Address：Peking University HSBC Business School,
Nanshan District, Shenzhen, China, 518055
Tel：86-755-2603 2551　Email：SIQEFadms@phbs.pku.edu.cn
Web：http://siqef.phbs.pku.edu.cn/en/
bilibili：https://space.bilibili.com/1868128581

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Sargent Institute of
Quantitative Economics and Finance

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SARGENT INSTITUTE OF
QUANTITATIVE ECONOMICS
AND FINANCE

SIQEF
NEWSLETTER

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SIQEF

Mission Statement

“Our institute strives to put mathematics and statistics at the service of quantitative analysis of questions about economics, finance, and government policy. Scientists use mathematics because we want our models to be coherent. We use statistics because we want our models to describe data well. Our purpose is to learn, teach, and apply an array of methods made possible by the availability today of powerful and inexpensive computational methods and large data sets. We provide a platform for developing computational economics and finance based on user friendly and powerful open source languages, especially Python and Julia.”

— *Thomas Sargent*

SARGENT INSTITUTE OF QUANTITATIVE ECONOMICS AND FINANCE

News

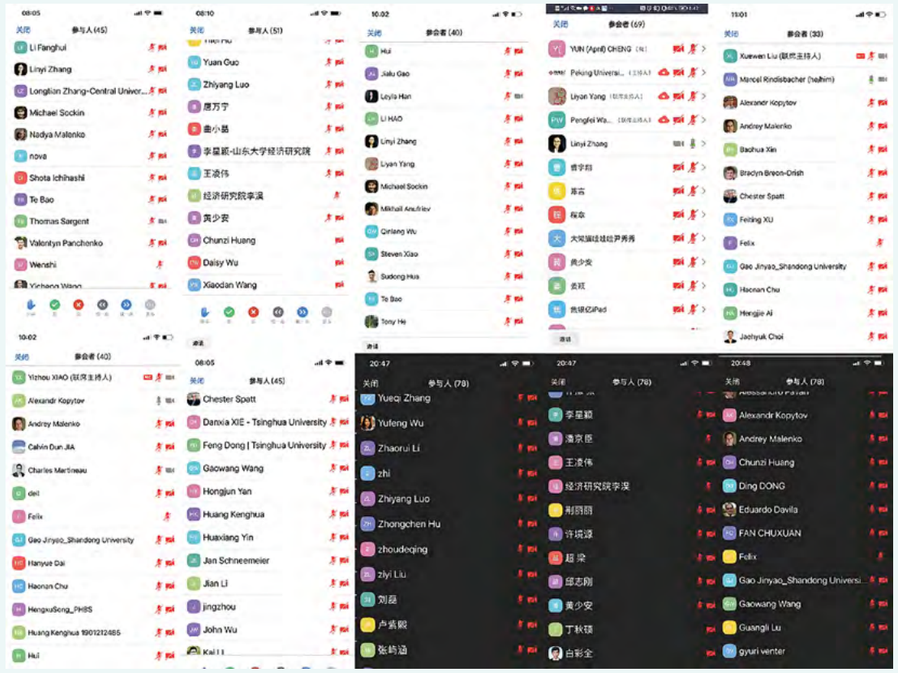
SARGENT INSTITUTE OF QUANTITATIVE ECONOMICS AND FINANCE

The Academic Forum on Markets and Economics from the Perspective of Information Held Online

Written by: Jian Li, Kaihong Song, Shiqi Chen
Translated by: Ziying Chen

From August 30th to 31st, 2021, the Academic Forum on Markets and Economics from the Perspective of Information was held online. The forum was co-hosted by Peking University HSBC Business School, Shandong University Economic Research Institute, and the *Journal of Economic Dynamics and Control*. It was organized by Peking University Sargent Institute of Quantitative Economics and Finance and Peking University Macroeconomics and Finance Research Center, with additional support from Ping An Macroeconomics and Financial Research Center. Nearly 100 experts and scholars from around the world held discussions on the latest academic research into the market and economy from the perspective of information, with a total of nearly 700 participants.

At the opening ceremony on the 30th, Professor Pengfei Wang, Vice-Chancellor of Peking University Shenzhen Graduate School and Dean of Peking University HSBC Business School, expressed his welcome and gratitude to the participants on behalf of the organizers. The forum received more than 150 submissions, attracting widespread attention from the academic community. He hoped that this online forum could promote the friendship of scholars and help scholars keep up with cutting-edge research.



- Scholars attended the online forum

Professor Liming Fan, President of Shandong University, welcomed the guests and expressed her thanks to the organizers. She suggested that the world is now going through a wider and deeper technological revolution and industrial transformation. The modern information technologies such as the Internet, big data, and artificial intelligence are making breakthroughs and the digital economy is booming. The interests of all countries are more closely linked. The post-Covid19 era continues to deepen the horizontal and vertical relations between information and markets and economics. She expected this forum to spark ideas, gather wisdom, and promote the deepening of industry-university-research cooperation of information economics. With the motivation of mutual progress and win-win, she hoped that the outcomes of this forum would contribute to the world's economic development.

Professor Thomas J. Sargent, 2011 Nobel Laureate in Economics and director of the Sargent Institute of Quantitative Economics and Finance at Peking University HSBC Business School, said that information economics and information friction are the frontier of current economic research. He suggested that starting from the friction-less general equilibrium theory founded by economists such as Walras, Hicks, Arrow, and Debreu, information friction has gradually evolved into an important element in economic research, while

- Professor Liming Fan delivered opening remarks

mechanism design and the follow-up dynamic mechanism design, information friction, and optimal contract theory all challenge the welfare theorem of economics. How these research results are applied to the original frictionless economy is very important. Professor Sargent said with satisfaction that there were many young scholars in the forum for whom he had high hopes, and that he looked forward to exploring the frontiers of information economics with them.

- Professor Thomas J. Sargent delivered a welcome speech

> The forum was co-hosted by Peking University HSBC Business School, Shandong University Economic Research Institute, and the *Journal of Economic Dynamics and Control*.

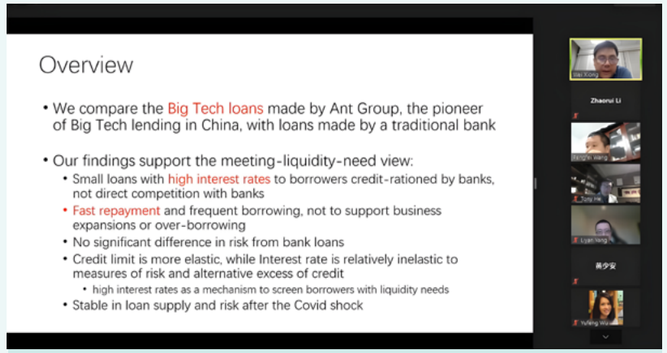
Wei Xiong, the Trumbull-Adams professor of finance and economics at Princeton University, had been invited to give a keynote speech. He presented the paper "*The Big Tech Lending Model*" co-authored with Guangli Lu, Lei Liu, and Zhenhua Li. Based on the comparison of the big data technology loans of large financial technology companies and the loan data of commercial banks, this paper discussed the competitiveness, characteristics, risks, and other issues of small high-interest loans provided by technology companies. He demonstrated that big data technology loans met liquidity needs, and their use of high interest rates as a strategy to screen loans for liquidity needs has not resulted in higher risks.

The organizers selected 26 high-quality academic papers from numerous submissions, and invited the authors to attend the forum to present and discuss their work. These papers covered major areas such as information economics and asset pricing, information efficiency, market liquidity, corporate investment, macroeconomics, information design, and the digital economy.

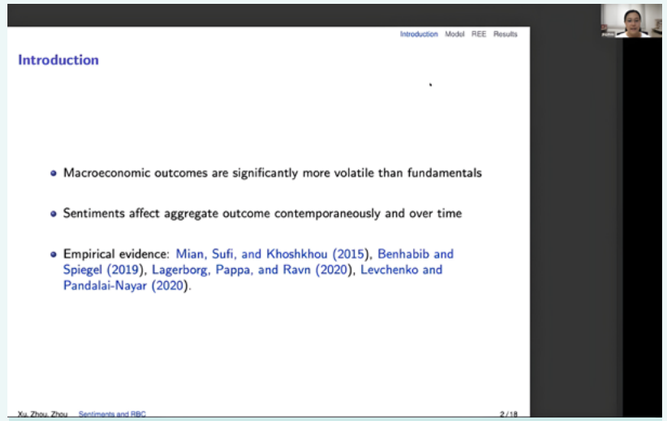
The paper"*Sentiments and Real Business Cycles*" co-authored by Associate Professor Zhiwei Xu from Peking University HSBC Business School, Fei Zhou from Hong Kong Baptist University, and Jing Zhou from Fudan University was selected for this forum. The paper introduced sentiments under incomplete information into the standard real economic cycle theory, and verified that there is a sentiments-driven rational expectation equilibrium in addition to the traditional fundamental equilibrium. In this sentiments-driven equilibrium, optimism accelerates overall economic development, leading to a positive correlation between output, consumption, investment, and hours worked.

The forum had a total of 10 themed sessions including"Social Network and Data Economy", "Trading and Machine Learning", and"Information Frictions and Asset Pricing". It was held simultaneously in two online sessions chaired by Chair Professor Pengfei Wang of Peking University HSBC Business School and hosted by Associate Professors Kai Li and Xu Zhiwei, and Assistant Professor Yicheng Wang. In addition to the authors presenting, the forum also invited well-known scholars in the field to serve as reviewers, and encouraged participants to communicate and discuss with each other.

The forum attracted scholars from institutions such as Yale University, the University of Toronto, the University of New South Wales, Boston University,



- Professor Wei Xiong delivered a keynote speech



- Jing Zhou from Fudan University presented paper

INSEAD, the Singapore Management University, the University of Hong Kong, the Chinese University of Hong Kong, Tsinghua University, Fudan University, Renmin University of China, the University of International Business and Economics, and the Shanghai University of Finance and Economics.

On the 31st, Professor Pengfei Wang of Peking University HSBC Business School, co-editor of the *Journal of Economic Dynamics and Control*, Professor Tony He of the University of Technology Sydney, and Professor Liyan Yang of the University of Toronto, Canada, as co-organizers of the forum, made concluding speeches respectively. They congratulated the success of this meaningful event despite many hardships associated with the pandemic, and expressed gratitude to the staffs.

The forum provided a high-level communication platform for scholars and industry personnel in related fields at home and abroad and promoted an in-depth discussion on economics and information. Through discussions on latest research outcomes, the forum hoped to stimulate the exchange of wisdom and the collision of ideas as well as enhance mutual cooperation.

Peking University Nanyan 20th Anniversary Academic Forum (Applied Economy Subforum) was held at Peking University HSBC Business School

Written by: Xiaochun Sheng
Translated by: Can Liu

On December 4, 2021, the Peking University Nanyan 20th Anniversary Academic Forum(the Applied Economy Subforum) was held to celebrate the 20th anniversary of the Shenzhen Graduate School of Peking University, as one of the series of activities. Three famous economists, Danyang Xie, Ying Fang, and Pengfei Wang, made outstanding academic reports on their respective research fields and conducted a roundtable discussion on "business education and the development of the Greater Bay Area". Online and offline, professors and students gathered together to celebrate Nanyan's 20th birthday and exchange the latest developments within the academic community.

- Teachers and students attended the forum.

Academic Report

Danyang Xie

- Professor Danyang Xie presented his paper.

Chair Professor Danyang Xie of the Department of Economics at the Hong Kong University of Science and Technology Business School and Acting Dean of the Social Hub of Hong Kong University of Science and Technology (Guangzhou), shared his research, thinking, and ideas from the three aspects of "endogenous economic growth theory", "inclusive growth", and "social innovation" in his report entitled "*Exploration and Analysis of Inclusive Growth and Social Innovation*". He reviewed the development, expansion, and improvement of endogenous economic growth theory through a classical literature review, identifying that the main problem explored by this theory lies in "the determinants of economic growth and how to make the economy grow faster and more lasting". Professor Xie believed that globalization will continue, but we must pay attention to its inclusiveness. One of the important means of inclusive growth is social innovation. The main body of social innovation can be government agencies, profit-making enterprises, non-profit enterprises, public welfare organizations, influential investors, or social enterprises. He mainly introduced the development and typical cases of social enterprises at home and abroad. Finally, Professor Xie called for more study, attention, and support from the academic community for the development of social enterprises and joint promotion of inclusive growth.

Ying Fang

-Professor Ying Fang presented his paper.

Professor Ying Fang, Assistant President of Xiamen University and Professor of the Statistics and Data Science Department of the Wang Yanan Institute of Economics and the School of Economics at Xiamen University, and Chair Professor of Changjiang Scholars, pointed out in his report entitled "*Econometrics Training and Research in Economics and Finance: the Credibility Revolution of Empirical Economics*" that, on the one hand, econometrics has played an important role in promoting the increasingly scientific development of economics, while on the other hand, it has been widely criticized since its birth. Starting from "the credibility revolution of empirical research", Professor Fang reviewed the development history of econometrics and the doubts raised by scholars, such as David F. Hendry, Edward E. Leamer, Joshua Angrist, and Jörn-Steffen Pischke, from different angles. Professor Fang believed that the credibility of empirical research is widely questioned not only because of the problems of econometrics itself, but also because of the misuse and abuse of econometrics by researchers. However, good econometric training can improve the empirical research level of finance by finding research topics, delving into innovative contributions, measuring interested research objects or economic phenomena, selecting appropriate econometric models, interpreting the results of econometric models, and robustness testing. Finally, he reminded all scholars that when conducting empirical research, one must maintain the scientific spirit, for as Edward E. Leamer said, "a fragile inference is not worth taking seriously."

Academic Report

Chair Professor Pengfei Wang, the Vice Chancellor of Peking University Shenzhen Graduate School and Dean of Peking University HSBC Business School, demonstrated in the report entitled "*Asset Bubble and Monetary Policy*" that asset bubbles are one of the core issues of asset pricing. However, academics and policy makers have not reached a consensus on this core issue. He talked about the history of famous asset bubbles, such as Tulip mania, the South Sea Bubble, and introduced the latest related academic research. He discussed the causes of asset bubbles and their impact on the economy from two aspects of theory and practice, and how to use monetary policy to deal with asset bubbles. Professor Wang pointed out that, historically, the impact of asset bubbles on economic development is not necessarily entirely negative because asset bubbles can relieve financing constraints and improve liquidity. Especially for high-tech and human-capital intensive industries, equity bubbles are conducive to financing and R&D, and have certain benefits to the economy. The main harm of asset bubbles is that they will squeeze out investment, cause excessive economic fluctuations, and may even bring systemic risks. Therefore, when we cannot eliminate asset bubbles, we should think about how to coexist, allowing them to play a positive role and reducing their negative effects.

Pengfei Wang

- Professor Pengfei Wang presented his paper.

Roundtable Discussion

Yizhen Gu

- Professor Yizhen Gu chaired the roundtable discussion.

During the roundtable discussion, the participating scholars conducted in-depth exchanges on "the current situation of business education in various colleges and universities and the future layout of the Greater Bay Area", "the characteristics of economic development in the Greater Bay Area", and "the reform of economic education" within the theme of "business education and the development of the Greater Bay Area". The roundtable was chaired by Yizhen Gu, Associate Professor at Peking University HSBC Business School.

- Participants.

In addition to the Applied Economy Subforum, the Peking University Nanyan 20th Anniversary Academic Forum also includes three subforums in materials and chemical genomics, electronic science and technology, and human settlements science and technology, with over 150,000 viewers participating online.

Peking University Nanyan 20th Anniversary Academic Forum
(Applied Economy Subforum) was held at
Peking University HSBC Business School

The First CUHKSZ-PHBS Economics and Finance Workshop Held

Written by: Liling Huang, Xin Liu, Jing Ye
Translated by: Yifu Liu

> The workshop consisted of keynote speeches, paper presentations and roundtable discussions, with more than 70 scholars conducting in-depth discussions on the latest academic research findings in the fields of economics and finance.

- Scholars attended the workshop.

- Representatives from the organizers delivered speeches (left to right: Bohui Zhang, Pengfei Wang, Jian Wang)

The First CUHKSZ-PHBS Economics and Finance Workshop was held on December 18 and 19, 2021 at the Shenzhen Finance Institute, jointly organized by Peking University HSBC Business School (PHBS), the School of Economics and Management of the Chinese University of Hong Kong, Shenzhen (CUHKSZ) and the Shenzhen Finance Institute. The workshop consisted of keynote speeches, paper presentations and roundtable discussions, with more than 70 scholars conducting in-depth discussions on the latest academic research findings in the fields of economics and finance.

At the opening ceremony on the 18th, Professor Bohui Zhang, Executive Associate Dean and President's Chair Professor of the School of Economics and Management of The Chinese University of Hong Kong (Shenzhen), Professor Pengfei Wang, Vice Chancellor of Peking University Shenzhen Graduate School and Dean of PHBS, and Professor Jian Wang, Associate Dean of the Shenzhen Institute of Advanced Financial Studies of The Chinese University of Hong Kong deliverded speeches on behalf of the organizers. Professor Bohui Zhang expressed his gratitude to the partners of the symposium and hoped that the conference would enhance the friendship between scholars, promote the development of young scholars, and track the academic frontier. Professor Pengfei Wang introduced the history of the founding of the workshop and expressed his hope that academic exchange and cooperation would enhance institutional friendship and jointly promote academic development and research cooperation in the Greater Bay Area. Professor Jian Wang said that it was a good opportunity to unite scholars from the two schools for in-depth academic communications and exchange of research experiences, and that the invitation of senior scholars as commentators for this symposium was conducive to promoting the academic development of the two schools.

CUHKSZ-PHBS

CUHKSZ-PHBS Economic and Finance Workshop

Yongmiao Hong

Dean of the School of Economics and Management at the University of Chinese Academy of Sciences

In his keynote speech, Professor Yongmiao Hong, Dean of the School of Economics and Management at the University of Chinese Academy of Sciences, presented his latest paper '*Can Interval Data Help Improve Volatility Forecasts*?' He explained in detail the evolution of econometric models such as GARCH, TGARCH, and CARR and the advantages and disadvantages of forecasting volatility, showing the advantages of applying interval data in financial research. After an introduction to Interval Models and their relationship with volatility forecasting, Professor Hong analyzed Interval Models in the context of their application to economic and financial fields such as economic growth, climate change, and stock markets, comparing and evaluating the performance of various models in forecasting volatility.

Shuaizhang Feng

Director of the Institute of Economic and Social Research at Jinan University

Professor Shuaizhang Feng, Director of the Institute of Economic and Social Research at Jinan University, gave a keynote speech based on his paper "*Effects of Childhood Peers on Personality Skills*" and introduced the empirical research process. Using data from a study of primary school students in Mianzhu, Sichuan Province, the paper investigated the influence of left-behind children on the development of the non-cognitive skills of non-left-behind children. It then verified the peer effect of childhood as an influence mechanism, and used identification strategies such as random class allocation and parental absence, as well as a series of robustness tests to validate the findings.

In the three paper presentation sessions, which included "Information Disclosure", "Behavioural Finance", and "Gender and Politics", six young scholars shared their latest research and exchanged views with colleagues and students on specific issues such as sample data collection, improvement of research methods, and consistency of hypothesis testing.

In the session "Disclosure", Assistant Professor Fangyuan Ma of PHBS presented the paper "*Mergers under the Microscope: Analyzing Conference Call Transcripts*', which she co-authored with Sudipto Dasgupta. The paper uses machine learning and text analysis methods to deconstruct and count the content of M&A conference call presentations, conference call transcripts, and M&A announcements on a word-by-word basis, and to construct metrics to measure different types of information using M&A transaction data from the US market as the main sample. The study shows that M&A conference calls release highly value-relevant information to the market and, to some extent, address governance, ownership, and compliance processes that affect deal outcomes. Associate Professor Rui Shen of CUHK discussed and commented on the paper, making detailed suggestions for improvements to the machine learning and text analysis methods used in the study.

Fangyuan Ma

Assistant Professor of PHBS

Assistant Professor Xiaoqiao Wang from the Chinese University of Hong Kong, Shenzhen presented her co-authored paper "*Externalities of Private Firm News Disclosure*". She pointed out that private firms play an important role in the real economy and their impact cannot be ignored. Based on data from the Capital IQ database of all private and listed companies, the paper finds that listed companies are more sensitive to investment opportunities in industries where private companies disclose information intensively, and that this finding is true for both positive and negative information disclosed by private companies. The paper was reviewed and commented on. by Zhao Jin, Assistant Professor at Cheung Kong Graduate School of Business.

Xiaoqiao Wang

Assistant Professor from the Chinese University of Hong Kong, Shenzhen

Pengfei Sui

Assistant Professor from the Chinese University of Hong Kong, Shenzhen

In the Behavioural Finance session, Assistant Professor Pengfei Sui from the University of Hong Kong, Shenzhen presented his paper "*Prospectus Theory and Mutual Fund Flows*". He argued that investor decisions are a more direct reflection of investor preferences, and that fund flows are an important expression of investor decisions. The paper examines whether prospectus theory is valid in fund investment by constructing a value indicator, using actively managed equity funds in the US mutual fund market as an example. The study shows that fund flows are consistent with investor preferences based on prospect theory and that the phenomenon is more pronounced in funds with a high concentration of retail investors and during periods of high investor sentiment. Linlin Ma, Associate Professor at PHBS, commented on the paper. She argued that the work goes some way to filling a gap in the study of mutual funds in behavioral finance and suggested that the authors further consider the intrinsic link between their prospect theory-based form of utility function and the widely documented finding that fund flows follow a convex functional relationship with returns.

Dun Jia

Assistant Professor of PHBS

Dun Jia, Assistant Professor at PHBS, presented his paper "*Attention, Uncertainty, Reduction, and Pre-announcement Premium in China*". He found that there is a significant equity premium in the Chinese stock market prior to the announcement of monetary policy by the People's Bank of China, and that this phenomenon is not caused by data leakage or changes in expectations. The paper therefore constructs a theoretical model based on the monetary policy announcement cycle and the aforementioned empirical evidence to provide an in-depth analysis of the transmission channel of the attention-driven decline in market uncertainty, which provides a theoretical basis for explaining the pre-policy equity premium phenomenon in China. Jun Pan, Professor at the Shanghai Advanced Institute of Finance, Shanghai Jiao Tong University, provided an in-depth review of the paper by combining the existing literature, his own research experience, and replicating the results of the paper using data from 2010-2020.

Yuchen Xu

Assistant Professor of PHBS

In the session “Gender and Politics”, Yuchen Xu, Assistant Professor at PHBS, presented her paper “*Partisan Depositor Responses to a Currency Shock*”. Using unique depositor microdata from a listed bank in Turkey, the paper investigated household deposit behavior in the face of a large currency shock. The study shows that the share of foreign currency deposits held by households increases significantly following a negative shock to the domestic currency and the shift to foreign currency will persist for a long time after the shock even if the value of the domestic currency subsequently returns. Following the paper presentation, Jun Qian, Professor at the Fanhai International School of Finance, Fudan University, gave advice on the background of the paper and the refinement of the hypothesis testing.

Peng Zhang, Assistant Professor at the School of Economics and Management of CUHK, presented his paper “*Gender Differences in Reactions to Failure in High-stakes Competition: Evidence from the National College Entrance Exam Retakes*”. The article uses RD Design empirical analysis to analyze the dynamic differences between candidates of different genders in Ningxia Province whose scores in the entrance examination are close to the admission mark of Category 2 institutions. The study shows that when the entrance examination score is slightly below the acceptance mark of second-class institutions, retakes can improve candidates’ performance in the re-entry examinations; male candidates are more likely to choose retakes than female candidates, and there is no heterogeneity in other factors such as ethnicity, household registration, or arts and science division. Hong Song, Associate Professor at the School of Economics, Fudan University, commented on the theme and contribution of the article and gave suggestions for other possible explanations.

Peng Zhang

Assistant Professor from the Chinese University of Hong Kong, Shenzhen

- Roundtable discussion (L-R: Jianpo Xue, Yongmiao Hong, Shuaizhang Feng, Pengfei Wang)

The workshop also featured a roundtable discussion between Professors Yongmiao Hong, Shuaizhang Feng, Pengfei Wang, and Professor Jianpo Xue from the Wang Yanan Institute for Studies in Economics, Xiamen University, on the topic of fund application. Professor Jianpo Xue shared his own experience in applying for funds and discussed the key points to note in applying for funds, such as motivation, type selection, and application code. Professor Shuaizhang Feng emphasized the importance of applying for research projects for young scholars and shared the process of application and closing of projects with the example of the fund he hosted. Professor Pengfei Wang said that the writing of fund applications should focus on research purpose, expression logic, and format review, and he encouraged young scholars to actively apply for grants in the light of their own interests and social focus. Professor Yongmiao Hong stressed the importance of grants as an accumulation of scientific research to enhance competitiveness, and said that the topics applied for should be important and scientific.

