### Research statement

**Siyuan Lyu (Stony Brook University)**

My research topic lies in innovation, especially for firms who invest in R&D and apply for different types of patents, as well as scientists remaining actively in academia, especially those whose talents are identified early and result in breakthroughs later. My work spans both theoretical and empirical approaches, exploring the dynamic relationship between knowledge accumulation, patent citations, and firm innovation. In addition, I have a growing interest in how to identify individual talents and motivate them for scientific innovation in academia. Beyond innovation studies, I also have broader interests in development economics, particularly in understanding the impact of crises and historical events on market behavior and policy decisions.

My job market paper, “Knowledge: Gift or Burden of Innovation?”, examines the dual role that knowledge accumulation plays in scientific innovation. While traditional economic literature tends to highlight the benefits of accumulated knowledge in facilitating innovation through recombination, recent trends show a decline in breakthrough innovations, despite the growing volume of research. My work explores this paradox by distinguishing between field-level knowledge accumulation and direct citation of prior works, proposing that while field-level knowledge reserves facilitate innovation, direct citations can increase the difficulty of innovating. Drawing from Arora et al. (2021) and utilizing the NBER Patent Project database, I build a theoretical model showing that accumulated knowledge can complement citations in innovation cost reduction but that citation behavior may lead to diminishing returns. Empirical results support this, indicating that citations constrain rather than promote innovation, contributing to the observed decline in breakthrough innovations. This research highlights my ability to combine theoretical modeling with empirical analysis.

Another ongoing project, “Hard Problems: Young Math Talents in the U.S. and Their Choices of Higher Education”, manages to shed light on how prestigious math competitions, and USAMO and Putnam, effectively predict future academic decisions and how receiving different levels of honors varies in these effects. Using a self-construct dataset of USAMO and Putnam awardees from 1985 to 2010, collected through both manual research and automated matching, we are able to analyze their higher education and career paths. Nearly half of the USAMO awardees obtained a Ph.D. in mathematics-related STEM fields such as Pure Math, Applied Math, Physics, Computer Science, and Economics, compared to 58.49% of the Putnam awardees. Furthermore, USAMO gold medalists were significantly more likely than Honorable Mention recipients to pursue higher degrees in these fields and remain in academia. While the pattern in Putnam awardees remain ambiguous, in terms of both their absolute performances and relative rankings within colleges. These results contribute to discussions on talent screening through competitive challenges, suggesting that while high-level mathematics competitions identify strong academic candidates, psychological factors and institutional influences shape long-term career outcomes. This paper is still at work, while I have submitted to several conferences.

The third project is a co-authored empirical paper, which evaluates the impact of China’s “Green Factory” policy on firm-level green innovation. Using firm-level data from 2017 onwards, we assess how the policy, which promotes sustainable manufacturing, affects firms' performances in terms of green patents, innovation investment, and technology transfer efficiency. Our findings show that being labeled as a "Green Factory" has a significant positive impact on the number of green patents, R&D investment, and transfer efficiency, with these effects being most pronounced for smaller firms and non-state-owned enterprises (non-SOEs). I took a leading role in the data analysis and writing of this paper, which is nearing completion and will soon be submitted for publication.

Besides the topic, my research interests extend beyond innovation economics to encompass broader issues in development economics. I have published work on the impacts of the COVID-19 pandemic on China's green bond market, providing insights into the resilience of sustainable finance in times of crisis. Additionally, my paper on the influence of local leaders' famine experience on housing sector development in China, currently under final review, exemplifies my commitment to understanding the long-term effects of historical events on economic decision-making.

In conclusion, my research agenda is driven by a desire to unravel the complexities of innovation processes and their interaction with policy and firm behavior. By combining rigorous theoretical work with data-driven empirical analysis, I strive to produce research that is not only academically rigorous but also relevant to policymakers and practitioners in the field of innovation and sustainable development.

