Townsend (MIT**) (working paper is available) (presented in Penn, Wharton, IMF, PKU, Asian Econometric Meeting, North American Econometric Summer Meeting, CUFE, invitation report by VoxChina)
Using a proprietary dataset covering all registered firms in China (40 million), we document a rapid expanding but structure stable firm-to-firm equity-holding networks (5 million firms in network in 2017). We show that internal capital markets in business groups can propagate corporate shareholders' credit supply shocks to their subsidiaries. An average of 16.7% local bank credit growth where corporate shareholders are located would increase subsidiaries investment by 1% of their tangible fixed asset value, which accounts for 71% (7%) of the median (average) investment rate among these firms. 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.

4. **Equity Holding Networks, Risky Taking, Investment Decision. (with Rakesh Vohra (Penn Econ and CS) and Yiqing Xing (Stanford)) (**working paper is available**)**.
We propose a model of equity holding networks that allow firms to take an investment decision in response to an exogenous shock. It encompasses various firm level frictions - default cost, limited liability, interest conflicts between shareholders and mangers and moral hazard. We argue that the underlying frictions at the firm level and not just the network structure, play a key role in amplifying or muting the propagation of exogenous shocks. In the presence of default costs or limited liability, firms make investment choices that serve to mitigate the spread of an initial shock. In the face of interest conflicts or moral hazard, shocks are amplified by firm level investments choices. We also examine the role of network structure in propagating shocks. In the presence of interest-conflicts we show, unlike other work, that denser or more integrated networks need not facilitate the propagation of shocks. This suggests a potentially important role for corporate governance in macro fluctuations.

5. **Economic Holding Networks and Firm Growth – What 5 million firms tell us about Chinese Economy? (with Allen Franklin, Junhui Cai, Xian Gu, Jun "QJ" Qian, Linda Zhao)** (working paper is available, Presented in Penn Wharton China Conference)

6. **Who Control Chinese Economy? How and Why? (with Allen Franklin, Junhui Cai, Xian Gu, Jun "QJ" Qian, Linda Zhao)** (Preliminary draft is available)

7. **Innovation and Equity Holding Networks (with Allen Franklin, Junhui Cai, Xian Gu, Jun "QJ" and Linda Zhao)**

In this project, we use the proprietary big dataset to establish a dynamic firm-to-firm cross-holding networks involving 5 million firms in the networks and 35 million out of network to study a sequence of topics like the dynamic evolution of the networks, formation of networks and statistics inference on network structure.

8. **Unexpected Fruits of Government Stimulus Policy during Crisis - Inefficiency in Internal Capital Market.** (In Progress with preliminary results, with Yu Shi (IMF))

To mitigate the financial shock from US, Chinese government implemented a stimulus package worth 4 trillion RMB and inject them into the top SOEs which has been criticized by economists and commentators as driving force of following slow down economic growth due to directly crowding out private investment and increasing market monopoly. In this paper, we document a novelty channel – SOEs is also inefficient in allocating resource via internal capital market. We find that resource can be reallocated to high productive subsidiaries in private sectors. However, in SOEs, the credit does not flow from holdings to efficient subsidiaries after credit shocks to holdings. In sum, the distortions in internal capital market in SOE sector further deteriorate the resource allocation following the initial 4 trillion stimuli.

Other Related Researches

9. ***Project of Big Data with Long Credit Company (reported by CCTV-2 for several times)*** Taking charge of a sub-project of Long Run-Long Credit Entrepreneurship-Innovation Project in China.
10. ***The Patterns and Drivers of E-commerce Development in China*** (With Xiaobo Zhang, Presented in CCER-NBER Conference in July 2015, and presented in AEA conference in Jan 2016, Working Paper is available)
11. ***Mitigating the Financing Constraints Facing the Small and Medium Enterprises in China*** (Grant from National Natural Science Foundation of China, finished in Dec 2013.)

Internship Experience

Jun 2018- Sep 2018 IMF (International Monetary Fund), Machine Learning, Behavior Bias and Credit Market Crashes. (IMF Summer Funding Internship Program for Ph.D.).
Sep 2014-Dec 2014 Research Assistant, the State Development Research Center, China
Jan 2014-Jun 2014 Counsellor Office of the State Council, Central Government, China.
Establish model and write reports to predict and analyze the macro performance of China in New Stage.

Conference and Seminar Talk

AMES(June 2019),IMF(April 2019), Jane Street Symposium (Jan 2019), PKU(June 2018), Penn Econ (April 2018), IMF (April 2018), Penn Wharton (Oct 2017, MBA Talk), AEA Conference San Francisco (Jan 2016), Alibaba (2016), NBER-CCER Conference (June 2015), Stockholm-China Meeting (Sep 2014).

Quantitative Courses Taken (all PhD Level)

Optimization in Machine Learning (Audit), Continuous Time Asset Pricing (A), Empirical Methodology of Asset Pricing (A), Empirical Corporate Finance (Audit), Probability Theory (A), Stochastic Process I (A), Stochastic Process II (A), Measure Theory (A), Real Analysis (A), Non-Parametric and Machining Learning (A), Data Mining (A), Econometrics I (A), Bayesian Econometrics II (A), Econometrics IV (A-), Financial Market and Macro Finance (A)

Honors and Awards Related to Math

Meritorious Winner (First Prize), Mathematical Contest Modeling United States (2008), First Prize, Chinese National College Mathematical Competition of Modelling (2007), First prize, the 17th and 18th College Mathematical Olympic of China (highest competition

at that time)

Conference Organizer.

The 1st NSE Summer Conference (2014). Editors' conference of Oxford-Economic Growth handbook of Africa, Joint with World Bank &IMF (2013)