- Group photograph of some of the participants

Inspired by the joint academic forum held between Cornell University and Pennsylvania State University, the CUHKSZ-PHBS Economics and Finance Workshop is held biannually and is dedicated to stimulating the research potential of young scholars, promoting academic exchanges between them, and advancing academic development and research cooperation in the Guangdong-Hong Kong-Macao Greater Bay Area.

CUHKSZ-PHBS Economics and Finance Workshop

PHBS Holds Fourth International Workshop in Macroeconomics and Finance

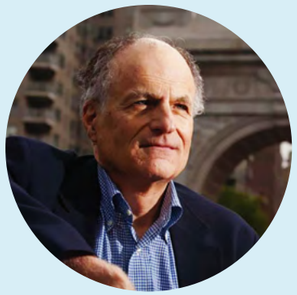
By Annie Jin

Sponsored by Peking University HSBC Business School (PHBS), the Sargent Institute of Quantitative Economics and Finance (SIQEF) at PHBS and the Center for Macroeconomy and Finance (CMF) of Peking University jointly organized the Fourth International Workshop in Macroeconomics and Finance on April 23-24.

The workshop invited renowned scholars and experts from prestigious universities and institutions worldwide, including Massachusetts Institute of Technology, University of Pennsylvania, Columbia University, Duke University, University of Chicago, University of Maryland, Arizona State University, Northwestern University, University of Minnesota, the London School of Economics and Political Science, London Business School, University College London, Peking University, Federal Reserve Bank of Richmond, and Federal Reserve Bank of St. Louis. In spite of pandemic challenges, they converged online to exchange research insights and explore cutting-edge research areas with more than 200 young researchers from home and abroad.

- Over 200 scholars attend the online workshop

Professor Pengfei Wang



Professor Thomas J. Sargent

Professor Wang expressed his warm welcome to all the participants and heartfelt gratitude to Winston Dou (assistant professor, University of Pennsylvania), Li Kai (associate professor, PHBS) and Zhang Shengxing (assistant professor, LSE) for their efforts in organizing the workshop. He introduced the school's academic achievements in 2021, including the selection of our applied economics field into "first class" discipline construction sequence of Guangdong Province, multiple publications in top academic journals, and the recent development of SIQEF. PHBS faculty members published 58 papers in first-class academic journals last year, including 14 papers in top international journals such as *The Journal of Finance, Journal of Financial Economics, Econometrica*, etc, with a 50% increase in high-quality publications from 2020; In addition, SIQEF has been approved as one of the "Key Laboratory of Philosophy and Social Sciences at Colleges and Universities in Guangdong Province." After briefing on the workshop's agenda, he also emphasized the importance of such academic exchanges in macroeconomic and finance during the pandemic.

Professor Sargent shared his recent discussion with Professor Lars Peter Hansen, 2013 Nobel laureate in economics. He mentioned two primary components of Bayesian analysis: prior distribution and likelihood function, further pointing out Bayesian researchers' firm subjective beliefs about the prior distributions. Since Aldo Rustichini and his coauthors extended von Neumann and Savage's expected utility theory to variational preferences, he and Professor Hansen have been developing new frameworks in this regard. Based on this, Professor Sargent elaborated on how to deal with decision-making problems when people don't have a unique prior over statistical models (i.e., likelihood functions) and suspect that each statistical model is misspecified.

Following the remarks, the workshop featured two keynote speeches and four sessions, which included research papers in the fields of macroeconomics and finance. Each presenter had 20 minutes to talk about their research findings, followed by a ten-minute discussion.

In the keynote speech, Professor He Zhiguo from University of Chicago introduced his paper "Is There an Industrial Land Discount in China? A Public Finance Perspective." He pointed out China's land market featured a substantial industrial discount: industrial-zoned land is an order of magnitude cheaper than residential land. Based on the data of land parcels, Professor He and his coauthors found that the flow of tax revenues from industrial land could quantitatively explain the size of the upfront industrial land discount; in addition,

-Keynote speakers

- Presenters of four sessions

The Fourth PHBS Workshop in Macroeconomics and Finance

> Their research has proved that industrial land sales in China are not subsidized relative to residential land sales; and for policy implication, the tax sharing scheme between the central and local governments can be carefully designed to achieve desired land allocation outcomes.

the internal rate of return from the industrial-residential land tradeoff was greater than local governments' cost of capital. Their research has proved that industrial land sales in China are not subsidized relative to residential land sales; and for policy implication, the tax sharing scheme between the central and local governments can be carefully designed to achieve desired land allocation outcomes.

Professor Benjamin Moll from London School of Economics and Political Science presented his paper "Asset-Price Redistribution." Professor Moll and his coauthors analyzed how the process of continuous asset price growth and buying-selling process could affect the individual welfare growth. Using Norwegian panel microdata from 1994-2015, they conducted the empirical analysis on welfare gains and asset-price redistribution, showing redistribution effects from the young to the old for multiple types of assets, including real estate, bonds, deposits, and warrants. He also elaborated on their simple heterogeneous agent model to quantify the welfare effect of historical asset price fluctuations, and suggested that governments should take asset-price redistribution into consideration to make optimal policy.

A total of eight papers were presented this year at four sessions. In the Human Capital and Macro Development session chaired by PHBS Assistant Professor Jia Dun, PHBS Assistant Professor Ma Xiao presented his paper "How do Workers Learn? Theory and Evidence on the Roots of Life-Cycle Human Capital Accumulation." Based on worker qualification data from Germany and the US, Ma and his coauthors found that internal learning (learning through colleagues) decreased with worker experience, while external learning (on-the-job training) had an inverted U-shape in worker experience. To shed light on these findings, they embedded this two-source learning mechanism in a quantitative search framework where firms and workers jointly fund learning investments. Their research shows that subsidizing learning can generate sizeable increases to human capital and aggregate output. Discussant Victoria Gregory from the Research Department of the Federal Reserve Bank of St. Louis gave suggestions on the heterogeneity of learning and training methods, endogenous training mechanism, and data processing refinement.

The other three sessions included Industrial Organization and Asset Pricing, Climate Finance, and Corporate Frictions and Macro Finance, with Assistant Professor Winston Dou, Associate Professor Li Kai and Assistant Professor Zhang Shengxing as each session's chair.

Initiated in 2018, PHBS Workshop in Macroeconomics and Finance has provided an effective platform for some of the most prominent scholars and young researchers to promote academic exchanges among macroeconomic and financial research institutions, deepen the understanding of China's macroeconomic and financial issues, and facilitate the application of research findings into China's reform and development.

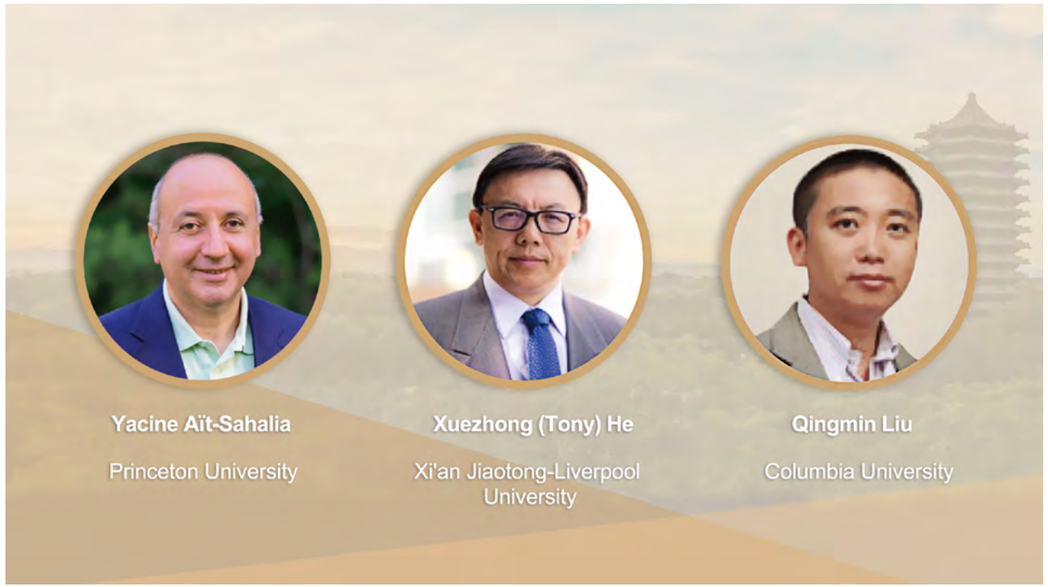
> Human Capital and Macro Development
> Industrial Organization and Asset Pricing
> Climate Finance
> Corporate Frictions and Macro Finance

The Sixth PKU-NUS International Conference on Quantitative Finance and Economics Held Online

Artical Source: Peking University HSBC Business School

The sixth PKU-NUS International Conference on Quantitative Finance and Economics was held online from May 14 to 15. Jointly sponsored by Peking University HSBC Business School (PHBS), the Risk Management Institute (RMI) of the National University of Singapore (NUS), and Key Laboratory of Mathematical Economics and Quantitative Finance at Peking University, this year's annual conference was organized by the School of Mathematical Sciences of Peking University, attracting more than 100 scholars to enhance their quantitative techniques, discuss new methods, and share the latest research findings.

Opening remarks were delivered by Professor Chenxu Li, the Guanghua School of Management, Pengfei Wang, Vice Chancellor of PKU Shenzhen Graduate School and dean of PHBS, and Yi-Chun Chen, director of the RMI. Professor Li hoped that this conference could promote in-depth and extensive academic exchanges and cooperation among universities. Professor Wang expressed his heartfelt gratitude to our co-organizers and hoped that this annual event could enhance the relations among scholars and keep close track of academic breakthroughs. He also introduced our school's academic achievements in 2021 and reflected on the long-lasting cooperation with NUS. Professor Chen briefed on the history of the conference, noting that PKU and NUS should further enhance cooperation and relations.



The conference invited three keynote speakers, Professor Yacine Aït-Sahalia (Princeton University), Professor Xuezhong He (Xi'an Jiaotong-Liverpool University), and Professor Qingmin Liu (Columbia University), to share their insights. Professor He elaborated on his paper "*Quantitative Investing and Price Informativeness*," where he established an equilibrium model of quantitative investment (QI) in the asset management market to study the impact of QI on market efficiency and stability. The research shows that QI affects price informativeness through two channels: directly, it brings more informed capital and superior price information; indirectly, imperfect price interpretation injects systematic noise into equilibrium results due to common errors in institutional price processing. In the equilibrium of an endogenously-determined fund market, whilst also inducing more capital flows to quantitative funds, lowering price information could further motivate the formation of quantitative funds. Professor Aït-Sahalia and Professor Liu shared the findings of their papers "*How and When are High-Frequency Prices Predictable*" and "*Stability and Efficiency of Two-Sided Matching Markets*" respectively.

Following the keynote speeches, the workshop featured six sessions, covering papers in the fields of macroeconomics, microeconomics, computational finance, algorithmic trading, financial modelling, liquidity and credit risk, mathematical economics, portfolio selection, mean-field game theory, and FinTech. 45 high-quality papers were selected from many submissions, and seven papers of our faculty and researchers were presented.

PKU-NUS International Conference on Quantitative Finance and Economics has been held annually to exchange the latest insights, keep close track of market moves, explore new research methods, and respond to regulatory changes in the financial sector.

Ding Dong, a Ph.D. candidate from Hong Kong University of Science and Technology, introduced his paper "*Turbulent Business Cycles*," coauthored with Professor Pengfei Wang and Zheng Liu, the Federal Reserve Bank of San Francisco. They found that turbulence was countercyclical and closely associated with recession: at the micro level, turbulence could reallocate resources from high-productivity firms to those with low-productivity, and the reallocation effect could be stronger in the industry with severe financial frictions. Based on this, they proposed a RBC model with heterogeneous firms and borrowing constraints to analyze the impact of turbulence on the macro economy and resource allocation, revealing that the impact of turbulence shock is significantly magnified by financial friction. Dong also discussed the implications of borrowing subsidy and credit easing: The former could effectively stabilize economy but exacerbate misallocation, while the latter could improve efficiency.

Assistant Professor Zhenda Yin presented his paper "*Promotions, Adverse Selection, and Efficiency*." The paper studied how adverse selection could affect promotion efficiency. Based on a labor market model with positional constraints and asymmetric employer learning, Yin and his coauthors found that, under standard promotions, adverse selection could reduce worker turnover and, in turn, cause promotion inefficiency or decrease social welfare. However, employing "up-or-out" contracts that force worker turnover could reduce the adverse selection problem and, in turn, increase social welfare, because higher-ability workers would be better sorted into higher-level job positions. Moreover, the paper explained several firm behaviors and practices related to the use of "up-or-out" contracts in real world labor markets.

Associate Professor Jaehyuk Choi discussed his paper "*A New Exact Simulation of the Ornstein-Uhlenbeck Driven Stochastic Volatility Model Using the Karhunen-Loève Expansion*." Efficient and accurate Monte Carlo simulation under the Ornstein-Uhlenbeck Driven Stochastic Volatility (OUSV) model has been recently proposed, but the accurate simulation of various stochastic volatility (SV) models requires substantial computational cost. Choi used Karhunen–Loève (KL) expansion to express the volatility path as an infinite sine series. The new method is faster than the exact method and its effectiveness has been verified by numerical tests.

Assistant Professor DuckKi Cho elaborated on his paper "*How Does Declining Worker Power Affect Investment Sensitivity to Minimum Wage?* " Considering microeconomic implications of declining worker power in the U.S., Cho probed how weakening working power affects firm-level investment decisions. Based on historical changes in minimum wages over the period 1983 to 2017, he found that various forces that have been advanced in the literature as driving the decline in worker power could reduce firms' investment-wage sensitivity. Those factors include globalization (1999 US-China bilateral agreement, and China's accession to the WTO in 2001), technological change, and weakening union power.

Ph.D. candidate Yueqi Zhang presented the paper "*Affine Term Structure Model of China's Key Interest Rates*," coauthored with PHBS Associate Professor Kai Li. Focusing on DRepo, Repo, and SHIBOR interest rates, they employed a five-factor affine term structure model to study the term structure of interest rate spreads in the Chinese interbank market based on the data of different maturities observed from 2015 to 2021. The research findings show that liquidity factor contributes to the spread of the Repo rate and the DRepo rate, and the spread of the SHIBOR and the DRepo rate, and credit factor contributes to the spread of the SHIBOR and the DRepo rate: The increase of liquidity risk will increase the spread of the Repo rate and the DRepo rate, but decrease the spread of the SHIBOR and the DRepo. In addition, the effect of liquidity factor and credit factor will decrease as maturities increase.

Proper pricing has always been a central concern for art investment. Ph.D. candidate Li Jian presented his paper "*Information Extraction and Artwork Pricing*," coauthored with PHBS Associate Professors Jaehyuk Choi, Lan Ju, and Zhiyong Tu. Based on the hedonic pricing model and Shannon information theory, the paper proposed an image information quantity factor measured by singular value decomposition (SVD) entropy. The authors used the data of FindArtinfo and WikiArt to empirically verify the positive impact of information on art pricing and compare it with other content factors in previous research. Li concluded that the research could improve the explanation for content heterogeneity and show the powerful application of computer graphic techniques in the field of artwork pricing.

Associate Professor Xianhua Peng presented his paper "*A Machine Learning Algorithm for Stochastic Control Problems*." Based on deep neural networks, he and his coauthor proposed a machine learning algorithm called the Monotonic Monte Carlo Control (MMCC) algorithm for solving high dimensional time-inhomogeneous stochastic control problems, and applied the algorithm to solve various problems in economics and finance, such as portfolio selection under stochastic volatility models.

Other scholars presenting and discussing papers came from world renowned universities and institutions, including Yale University, Cambridge University, the University of British Columbia, the University of North Carolina at Charlotte, the University of Wisconsin–Madison, the National University of Singapore, Hong Kong University, the Chinese University of Hong Kong, City University of Hong Kong, Hong Kong University of Science and Technology, Tsinghua University, Peking University, Nanjing University, and the Microsoft Research University of Chicago Booth School of Business.

Initiated in 2016, the PKU-NUS International Conference on Quantitative Finance and Economics has been held annually to exchange the latest insights, keep close track of market moves, explore new research methods, and respond to regulatory changes in the financial sector.

Featured Articles

SARGENT INSTITUTE OF QUANTITATIVE ECONOMICS AND FINANCE

FEATURED ARTICLES

Inclusive Growth and Social Innovation Analysis

Presenter: Danyan Xie
Author of this article: Wenya Cao

This article summarizes Professor Danyang Xie's conference presentation "An Analysis of Inclusive Growth and Social Innovation", delivered on December 4, 2021 at a forum organized by the Peking University HSBC Business School.

In his presentation, Professor Xie reviewed development in the theory of endogenous growth, and emphasized the role of social enterprises as a means to achieve sustainable and inclusive economic growth.

The theory of endogenous economic growth has a history of nearly forty years and has been constantly updated with the development of society. Romer (1986)[1] studied partial exclusivity, and non-rivalry and knowledge spillovers; Lucas (1988)[2] studied human capital; Grossman and Helpman (1991)[3] studied trade and specialization; Aghion and Howitt (1992)[4] studied Schumpeter's "Problem of Creative Destruction". Subsequent scholars have improved and supplemented the endogenous growth theory in terms of democracy, religion, government, and education. Professor Xie's paper detailed his unique contribution to the theory of endogenous growth in terms of multiple equilibrium and specialization at both ends of production and consumption, before making a general summary of the theory of endogenous economic growth from the perspective of production function.

The endogenous economic growth theory mainly discusses how to achieve rapid and sustainable growth. Although a few studies have examined the relationship between income distribution and growth, countries in general have not paid enough attention to inequality. Professor Xie pointed out that, while fast growth in emerging market countries in the past four decades has narrowed the cross-country income gap, within-country income equality has deteriorated rapidly. Some scholars have even questioned whether globalization has gone too far. However, Professor Xie believes that, as transportation and communication costs continue to drop, globalization will continue, but its inclusiveness must be emphasized.

Inclusive growth, first proposed by the Asian Development Bank in 2007, is a growth concept that seeks harmonious social and economic development and sustainable development. As opposed to purely pursuing economic growth, inclusive growth advocates growth with equal opportunities, aiming to share economic growth fairly and reasonably. The key point of inclusiveness is to help disadvantaged groups through platform construction, including platforms for the construction of infrastructure investment and financing, commerce and financing, education and human capital development, and occupational transformation and vocational retraining platforms.

> **"Globalization will continue, but its inclusiveness must be emphasized."**

As indicated in Professor Xie's report, one of the important tools of inclusive growth is social innovation, which refers to innovative regulations, technologies, means or procedures to solve social problems that the government and the market have failed to solve in the past. The main body of social innovation can be government agencies, for-profit enterprises, non-profit organizations, influence investors, or social enterprises. Professor Xie focused on introducing the system of social enterprise and its contribution to inclusive economic growth.

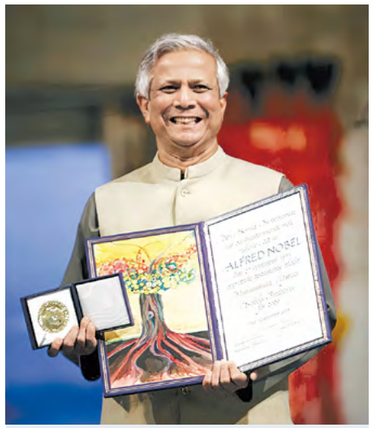
[1] Romer, Paul M., "Increasing Returns and Long-Run Growth," *Journal of Political Economy*, October 1986, 94:5, 1002-37

[2] Lucas, Robert E., Jr., "On the Mechanics of Economic Development," *Journal of Monetary Economics*, July 1988, 22:1, 3-42

[3] Grossman, Gene M., and Elhanan Helpman, "Trade, Knowledge Spillovers and Growth," *European Economic Review*, May 1991b, 35:3, 517-26

[4] Aghion, Philippe, and Peter Howitt, "A Model of Growth Through Creative Destruction," *Econometrica*, March 1992, 60:2, 323-51.

Social enterprises behave like a business with social objectives. They should engage in activities that have positive externalities but are ignored by the market and the government. They focus on “value creation”, and on continuously solving social problems and empowering the public. Their areas of concern are not limited to helping the poor, the disabled and orphans, but also other areas of sustainable development goals such as community development, environment, and energy. Social enterprises can also make technological innovations in the process of empowering others, helping disadvantaged groups and solving practical problems while making sustainable profits.



Muhammad Yunus
Banker, Economist
The Nobel Peace Prize 2006

Professor Xie introduced the standard developing process for social enterprises. At the start-up stage, social enterprises need help from the government and people from all walks of life. After gradually maturing, their sources of income include the sale of goods and services, government purchases, and public welfare sponsorships. The majority of their profits are invested in further related social innovation projects, while the remainder can be appropriately allocated to influence investors. Typical examples of social enterprises are: Grameen Bank (to empower small and micro enterprises), and Xihan’er Car Wash (to empower the mentally disabled).

Yunus, a banker from Bangladesh known as the “banker to the poor”, is dedicated to helping the poor through financial means and has developed and provided them microfinance services. In addition, he works with the International Olympic Committee to help Olympians make career transitions. Yunus’s ideas and successful practices on microfinance, microinsurance, medical insurance have important reference value for countries around the world to achieve inclusive economic growth. For instance, the Fudian-Grameen Poverty Alleviation Loan Project, which helps poor women to build their own small micro enterprise, has become a successful case of China’s “inclusive finance”. Yunus has won nearly 70 honors for his outstanding contributions in the eradication of poverty, including the Nobel Peace Prize, the Olympic Laureate of Excellence, the Bangladesh President’s Award, and the Sydney Peace Prize.

As indicated in Professor Xie’s report, the concept of social enterprise was first proposed by Freer Speckley of the United Kingdom in 1978, who emphasized three important attributes of social enterprise: financial independence, social mission, and responsiveness to government failure. Around the world, 32 countries and regions are cultivating the ecosystem of social enterprises. The experience of the United Kingdom, Finland, the United States, South Korea, and other countries in the social enterprise certification framework is worth learning from.

Moreover, Professor Xie has summarized several successful cases of social enterprises in China. According to the “2019 China Social Enterprise and Social Investment Industry Scanning Report”, there are currently 1,684 social enterprises in China, and their organizations are diversified, with the largest number focusing on education, community development, and employment skills, followed by environmental energy, social enterprise industry support, medical and health, elderly services and industries, poverty alleviation, arts, culture and sports and other fields. Professor Xie also listed the following pilot areas for social enterprises in China:

① The Social Innovation Center of Shunde District, Foshan, launched a social enterprise incubationsupport plan in 2014.

② Shenzhen Futian District launched a social impact investment plan in 2017.

③ In 2018, Beijing Social Enterprise Development Promotion, an organization backed by the Beijing government, issued guidance on obtaining certification of social enterprises.

④ Chengdu has included the development of social enterprises as an assessment criterion of various district government departments. Since 2018, more than 20 related policies have been issued. On October 25, 2021, the “Administrative Measures for the Cultivation and Development of Social Enterprises in Chengdu” was issued and implemented, and remarkable results have been achieved. Based on 2021 data, Chengdu had developed 106 accredited social enterprises of various types, involving elderly care services, employment promotion, barrier-free services, community economy and other social fields, making Chengdu the city with the largest number of accredited social enterprises and the most dynamic development in China.

- The successful practice of the Fudian-Grameen poverty alleviation loan project in China.

-Grameen Bank staff handling microcredit business.

> **Social enterprises should utilize the government's policy call for common prosperity, seize the growth opportunities brought about by the advancement of artificial intelligence and Internet technology, and cooperate with many domestic universities.**

There is no consensus in academic circles on the necessity of social enterprises. Professor Xie believes that even though the central and local governments are fast and powerful in decision-making and execution, the governments do not have to do everything. It should stimulate the power of the people, so that they can actively discover the social problems around them and propose creative and lasting solutions. Therefore, social enterprises have their existence value. At present, social enterprises in China are facing unprecedented opportunities. In the face of growing social demands and an improving social investment ecosystem, social enterprises should utilize the government's policy call for common prosperity, seize the growth opportunities brought about by the advancement of artificial intelligence and Internet technology, and cooperate with many domestic universities to achieve win-win, and make good use of this important development opportunity brought by the "third distribution[1]".

In the process of achieving economic growth, sustainability and equity are two important issues. Professor Xie's report systematically analyzed potential problems and solutions in the process of China's economic growth. It provides inspiring ideas with which China could achieve inclusive growth, improve social innovation, and build a social enterprise ecosystem.