My research interests lie at the intersection of innovation, firm behavior, and environmental policy, with a specific focus on how firms invest in R&D, apply for patents, and respond to policy incentives. My work spans both theoretical and empirical approaches, exploring the dynamic relationship between knowledge accumulation, patent citations, and firm innovation. In addition, I have a growing interest in using network analysis to capture the complexities of patent citation behavior and its implications for innovation. Beyond innovation studies, I also have broader interests in development economics, particularly in understanding the impact of crises and historical events on market behavior and policy decisions.

My recent paper, “Knowledge: Gift or Burden of Innovation?” examines the dual role that knowledge accumulation plays in scientific innovation. While traditional economic literature tends to highlight the benefits of accumulated knowledge in facilitating innovation through recombination, recent trends show a decline in breakthrough innovations, despite the growing volume of research. My work explores this paradox by distinguishing between field-level knowledge accumulation and direct citation of prior works, proposing that while field-level knowledge reserves facilitate innovation, direct citations can increase the difficulty of innovating. Drawing from Arora et al. (2021) and utilizing the NBER Patent Project database, I build a theoretical model showing that accumulated knowledge can complement citations in innovation cost reduction but that citation behavior may lead to diminishing returns. Empirical results support this, indicating that citations constrain rather than promote innovation, contributing to the observed decline in breakthrough innovations. This research highlights my ability to combine theoretical modeling with empirical analysis and was presented at a game theory conference this past summer.

I am currently working on a co-authored empirical paper, which evaluates the impact of China’s “Green Factory” policy on firm-level green innovation. Using firm-level data from 2017 onwards, we assess how the policy, which promotes sustainable manufacturing, affects firms' performances in terms of green patents, innovation investment, and technology transfer efficiency. Our findings show that being labeled as a "Green Factory" has a significant positive impact on the number of green patents, R&D investment, and transfer efficiency, with these effects being most pronounced for smaller firms and non-state-owned enterprises (non-SOEs). I took a leading role in the data analysis and writing of this paper, which is nearing completion and will soon be submitted for publication.

Recently, I have begun to explore how network analysis can be used to better understand the citation behavior of patents and its relation to innovation. Traditionally, patents that cite more references tend to be viewed as less innovative due to path dependence. However, my preliminary work suggests that the relationship between innovation and citations may follow a U-shape, with highly cited patents (e.g., in the top 5% of citations) also being more innovative. I hypothesize that this is due to their unique position in the citation network, particularly their high betweenness centrality. My ongoing work aims to develop a theoretical model that captures how a patent's position in the citation network, rather than its sheer number of citations, drives its innovativeness. This research could potentially fill a gap in the literature, where most work on citation networks has been empirical, with limited theoretical exploration of concepts such as betweenness centrality and its role in innovation.

In addition to my focus on innovation, I maintain a strong interest in development economics. I have published a paper on “The Impacts of the COVID-19 Pandemic on China’s Green Bond Market,” which investigates how the pandemic has influenced the environmental finance sector. Additionally, my paper “Local Leaders’ Famine Experience and Development Strategy of Housing Sector in China” is currently under the final round of review. These works reflect my interest in understanding how crises and historical experiences shape economic development and market behavior.

Moving forward, I plan to continue building on my current research by deepening my work on the intersection of innovation, knowledge, and networks, while also expanding my empirical work on environmental policy and sustainable innovation. I am particularly interested in exploring how network theory can be applied to capture the nuanced relationships between firm innovation, policy interventions, and market outcomes. Furthermore, I am excited to engage with interdisciplinary approaches that blend innovation economics with insights from development economics, sustainability, and policy studies.

 What is your research topic? What are your main research questions?

 What specific research work have you completed so far? Have there been any significant findings or breakthroughs?

 Have you published any articles, presented at conferences, or produced other academic outputs?

 What research work are you currently engaged in? What challenges or difficulties are you facing?

 What research tasks do you plan to complete in the coming months?

 What is the general structure of your doctoral thesis? Which parts have you completed and which are still in progress?

 What potential contributions do you believe your research will make to your field?

 How do you plan to schedule your time from now until graduation?