[1]The third distribution, different from primary distribution and redistribution, is mainly distributed by high-income stratum on a voluntary basis, in the form of fundraising, donation and funding. The third distribution is a useful supplement to primary distribution and r edistribution, which is conducive to narrowing the social gap and achieving a more reasonable income distribution.

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[1] Romer, Paul M., "Increasing Returns and Long-Run Growth," *Journal of Political Economy*, October 1986, 94:5, 1002-37

[2] Lucas, Robert E., Jr., "On the Mechanics of Economic Development," *Journal of Monetary Economics*, July 1988, 22:1, 3-42

[3] Grossman, Gene M., and Elhanan Helpman, "Trade, Knowledge Spillovers and Growth," *European Economic Review*, May 1991b, 35:3, 517-26

[4] Aghion, Philippe, and Peter Howitt, "A Model of Growth Through Creative Destruction," *Econometrica*, March 1992, 60:2, 323-51.

Ying Fang: The Credibility Revolution of Empirical Economics

Presenter: Ying Fang
Author of this article: Shuocen Liu

This article summarizes Professor Ying Fan's conference presentation "Econometric training and economic research: the credibility revolution of empirical economics", delivered on December 4, 2021 at a forum organized by the Peking University HSBC Business School.

Although the history of econometrics is not very long, as a branch of economics, it has played a very important role in promoting the development of modern economics. It has allowed researchers to test different theoretical assumptions of economics, making it more in line with the paradigm of modern science. In 1969, the Nobel Prize considered economics to be a discipline that was very close to the natural sciences in the field of social sciences and established the Economics Prize, which was awarded to Frisch and Tinbergen, two econometricians who pioneered the field.

However, the development of econometrics has not been smooth. In the discussion, Fang reviewed the entire history of econometrics, highlighting questions that have been raised in this field, then explained how econometrics use three tools to solve these questions. He also discussed the problem that econometrics is currently facing and how econometrics can help our studies.

History of econometrics: From a dubious tool to mainstream scientific method

In 1983, Edward Leamer published the article *Let's Take the Con Out of Econometrics* in the *American Economic Review*, arguing that there are two major problems with econometrics: no one takes their own data analysis seriously, and no one takes other people's data analysis seriously. However, when Angrist and Pischke wrote *Credibility Revolution in Empirical Economics* in 2010, they found that the situation had been completely reversed: most top journals no longer accept papers without empirical research. The reasons for this, Angrist believes, are inseparable from the emergence of large amounts of data, innovations in computing power, and advances in research design.

Angrist believes that the most important reason for this change is the improvement of the data base. Thirty years ago, the vast majority of researchers lacked data, which prevented them from conducting solid economic research. With the establishment of a large number of micro-databases, and even the advent of the digital economy and the era of e-commerce, many empirical studies became possible. Second, he argues that computing power is also an important driver of the acceptance of econometrics. Most previous models were based on linear models, including the assumption of conditional homoscedasticity, to avoid calculation exceeding the scope of computing power at the time. However, now with the advancement of science and technology, a large number of nonlinear models can be used. Machine learning has also improved the accuracy of calculation, making the model closer to the real world. Furthermore, Angrist sees research design as the key to the development of empirical economics. Econometricians have begun to focus on causal analysis by capturing the factors of random shocks, which has led to very significant advances in the credibility of research.

> In the research process, we should first look for valuable topics, consider how to accurately measure the research object, and then choose an appropriate measurement model.

Three important tools of causal analysis

In his book, *Mostly Harmless Econometrics*, Angrist emphasizes three important tools for causal analysis: instrumental variables, difference-in-difference, and regression discontinuity. Fang illustrated these tools using prominent examples of academic research.

Instrumental variables are mainly used to solve endogeneity problems. For example, when researchers try to estimate the effect of education on future earnings, there is an important omitted variable, "personal ability". To address this, Angrist uses an instrumental variable which is very important in the econometrics literature: quarter of birth. The US education system stipulates that children born in the first half of the year can enroll in the year they turn 7 years old, but children born in the second half of the year will not be able to enroll until September next year. There is a difference in the age of admission between the two sides. In terms of graduation, however, it is automatic graduation after reaching the required age. This leaves a one-year school education gap between the two groups, and makes quarter of birth as a fundamentally exogenous variable that can be used to identify the effect of education on future income.

The second well-known tool is the difference-in-difference model. A typical study case is the effect of minimum wage on employment. The study finds data on fast-food restaurants near the border of two adjacent states. Because fast-food restaurants in one state raises the minimum wage while the other did not, the difference is used to estimate the effect of the minimum wage on employment. By using common time trend hypothesis, the study finally removes the unknown common factor's influence on employment.

An important piece of literature in the regression discontinuity research focuses on the impact of class size on educational outcomes by selecting schools in Israel for this study. The Israeli government stipulates that if a class has more than 40 students, it must be divided. This results in a discontinuity in the number of students in each class, and is completely influenced by exogenous policy. Therefore, it can be used as an identification of causality.

These three important tools have freed econometrics from previous doubts about its credibility, and made econometrics an important basis for economic research today. At the same time, however, academic circles have raised new questions about econometrics.

Edward Leamer

Professor in Economics & Statistics
Director, UCLA Anderson Forecast

Criticism and controversy of modern econometrics

Fang believed that the current problems in econometrics can be divided into two categories: misuse and abuse.

The misuse of econometrics is largely related to the nature of econometrics itself. It has many important assumptions that are difficult to test, and currently there is no procedural way to test it, such as a chemical or physical experiment in the econometrics community. This leaves operational problems for empirical economists, who find many assumptions difficult to test, and sometimes pull tricks with econometrics. For example, some research may be actually wrong despite significant results, because the results overly reject the null hypothesis. In this case, it is easy for empirical economists to keep this result, so that although the measurement method is very advanced, it may just wrap a wrong body with a scientific coat.

Another important issue is the abuse of econometrics. Many researchers like to use complex measurement tools, but they may not understand the tool very well. This abuse is as widespread as misuse in econometrics.

Fang suggested that researchers should not overestimate the role of econometrics in the entire economic research. We should seek truth from facts and regard econometrics as an important aid, rather than conducting econometrics research for the sake of using the econometric tool. In the research process, we should first look for valuable topics, consider how to accurately measure the research object, and then choose an appropriate measurement model.

Wen Hai: Common Prosperity Lies in Teaching People How to Fish and Improving the Ability of the Poor to Become Rich

Written by: Wen Hai
Translated by: Qi Li, Yizou Wu

> In practice, relying on income redistribution brings about many practical problems.

In the early days of reform and opening-up, the most famous sentence was: let some people get rich first. One of the issues that society is most concerned about now is: now that some people have become richer, how to promote common prosperity?

After more than 40 years of reform and opening-up, it is true that many people have become rich, but at the same time, there are indeed many people who have not become rich or are even very poor. According to data released by the National Bureau of Statistics in 2020, the per capita disposable income of Chinese residents was 32,189 yuan. However, according to the China Statistical Yearbook 2021, in 2020, the per capita disposable income of the lowest 20% of residents was only 7,868.8 yuan. That is only 655.7 yuan per month. The per capita disposable income of the next 20% was 16,442.7 yuan; only 1370.23 yuan per month. The population of these two groups was 564 million. As 40% of people's per capita disposable income was around 1,000 yuan per month, obviously we have not achieved common prosperity.

So, how can "common prosperity" be attained? An accustomed and relatively easy way is to improve income distribution, that is, to improve income distribution, which means intervening in the "first distribution" of the market (such as raising the minimum wage of labor), playing the "second distribution" of government functions (such as increasing taxes and transferring payment), and emphasizing social responsibility or moral "third distribution" (such as encouraging social donations) to raise the income or standard of living of that 40% of the population. Of course, in theory, these measures can narrow the gap to a certain extent and help low-income people become richer. However, in practice, relying on income redistribution brings about many practical problems.

Problems of promoting common prosperity through three distributions

First of all, how can we do well in these three allocations? What problems exist in these three allocations? What can the government do? What should be avoided?

For the first distribution, if we adhere to a market economy, then labor income is basically determined by the market, specifically, the product price and labor productivity of the industry in which workers are engaged. The government can limit illegal or illegitimate high income, but it is difficult to increase the income of the poor by intervening in the market. If the minimum wage for labor is continuously raised through administrative law, the result is that the income of those who have jobs will increase. However, companies will reduce the number of employees due to the increase in labor costs, the unemployment rate will increase, and those without jobs will become poorer.

The second distribution refers to the government's adjustment to the income gap through taxation and subsidies. In terms of tax burden, China's personal progressive income tax and corporate tax burden are already very high, and further increases will inevitably affect production and consumption, thereby affecting economic growth. Raphael's Law tells us that if the tax rate is too high, it will affect the enthusiasm of people to create wealth, and the government's tax revenue will decrease. Property tax can certainly be considered, but how can it be introduced? How can opposition from the majority be avoided? This is not only an economic issue, but also a political and social issue, because a large number of urban residents own real estate through housing reform and through the market. Some retirees also own real estate, but they do not have much cash income. Therefore, the collection of real estate tax must consider how to avoid negatively affecting their lives, otherwise it will be difficult to implement.

In fact, the most important improvement in the second distribution is how governments at all levels can help the poor through transfer payments, instead of wasting tax revenue on buildings, blind construction, duplicate construction, or ineffective investment. How can the government help the poor to increase their income through the second distribution? This is another process that needs further consideration and improvement. Should income subsidies be offered directly, or should public goods be increased and more social benefits provided? Should it be a subsidy for income or materials, or more investment in education to help the poor to improve their working ability? The effect of promoting common prosperity varies greatly depending upon the measures taken.

As for the third distribution, encouraging the "rich" to make social donations is indeed a means to help narrow the income gap, and it is also the result of social civilization

and economic development to a certain extent. At present, the total scale of China's annual charitable donations has reached about 340 billion yuan, but there is still a gap compared with developed countries. To realize the "third distribution" by encouraging social donations, we must not only cultivate the character of being helpful and establish a fiscal and taxation system that is conducive to donations, but we must also establish practical measures to prevent the " robbing the rich to give the poor" and "forcing donations". Donation must be a voluntary act, otherwise it will be unsustainable.

To promote common prosperity, we must first find out who the poor are

In addition to improving distribution, what else can be done to promote common prosperity? In fact, the core mission of promoting common prosperity is not only to improve the income level of the poor through various policies, but more importantly, to improve the ability of the poor to "get rich". So, let's take a look first, who are the poor? Why are they poor?

The relatively "poor" people in China are firstly farmers, especially those who are still engaged in agricultural production. Over the past four decades, with China's economic take-off, the industrial structure has undergone rapid changes: on one hand, China has solved the problem of feeding 1.4 billion people, and the agricultural output value has also greatly increased. On the other hand, as the economy develops and income increases, the proportion of people spending on food is declining (Engel's law), and the proportion of agricultural output in gross domestic product (GDP) is also decreasing. This is an irresistible economic law and a common experience of all developed countries in the process of development.

China is also facing the problem of a relative decline in the proportion of agricultural output after the economic take-off. With the rapid economic growth, the proportion of agricultural output value has dropped from about 30% in the 1980s to less than 7% now. However, unlike developed countries, the proportion of Chinese farmers has not dropped accordingly. According to the seventh national census, as of 2020, more than 36% of China's population and labor force live in rural areas, and 509.79 million people are engaged in agricultural production. By rough calculation, nearly 64% of the population is producing and distributing 93% of GDP, while the other 36%, made up of farmers and the rural population, are producing and distributing less than 7% of the output value. The real poor are in the rural areas; the difference between the rich and the poor in China mainly comes from the industrial and social structures; the main reasons for the poverty of farmers are the decline in the proportion of agricultural output value and the relatively low agricultural labor productivity.

The key to promoting common prosperity is to increase non-agricultural employment opportunities for farmers and enhance the ability of the poor to become rich

To promote common prosperity in China, we must start by helping farmers become rich. This is the same effort as "eliminate poverty" in the past. " Eliminate poverty " mainly aimed at the poor in rural areas and helping those farmers out of poverty, we also aim to help all farmers become rich, and industrial structural problems need to be solved.

To help farmers become rich and promote common prosperity, efforts need to be made in the following three aspects:

1. Accelerate urbanization and rural revitalization, develop non-agricultural industries, and promote agricultural modernization

The main reason for the relative poverty of farmers is that the demand for agricultural products is limited, and the consumption growth of agricultural products cannot keep up with the growth of income. However, there are a huge number of farmers in China, and the per capita land is very small. The income obtained from agricultural products cannot keep up with other industries, and the income gap is increasingly widening. In the process of economic development of a country, as the proportion of agricultural output value declines, the proportion of agricultural labor force will also decline. In 2019, the agricultural output value of the United States accounted for less than 1% of GDP, and farmers accounted for 1.5% of the labor force; Japan's agricultural output value accounted for 1.3% of GDP, and farmers accounted for 3.1% of the labor force; South Korea's agricultural output value accounted for 1.6% of GDP, and farmers accounted for 5.1% of the labor force. China's agricultural output value was only 7%, but the labor force engaged in agricultural production accounted for nearly 40%. It can be seen that the labor productivity of Chinese farmers is low, and there are too many farmers engaged in agricultural production.

> "The core of "common prosperity" is "prosperity", not equalizing the rich and the poor, and it cannot rely solely on redistribution."

The main way to increase labor productivity and income of farmers is to gradually induce most farmers to leave agricultural production. To this end, it is necessary to speed up the process of urbanization, and to promote rural revitalization focusing on the development of non-agricultural industries. At the same time, for farmers who continue to engage in agricultural production, it is necessary to help them concentrate land, increase the per capita arable land, provide them with financial services, and develop modern agriculture based on high technology and mechanization. To this end, the government should eliminate various discriminatory policies against migrant workers in cities and towns as soon as possible, and meanwhile provide more and fairer job opportunities and living conditions for migrant workers. The government should also encourage capital to flow to the countryside, develop non-agricultural industries, and support agricultural modernization. When the proportion of farmers engaged in agricultural production is relatively close to the proportion of agricultural output value, the poverty caused by the industrial structure and social structure will gradually disappear.

2. Promote the development of private enterprises and service industries, create more employment opportunities, and absorb the rural labor force

Creating more non-agricultural employment opportunities for the surplus rural labor force mainly depends on private enterprises, including farmer entrepreneurs. Private enterprises are the main force for innovation and entrepreneurship and the creation of many employment opportunities in terms of motivation, pressure, and mechanism. They understand the market better and know how to provide products and services to meet market needs. The contribution of private enterprises to China's social economy is not only in providing more than 50% of tax revenue, more than 60% of GDP, more than 70% of technological innovation, and more than 80% of urban labor employment, but also in

providing more opportunities for employment and prosperity, and taking the historical responsibility of promoting the common prosperity of the society. Moreover, the industrial structure and technical requirements of private enterprises make them more suitable for the labor force transferred from agricultural and rural areas. To this end, the government should pay more attention to the development of private enterprises, formulate corresponding policies, and encourage private entrepreneurs to go to the countryside to innovate and start businesses.

At the same time, the government should encourage the development of the service industry. On one hand, after a country's economic development reaches a certain stage, and material life is satisfied to a certain extent, people's demand for the service industry will increase, and the service industry's proportion in GDP will also increase. This is a basic law of economic development. On the other hand, the service industry is basically a labor-intensive industry, which can absorb a large amount of agricultural surplus labor.

3. Reform the education system, increase investment in education, and improve the working ability of farmers

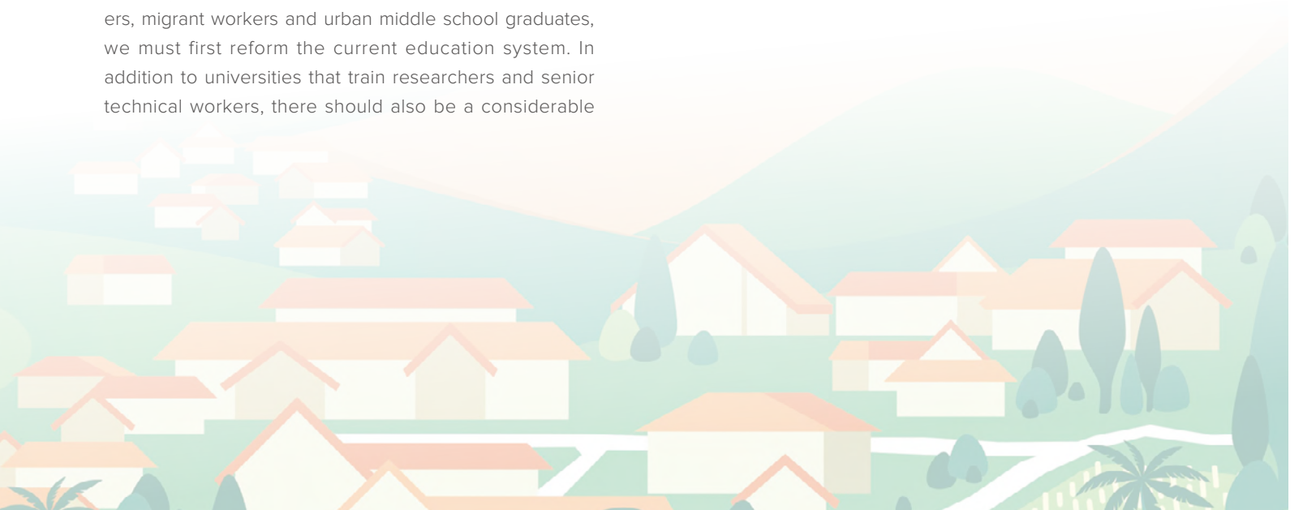
Urbanization, the development of non-agricultural industries, the promotion of agricultural modernization, and the encouragement of the development of private enterprises are all opportunities for farmers to find employment and become rich, but whether they are able to seize these opportunities and be competent for these jobs depends on the farmers' (including migrant workers in cities) basic education and level of vocational education.

Unfortunately, our country's education in this area is still very weak. According to a 2019 survey by the National Bureau of Statistics, about 70% of China's migrant workers' education ends at junior high school or high school, and less than one-third of migrant workers have received vocational training. As for the peasants who stayed in the countryside to farm, their education level was even lower.

To improve the education level and work skills of farmers, migrant workers and urban middle school graduates, we must first reform the current education system. In addition to universities that train researchers and senior technical workers, there should also be a considerable number of vocational education institutions of higher learning aimed at improving the working skills of adults. Such schools should have low entry barriers, no age restrictions, and low tuition fees, similar to "community colleges" in the United States, which award students with junior college or "associate bachelor's degrees" after two years of part-time study. At the same time, some vocational and technical training non-degree-granting institutions should be funded by the government. These would be similar to the "adult schools" in the United States that provide basic knowledge and skills training free of charge to help farmers in cities integrate into society and find jobs as soon as possible.

To this end, the government needs to increase education funding, especially the funding aimed to improve the knowledge and skills of farmers and migrant workers. Vocational and technical training schools should first be set up in cities where migrant workers are concentrated, and the funding should be mainly borne by the governments of these cities. These cities are generally relatively developed, and migrant workers have also made considerable contributions to this development.

In short, the main goal of the road to common prosperity is not to narrow the income gap, but to make the poor richer. The core of "common prosperity" is "prosperity", not equalizing the rich and the poor, and it cannot rely solely on redistribution. The fundamental solution is to promote the development of the private economy, create more employment opportunities through industrialization, urbanization, and agricultural modernization, and to improve the ability of the poor to become rich through the development of various types of education. Only in this way can real common prosperity be guaranteed instead of retreading the old path of egalitarianism.



Wen Hai: Follow the Laws of Economic Development and Correctly Understand Rural Revitalization

Source: Rural Development Foundation
Translated by: Yongqiao Chen, Chuan Hu

Recently, Professor Wen Hai, Founding Dean of Peking University HSBC Business School, former Vice President of Peking University, Dean of the Rural Development Research Institute of Yan'an University and Vice Chairman of the Rural Development Foundation Founder Association, accepted an exclusive interview with Dr. Bo Lu, Secretary General of the Rural Development Foundation. In the interview, Professor Hai emphasized, "There are three main problems to be solved for rural development. The first is the farmers' problem, which is to make farmers rich by increasing their incomes from various sources. Second is the agricultural problem, which is to improve agricultural production efficiency, and to develop high-quality and efficient agriculture. The third is the rural issue, which is to improve the rural environment and build livable and business-friendly villages."

01

Bo Lu: As a famous economist, could you share your view on the relationship between economic growth, urbanization, and rural revitalization from the perspective of development economics?

Wen Hai: After 40 years of reform and development, China's economy has become moderately prosperous and reached the middle income level. However, our agriculture is still a considerable distance away from modernization. The income of farmers is relatively low, and the gap between urban and rural areas is still relatively obvious. Therefore, the central government proposed a rural revitalization strategy. Rural revitalization is also a part of "three rural issues": agriculture, rural areas, and farmers. How can we help agriculture, rural areas, and farmers to develop better? Rural revitalization is the answer.

There is a theory in development economics - the take-off theory. The general idea of this theory is that any socio-economic growth has three major stages. The first stage is the traditional economic stage. Before the Industrial Revolution, the world was in a traditional economic stage. Before the 1990s, China was basically in a traditional economic stage. The traditional economy is based on natural resources and the main industries are agriculture, forestry, animal husbandry, and fishing. During this stage, whether a country's economy is developed or not depends entirely on the amount of its resources, especially natural resources such as land, forest, and water. The second stage is the modern economic stage. The modern economy is featured by industry and services and its characteristic is that it does not rely entirely on natural resources,

> There are three main problems to be solved for rural development. The first is the farmers' problem, which is to make farmers rich by increasing their incomes from various sources. Second is the agricultural problem, which is to improve agricultural production efficiency, and to develop high-quality and efficient agriculture. The third is the rural issue, which is to improve the rural environment and build livable and business-friendly villages.

but mainly relies on science and technology, capital, and the improvement of labor productivity to promote economic development. For example, Japan, Singapore, and the Nordic countries do not have many natural resources, but they can be very developed. Modern agriculture does not require a lot of land, and can use new technologies to produce agricultural products.

From the traditional economy to the modern economy, there is a transformative stage in between: the take-off stage. During this period, in addition to the rapid economic development, the most salient features are the changes of industrial and social structure. The economy transitions from an agriculture-based to a manufacturing-based structure and finally to a service-based structure. The major population of the society changes from rural to urban. This is called the take-off process as theorized by American economist Rostow. Why is economic development compared to a plane's taking off? The plane is either on the ground or in the air. The process from the ground to the air is called take-off, which is a huge transition, just like the transition period from the traditional economy to the modern economy.

A country's economic growth is a process. At present, our country is in the process of taking off but the process has not been completed. China is rapidly transitioning from a traditional economy to a modern economy. In the era of the traditional economy, agriculture, rural areas, and farmers are common problems, but when the economy develops to a certain stage, they will become bottlenecks that constrain further development.

China is still in the process of taking off. Historically, for thousands of years, there have never been such a large number of migrant workers entering the city. This migration began in the 1990s, with about 10 to 20 million migrant workers flocking every year. So far, the speed of migration cities has slowed down, but there are still nearly 300 million migrant workers who need to move from the countryside to the cities to live and work.

In accordance with the three stages of economic development, there are also three stages of human life. The first stage is the pursuit of survival. Food and clothing are the most basic human needs. China has been solving the problem of survival for thousands of years. It was not until the reform and opening up that this problem was basically solved. The second stage is material need. Since the 1990s, the development of durable goods, housing, and automobiles has met the material need of the people. The third stage is the pursuit of quality. Now, the lives of the vast majority of people have entered a new stage of pursuing quality of life.

Since the 1990s, China has entered a stage of take-off. The change of industrial structure and urbanization are two features of this stage. In this process, the main industries and main production factors are also different during different periods of economic growth. In the traditional economic period, agriculture was the mainstay, principally relying on natural resources. The important feature of the take-off stage was industrialization, with manufacturing becoming the main industry and a large number of agricultural laborers being transferred to that industry. From the end of the 1980s to the beginning of this century, a large number of migrant workers entered the cities, becoming textile workers or toy processing workers, especially in the coastal areas of Guangdong and Zhejiang. Up to now, some coastal cities and regions have entered the post-industrial era, and the people are more concerned with their quality of life, and the proportion of agriculture has decreased. At this time, the most important industry is the service industry, but this is not unique to China. No matter which country, it must go through this process from a traditional economy to a modern economy; it is the law of economic development.

What is the impact of this economic growth on agriculture, rural areas, and farmers? China's economy has developed rapidly, with skyscrapers built and people's living standards improved. At the same time, the negative impact on the countryside has also appeared. In my opinion, the economic take-off impacts agriculture, rural areas, and farmers in three ways. Firstly, the proportion of agricultural output value declines. It does not mean that the grain output is low. In fact, our country's grain output is far greater than before. However, the proportion declines because the industrial and service industries grow faster. Secondly, the number of people working in agriculture decreases, so does the number of peasants. Thirdly, the countryside gradually declines, with a large number of peasants moving into cities. As a result, the population of villages becomes smaller and smaller, and young adults gradually leave the countryside.

Is this phenomenon normal or abnormal? In fact, it is normal, and it is the natural result of economic development. First of all, why did the proportion of agriculture decline? It has a lot to do with our income. When people's income is low, most of the money is spent on agricultural products. Back in the 1960s and 1970s, people's monthly salary was about 20 yuan, nearly all of which was spent on food. It was a very large proportion. With the increase of income, the consumption of agricultural products increased, but the ratio decreased. The reason is that people's demand for food is limited. People's income can increase 10 times, but food intake certainly can't increase that much. Some people may say that when you go to restaurants for a meal, consumption is generally high, but this is not accounted as agricultural business, but as service instead. In the early days of reform and opening up, from the people's communes to the household contract responsibility system, rural reforms increased the quantity of agricultural products. After reaching a peak around 1983, the proportion of agricultural products has been on a downward trend. By 2019, agricultural output accounted for less than 7% of GDP.

This is not a phenomenon unique to China. Taking South Korea as an example, when the per capita income is low, the consumption of agricultural products accounts for about 50%. With the increase of income, the proportion of agricultural products consumption also shows a downward trend. So far, the consumption of agricultural products in South Korea accounts for less than 20%. Another example is the United States, where its agriculture is very developed, but its agricultural products only account for about 1% of GDP.

Furthermore, why is the rural population decreasing? The rural population mentioned here includes farmers, as well as people who do not engage in agricultural production but live in rural areas. For example, Japan's current rural population is about 8% of the national population, South Korea's is 18%, and Taiwan's is about 21%. Looking at mainland China, about 40% of the population still lives in rural areas. Compared with developed countries, this proportion is very high, but it should be noted that in the 1960s, more than 80% of our country's population lived in rural areas. Over the years, along with the economic development, the rural population has declined sharply, and this trend will continue. So, where have these rural populations gone? The migration of a large number of farmers from rural areas to urban life is called urbanization. In the 1960s, our country's urbanization rate was less than 20%; now, that rate has exceeded 50%. While considerable progress has been made, the ratio is still low relative to developed countries. For example, Japan's urbanization rate is 80%, and the United States is also above 70%. Let's look at another set of data. The population living in big cities is the highest in Japan, which is about 40%, South Korea is over 30%, the United States is about 10%, but in our country it is only about 5%.

The reason why I spend so much time talking about urbanization is related to my understanding of rural revitalization. How can we revive rural areas? I don't think it's about investing money in the countryside, it's about promoting urbanization and getting most of the rural population to settle down in cities. Why do they live in big cities? This is because of economies of scale. For example, the living conditions of Beijing, Shanghai, Guangzhou, and Shenzhen are actually not as good as some small and medium-sized

In 2007, Professor Wen Hai returned to the farmland in northeast China, where he was sent to work in rural farmland during his youth.

cities, and the cost of living is still high. So, why do people still go there? First, there are more job opportunities in big cities. Second, urban life is also attractive. When the standard of living reaches a certain level, people's pursuits are not limited to income, or the good weather, there will be more pursuits, such as nightlife, as well as various cultural entertainment, education, and medical care. Therefore, the concentration of population in big cities is an inevitable trend of economic development.

Back to the discussion of migration, why are there fewer farmers? The faster the economy grows, the faster the proportion of agriculture declines, and the faster the number of farmers who rely on agricultural income decreases. From 1978 to 2019, the proportion of farmers in Japan decreased from 11% to 3.1%; farmers in South Korea only accounted for 5.1% of the population in 2019; in Taiwan, that number dropped from 25% to 4.4%. In mainland China, farmers accounted for 76.3% in 1978, and by 2019, they still accounted for 42.9%. The proportion of farmers is declining, and there is still a large room for further decline. No developed country has more than 5 percent of the population in farming.

From the comparison of agricultural data between different countries or regions at different stages of development, the United States, similar to China in terms of the relative completeness of industries and the important role in of the agricultural market, is still a major producer of agricultural products, although it has an agricultural output value accounting for less than 1% of GDP. Japan, South Korea, and China's Taiwan region, culturally similar to mainland China, all attach great importance to agriculture. We differ in the following aspects:

Firstly, the proportion of agricultural output in GDP in developed countries or regions is very low. In the United States, Japan, South Korea, and China's Taiwan region, the proportion of agricultural output value and the proportion of farmers' population are basically the same. In mainland China, nearly 40% of the population lives in rural areas,

with farmers taking up 42.9% of the labor force (population over the age of 16 but under the age of 60), but the agricultural output value only accounts for 7.1% of GDP. There are many farmers and agricultural industry practitioners but the production value is low. This is the current situation in our country.

Looking at the income ratio of farmers to non-agricultural labor, the United States is 1.25, meaning that the income of farmers is higher than that of non-agricultural labor. When a US non-farm labor earns $1, a typical farmer earns $1.25. In Taiwan, non-agricultural labor earns 1 yuan when farmers earn 0.81 yuan. There is a considerable gap, but it is relatively small. The gap in mainland China is relatively large. When a non-agricultural labor earns 1 yuan, a farmer only earns 0.38 yuan. This gap is also an important consideration for our country to solve the rural issues.

According to the general law of economics, with the decline of agricultural output value, the rural population and agricultural labor force also decrease. The current situation in our country is that the agricultural output value is declining, in line with economic theory. However, the reduction of the rural population and agricultural labor force is lagging behind, resulting in the low income of farmers and the underdeveloped countryside.

02

Bo Lu: Many regions have implemented policy to promote rural revitalization. However, there are many pitfalls. What pitfalls do you think deserve special attention?

Wen Hai: Personally, I think there are three pitfalls that need our special attention. The first is about raising farmers' incomes. Some people say that we should raise the prices of agricultural products and raise the prices of grain, so as to increase the farmers' enthusiasm for farming and agricultural output, and thus raise farmers' incomes. This is a false perception. The increase in farmers' income is not due to the price and output of agricultural products, but to the declining proportion of demand for agricultural products. As incomes rise, people spend a smaller percentage of income on food. Therefore, the increase in agricultural output value may not be sold entirely, and it is difficult for farmers to raise grain prices and increase output with their income from existing land. The right approach is that most farmers should not be farmers but should engage in non-agricultural industries. We should reduce the number of farmers, increase investment and per capita arable land, improve agricultural labor productivity, and then increase farmers' income.

The second pitfall is to increase investment in rural areas, encourage farmers to return to their villages and change the current situation of leaving only the elderly and children in rural areas, instead of taking the old road of western urbanization development. As a result of the decline in the proportion of agricultural output, the income gap will inevitably lead to the reduction of farmers. The rural-urban divide, the jobs created by economies of scale, and the lure of urban life make it impossible for all farmers to stay or return to the countryside. In my view, we should not induce migrant workers to return to their hometowns, but let the elderly and children move to the cities. Urbanization is an inevitable law of social development and an important part of rural revitalization.

Therefore, when we talk about rural vitalization, we do not mean vitalizing just for the sake of vitalization. The rural areas are lagging behind now. Should we pour money into rural areas to encourage rural residents to return or follow the law of economic development and allow rural residents to live in cities and towns? Like the condition in Chinese fairy tale "King Yu combating the flood", should the flood be "blocked" or "channeled"? To revitalize rural areas, should we solve rural problems in the rural areas, or should we allow the majority of people to move into urban areas through urbanization? I think this is the difference between "blocking" and "channeling" in rural revitalization.

The third pitfall is that we should increase investment in rural infrastructure and improve the rural living environment, so that every village can be built for people to live and work well. This is a good wish and we also hope that every village can be built well. However, the truth is, it is impossible. With the rural population shrinking, China does not need so many villages. Some villages are so close to cities that they are naturally urbanized. There are also places with poor natural conditions and limited food production that are not suitable for human habitation. In these places, the extinction of the countryside is the inevitable trend of the development of human society.

Generally speaking, in developed countries, including Europe, the US, South Korea and Japan, the output value of agriculture accounts for less than 5%, but there are still people willing to live in the countryside, and the rural population accounts for about 20%. At present, 40% of the total population of China is rural, that is to say, nearly half of the rural areas are expected to disappear in the future, which is the trend of economic development. We should not fight this trend. Instead, better manage the villages that naturally survive urbanization.

Let's take a look at a set of statistics. In 2017, there were more than 1,000 so-called "towns with distinct features" in China, some of which had a large investment of money. Because there were no tourists or the tourism industry was not sustainable, by the end of 2018, 419, or nearly half, had been eliminated or rebuilt.

Therefore, we should follow the law of economic development, correctly understand rural revitalization, avoid some development pitfalls, and avoid detours.

03

Bo Lu: At present, rural revitalization and modernization of agriculture and rural areas are national strategies. In your opinion, what are the basic problems that need to be solved to revitalize rural areas? How should we go about it?

Wen Hai: As far as I am concerned, there are three main problems to be solved in rural development. First, the problem of farmers. We need to increase their incomes and make them rich and prosperous. Second, agricultural issues. We must improve agricultural production efficiency, and develop high-quality and efficient agriculture; Third, we need to improve the rural environment and build a livable and working countryside.

The national rural revitalization strategy has a set of principles: "Industry prosperity" refers to agricultural modernization and development of non-agricultural industries; "Ecological, livable, and civilized countryside; effective governance" refers to the improvement of rural environment, including natural, cultural and social; "Living in prosperity" means to increase the income of peasants.

First, how can we raise farmers' income? Let's examine main methods to increase farming income through different development stages. First, before industrialization, the increase of farmers' income mainly depended on the improvement of labor productivity brought by the progress of agricultural technology. Earlier, Chinese agriculture had an "eight-words constitution", namely "soil, fertilizer, water, seed, density, protection, management, tools", soil improvement, fertilization, appropriate water conservancy construction, good seed, rational close planting, disease and pest prevention, effective management, and tool improvement. We increased farmers' income by increasing yields per mu (e.g. develop hybrid rice) or increasing land area.

Second, in the process of industrialization, we should rely on industrialization and urbanization and promote agricultural modernization to raise farmers' income. Rapid industrial development needs a large number of laborers. At this time, many farmers go into the city, become indus-

The Institute of Rural Development of Yan'an University was inaugurated in September 2019.

trial workers, gradually divorce from the farmer identity, and become new immigrants to the city. After most of the peasants have moved to the cities, the remaining peasants increase their incomes by increasing the scale of land management and promoting agricultural modernization. For example, with 100 mu of land and 100 people engaged in production, if the total income is 10,000 yuan, the per capita income will be 100 yuan; If 20 people move to the city and 80 people are left, the per capita income is 125 yuan; If half of the people go to the city, the per capita income of the remaining 50 people is 200 yuan; If 90 people enter the city and 10 people remain, the per capita income will become 1,000 yuan.

Look at the data on the average Farmer's land in each country. The per capita arable land area of American farmers is 600,000 square meters, while the per capita arable land area of Chinese farmers is 5,000 square meters, a difference of 120 times. Even if the per-acre yield in the United States is half that in China, the income of American farmers is 60 times that of Chinese farmers. South Korea's per capita arable land area is more than 10,000 square meters. Japan's land area is small, but because of its small number of farmers, the per capita arable land area is more than 20,000 square meters. Look again at the fixed capital stock per agricultural labor. In 2017, China's fixed capital stock per agricultural labor was 3 percent of that of the United States. In other words, when an American farmer possesses 100 yuan (worth of capital), a Chinese farmers only has 3 yuan. These data show that China's agriculture is still a distance away from modernization.

Third, in the post-industrial era, countries adopt policies to support agriculture and subsidize farmers. It is common practice in developed countries to subsidize agriculture. These subsidies take the form of either production subsidies, based on land area, output, and price protection, or income subsidies, including tax reductions and transfer payments. But China currently is not in a position to offer large subsidies to farmers.

Subsidies follow the principle of the many subsidizing the few. In developed countries, only 5% of the population are farmers, so it is relatively easy for 95 people to subsidize 5 people. Only 1.5% of the population are farmers in the United States. 98 people in the non-agricultural sector give 1 yuan subsidy to farmers, and two people divide it, so their income is considerable. But more than 40% of our population are farmers at present. For example, even if 60 percent of non-farmers give a subsidy of 1 yuan to each farmer and divide it among 40 farmers, the increase in income will be limited. If you want to raise the subsidies to the level of that in developed countries, the non-farm population can't afford it. So, the number of Chinese farmers will have to shrink to a certain point before large subsidies can be implemented.

The main channels for China to increase farmers' income at the present stage are as follows: First, emigrate to cities and towns, especially big cities, and engage in non-agricultural industries, such as the service, manufacturing and construction industry, so as to reduce the number of farmers and increase farmers' income; Second, engage in local non-agricultural industries, such as tourism, cultural innovation, health care, and manufacturing, or engage in agriculture-related industries, such as processing and sales; Third, engage in land-concentrated modern agriculture, namely large-scale, mechanized, and high-tech agriculture.

Why is the service industry important? Not all farmers turn to manufacutring, but some turn to the service industry. As the country develops to a certain extent, the proportion of the service sector in GDP will increase. At present, the value added of the service sector accounts for 61.2% of GDP on average worldwide, but only 53.9% in China. There is still much room for growth.

Second, how can we improve agricultural labor productivity? Labor productivity is measured in terms of output per person. Factors that increase labor productivity include: reducing agricultural workers and increasing per capita land area; centralized land and mechanized production; increasing agricultural capital; improving agricultural science and technology.

Third, how can we improve the rural environment? Eliminate pollution and protect the ecological system; construct transportation, water, electricity, communications, public facilities, and other infrastructure; improve the management of community-level organizations and institutions; develop culture, education, the people, and the legal system; improve business, medical care and other social security.

In summary, to achieve rural revitalization, we must follow economic laws. First, reduce the number of farmers by migrating them to the cities or by engaging them in non-agricultural industries, and then concentrate the land and capital in the countryside to achieve agricultural modernization; Second, we should encourage innovation and entrepreneurship, develop non-agricultural industries, and expand employment channels and increase farmers' incomes. At present, the Rural Development Institute of Yan'an University and Peking University HSBC Business School are training agricultural talents, called training for New Farmers. What are they being training for? There are many young people and new farmers who are in the stage of starting their own businesses. This training will let them broaden their horizons and access more resources. This is an important aspect of rural vitalization. We need to train people to innovate and start businesses and develop non-agricultural industries. Third, we should reduce the number of villages, increase investment, strengthen management, and improve the rural ecological, cultural, and social environment.

To achieve this goal, we need to start from three aspects. First, we need to deepen reform, including land system, household registration system, and capital market reform; Second, we need to cultivate talents by strengthening basic education, innovation and entrepreneurship training, and management training; Third, we need to increase input, such as Government input, and capital input.

To sum up, we need to solve three basic problems in rural vitalization: first, how to increase farmers' income; Second, how to modernize agriculture; Third, how to develop the naturally preserved villages. Without the modernization of agriculture and rural areas, there can be no modernization of the country. Without rural revitalization, there will be no great rejuvenation of the Chinese nation. Both the 5th Plenary Session of the 19th CPC Central Committee and the 14th Five-year Plan have given priority to the development of agriculture and rural areas, and comprehensively promoted rural revitalization. Implementing the rural revitalization strategy is a necessary requirement for overcoming the principal challenge facing Chinese society in the new era and realizing the "Two Centenary Goals" and the Chinese dream of national rejuvenation.

04

Bo Lu: As the first dean of the Institute of Rural Development of Yan'an University, can you share the short-term goals and long-term plans of the Institute.

Wen Hai: In the near future, the main work of the Institute of Rural Development is personnel training, including new farmers, township cadres, selected graduates, rural cadres, and researchers. The Institute of Rural Development recruit students with a master's degree in rural revitalization and development. Interested young people are welcome to join. Scholars interested in rural development are also welcome to join us.

In addition to personnel training, it is necessary to strengthen theoretical and policy research on rural development and explore the path of rural revitalization. For example, what is the specific goal? How can we solve each problem through practical operation? Where are the experiences? In addition, we should conduct some theoretical research concerning China's rural problems. This will involve an understanding and implementation of international economic development. In the future, other major countries in the world can learn some theoretical innovations from China on how to solve rural problems in the process of economic development.

Finally, I would like to encourage more aspiring young people, scholars, and entrepreneurs to pay attention to rural development, agricultural modernization, and the increase of farmers' income. I hope we can work together to help farmers, villages, and agriculture.

Sources of Artificial Intelligence

Thomas J. Sargent June 3, 2022

This essay describes a partially eyewitness account of how artificial intelligence and machine learning were invented. I name names and ideas.

01 Introduction

This essay is about human and artificial intelligence and learning. I take *artificial* to mean 'nonhuman'. Before describing *artificial intelligence* and *machine learning*, I'll state my understanding of what *natural* or *human* intelligence is by describing salient classes of *activities* that a combination of innate and learned skills enable intelligent people to perform: *recognizing patterns* and *making choices*. Other aspects of intelligence are awareness of time and space, and also sympathy and empathy with other people. Successive generations of parents pass on to their children tools and perspectives that their parents taught them, as well as new ideas that they have learned. After describing how Galileo and Darwin combined their innate talents with their text-book knowledge to create scientific breakthroughs, I'll tell how modern researchers have designed computer programs that can recognize patterns and make choices.[1]

While I hope that my description of the machine-learning "forest" is clear, I do mention many "trees", i.e., a variety of concepts and technicalities that might be new to a general reader. For readers curious to learn more about a perplexing "tree", I recommend checking a good online search engine or some of the items in the references at the end of this essay.

02 Human Intelligence

I start with messages from chapter 13 of *The Blank Slate* by cognitive psychologist Steven Pinker. Chapter 13 of Pinker (2003) is titled *Out of Our Depths*. Read it if you are a high school student or college freshman or anyone else who wants to think about the purpose of education. Steven Pinker provides advice about what to study in high school and college and why, advice based on his understanding of our cognitive disabilities as human beings. He begins by describing some things evolution has hard-wired us to do well and some other things that we have to learn to do.

Things that we aren't hard-wired to do well weren't important during most of our 100,000 years of human history and pre-history. But modern life has elevated the importance of some things we just aren't hard-wired for. Pinker identifies four such subjects.

[1] Hayek (2011, Appendix A) discusses other possible interpretations of *natural* and *artificial*.

Physics
Theories of weight, time, space, motion, energy, heat, and light.

Biology
Theories of life, birth, and death.

Statistics
Methods for describing uncertainty and for recognizing and interpreting relative frequencies.

Economics
Descriptions of work, production, distribution, prices, and quantities.

Making wise private and public decisions in modern life requires understanding these four fields. But these are subjects for which our "intuitions" often fail us. For working purposes, just define "intuition" as how we think about situations that evolution constructed us to understand quickly. Maybe "common sense" is a synonym for intuition, things that we think we understand instinctively. Steven Pinker describes how our hard-wired theories in these four fields can lead us astray unless they are improved by education.

Pinker provides fascinating examples from all of these areas. Thus, our common sense and intuition don't help us understand modern physics. The general theory of relativity and quantum mechanics make no sense according to Richard Feynman and other distinguished physicists. Pinker tells how we evolved to make some statistical calculations that helped us when we were hunters and gatherers. These involved probabilities of events that occurred frequently relative to the incidence of important risks that we have to evaluate today. We are not naturally well-equipped to deal with probabilities of events that occur very infrequently. That has been costly in terms of public policy decisions that involve balancing costs and benefits from accepting low probability risks. Pinker describes how evolution gave our ancestors a set of economic theories about production and exchange that do not equip us to understand the division of labor, distribution, markets, middlemen, intermediaries, stabilizing speculation, and profits. Actually, we innately *misunderstand* these things, with too often tragic consequences that have occurred during recurrent expropriations and pogroms against middlemen and traders, speculators and liquidity providers, people who were often members of ethnic minorities.

These cognitive deficiencies set the stage for Pinker's chapter 13 recommendations for redesigning curricula.

Pinker describes education as a technology for compensating for our innate cognitive limits and for capitalizing on our innate abilities to learn. He calls for significant changes in academic curricula to align them better with what will help us enjoy life and make good decisions today: biology, statistics, and economics. He acknowledges that teaching more of these subjects means teaching less of others.

2.1 AI and Our Innate Cognitive Limits

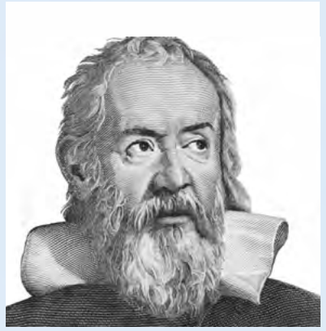
Another lesson that we can learn from chapter 13 is how we want "artificial intelligence" to supplement and surpass our innate natural human intelligence.

A paradox lurks here because the principal technical tools that have been and are being used to create artificial intelligence and machine learning are drawn from physics, biology, statistics, and economics, the same areas in which we are innately limited. Thus, the very fields that we are not naturally equipped to be good at are being used to create artificial intelligence and machine learning. Early pioneers and practitioners of machine learning and AI compensated for their natural cognitive deficiencies by thoroughly learning and then imaginatively using the best analytical techniques available to them.

03 Two Pioneers of Machine Learning

3.1 Galileo

Because he believed that the earth revolved around the sun, the great early 17th century Italian mathematician, scientist, physicist, astronomer Galileo Galilei (1564-1642) was eventually arrested by the Inquisition. Many years before he was arrested, Galileo did something that I regard as illustrating the essence of the "machine learning" approach. Galileo (1) designed and conducted experiments to collect data; (2) stared at his data and tried to spot patterns; (3) reduced the dimension of the data by fitting a *function*; and (4) interpreted that function as a general law of nature. Galileo's strategy offers a beautiful example, maybe the first, for what machine learning and artificial intelligence are all about.



Galileo Galilei
Italian physicist, mathematician, astronomer and scientist

I am of course writing about Galileo's "inclined plane" experiments and the data processing and data reduction that he performed on his data. Galileo wanted to discover the natural laws that govern the dynamics of falling bodies. Perhaps you are thinking: "That's easy, just apply Newton's laws of gravity." But not so fast: Newton wasn't born yet. The most widely accepted prevailing theory was the one that Aristotle had pronounced 2000 years before: heavier bodies fall faster than lighter ones.

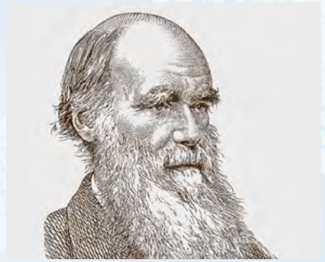
Galileo wanted to study Aristotle's theory empirically. Why not just drop balls of different weights and measure how fast they fall? Galileo couldn't do that because balls of *all* weights fell much faster than existing clocks could accurately measure. Therefore, Galileo decided to construct smooth inclined planes of different angles, and to adjust the angle so that falling balls slowed down enough so that he could measure their rates of travel along the plane with the clocks he had. For a plane of length l and height h, the ratio $\frac{h}{\ell}$ determines the angle of the plane. Galileo dropped a ball and carefully measured the distance d along the plane that the ball traveled as a function of the time t elapsed after the ball had been dropped. He made a table with two columns in which he recorded t_i and d_i, $i = 1,...,n$ for his n measurement times for each experiment. For a given experiment, he then plotted d_i against t_i. He conducted experiments for a variety of balls of different weights with different settings of l and h (i.e., different angles for the inclined plane). He then stared at his graphs. He noticed a striking thing: for *all* of the graphs, $d \propto t^2$ - the distance traveled was proportional to the square of the elapsed time, independently of weight of the ball and independently of the angle of the plane. He inferred a formula

$$d = \tilde{g} \cdot \frac{h}{\ell} t^2 .$$

Notice that, remarkably, the weight of the ball is *not* in the function on the right side. So the rate at which a ball falls is apparently *independent* of its weight. Thus, by fitting a *function* to data from his experiments, Galileo simultaneously accomplished data dimension reduction and generalization. He discovered a law of nature that was an important input into Isaac Newton's thinking 50 years later.

Galileo's inclined plane experiments have all of the elements of modern machine learning and artificial intelligence. He started out not knowing how the world works and not having a good theory. What he did was entirely *atheortical*. So he conducted a set of experiments and collected tables of numbers, one table for each experiment, indexed by the weight of a ball as well as by the length l and height h of his inclined plane. From his tables of many numbers he deduced (i.e., "fit") a function that turns out to be determined by only one new number, the "parameter" $\tilde{g}$. [2]

I don't fully understand what inspired Galileo to design his experiments, collect those measurements, and reduce the dimensionality of his measurements by fitting a function. I do know the tools that Galileo possessed and the tools that *could* have helped him but that he didn't possess. In particular, he didn't know differential and integral calculus – only decades later would those tools be invented by Fermat and Newton and Leibniz. But Galileo did know geometry and algebra very well. He was thoroughly conversant with Euclid and Archimedes. Without those tools, pure inspiration and his skepticism about Aristotle's theory would not have been enough.[3]



Charles Robert Darwin
British naturalist, biologist, founder of the theory of evolution

3.2 Charles Darwin

This next story is about the role that an economic theory played in helping Charles Darwin (1809-1882) complete his theory of "evolution of species by natural selection". The following 1899 statement by Simon N. Patton cited by Hayek (2011, Appendix B) summarizes my message: "... just as Adam Smith was the last of the moralists and the first of the economists, so Darwin was the last of the economists and the first of the biologists."

Darwin used raw empiricism and dimension reduction to construct his theory. He didn't know what a gene was. He didn't know what DNA was. What he did "know" was a huge data set, collected from his breeding pigeons and observing animals and plants in nature. From his pigeon data alone he could deduce two of his three fundamental principles.

1. Natural variation
2. Statistical inheritance of new variations.

As a pigeon breeder, Darwin used these two principles to select desirable traits and then rely on statistical inheritance to produce new varieties of pigeons. Baby pigeons acquire some characteristics from their parents. "Selection by Charles Darwin," not *natural selection* guided his breeding or pigeons. For a long time Darwin lacked a source for selection in nature. Then he read a book by Thomas Malthus (2007) entitled *An Essay on the Principle of Population as It Affects the Future Improvement of Society.* Malthus wrote about a struggle that was set off by the propensity of people to reproduce at faster rates than food sources. This situation created a struggle for existence that aligned surviving populations with available food. This part of Malthus's argument presented Darwin with the missing piece: natural selection that emerges from a struggle for existence. More babies were born than food sources could feed. The introduction to Darwin (1859) credited Malthus with the third pillar of his theory.

3.Selection via Competition – the struggle for existence.

Some distinguished game theorists and economists now routinely use evolution as a source of economic and social dynamics. Maybe some of them think that they got this idea from Darwin. But Darwin actually got an essential piece of his theory from economists. Thus, Hayek (2011, Appendix A) notes that Darwin's study of Adam Smith in 1838 provided him with a key component of his theory of biological evolution natural selection. Hayek (2011) also documents that theories of cultural evolution were widely accepted by economists and sociologists long before 1800.

Darwin's research strategy stands as a wonderful example of reducing a huge data set to extract a low-dimensional model based on three principles that can be applied generally. Data collection, data reduction via three principles, and then generalization: what an extraordinary package!

Like Galileo, Darwin did not start from a blank slate. He was well read not just in biology and geology but also in economics. His deep understanding of existing work in these fields empowered him to step beyond what had been known and understood. He was a "macro" person in the sense that he had no "micro-foundations" for the first two pillars of his theory – variation and inheritance of some of new traits. He was vague about how much time would be required for his three pillars to produce the paleontological and biological evidence at hand.[4]

[2] Fast forward to today and watch how scientists use machine learning and AI. You'll see smart people collecting masses of data and fitting functions. For some wonderful examples, please see de Silva et al. (2020) and Brunton and Kutz (2022).

[3] To find his three laws of planetary motion that were buried in Tycho Brahe's (1546-1601) tables of time-stamped measurements of the positions of the known planets, Johannes Kepler (1571-1630) used a method similar to Galileo's. Li et al. (2021) follow in Kepler's footsteps by using machine learning techniques to extract one of Kepler's laws from Brahe's data. See Weinberg (2015) for spell-binding accounts of the scientific methods of Kepler and Galileo.

[4] Darwin's work was not immediately accepted by leading scientists. For example, on the basis of the then prevailing estimates of the age of the earth, Lord Kelvin would soon say that the earth was simply much too young for Darwin's theory to work.

04 Artificial Intelligence

So far we have been talking about human intelligence and inspiration. Let's now turn to artificial intelligence or machine learning. What is it?

By artificial intelligence I mean computer programs that are designed to perform some of the "intelligent" things that some humans do. Big parts of "machine learning" deploy calculus and statistics to accomplish pattern recognition. Designers of the computer chips and programs that do machine learning and AI copy Galileo's approach to measuring speeds of falling bodies with his inclined plane experiments. Thus, think of a *function* as a collection of "if-then" statements. Think of the "if" part being the abscissa x in a function $y=f(x)$ and think of the "then" part the y ordinate. Using a computer to recognize patterns involves (1) partitioning data into x and y parts, (2) guessing a functional form for f, and then (3) using statistics to infer f from data on x and y. The discipline called "statistics" provides tools for inferring or "fitting" the function f.

Here's a simple example. Suppose that at a given location on the earth, each day of the year you record the length of "daytime" from sunrise to sunset. Record the day of the year as an integer running from 1 to 365 on the x axis. Record time from sunrise to sunset on the y axis. Make a table with x and y as the two columns. This table has 365 times 2 equals 730 numbers. Now plot them and stare. Guess that a *function* $y=cos(\alpha+\beta x)$ might summarize the data well. Use calculus to find values of the two parameters α, β that make the function fit well in the sense that they minimize $\sum_{i=1}^{365}(y_i-cos(\alpha+\beta_i))^2$. You'll find that this function fits well (though not perfectly). By summarizing the data (also known as performing "data compression" or "data reduction") in this way, we have "generalized" by discovering a rule of thumb (a function) that we can use to predict lengths of days for days i ą 365 outside of our sample.

05 Tools for AI

Machine learning and artificial intelligence import their essential methods from the following fields:[5]

1. Physics 2. Biology
3. Statistics 4. Economics

Let's take these up one by one.

5.1 Physics

Eighteenth and nineteenth century work by Euler, Lagrange, and Hamilton extended and perfected ways to use calculus to optimize integrals of functions of quantities over time. That set in place essesntial building blocks for a twentieth first-century Hamiltonian Monte Carlo simulation technique that is now powering sophisticated Bayesian estimation and machine learning techniques. Nineteenth century work by Clausius, Boltzmann, and Gibbs created concepts for describing thermodynamics statistically. They defined a second law of thermodynamcs in terms of entropy, an expected value of a likelihood ratio, i.e., the ratio of one probability distribution to another. One of those probability distributions was a flat uniform distribution that statistically represented complete disorder, the other a distribution that represented "order" in a precise statistical way. In the late twentieth century and early twenty first, entropy provided a way for many machine learning algorithms to measure discrepancies between a fitted model's probability distribution and an empirical distribution traced out by data. In ways that would pave the way to producing further tools for artificial intelligence and machine learning, Paul Samuelson (1947) and his colleagues imported these and other techniques from mathematical physics into economics.

5.2 Mathematical Biology

Biology is about patterns of reproduction and variation of species across time and space. Patterns can be detected at "macro" and "micro" levels, depending on the unit of analysis – either an individual person or animal, or smaller units like DNA, RNA, or the molecules composing them. Mathematical theories of biology (e.g., Feldman (2014) and Felsenstein (1989)) formalize these things by constructing dynamic systems in the form of stochastic difference or differential equations. At the micro-level, key ideas involve encoding DNA as a binary string upon which an analyst can perform mathematical operations of *mutation* and *sexual reproduction* via cutting and recombining. For example, see Holland (1987).

5.3 Statistics

Modern mathematical statistics deploys two possible meanings of "probability":[6]

- A *frequentist* interpretation that a probability is a relative frequency to be anticipated after observing a very long sample of independently and identically distributed random variables.
- A *Bayesian* interpretation that a probability is a subjective expression of uncertainty about an unknown hidden "state" or "parameter".

Modern statistics deploys an arsenal of tools for (1) specifying sets of functions that are characterized by vectors of parameters, or sometimes by a hierarchy of vectors of parameters; (2) inferring or "estimating" those parameters from observations; (3) characterizing the uncertainty that a reasonable person should ascribe to those inferences; and (4) using probabilistic versions of those fitted functions to generalize by projecting "out of sample". These bread and butter techniques of machine learning in turn rest on differential and integral *calculus*, tools unknown to Galileo, as we have noted earlier.

5.4 Economics

Economics is about how collections of individuals choose purposefully to utilize and to allocate sets of scarce resources. Modern economic theory is multi-person decision theory within coherent environments. The abstract artificial people inside a coherent economic model are "rational" in the sense that all of them solve constrained optimization problems that take into the account their common correct understandings of their environment.[7] Two leading classes of such multi-person decision theories are[8]

- Game theory
- General equilibrium theory

Components and forces in these theories include

- Constraints
- Uncertainties
- Decentralizations and parallel optimizations
- Ledgers for exchange networks
- Prices
- Competition

In these models, one agent's decision rules form part of the constraint set of other agents' choice problems. Such constraints arise via a model's "equilibrium conditions". A solution of an agent's constrained optimization problem produces a personal *value* that contains useful information for allocating resources.

These economic models describe "parallel processing" and decentralized decision making. An arrangement called an equilibrium serves to reconcile diverse selfish decisions with each other and with limits on physical resources. Within both of these dominant frameworks, precise notions of an *equilibrium* prevail. Defining an equilibrium is one thing. Computing one is another. Thus, prominent economic theorists for years have wrestled with curses of dimensionality as they sought fail-safe methods to *compute* a competitive equilibrium allocation and price system. Landmark contributions to that enterprise were Arrow and Hurwicz (1958), Arrow et al. (1959), Arrow (1971), and Nikaido and Uzawa (1960) as well as Scarf (1967), Scarf et al. (2008). These algorithms deploy accounting schemes that keep track of individual and social *values* and *gaps* between quantities of goods and activities that people want and quantities that the social arrangement provides.

Work on computing an equilibrium eventually discovered an intimate connection between *computing* an equilibrium and *convergence* to an equilibrium by a collection of boundedly rational agents. Bray and Kreps (1987) and Marcet and Sargent (1989) present important distinctions between "learning *within* an equilibrium" and "learning *about* an equilibrium". Marcet and Sargent (1989) and Sargent et al. (1993) study convergence to a rational expectations equilibrium by using the mathematics of stochastic approximation (e.g., see Gladyshev (1965)). So far as I know, initial work on stochastic approximation began with the quest of Hotelling (1941) and Friedman and Savage (1947) to construct a statistical sampling method to find the maximum of an unknown function that could nevertheless be accurately evaluated at a given abscissa.[9]

Related work by Shubik (2004) and Bak et al. (1999) formulated *games* that could be used to think about equilibriating processes facilitated by the presence of *price setters*. (Inside a general equilibrium model, there are only price-*takers*, no price-*setters*.) Shubik's work exploited his expertise about a topic with important lessons for machine learning and AI, a topic that lives in the interstices between the general equilibrium theory and game theory:

- Monetary theory

In the spirit of Shubik (2004), a good way to think about monetary theory is to notice that its aim is to provide a theory about how an equilibrium price vector could be set by the agents who actually live inside a general equilibrium model. The classic general equilibrium model of Arrow and Debreu tells properties of an equilibrium price vector, but is silent about *who* sets that price vector and how. Instead, *deus ex machina* outside the model mysteriously announces a price vector that simultaneously clears all markets. An equilibrium price vector assures that every agent's budget constraint is satisfied. In a general equilibrium model, trade is multilateral and budget constraints are reconciled in a single centralized account. Monetary theory is instead about a decentralized system populated by people who meet only occasionally in a sequence of bilateral meetings and exchange

[4] Thus, it was not a coincidence that an important inventor of modern computing and AI, John von Neumann, studied and substantially contributed to all four of these fields. See Bhattacharya (2022) for a wonderful account of von Neumann's work and life.

[5] This site explores these two possible senses of probability with the assistance of some Python code: https://python.quantecon.org/prob_meaning.html.

[7] When economists speak of "rational expectations" they are referring to an assumed "common correct understanding of an environment". The phrase "rational expectations" modifies "model", not "people".

[8] See Kreps (1997) for an account of common features and shortcomings of these two classes of models, as well as some thoughtful opinions and conjectures about new directions that seem to me to have forecasted subsequent incursions of AI into economics.

[9] The work of Hotelling and Friedman and Savage ultimately led to the "Bayesian optimization" machine learning technique. For example, see Snoek et al. (2012).

goods and services by using “media of exchange”. Media of exchange can be durable metals (gold or silver), tokens (pennies or paper “dollars” or “pounds”), circulating evidences of indebtedness, or entries in a ledger of a bank or clearing house or central bank. Ostroy and Starr (1974), Ostroy and Starr (1990), and most recently Townsend (2020) describe work in this tradition that leads directly to a theory for crypto currencies.

I offer a few more words about how studying games has contributed to machine learning. For decades, applied economists have constructed algorithms to compute an equilibrium of a game. Key tools that underlie these calculations include backward induction (dynamic programming) and tree search. Because the dimension of possible states to be investigated grows exponentially, reducing the number of situations to be investigated is essential to making headway on approximating equilibria. Here the minimax algorithm and the alpha-beta pruning tree search algorithm are mainstays. See Knuth and Moore (1975) and https://www.youtube.com/watch?v=STjW3eH0Cik for descriptions of alpha-beta tree search and watch for an accounting system and a “survival of the fittest” idea. A related line of research studied whether a collection of players who naively optimize against histograms of their opponents past actions converges to a Nash equilibrium. For examples, see Monderer and Shapley (1996), Hofbauer and Sandholm (2002), Foster and Young (1998), Fudenberg et al. (1998). When convergence prevails, such “fictitous play” algorithms provide a way to compute an equilibrium (see Lambert Iii et al. (2005)).

John Henry Holland

American scientist, pioneer of complex theory and nonlinear science, father of genetic algorithm

5.5 John Holland’s Circa 1985 Vision for AI

The renowned computer scientist John Holland [10] was a pioneer. He combined ideas from all of the technical fields we have mentioned to construct computer models of decision makers living in environments in which they have no choice but to “learn by doing” in the sense of Arrow (1971). See Holland (1987, 1992) for descriptions of Holland’s approach and Marimon et al. (1990) for an application to a multi-person economic environment. A substantial piece of Holland’s approach was a global search algorithm that he called a “genetic algorithm”. It searched “rugged landscapes” by representing arguments of functions by strings that could be randomly matched into pairs of strings, cut, and recombined. This was Holland’s mechanical way of representing “sexual reproduction”. Such a “genetic algorithm” comprised part of what he called a “classifier” system. Holland’s classifier system consists of (1) a sequence of if-then statements, some of which must compete with each other for the right to decide on-line (i.e., in real time); (2) a way to encode if-then statements as binary strings that can be subjected to random mutation, cutting, and recombining; (3) an accounting system that assigns rewards and costs to individual if-then statements; (4) procedures for destroying and creating new if-then statements that includes random mutations and sexual reproduction based on DNA cutting and recombining; and (5) a competitive struggle that promotes survival of fit decision rules. Systems of Holland classifiers have been shown to learn how to be patient in dynamic settings, a subtle outcome summarized by Ramon Marimon’s phrase “patience requires experience” in a world of Holland’s artificially intelligent agents. Holland classifiers succeeded in computing a “stable” Nash equilibrium for a dynamic economic model that the model’s authors had not recognized a *priori*, although they could verify the “guess” that the Holland classifier handed to them. See Marimon et al. (1990).

[10] Please see https://en.wikipedia.org/wiki/John_Henry_Holland, https://www.nytimes.com/2015/08/20/ science/john-henry-holland-computerized-evolution-dies-at-86.html.

5.6 AI today

In a remarkable achievement, DeepMind’s computer program called AlphaGo succeeded in mastering the game of Go so well that defeated champion human players of Go. See Wang et al. (2016). The approach that the creators of AlphaGo deployed reminds me of cooking delicious food – add a touch of this to a handful of that, taste, and add something else …. Among the ingredients combined to cook up AlphaGo were ideas gathered from dynamic programming; Thompson sampling (see Thompson (1933)) and stochastic approximation (see Hotelling (1941) and Friedman and Savage (1947)); alpha-beta tree search (see Knuth and Moore (1975)); Q-learning (see Watkins and Dayan (1992)); and Monte Carlo tree search (see Browne et al. (2012)). A rule of thumb choice for tuning a parameter that trades off “exploration” for “exploitation” is important (as it also is in Fudenberg and Kreps (1993) and Fudenberg and Kreps (1995).)

Other recent advances in machine learning also import heavily from economics and statistics. Thus, computational optimal transport (e.g., Peyr´e et al. (2019)) uses a linear program of Dantzig, Kantorovich, and Koopmans to measure discrepancies between a theoretical probability and an empirical measure. It then uses that measure to construct a computationally efficient way to match data to a theory. An economist Hotelling (1930) used Riemannian geometry to represent parameterized families of statistical models. That idea inaugurated computational information geometry, an approach systematized by Amari (2016).

06 Sources of Creativity: Imitation and Innovation

I described how Galileo and Darwin discovered new laws of nature by somehow combining mastery of findings and methods of their predecessors with unprecedented flashes of insight. Respect for precedent, and their ability to venture beyond, characterized the work of both geniuses. Many subsequent geniuses used the same general approach. A source of other examples is electricity and magnetism and the sequence of discoveries by Franklin, Davy, Faraday, Maxwell, Michaelson and Morley, and then Einstein. Each of them began not from a *Blank Slate* (not coincidentally the title of Pinker (2003)) but from their deep understanding and respect for their predecessors. Each saw something that their predecessors hadn’t, often because they deployed improved ways of observing or reasoning. Thus, by unleashing mathematics that Faraday did not know, Maxwell organized a breathtaking unification, generalization, and reduction of the laws governing electro-magnetic dynamics into twelve equations that Heaviside would soon reduce to four equations. Those four equations set the stage for Einstein’s special theory of relativity. [11]

Seemingly unrelated, purely theoretical work in mathematics preceded and then coincided with those discoveries about electro-magnetism. Descartes invented a coordinate system that enabled him to convert geometry into algebra and to write down *functions*. Fifty years later Newton and Leibniz used Cartesian coordinates to invent differential and integral calculus. In the first half of the nineteenth century, Gauss and his student Riemann refined geometries for curved spaces and parallel lines that meet. Ricci added a sharp notion of curvature.

Einstein brought together these two independently motivated and seemingly “unrelated” lines of work, the first about practical physical phenomena, the second about some purely abstract mathematics. Struggling to extend his special theory of relativity, Einstein learned how to use Riemannian geometry and Ricci curvature in order to construct a coherent general theory of relativity. [12]

Scientific advances illustrate an interaction between “imitation” and “innovation” that is featured in modern theories of economic growth (for example, see Benhabib et al. (2014) and Benhabib et al. (2020)). For those pioneers in electro-magnetism, relativity, and mathematics, the “imitation” phase was copying the techniques of their predecessors and teachers; the “innovation” phase was somehow stepping beyond because they had learned and understood more than their teachers.

07 Concluding Remark

My survey of ideas from physics, biology, statistics, and economics confirms my claim that the subjects in which Pinker (2003) tells us we are all innately cognitively challenged are the ones that are being deployed to create artificial intelligence and machine learning. This is just one more reason to study these subjects in school and after school too. I think that their intrinsic beauty is another.

[11] A photo of Maxwell hung on Einstein’s office wall.

[12] See Farmelo (2019, ch. 3) for an account of these events.

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40 Years of Growth and Macroeconomic Regulation in China: The Making of Judgment

Presenter: Yongding Yu
Author of this article: Chuan Hu, Qi Li

On June 11, 2022, the second PHBS-CUHKSZ Economic and Financial Workshop was successfully held at Peking University HSBC Business School. Professor Yongding Yu, member of the Chinese Academy of Social Sciences, PhD in economics from the University of Oxford, research fellow and doctoral advisor from the Chinese Academy of Social Sciences Institute of World Economics and Politics Research Institute, president of the China International Economic Association, and member of the United Nations Development Policy Committee, was invited to review China's growth and macroeconomic policy since the 1980s. By reviewing the history and reflecting on the policy making of China's macro-control in the past 40 years, Yu concluded that China's economy has made a great leap in the past 40 years and that macro-economic policies have been very successful. This article is compiled from Professor Yu's presentation at the Workshop.

> Another important point for the studies of the Chinese economy is to get into details of the subject.

Let's start with the economic policies in the 1980s. At the beginning of reform and opening up, China was in the early stage of take-off, when the main constraints on development were lack of capital and foreign exchange. At that time, China focused on importing foreign advanced technology and expanding international trade, which further aggravated China's foreign exchange shortage: in 1980, China's foreign exchange reserves were -1.3 billion USD. Consequently, Chinese economists held a series of discussions on how to solve the problem of the foreign exchange shortage. I advocated import substitution, influenced by orthodox Marxism and the left-wing economic school. Concurrently, another view held that China should learn from Southeast Asian countries and adopt export-oriented policies. In the 1980s, the Chinese scholar Jian Wang posited a theory of "big in, big out". However, I did not agree, believing that there was a contradiction with the theory I learned, and that the economy would rely too much on western countries. History has proved Wang's theory apt and timely. Finally, during this period, the rise of OEM brought opportunities for China to take advantage of rich labor resources and promote foreign trade under the condition that the foreign exchange was in shortage. At the same time, following suggestions of American economists, China avoided the negative experience of Latin American countries, by refraining from accumulating foreign debts. Instead, China embraced a large amount of FDI. Both processing trade and FDI brought foreign exchange, which generated a double surplus of capital account and trade. Finally, China's foreign exchange reserves increased rapidly, allowing her to smoothly enter the take-off stage.

Next, I will talk about the evolution of China's macro-economy and the disputes during this process. In the 1980s, China does not have a standardized macro-economic policy framework, and the following issues were discussed. First, the reform of the economic system. There were three famous Chinese economists at that time: the "Wu Market" (Jinglian Wu, advocated legal market economy), "Li Shares", and "Yang Contracting" (Yining Li and Peixin Yang advocated creating shares and contracting in the reform of state-owned enterprises). Turning to the reform of the market price system, Weiying Zhang and some other scholars raised issues such as the dual track system. Then, we established the "foreign exchange earning economy ", the international cycle based on the "big in, big out" theory advocated by Jian Wang mentioned before. Finally, attention fixed on the macro problem of controlling inflation. At that time, people believed that excessive currency issuance was like a tiger in a cage. Sooner or later, it would result in inflation. However, obviously the excessive currency did not translate into inflation. On the contrary, it translated into output. So I sometimes believe that money can be used as one of the independent variables in the new classical aggregate production function. Next, from 1990 to 1997, the main focus of macro policy was to suppress inflation; from 1997 to 2002, deflation was the problem; from 2003 to 2008, while maintaining high growth, China curbed asset bubble and controlled inflation; from 2008 to 2010, China experienced a V-shaped rebound; and since 2010, China's economy has been declining.

In the early 1990's, China carried out expansionary fiscal and monetary policies. By 1993, the inflation rate had reached 13.4%, and peaked at 25% in 1994. At that time, economists discussed whether to implement the inflation-indexed deposit policy learned from Latin American countries, but were afraid of forming high inflation expectations. However, time showed that the policy was still effective. In the second half of 1993, China began a series of deflationary policies. The tightening policy lasted until 1997, and Chinese economists had a new debate and raised the following questions: Had inflation been suppressed in 1997? Should macro policies be shifted? Finally, the government, worried about the overheating of the stock market, cut interest rates and implemented a loose monetary policy as late as October of 1997. This resulted in China withdrawing from the tightening policy too late, leaving the economy overcooling. From this, the country learned that overheating was easier to solve through macroeconomic policies, while overcooling remained difficult to tackle.

Let's move to the years between 1998 and 2002, following the Asian financial crisis. China's CPI had negative growth in April 1998, with an annual growth rate of -0.8%, and the GDP growth rate in 1999 was only 7.1%. At that time, against the background of global currency depreciation, domestic economists debated whether the RMB should be depreciated. If the RMB did not depreciate, they questioned whether China's economy would decline, and, at the same time, whether China should implement an expansionary fiscal policy. At that time, China had much non-performing loans, and the government's financial situation was poor, so if the fiscal policy of expansion was carried out, there was concern as to whether it further aggravate the fiscal deficit. Finally, economists gave the answer: if GDP growth could be maintained, the ratio of national debt balance to GDP could be stabilized at about 30%. Consequently, China implemented an expansionary fiscal policy, which has proved to be a correct decision.

The period from 2003 to 2008 was the best period during China's development, inflation was low and growth was high, with policy mainly concerned with balancing growth and inflation. In 2002, economists discussed whether the exchange rate should continue to be pegged to the US dollar. Previously, the policies of a dollar peg and capital control had successfully reduced capital flight. In the long run, China's twin surplus of capital account and current account made the appreciation of RMB almost inevitable. However, in the end, the RMB did not appreciate. The foreign exchange reserves increased sharply, hot money flowed in, and there was quite a lot of asset bubble in the market. Inflation worsened again in 2007 and 2008. However, after the start of the economic crisis in 2008, inflation suddenly disappeared, which changed our perception and understanding of inflation: Friedman's theory had previously proposed that inflation was only a monetary phenomenon, but the developments in 2008 proved Sargent's theory that inflation depends on the gap between supply and demand, and if the gap disappears, inflation will disappear.

From 2008 to 2010, in response to the economic crisis, China launched a RMB 4 trillion large-scale economic

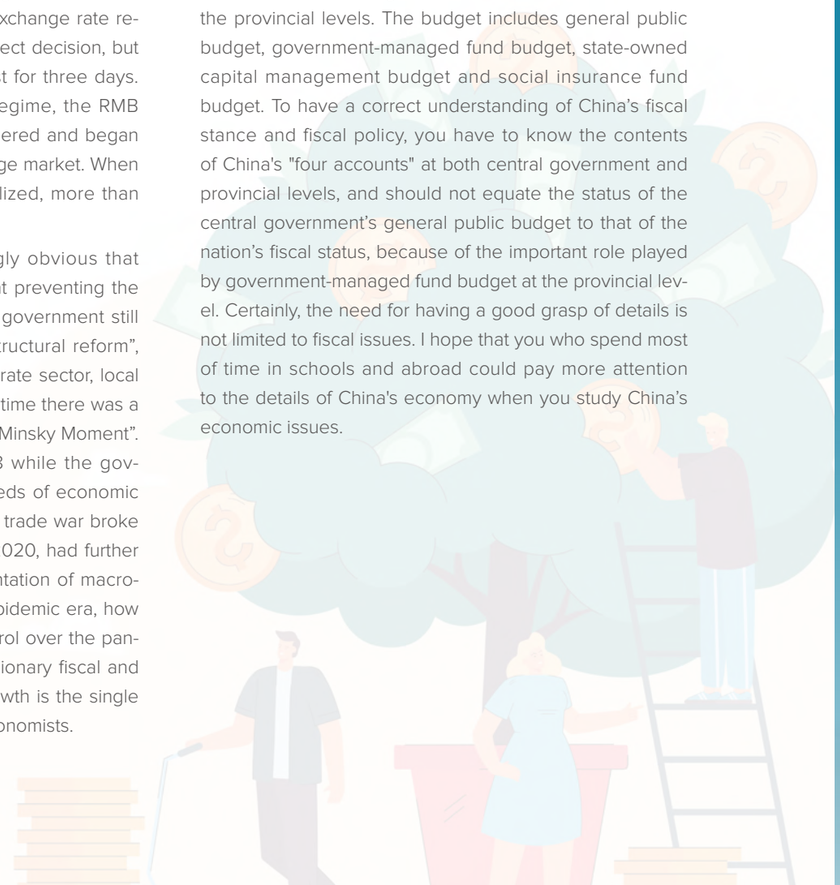
stimulus plan, which is a correct and effective policy in its general direction. However, it was not fully prepared, and the National Development and Reform Commission did not have enough projects reserves, leading to many projects being inefficient. At the same time, the central government only paid one-third of the cost of the projects, and consequently, local government debts increased as they needed financing.

The stimulus policy left some side effects afterwards. From 2010 to 2015, there were real estate bubble and high leverage of enterprises. Many scholars believed that the 4 trillion policy was not good enough, but I believed that the negative effects were actually caused by the rapid withdrawal of the policy. Many countries in Europe and the United States continued to implement the expansion policy until now, but it was only carried out for two years in China. Moreover, China fell into the US dollar trap because of the long-lasting twin surplus and too much foreign exchange reserves. In 2012, the country formulated a road map for RMB import settlement, proposing to liberate the essential capital account in 2015, followed by complete liberalization in 2020. However, foundations of capital liberalization were lacing, including property rights protection and full floating of the exchange rate, which led to adverse consequences such as arbitrage and capital flight. In 2015, the Central Bank proposed a more flexible exchange rate regime, which, again, I believed, was a correct decision, but back then, the policy was carried out just for three days. Because of the introduction of a new regime, the RMB started to devalue. The Central bank dithered and began to intervene heavily in the foreign exchange market. When the RMB exchange rate eventually stabilized, more than $800 billion has gone.

After 2015, it has become increasingly obvious that China's policy priority should be aimed at preventing the economy from further declining, but the government still focused on the so-called “supply-side structural reform”, lowering high leverage ratio of the corporate sector, local government debt and so on. In 2017 for a time there was a sudden surge of the fear of the arrival of “Minsky Moment”. But nothing the sort happened. In 2018 while the government was juggling the competing needs of economic growth and financial stability, the Sino-US trade war broke out. The Covid-19 epidemic in the early 2020, had further complicated the formation and implementation of macroeconomic policies in China. In the post epidemic era, how to strike a fine balance between the control over the pandemic and the implementation of expansionary fiscal and monetary policy to reignite economic growth is the single most challenging issue facing Chinese economists.

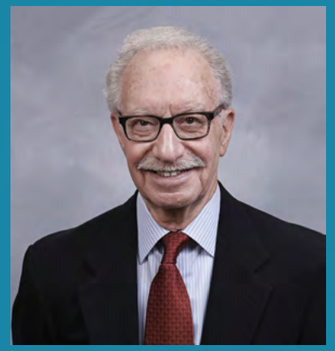
As a student of economics who studied at the University of Oxford for 6 years, I certainly appreciate the beauty of economic theories. We all know that theory is a plausible or scientifically acceptable general principle or body of principles offered to explain phenomena. The greatest satisfaction for a student of economics comes from the moment when he/she has succeeded in deriving certain conclusions that have important practical significance while consistent with economic principles. The economic training is extremely important, because it will force you to think in a comprehensive and consistent way. However, a thorough training and a good command of literature are not enough for you to think in a creative way. In my view, how to raise right question is the most important challenge for an economist. As an economist who have participated in China’s economic debates for more than 40 years, I deeply believe that the inspiration for raising right question, which we call “the sense of question” (wenti yishi), comes from your involvement in tireless search of solutions for real economic problems or contradictions.

Another important point for the studies of the Chinese economy is to get into details of the subject. For example, researchers who study China’s fiscal policy must have a very detailed understanding China’s fiscal budget, The State establishes budget at the Central Government and the provincial levels. The budget includes general public budget, government-managed fund budget, state-owned capital management budget and social insurance fund budget. To have a correct understanding of China’s fiscal stance and fiscal policy, you have to know the contents of China's "four accounts" at both central government and provincial levels, and should not equate the status of the central government’s general public budget to that of the nation’s fiscal status, because of the important role played by government-managed fund budget at the provincial level. Certainly, the need for having a good grasp of details is not limited to fiscal issues. I hope that you who spend most of time in schools and abroad could pay more attention to the details of China's economy when you study China’s economic issues.



A Series of Brief Paragraphs on Economics and Finance

Written by: William Silber



William Silber

NYU Stern School of Business
Professor of Economics and Finance

William L. Silber is the Marcus Nadler Professor of Finance and Economics at the Stern School of Business, New York University. He is also a member of the New York Mercantile Exchange and has also been a Senior Economist with the President's Council of Economic Advisors, a member of the Economic Advisory Panel of the Federal Reserve Bank of New York, and a member of the investment committee of the SSRC endowment fund. He holds an M.A. (1965) and Ph.D. (1966) from Princeton University and is a graduate of Yeshiva College (1963).

Professor Silber has consulted for various government agencies, including the Federal Reserve Board, the U.S. Senate Committee on the Budget, the House Committee on Banking and Financial Services, and the President's Commission on Financial Structure and Regulation. In 1980 he received the Excellence in Teaching Award at NYU's Stern School of Business and was voted Professor of the Year by MBA students in 1990, 1997, and 2018. In 1999 he was awarded NYU's Distinguished Teaching Medal.

VOLCKER: The Triumph of Persistence is a biography of Paul Volcker, the former chairman of the Federal Reserve, written by Professor Silber. Using vivid language and typical examples, this book gives readers a panoramic view of the life of Paul Volcker, a legendary figure who had a profound influence on the development of monetary and financial policies in the United States and around the world: He successfully responded to three financial crises, served a second term as chairman of the Federal Reserve, advised five U.S. presidents, including Jimmy Carter and Ronald W. Reagan, and designed the “Volcker Rule”, created the “Volcker Miracle”.

The Power of Nothing to Lose: The Hail Mary Effect in Politics, War, and Business is another book by Professor Silber. This book explores a phenomenon in politics, war and business, that is, the situation where there is a huge space for rise and a limited space for fall will lead to people's desperate "gambling" behavior. Through the stories of George Washington and other characters, the author shows that whether it is a refugee seeking asylum, a president facing term limits, or a patient suffering from terminal illness, people's risk-taking behavior will produce amazing results without any loss, and sometimes even affect the process of history.

In these two books, the author expounds many basic economic theories through interesting stories. Through reading, readers can find that economics is everywhere in life. As a discipline closely related to real life, the study of economics is not necessarily confined to complex theories and formula derivation. On the contrary, in real life, the wisdom and principles contained in economics are fully reflected, ranging from individual decisions to national government policy-making. I believe that through reading the two books, readers can not only have a deeper understanding of those who have made outstanding contributions, but also deeply feel the charm of economics.

Here is a collection of the most popular 200-word paragraphs from my Linkedin posts for the first half of 2022. All are verbatim as they appeared on Linkedin on the date that appears below each paragraph.

1. The Coming Generational Clash.

It's a new year so let's take a longer view. Low interest rates favor borrowers over lenders, the young over the elderly. For example, since the young borrow to buy a home, and the old live on savings, the decline in rates this past decade has given youngsters reason to celebrate. The roaring stock market cushioned the blow to older folks, making both groups fat and happy. But rising interest rates going forward will trigger a conflict among generations. Not only do rising rates mean higher monthly mortgage payments for first-time home buyers, it will also make existing homeowners less mobile. Higher interest rates on government debt will force Congress to raise taxes, displeasing middle class workers, but giving retirees added income from their nest egg. The past decade has shown that nobody knows what the stock market will do, but the aphorism "Don't fight the Fed" has stood the test of time. Therefore, tighter monetary policy to fight inflation will tame speculative markets, making everyone more irritable but especially the young who have yet to accumulate enough. All of this will widen the political rift among generations, dividing an already combative electorate.

I hope I am wrong,
Bill Silber,
January 2, 2022, 5pm

2. Ten-Year Yields Can Go Higher Than You Think.

Could the yield on 10-year Treasury bonds, the benchmark long-term rate, currently at 1.75%, increase by a full percentage point by the end of 2022? Such a jump seems unlikely given that the Federal Reserve expects to tighten with only 3 increases of ¼% in their target short term rate during the year. Two days ago Goldman Sachs projected the 10-year Treasury ending at 2% "even as the Federal Reserve hikes rates." We know that in the last 50 years long rates usually move less over the business cycle than short rates but that dampening has been violated recently. For example, between June 5, 2020, and April 2, 2021, the 10-year rate rose from .77% to 1.72% while the 2-year rate actually fell from .18% to .16%. This pandemic experience might be dismissed as anomalous except that almost ten years earlier something similar occurred. Between July 27, 2012 and July 26, 2013, the 10-year yield rose from 1.47% to 2.57% while the 2-year yield barely moved, increasing from .23% to .32%. So do not be surprised if 10-year bond yields move towards 3% during the next 12 months as inflationary expectations catch up with reality.

Good luck,
Bill Silber,
January 9, 2022, 5pm

3. What to Expect After the "Bubble" Bursts.

Bubbles are obvious only after they have burst. And few can say we have been in a stock market bubble since early 2010 even though the broad market index, the S&P500, quadrupled. Low interest rates increased the discounted value of expected future cash flows from stocks. But now that the Federal Reserve has begun to tighten, removing that prop, I wondered how far stocks can decline. The answer, unfortunately, is more than we think. Many define a bear market as a 20% decline in prices from the previous peak, but that understates the experience in the new millennium. The S&P500 dropped 55% between October 2007 and March 2009, and declined by 49% between August 2000 and October 2002. The good news is that stocks recover because the Federal Reserve eases quickly, as it did after the 34% decline from February 19 to March 23 in 2020. The bad news is this time may be different. The so-called Greenspan put, named for former Fed Chair Alan Greenspan's support for a declining stock market, may not come so quickly. The Federal Reserve has waited too long to tighten and cannot reverse course until inflation subsides.

Good luck,
Bill Silber,
January 23, 2022, 4:45pm

4. The End of the Bull Market.

Last February I posted a paragraph here entitled, "When Will the Bull Market End?" I used the famous Wall Street adage, "Don't fight the Fed," to say that "The bull market will continue as long as the Fed can afford to keep interest rates near zero." Since then the S&P500 is up about 12%, compared with the 10% average annual return during the last century. I ended that piece with the following warning: "Even a hint that the Federal Reserve is thinking about tightening would send stocks crashing down." The Fed has said it will begin raising rates next month but so far stocks have declined only modestly, about 9% below their peak of early January. And that is because the Fed is not yet serious. The real interest rate, the nominal rate minus the rate of inflation, remains solidly negative, encouraging everyone to borrow and spend. But that will end when the Federal Reserve has no alternative but to turn the screws tighter to fight inflation. My advice: Don't fight the Fed, especially when it must raise rates more than anyone expects. Lower your exposure to equities now – you will sleep better at night.

Good Luck,
Bill Silber,
February 20, 2022, 5pm

5. Government Deficits, Inflation, and War.

My Wall Street Journal op-ed with Tom Sargent this past Friday stresses that government deficits provoke inflation by pushing the central bank to finance excess spending the easy way, by printing money. We also show that former Federal Reserve Chair Paul Volcker defeated the 1970s inflation by forcing budget sanity on Congress. The lesson for today is that lowering inflation requires both monetary and fiscal tightening. But I worry that Russia's invasion of Ukraine will distract Congress and the Fed from the inflation battle. Current Fed Chair Jerome Powell testified last week "I think it's appropriate for us to be careful in the way we conduct policy simply because things are so uncertain and we don't want to add to that uncertainty." It is always good to be careful, but it will not surprise anyone if the withdrawal of Ukrainian wheat and Russian natural gas from world markets worsens inflation in coming months. Some will use these supply effects to negate the necessity for tightening just like they used the Covid-19 supply disruptions to delay needed monetary and fiscal restraint. Let's not make the same mistake twice.

Good luck,
Bill Silber,
March 6, 2022, 5pm.

6. What Happens When Stock Markets Close.

The Moscow Stock Exchange suspended trading when Russia invaded Ukraine. Russian companies such as Gazprom certainly did not become worthless – they still had future cash flows – but investors lost liquidity, a forum for buying and selling, and that reduces a stock's value. The illiquidity discount varies but can be substantial – 50 percent for very risky securities. The press suggested that some large brokerage firms facilitated off-exchange transactions for investors who wanted to trade. This should not surprise anyone familiar with my book, "When Washington Shut Down Wall Street," on the closure of the New York Stock Exchange at the outbreak of World War I. Treasury Secretary William McAdoo shut the NYSE on Friday, July 31, 1914, and kept it closed until December 12, 1914 – more than 4 months. But beginning August 3, 1914, an unauthorized market in NYSE stocks emerged on New Street, right behind the Exchange, allowing investors to buy their favorites and sell their dogs. Trading volume was only about 20% of the NYSE but it provided liquidity to investors. And that is why we say: The more things change, the more they remain the same.

Good luck,
Bill Silber,
March 27, 2022, 1pm.

7. Revisiting the Interest Rate Outlook.

My paragraph, "Ten-Year Yields Can Go Higher Than You Think," written in this space 3 months ago, January 9, 2022, ended with the following: "So do not be surprised if 10-year bond yields move towards 3% during the next 12 months as inflationary expectations catch up with reality." The 10-year Treasury yielded 1.76% back then and a typical forecast was Goldman Sachs's prediction that yields would end the year at 2%. This past week the 10-year Treasury rose above 2.5% and ended at about 2.4%, so even Goldman would concede we are moving towards 3%. Where do we go from here? I wish I could say "no mas," as Roberto Duran supposedly said after seven punishing rounds from Sugar Ray Leonard in the November 1980 Welterweight Championship bout. But I think "no more" is premature. I will stick with 3% or higher by year's end because the Federal Reserve is not close to conquering inflation. Some analysts have said that aggressive Fed tightening will trigger a recession and lower rates. However, interest rates first must rise so that the real rate turns positive and curtails spending before they decline. And we are not nearly there yet.

Sorry,
Bill Silber,
April 3, 2022, 4:30pm

8. A Perfect Inflation Hedge.

Savers want to hedge against inflation, to earn a return to cover price increases. The conventional answers, such as gold, real estate, and the stock market, offer risky protection, so they don't quite measure up. But if the Federal Reserve followed the appropriate anti-inflation strategy of making real interest rates positive, raising short-term rates above inflation, then buying 3-month Treasury bills and reinvesting does the job almost perfectly. Buying bills limits the risk of unanticipated inflation to three months, after which savers reinvest at a new higher rate. Such an investment strategy also restrains inflation-induced spending, keeping a lid on upward price pressure. However, under the Federal Reserve's current policy of "forward guidance" none of this works. The Fed has kept its target short-term rate below the rate of inflation and says additional rate increases are to come. Meanwhile consumers might as well spend to avoid losing purchasing power, and that adds to inflationary pressure. The Federal Reserve should stop forward guidance and stop dragging its feet. Positive real rates on 3-month bills would please savers and help control inflation. It seems like a no-brainer.

Good luck,
Bill Silber,
April 17, 2022, 8:45pm.

9. Inflation Destroys Trust.

Last week Atlanta Fed President Bostic worried about “more [interest rate] hikes than are warranted given the economic environment.” And rumblings on the left about the costs of fighting inflation reflect a recent Opinion Column in Bloomberg that asked, “Targeting the cost of living is central banks’ primary purpose, but for whom?” The answer, of course, is us – but that question forces me to update an earlier message on trust. Citizens give the government the right to print money, trusting that elected officials will not abuse that privilege by debasing the currency. But it’s easy to cause harm. For example, if inflation runs at 3½ percent a year, just 1½ percent above the target, prices will double in twenty years, so that a $100 bill can buy only half as much as before. Elected officials erode our trust by failing to maintain the value of paper money, and trust is nothing more than a belief, so it is easy to shatter and hard to restore. Moreover, its importance has soared in today’s fractured political world. No wonder that John Maynard Keynes popularized Vladimir Lenin’s claim that the best way to destroy capitalism is to debauch the currency.

They were right,
Bill Silber,
April 24, 2022, 4:45pm.

10. Stop Complaining about Stocks.

Just about everyone I know is angry at the stock market. At the low last week, the broad S&P500 index was down about 18% for the year, a sharp decline compared with the historical annual average return of almost 10%. Investors who followed my February 21 suggestion to lighten up on equities would have lost less than half that. Holders of the technology-heavy NASDAQ index fared much worse -- a decline of over 30%. The grumblers should stop complaining, even though these losses hurt, because they have forgotten the previous 3 years. The S&P500 index increased by an annual average return of 24% from the start of 2019 to the end of 2021, more than double the historical 10% annual average. And NASDAQ holders earned a whopping 37% a year over that period. Moreover, even at its recent low the S&P500 was 55% higher than at the beginning of 2019 and NASDAQ was 75% higher. The stock market will probably go lower before it turns around, but no one knows when it will hit bottom. These numbers suggest that doing nothing now might make sense, despite the stomach-churning volatility. It is usually too hard to get back in for the long run.

So Stop Complaining,
Bill Silber,
May 15, 2022, 5pm.

11. That was a Bubble.

Bubbles are obvious only in retrospect, after they have burst, so were stocks in a bubble last year now that they are beaten down? And if so, why did most investors do nothing? Legendary hedge fund manager Michael Steinhardt, who made a killing buying bonds in the 1980s, said, “Betting against a bubble is dangerous.” He invested in Treasury bonds when no one wanted them, despite 13% interest rates, and emphasized the power of being a contrarian: “In your mind you’re going to be right ultimately, and there’s a certain virtue in being alone.” Another hedge fund contrarian, John Paulson, made a record $20 billion for investors betting against the housing bubble in 2007. He recalls many skeptics saying, “If you’re so smart, why isn’t everyone doing it?” Everyone, of course, cannot be a contrarian. In retrospect, stock prices were especially high last year because low interest rates reduced the risk-adjusted discount rate on equities, increasing their value. Many investors thought that the Federal Reserve could keep rates near zero forever, and that was a bubble – an exaggerated and unrealistic belief in the Fed’s power. Now that we know the truth, stock prices have a firmer foundation.

Good luck,
Bill Silber,
May 22, 2022, 5pm

12. Never Sell Naked Options.

The skewed payoff to call options limits the owner’s loss to the premium paid but offers unlimited upside. This asymmetry encourages risk taking in stocks or, more generally, swinging for the fences in life when given downside protection (see examples in my “The Power of Nothing to Lose” at http://bit.ly/TPONTLB). Option sellers, however, face potential disaster: nearly unlimited losses but maximum gains equal to the premium. The attraction of selling stock options is that most expire worthless, which is why some traders sell combinations of puts and calls (referred to as naked when unaccompanied by the underlying stock). They expect to collect big fat premiums like an insurance company, especially when option implied volatility is high. But companies such as Liberty Mutual make large payouts for rare events – like Hurricane Ida – and remain solvent by building cash reserves from premiums received. Option sellers should do the same but many view premiums as income rather than reserves, expecting to close positions to avoid disaster. They go bankrupt because they cannot anticipate Black Swan events. My advice: Stay home, remain humble, and never sell naked options.

Good luck,
Bill Silber,
May 29, 2022, 5pm.

13. Yellen is Wrong about What She Got Wrong.

Janet Yellen is a well-trained economist. And she showed courage by admitting recently that she was wrong last year that inflation would be "a small risk" and "manageable." Yellen blames new variants of Covid, lockdowns in China, and Russia’s war on Ukraine as the “Unanticipated and large shocks to the economy that have boosted energy and food prices, and supply bottlenecks that have affected our economy badly that at the time I didn’t fully understand.” She loses considerable credibility with her explanation because inflation had become persistent well before her bottleneck culprits. Crude oil prices ended 2021 at $75 a barrel, about $50 lower than today, but the annual rate of inflation in the 4th quarter last year was 6.6% compared with 1.9% in the first quarter. Moreover, back then Russia’s war on Ukraine was a micro-speck on the horizon. Yellen ignores the real sources of today’s persistent inflation – the overly expansionary fiscal and monetary policies of 2020 and 2021. And that is because she is talking like a politician, not an economist. The Biden Administration needs to stop making excuses and must accept the truth to succeed in the battle against inflation.

Good luck,
Bill Silber,
June 12, 2022, 5pm.

14. Keep Precious Metals.

Gold and silver are supposed to hedge against inflation, but they have disappointed so far despite inflation running hotter than anyone projected (except for us). Inflation jumped from under 2% to over 8% in the two years since the government stimulus to counter COVID, but gold, for example, has remained in a trading range between $1,700 and $2,025, hardly what we expected. One explanation is interest rates. In mid-2020, after the Federal Reserve eased to fight COVID, the U.S 10-year bond made a record low of about ½ percent and gold jumped to $2,025. Low interest rates encourage investors to own precious metals. Today gold is near the bottom end of its range for two reasons: 1) The 10-year yield over 3% discourages holding non-interest-bearing assets; and 2) Many investors believe that the Federal Reserve can restore price stability with tight credit. But precious metals will shine when interest rates reflect rising inflationary expectations more than tight monetary policy. Gold and silver also protect against the “unknown unknowns” of former Defense Secretary Donald Rumsfeld. Be prudent: Keep about 2-3% of your portfolio in precious metals as portfolio insurance.

Good luck,
Bill Silber,
June 19, 2022, 5pm.

A Series of Brief Paragraphs on Economics and Finance

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Effects of Childhood Peers on Personality Skills

Authors of the paper: Shuaizhang Feng, Jun HyungKim, Zhe Yang
Author of this article : Qiaoqiao Liu

This article summarizes and discusses Professor Shuaizhang Feng's conference keynote presentation delivered in December 2021 at the Peking University HSBC Business School in the first CUHKSZ-PHBS Workshop of Economics and Finance.

There is a growing literature that examines the roles of children's peers in shaping life cycle outcomes. Academics widely believe that peers may affect children's short-term outcomes such as academic achievement as measured by test scores, but the long-term impact is unclear. Some scholars have pointed out that the personality skill will be the link between peers and adult outcome (i.e., schooling, earnings, health). Personality skills are important factors influencing cognitive skills and also various life cycle outcomes such as education, future income, and crime. However, academic performance plays a little role as a channel and there is no rigorous investigation regarding the effect of peers on personality skills although there exists a recognition among researchers that peers may be able to play an important role.

Authors of the paper measure the quality of peers using the number of left-behind children (LBC) in a child's class. These refer to children with one or both parents temporarily migrated away from home to urban regions for employment. The household registration system in China called hukou restricts their children's access to public resources in urban regions (e.g., education, social insurance coverage, etc.), thus discourages parents from taking their children with them. These children will be left in the care of their relatives and usually suffered from disadvantages in academic performance, health and so forth. In China, 69 million children were left behind by migrating parents as for 2015, and this group accounted for a quarter of all the children.

Research Question

In this regard, this article examines two issues. First, what is the effect of the quality of a children's peers on the personality skills? Second, if it exists, can this effect be explained by grades or personality skills?

Research Method

This paper identifies peer effects by comparing primary school children assigned randomly across classrooms based on their exposure to disadvantaged classmates. The identification strategy would be flawed if the distribution of disadvantaged peers across classrooms is correlated with other unobservable factors that also determine children's development. On the one hand, this identification strategy may suffer from selection bias, and the other parents' migration decisions may be endogenous to the personality skill development of their children's peers which mainly involves the following two situations. The first is a possible reverse-causal relationship between parent's migration decision and the migration status of other parents who are able to provide assistance or information potentially. The parent may tend to be more open-minded to migrating as well. The second is migration decision may be influenced by temporal shocks (e.g., economic

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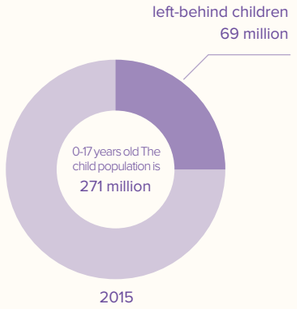


pressure) which also affect children's personality skill development. There are two assumptions made to bolster identification against this concern.

First, children do not self-select into classrooms based on their own characteristics or those of their classmates.

This assumption is based on the institutional feature of the primary schools in sample: Children were assigned to classrooms at random. To further bolster confidence in this assumption, the author conducted interviews with the principals of the schools in sample. According to the

interviews, schools have a strong incentive to ensure randomization so as to avoid complaints from anxious parents and to avoid burdening teachers with overly disruptive classes. Schools were also subject to a government mandate that forbids tracking based on academic performance at the primary school level. Although there are institutional features in place that make the children's class highly likely a random assignment, the paper provides empirical tests (Figure 1). The first column of Figure 1 shows the classroom distribution of left-behind children (LBC) in the first semesters of the first grade and the fourth grade. The classroom proportion of LBC is spread out between 0.1 and 0.9, with slightly higher concentration around 0.4. If the students were sorted by the left-behind status or related characteristics, there would be more classrooms at the either end of the distribution. In the second column, the author performs 1,000 Monte Carlo simulations in which students were randomly assigned to classes within school-cohorts in each wave. It does not reject the equality of the two distributions using the two-sample Kolmogorov-Smirnov test after testing.

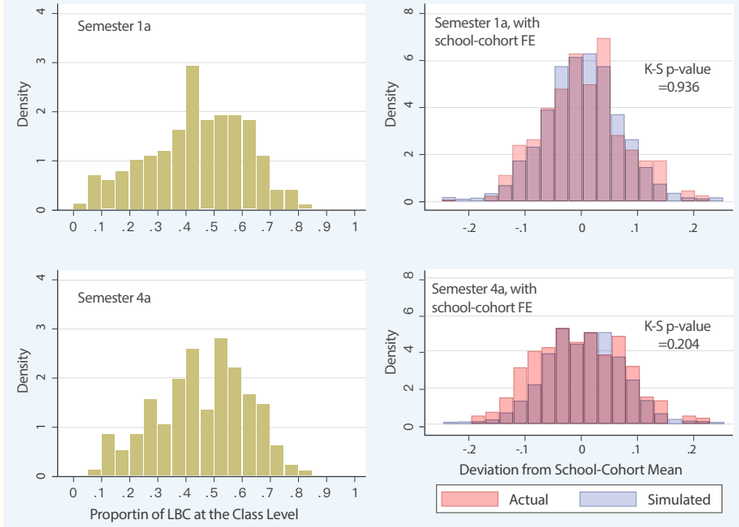


Figure 1: Distribution of Left-Behind Children across Classrooms

Note: Semester 1a indicates the first semester of the first grade. Semester 4a indicates the first semester of the fourth grade. LB: left-behind. To save space and focus on the range of deviations that really matters in the FE residual histograms, we combine distributions outside of (-0.25, 0.25) into the bins on the two edges of this interval. The heights of the bars are scaled so that the sum of their area equals 1.

Second, it is assumed that parents' migration statuses are not endogenous to the characteristics of their children's peers.

The "disadvantaged" status of children is represented by whether they are "left-behind children," which is a result of their parents' temporary migration away from home forced by low local wages. These children will be left home for months or even years under the care of the remaining parent, grandparents, or relatives due to the difficulty to attend public schools in the host city result from the household registration system, known as the "hukou" system, which designates each person a resident of a specific location and as either a "rural" or "urban" type. Usually, these left-behind children suffer various disadvantages such as lower academic achievement, more behavioral problems, and more depressive symptoms.

Measures of the children's personality skills are based on the Big-5 model of personality which is one of the most popular models used in the field of economics or psychology, and a social skill measure related to one's tactfulness in social interactions. Specifically, the Big-5 model involves five sub-dimensions: openness to experience, conscientiousness, extraversion, agreeableness, and emotional stability (also known as neuroticism).

Findings

Effects of Childhood Peers on Personality Skills

The paper distinguishes the peer effects "givers" and "recipients" by restricting the analysis sample to the children who were not left behind during the primary school period.

Disadvantaged classmates in primary schools have substantially negative impacts on children's personality skill development, but with no effect on their academic achievement. Firstly, After the normalization of outcome measures being mean 0 and standard deviation 1 within each school-cohort-wave, results show that a 10 percentage point increase in the classroom proportion of left-behind children reduces conscientiousness by 0.182, agreeableness by 0.190, emotional stability by 0.237, and social skill by 0.147 in standard deviation unit. Moreover, peer effects are smaller in magnitude and marginally significant when children are exposed to peers with above-median proportions of LBC. These personality skill measures, in particular conscientiousness and emotional stability, are highly predictive of years of education and earnings.

Secondly, left-behind children are primarily disadvantaged in personality skills but not in academic achievement (i.e., math grades, Chinese grades, and IQ scores), suggesting that peer effects on personality skills are mainly driven by the average personality skills of the left-behind peers.

Channels to Peer Effects on Personality Skills

The second question is *how* childhood peers affect personality skills. Specifically, the authors focus on peers' academic achievement and personality skills as potential channels. These results suggest that classroom peers' average left-behind status lowers personality skills but not academic achievements of never-LBC. On the other hand, classroom peers' average academic achievements do not significantly affect the academic achievements or personality skills of never-LBC. In short, the classroom proportion of LBC is a proxy for the proportion of peers with low personality skill but not low academic achievement. In practice, it means that improving children's personality skills, rather than focusing only on their academic achievements, may be an effective way to promote children's human capital development while reducing the negative externalities of disadvantaged peers.

Contributions

The first contribution of this study is filling the gap on the research regarding the effect of children peers on human capital development by showing that childhood peers are important inputs in the production of personality skills which will generates a series of life cycle outcomes. Considering the adverse effects of disadvantaged peers, failing to account for personality skills as outcome measures would have led us to underestimate the negative effects. And it confirms the conjecture that personality skill is the channel through which childhood peers affects long-term outcomes as well. Furthermore, considering only academic achievement as a measure of peer quality and as an outcome of peer effects may lead to misleading evaluations of policies that affect peer composition. Lastly, the importance of "nurture" would be reinforced in the nature-nurture debate of human capital development, given that personality skills play an important role in explaining the effects of disadvantaged peers and childhood peers are a part of "nurture" that can be shaped by parenting or viable policy.

The first contribution of this study is filling the gap on the research regarding the effect of children peers on human capital development by showing that childhood peers are important inputs in the production of personality skills which will generates a series of life cycle outcomes.

Pengfei Wang: Monetary Policy and Asset Bubbles

Source: Peking University National School of Development
Translated by: Mingyu He, Yi Wu

This article reports Professor Pengfei Wang's speech at the "Macroeconomics and Financial Markets Under the New Development Paradigm" forum, held on September 19, 2021.

I have been thinking about monetary policy and asset bubbles for years because most of my research focuses on the topic of asset bubbles. At the forum this morning, both Professor Weiying Zhang and Professor Gang Yi mentioned that the market is very smart. In fact, the financial market, to which I can deeply relate, is even more so. With a Ph.D. in economics from Cornell University and a masters from the China Center for Economic Research (CCER), Peking University, I sometimes feel that equipped with what I have learned, I can milk money from the market. However, whenever I have this impulse, it often turns out that my pocket is milked by others. So, the market is really smart.

Is There an Asset Bubble?

Theoretical and Empirical Study

Of course, no matter how smart the market is, it makes mistakes. Therefore, we've seen many surges and slumps in asset prices.

When referring to asset bubbles, the word "bubble" is sometimes put in quotation marks. Why use quotation marks? It's because the very existence of asset bubbles has been controversial among academics.

The earliest recorded asset bubble may be the "tulip bubble" in the Netherlands, which occurred around 1634-1638. The tulip is a very common flower in the Netherlands. It is a perennial, which means after flowering this year, it can continue to bloom next year. The rhizome of a tulip is a bulb, much like a garlic head, and can be propagated by division. Because of this property, tulips were traded as assets and, at its peak, the price of a tulip bulb was equal to the value of a large estate in Amsterdam. Yes, it's true, the market was so crazy.

From 1719 to 1720, France experienced the "Mississippi Company Bubble"; in 1720, the "South Sea Bubble" also hit the Great Britain. All of the above events eventually gave birth to the "Bubble Act" in the United Kingdom, which had a great impact on the asset market.

In the 1920s, the United States witnessed the so-called "Roaring Age". As for its consequences, we all know that the market crashed in 1929, and the stock market lost nearly 90% of its market value. It didn't really recover from the Great Depression until World War II. Since then, the United States, Japan, and China's stock market between 2005 and 2008, have also experienced asset bubbles. As far as I know, some people still haven't recovered.

> **The intrinsic value of an asset is the discounted value of its expected future cash flows, while an asset bubble is the difference between an asset's price and its intrinsic value.**

Professor Pengfei Wang delivered a speech.

Before defining asset bubbles, we need to think back on the fundamental financial concept of asset pricing.

What is the intrinsic value of an asset price? From what we've learned, the intrinsic value of an asset is the discounted value of its expected future cash flows, while an asset bubble is the difference between an asset's price and its intrinsic value.

There have always been two schools of thought regarding asset bubbles. One school believes that asset bubbles are real. Nobel laureate Robert Shiller is one of its supporters. There is also a faction that does not believe so, but rather believes that the market is always right. The latter faction is represented by Eugene Fama, also a Nobel Prize winner in economics.

Therefore, finance is very interesting: the core and most fundamental issue of the subject is asset pricing, on which economists and financial economists are yet to reach a consensus. What is even more unbelievable is that two people that held completely opposite views on this issue won the Nobel Prize at the same time in 2013.

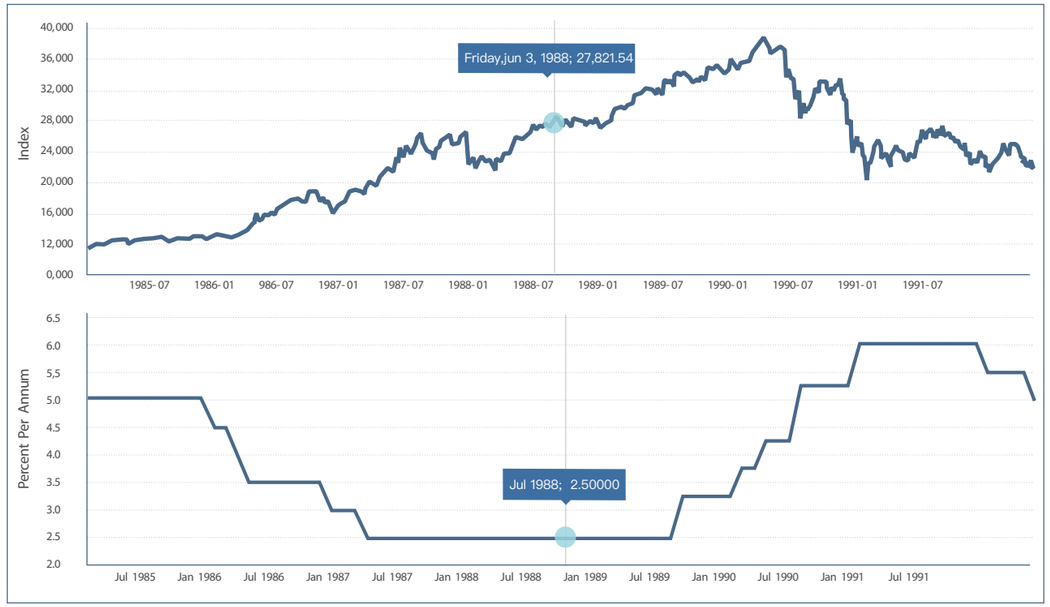
From the perspective of policy implications, many asset price surges and slumps seem to be a credit phenomenon.

When we talk about bubbles, it is natural to think of the Bank of Japan which conducted five rate cuts between January 1986 and February 1987, during which time the interest rate dropped from 5% to 2.5%, followed by the five rate hikes between May 1989 and August 1990 where the interest rate ascended from 2.5% to 6%. Another example was the Federal Reserve. It lowered the federal funds rate 13 times in a row from January 2001 to June 2003 with the interest rate dropping from 6% to 1%, and then it increased interest rates 17 times from June 2004 to August 2006 with the interest rate raised from 1% to 5.25%. Such a policy adjustment process of the Federal Reserve was largely in accord with the real estate bubble cycle in the United States at that time.

Due to the lack of consensus on this issue, we cannot intuitively tell if there is a bubble. However, "bubbles" are usually powerfully destructive, and policymakers have to take this factor into account when formulating policies.

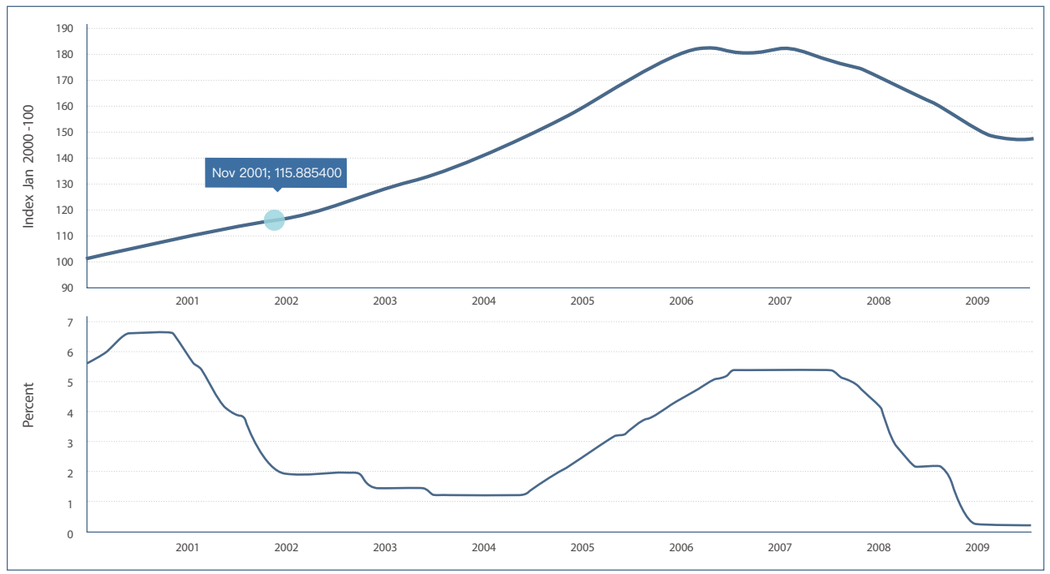
Figure 1 below shows the Nikkei index and Japan's benchmark interest rate. It appears that the Nikkei index was very consistent with the pace of interest rate cuts and hikes of the Bank of Japan.

Figure 1: Nikkei index and Japan's benchmark interest rate.



The same phenomenon was also observed in the United States: the subprime mortgage crisis actually occurred after the Federal Reserve raised interest rates in 2004. Why did housing prices stop rising as soon as interest rates were raised? It was because many low-income people applied for variable-rate mortgages when buying a house. When the interest rate is low, the monthly payment is less. When the interest rate is raised, the monthly payment increases. Once the income of those low-income borrowers cannot keep up with the increasing monthly payments, defaults will follow. The more defaults, the more the debt squeeze, and eventually the entire financial system is drawn into the catastrophe. That is what happened during the subprime mortgage crisis in the United States.

Figure 2: U.S. house price index and Federal Reserve interest rate



Do Asset Bubbles Exist?

I think this question should be investigated within a theoretical framework and with data support.

First, it is necessary to find out whether asset bubbles are possible theoretically.

Second, it is necessary to understand the possible impact of asset bubbles on the real economy.

Third, on this basis, it is necessary to discuss whether monetary policy should intervene when asset bubbles occur.

The supporters of efficient market theory have always denied the existence of asset bubbles. This theory was born when Eugene Fama wrote his doctoral dissertation in the 1960s. He found that stock prices were difficult to predict, and the correlation coefficient between daily changes in stock prices and the previous day's value was only 0.03. In addition, there is a myriad of literature that considers it difficult to predict asset price returns.

Fama's research gained immediate academic attention and was soon written into a well-known bestseller. Based on this finding, Fama pondered on the cause of the phenomenon. His final argument was a powerful literal description rather than a mathematical model. Fama believes that the game of asset pricing involves so many intelligent people, and all the information that can be used, and that which should not be used, may have already been reflected in asset prices through everyone's trading behavior. Future price changes would be inevitably driven by new information, making it almost unpredictable because no one can see into the future.

However, Fama's Efficient Market Theory made a logical error: unpredictability does not imply efficiency, and it took academics many years to see this simple truth. Think of it as a person gambling in a casino; there's no way to predict the outcome. However, the casino itself must have a fixed mechanism to ensure that they can make money, and these mechanisms are definitely not effective from the perspective of the gamblers.

Therefore, in theory, that the market is unpredictable does not mean that the market is always efficient. I myself constructed an asset price in the theoretical world: this price follows a random walk, and the best prediction for it is today's price. However, prices are heavily influenced by two factors, one is fundamentals and the other is investor sentiment. Why is the price unpredictable? Because investors' sentiment itself is unpredictable. It's just like predicting your wife's mood tomorrow, which is difficult, and perhaps actually unpredictable.

Evidence of the Bubble: Shiller's Test

In 1981, Robert Shiller proposed another way of testing market theory - the volatility test. He believes that future asset returns and cash flows are difficult to test directly because they have not yet been realized, but that we can compare the volatility of stock prices and cash flows with their post hoc values.

According to the efficient market pricing formula, asset prices are equal to the sum of discounted future cash flow expectations, which is essentially an average. The volatility of an average variable must be relatively small. Therefore, according to the efficient market theory, the volatility of asset prices calculated according to post hoc cash flows should be greater than that of real asset prices. However, Shiller found the opposite.

Professor Shiller's findings had such an impact in 1981 that much of the research in behavioral economics has been inspired by his paper, reflecting the intellectual appeal of asset pricing. A general conclusion is that asset prices are influenced by both fundamentals and investor sentiment.

Evidence of the Bubble: Smith's Experiment

Another factor is frothy sentiment among investors. Professor Smith, a Nobel laureate, conducted a series of experiments, like a theory class, in which each participant was told that future cash flows were evenly distributed, with relative independence, expectations, and possible highs and lows. In theory, since everyone involved has the same information, trading should be infrequent or should not happen.

However, in fact, the opposite was true. Given the same information, trading was still very frequent, and bubbles and crashes were common outcomes.

This experiment can accurately predict when bubbles will occur, and sometimes asset prices will be greater than the maximum possible cash flow discount. This is often the case in reality, and so many people in the stock market are ripped off. According to Smith's design, the time value is downward and the asset value must decrease over time. Because dividends are distributed independently, asset prices should fall as assets last longer, but Smith found that the stock market went up and then crashed.

Evidence of the Bubble: Warrants Bubbles

Between 2005 and 2008, the Shanghai Composite Index reached more than 6,000 points. China's stock market has a limit of ups and downs, meaning that stocks cannot rise or fall more than 10% a day. Suppose the strike price of the put option is $10, and now there are 5 trading days left, and the price is still $20. Now it is impossible to reach the $10 level in 5 days, the

price is theoretically zero, and it does not require any model. However, often the price is not zero. Wuliangye had a put option that was priced above the strike price, which would have been theoretically impossible without the bubble, as it would have required the stock price to turn negative. According to the 10% daily limit of up and down, we can calculate how much the price will go down, what the lowest price will be, and then the theoretical upper price of the put option can be calculated. The reality, however, was that the stock price was above the ceiling for almost the entire trading period, and when the ceiling equaled to zero, it did not immediately go back to zero, and frantic trading continued for last few days.

Crazy transaction in doomsday options is common, with many options being liquidated after prices actually hit zero, which is impossible in efficient markets. So, the price of warrants in China's stock market gives a very strong case for asset bubbles in real transactions, and this was concluded by Professor Wei Xiong of Princeton University and my former colleague Jialin Yu of the Hong Kong University of Science and Technology in an article published in the American Economic Review.

Bubble Theory and Its Effect on Economy

Why do bubbles exist? There are several theories.

One is the Ponzi game proposed in 1985 by Jean Tirole, winner of the 2014 Nobel Prize in Economics, that the economy is dynamically ineffective, that the interest rate itself is lower than the economic growth rate, and that, if there are too many savings, bubbles can provide a better way to invest, and the return of bubbles is basically equal to the economic growth rate. Assume someone buys a piece of land and does not do anything. If the economy is growing at 10%, the price of land in the long run is going to grow at 10% along with the economy, and if the real interest rate is less than 10%, the investment in land is going to be higher than the return on investment in the real economy. Now, you have a bubble. At this point, the bubble squeezes out physical investment because it provides a channel for other investments. However, Tirole's theory cannot fully explain the linkage between asset prices and the real economy in the United States and some other countries. For example, when the real estate price rose, the US economy was doing well, but it fell into crisis after the crash, which is inconsistent with Tirole's theory.

Professor Jianjun Miao of Boston University and I have written a series of papers over the past decade on financing constraints, and we believe that bubbles can alleviate them to some extent. Suppose I have a very good business idea, but I do not have any collateral. At this time if the investor is willing to believe me and willing to give me the finance support, I will be able to put the idea into real investment, which not only produces benefits, but also enhance investor's trust in/of me, so as to form a benign mechanism of self-realization. This example explains why asset prices often move in tandem with the real economy.

There are also several behavioral economic explanations. One is the bigger fool theory, in which investors always believe they are likely to sell

The economic effects of bubbles are not necessarily all negative. Bubbles can ease financing constraints and increase liquidity. Especially for those high-tech and human-capital-intensive industries, equity bubbles are good for financing, and research and development, which has certain benefits for the economy.

their assets for a higher price to a bigger fool. There is also a moral hazard theory, which is very illuminating for us. For example, many people know that P2P can collapse, but why are so many people willing to take the risk? It is a moral hazard gamble in the minds of investors who always believe that if you make something too big to fail, someone will eventually bail it out. The same goes for bubbles, because if bubbles do not pop, the returns are amazing. From this point of view, moral hazard is also a very important factor.

The economic effects of bubbles are not necessarily all negative. Bubbles can ease financing constraints and increase liquidity. Especially for those high-tech and human-capital-intensive industries, equity bubbles are good for financing, and research and development, which has certain benefits for the economy.

The main harm of bubbles is that they crowd out investment, cause excessive volatility and may pose systemic risks.

Moreover, the volatility of the bubble could worsen income distribution. At present, the residents of big cities in China are basically divided into those who own houses and those who do not. If prices fluctuate, some people will benefit, while others will suffer, and consumption will fluctuate accordingly. Many theoretical and empirical studies have found that credit-driven bubbles are more damaging.

Should Monetary Policy Intervene in Asset Bubbles?

How should bubbles be dealt with? There are two main schools of thought: one is that it should not be intervened and the other is that it should be. Currently, this is also being debated in the academic community and this provides several perspectives. Greenspan, for example, argued that monetary policy should focus only on economic variables such as the price level and output, not on asset prices. But Jordi Gali argues that asset bubbles increase volatility, and currency assets should move against the wind.

Finally, I want to introduce a new word associated with the emergence of bubbles – CryptoPunk. In addition to "being ripped off", investors can also think about how to use the bubble to conduct some public welfare. For example, when universities need financial donations, they can receive scientific research funds through this platform. For example, they could put photographs of famous professors or the covers of their papers in the blockchain to make CryptoPunk. Someone then buys the copyright to support academic research at a high price of more than 10,000 yuan, and then sells it at a higher price. While contributing to public welfare, they can also receive investment returns. That is something we can think a little more about.

Is There an Industrial Land Discount in China? A Public Finance Perspective

Authors of the paper : Zhiguo He, Scott Nelson, Yang Su, Anthony Lee Zhang, and Fudong Zhang
Author of this article : Xingyi Zhan

This article summarizes Professor Zhiguo He's conference presentation "Is There an Industrial Land Discount in China? A Public Finance Perspective" delivered on April 23, 2022 at the 4th PHBS Workshop in Macroeconomics and Finance.

Zhiguo He
The University of Chicago Booth School of Business
Professor of Finance

· Motivation

As in many other countries, there are rigid zoning restrictions in China to classify different land parcels for different uses. Land zoned for residential use sells at roughly a ten-fold higher price than land zoned for industrial use. For example, in 2019 the average price of residential land in China was 3,619 RMB/m^2, while the average price of industrial land was 304 RMB/m^2 (Figure 1). This price difference between residential and industrial land is called the industrial land discount.

The huge price gap can be better understood under China's "land finance" system. A large share of city governments' operational revenues (about 29.44% in 2019) come directly from land sales. The typical view in the literature is that residential land sales are primarily a way for local governments to raise revenues, whereas industrial land is sold primarily to subsidize industry, stimulate economic growth, and support labor demand. As Liu and Xiong (2020) state, "it is common practice for local governments throughout China to offer industrial land at subsidized prices to support local industries."

· Contribution

However, this paper proposes an alternative explanation for the industrial land discount that stems from local public finance rather than from subsidies to industry. From the perspective of city governments as well as the central government, the choice between residential and industrial land sales essentially involves an intertemporal revenue trade-off. Industrial land generates future tax flows, since industrial firms pay value-added taxes and income taxes, along with various fees; residential land does not. This simple fact implies that governments face a choice between selling residential land, which pays larger upfront revenues from higher sale prices, and selling industrial land, which pays smaller upfront revenues but comes with a stream of future cash flows from tax revenues over time.

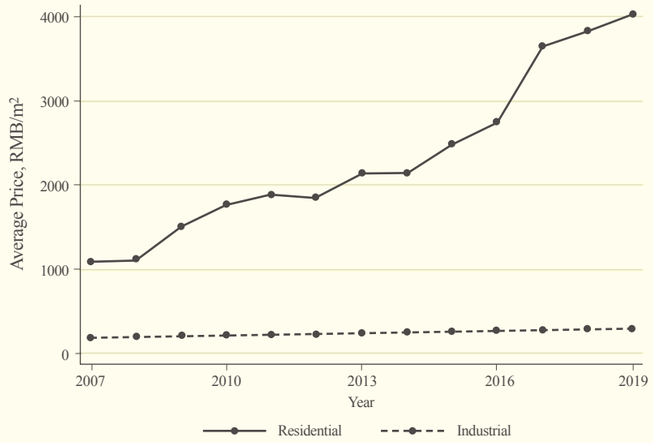


Figure 1: Average Land Prices Over Time by Land Use: Industrial vs. Residential
Data sources : the Ministry of Natural Resources

· Takeaway

This dynamic perspective implies that the large discount in the upfront sale price of industrial land relative to residential land does not necessarily imply that governments are systematically subsidizing industry through cheap land. The estimated internal rate of return (IRR) of industrial land is about 13.94% and it is greater than local governments' cost of capital, which, when proxied by municipal corporate bond MCB , yields between 3.5% and 7.5% by a significant margin. Thus, industrial land sales in China are not subsidized relative to residential land sales, once taking future tax revenues into account.

· Methods and Data

To reach these conclusions, the first step is to measure the cash flows generated over time by industrial and residential land sales. As the governments are facing a trade-off between selling residential land, which pays larger upfront revenues, and selling industrial land, which pays smaller upfront revenues but comes with a stream of future cash flows from tax revenues over time, the main target is to estimate the upfront revenue per square meter of industrial and residential land sales, and annual future tax revenues generated by industrial land sales. Then we can derive to the IRR of selling industrial land which makes the net present value (NPV) of both cash flows equal.

To estimate the industrial land discount, the paper estimates a hedonic model to predict what the prices of industrial (residential) land parcels would have been if they were, counter-factually, sold as residential (industrial). For instance, it estimates the impact of each characteristic on the price of residential parcels, including the area of the land parcel, the distance to the center of the closest urban unit, the year-quarter in which the land is sold and so on. With the estimators, the paper then predicts residential prices for industrial parcels by plugging these characteristics of industrial parcels. The industrial land discount is just the difference between the actual (predicted) residential price and the predicted (actual) industrial price, which is about 1,176.4 RMB/m^2.

To estimate the marginal tax revenues from industrial land sales, the paper first uses a differences-in-differences approach to estimate the marginal impact of land purchases on firms' sales. Then marginal tax revenues are computed by multiplying the increase in sales of the land-purchasing firms by an effective tax rate. The annual future marginal tax revenues from industrial land sales estimated in the paper are approximately 113.6 RMB/m^2 in the first two years, and 214.2 RMB/m^2 thereafter.

This calculation requires two datasets. The first is the dataset on the universe of land parcels sold by the Chinese government from 2007 to 2019, which contains the price of each parcel and the name of the buyer, whether it is zoned for industrial or residential use, and the characteristics of the parcel such as its location and size. The second is data on large Chinese industrial firms. By merging these two datasets, it is possible to identify which industrial firm acquired each land parcel, as well as the firm's performance before and after purchasing land.

> **The return of supplying industrial land instead of residential land, accounting for all future tax revenues that the industrial land generates, is higher than the usual range of government discount rates proxied by the city governments' MCB yields.**

These two sets of estimates for incremental cash flows back out an IRR of 13.94%, which is much higher than the local governments' cost of capital between 3.5% and 7.5%.

· Mechanism

A natural question is to ask what drives this positive wedge between the IRR and the government cost of capital. The paper shows that a city usually has a greater industrial land discount if it has a larger VAT share, or a lower discount rate as measured by city governments' municipal corporate bond yields.

Under the current tax system in China, city governments receive almost the entirety of the revenue from both residential and industrial land sales – a key feature of the "land finance" system. However, city governments only receive a fraction of future VAT tax revenue generated by firms. As a result, city governments may only internalize a fraction of future value-added tax revenues (about 22.8%), which is the most likely explanation for why the estimated land-sale IRR is higher than local governments' cost of capital. Based on a quasi-natural experiment of tax-sharing schemes' adjustment in 2016, which increased the share of VAT revenues to city governments, the paper finds that provinces which had a larger increase in the city government's share of tax revenues experienced larger increases in the industrial land discount.

If governments' land sale decisions reflect intertemporal revenue tradeoffs, then changes in city governments' discount rates should affect industrial land sale decisions: less constrained city governments should sell less residential land and more industrial land, increasing industrial discounts. The paper tests this hypothesis by analyzing the relationship between city governments' discount rates, proxied by the corresponding MCBs' issuing yields, and their industrial discounts. Consistent with the hypothesis, the result shows that MCB yields and industrial discounts are strongly negatively correlated.

· Conclusion

All in all, this paper analyzes the industrial land discount in the Chinese land market. Counter to conventional wisdom, the return of supplying industrial land instead of residential land, accounting for all future tax revenues that the industrial land generates, is higher than the usual range of government discount rates proxied by the city governments' MCB yields. The results have implications for understanding the drivers of land prices in China, and how they are linked to the tax sharing scheme with the central government, as well as local governments' intertemporal revenue tradeoffs.

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Asset-Price Redistribution

Authors of the paper : Andreas Fagereng, Matthieu Gomez, Emilien Gouin-Bonenfant, Martin Holm, Benjamin Moll, and Gisle Natvik
Author of this article : Weimin Zhou

This article summarizes Professor Benjamin Moll's keynote speech, delivered on April 24, 2022 at the 4th PHBS Workshop in Macroeconomics and Finance.

The study of macroeconomic questions in terms of distributions rather than just aggregates is a key issue in current macroeconomic research. For instance, as shown in Figure 1, China has experienced a large overall increase in real estate prices, but such increments are mostly concentrated in top cities, such as Shenzhen, Beijing, and Shanghai. What does this mean for wealth distribution across households in different cohorts and cities?

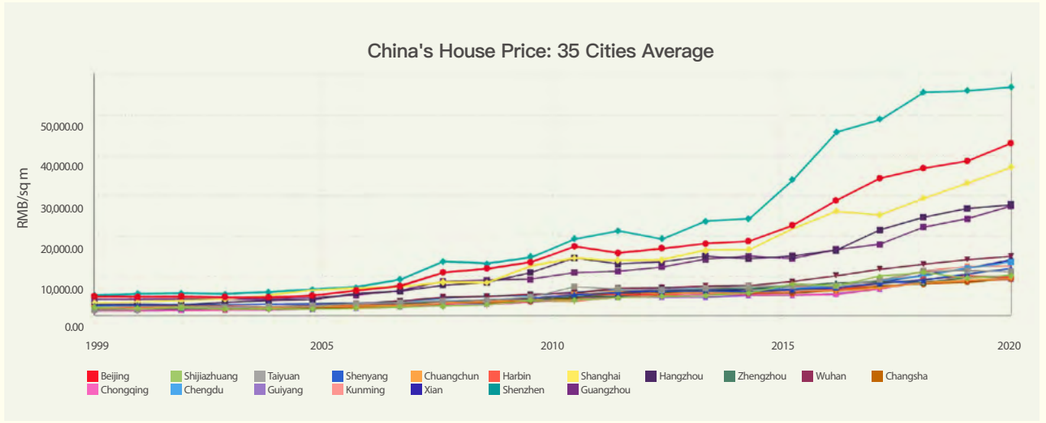

Figure 1
Source: CEIC China Premium Database
Note: The figure shows China's commercial residential building average selling price in 19 selected Tier 1 and Tier 2 cities.

China is not the only country in which price changes of major assets may have caused redistribution across the population. Moll pointed out that, in the United States, as shown in Figure 2, there is a rising asset price measured by market value, compared to measures of income such as profits, interests, and dividends. Thus, the question is: what are the consequences of asset price changes in terms of welfare? The answer is not obvious since there are two different views within the current literature: a shift of real resources towards the wealthy (Saez et al., (2021) or welfare irrelevant gains (Cochrane, 2020). This paper tries to address this question both theoretically and empirically.

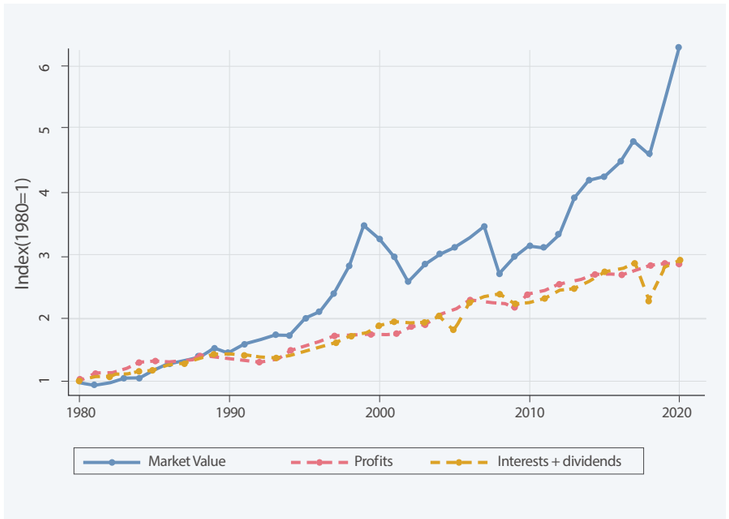

Figure 2

Source: Fagereng et al. (2022)

Note: The figure plots a rising stock price from 1980 to 2020 in the U.S., compared to income streams underlying these assets.

This paper first uses a two-period model to show that rising asset prices benefits sellers (with a high initial return), not buyers (with a low future return), and then considers a deterministic infinite-horizon model with liquid and illiquid assets. By deriving the welfare gain from household problem, the authors conclude that rising asset prices benefit net sellers but portfolio choice and timing of purchases also matter. Since there is only trading of existing assets among various households, the aggregate welfare gain is zero. Therefore, any price changes are purely redistributive from buyers towards sellers.

Applying the above theoretical insights to Norwegian administrative panel microdata (1994 – 2015), this paper calculates sufficient statistic of asset-specific welfare gain for every Norwegian, in which assets include housing, equity, debt, and deposit. Specifically, the authors compute welfare gain by summing up the product of discount rate, net asset sales, and price deviations over observed time periods for each asset and each household. As shown in Figure 3, there is a large amount of redistribution.

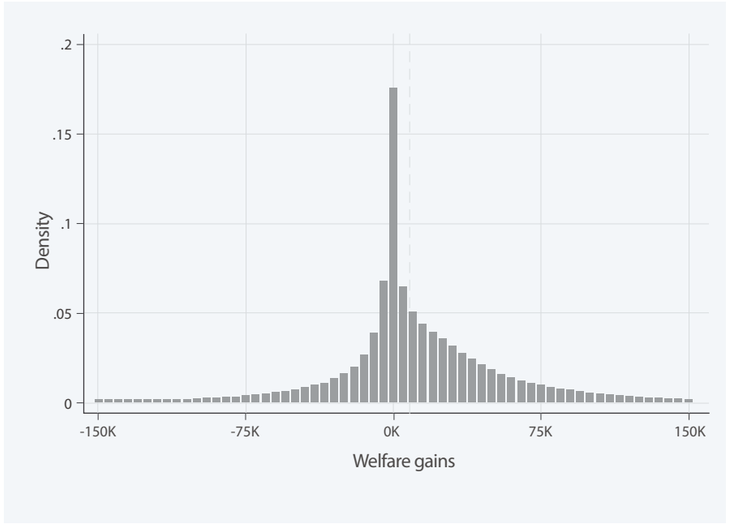

Figure 3

Source: Fagereng et al. (2022)

Note: The figure plots the density of each range of welfare gain based on authors' calculations.

The authors further separate households into young and old groups, and show a clear redistribution from young to old as shown in Figure 4. The rising prices lead to a large transfer of housing assets across cohorts, which benefits the old generation, especially those aged between 40 to 50. There is also a welfare gain among all cohorts from owning debt which is a welfare transfer from government. Overall, the welfare redistribution from young to old is largely contributed by the welfare transfer of housing assets.

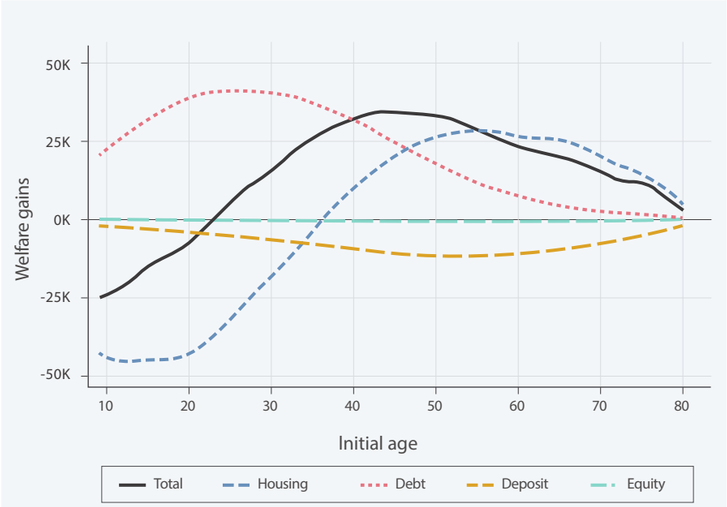

Figure 4

Source: Fagereng et al. (2022)

Note: The figure plots the asset-specific welfare gains relative to household age based on the authors' calculations.

By decomposing the data into household sector, government, and foreigners, the household sector has a positive welfare gain redistributed from the government due to the fact that households are net debtors. There is little redistribution between foreigners and domestic sectors. Moreover, the authors also compute the welfare gains by their separation of sectors into households, government, and foreigners. The results show that household sector has a positive total welfare gain mainly from government and there is little redistribution between foreigners and domestic sectors. Decomposing the assets into housing, debt, deposit, and equity, household sector has a positive welfare gain from debt since households are net debtors and government is a net lender to household.

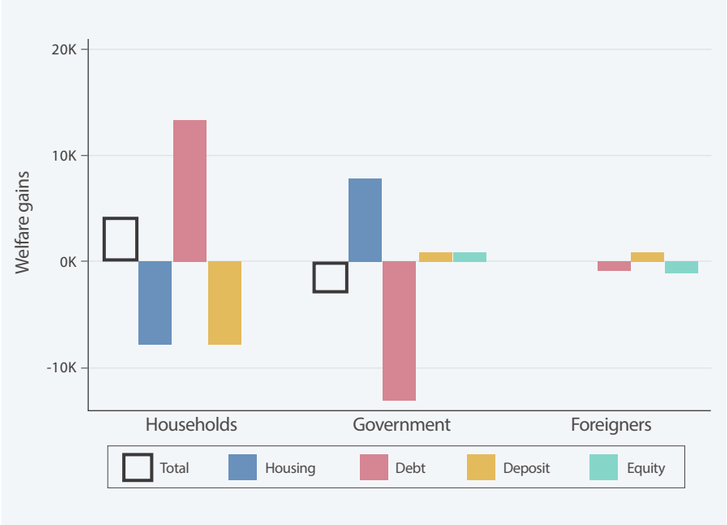

Figure 5

Source: Fagereng et al. (2022)

Note: The figure plots the asset-specific welfare gains by different sectors based on authors' calculations.

In Figure 6, the authors provide a computation of welfare gains based on initial wealth percentile. Households with a higher initial wealth benefit most from rising asset prices. The welfare gains are concentrated at the top, largely reflecting a further wealth inequality. Moreover, instead of welfare gains, the authors also change to an alternative measure by defining wealth gain as the contribution of price deviations to wealth. The above redistribution results still hold using the measure of wealth gain.

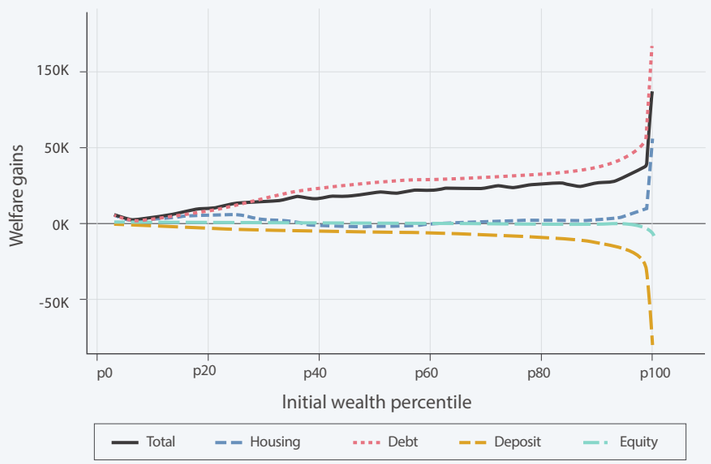

Figure 6

Source: Fagereng et al. (2022)

Note: The figure plots the asset-specific welfare gains relative to initial wealth percentile based on authors' calculations.

Conclusion

Fagereng et al. (2022) provide a framework to quantify the welfare effect of historical asset price fluctuations. Based on a two-period model with liquid asset and long-duration asset, they first construct a sufficient statistic to characterize welfare gain and wealth gain based on price deviations of holding assets as well as interest rate and bequests, and find that rising asset prices benefit sellers not holders and are purely redistributive in terms of welfare and wealth. Using Norwegian administrative panel microdata from 1994 to 2015, which documents a 4 percentage point decline in interest rates and a 3 times increase in housing price-to-rent ratio, captures the redistribution effects over significant price deviations. The result shows a redistribution from young to old and from poor to rich. Moreover, there is a redistribution between household sector and government: household sector has a positive welfare gain from debt since households are net debtors, but a negative welfare gain from the housing market.

The key takeaway from this paper is that, although many countries have experienced a large rise in asset prices, by looking at the welfare and wealth gains among different households, we find that not everyone is happy, and that there is a clear redistribution across types of household. The methodology can be easily applied to calculate household welfare gain from various types of asset in a certain country, enabling the checking of redistribution effects and analysis of how rising equity price or house price amplifies/reduces net wealth inequality. Moreover, there remains an open issue to discuss policy implications on such wealth inequality associated with asset price increases.

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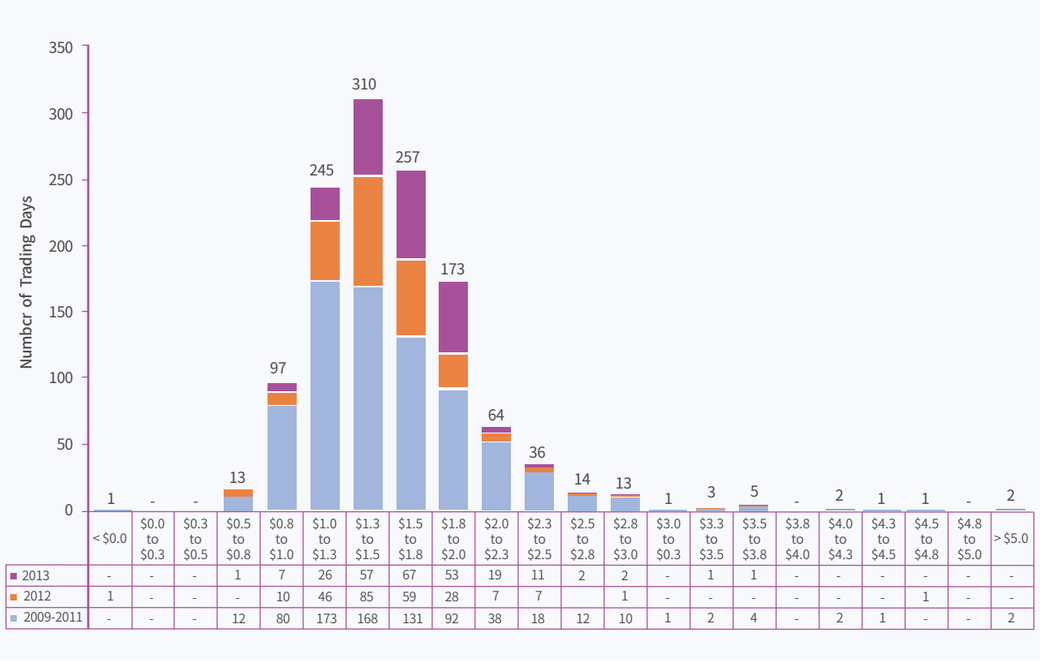
How and When are High-Frequency Prices Predictable?

Authors of this paper : Yacine Aït-Sahalia, Jianqing Fan, Lirong Xue and Yifeng Zhou
Author of this article : Lianghao Shen

This article summarizes Professor Yacine Aït-Sahalia's Keynote Speech at the 6th PKU-NUS Annual International Conference on Quantitative Finance and Economic.

The question of asset return predictability is a key issue in current research, which reflects financial market information efficiency and guides the design of financial markets, as well as trading and execution strategies. This paper answers this question from the ultra-short-horizon (a millisecond timescale) perspective by finding a large, systematic, and pervasive predictability from high-frequency trading. As shown in Figure 1, which is the income flow distribution of high-frequency trading firm Virtu Financial that it only experienced 1 loss day in 1238 trading days from 2009 to 2013. Such an excellent investment performance can directly support the consistent presence of high-frequency trade predictability.



	< $0.0	$0.0 to $0.3	$0.3 to $0.5	$0.5 to $0.8	$0.8 to $1.0	$1.0 to $1.3	$1.3 to $1.5	$1.5 to $1.8	$1.8 to $2.0	$2.0 to $2.3	$2.3 to $2.5	$2.5 to $2.8	$2.8 to $3.0	$3.0 to $0.3	$3.3 to $3.5	$3.5 to $3.8	$3.8 to $4.0	$4.0 to $4.3	$4.3 to $4.5	$4.5 to $4.8	$4.8 to $5.0	> $5.0
2013	-	-	-	1	7	26	57	67	53	19	11	2	2	-	1	1	-	-	-	-	-	-
2012	1	-	-	-	10	46	85	59	28	7	7		1	-	-	-	-	-	-	1	-	-
2009-2011	-	-	-	12	80	173	168	131	92	38	18	12	10	1	2	4	-	2	1	-	-	2

Figure 1: Virtu Financial Daily Adjusted Net Trading Income Distribution 2009-2013*(in millions)

Source: Virtu Financial, Inc. SEC IPO S-1 Prospectus, March 2014

An insight from the authors is that because of market competitiveness, low-frequency predictability should not be expected to last, while the technological costs and barriers to entry into high frequency trading and the short shelf life of ultra-short horizon predictability make it more likely to persist. To find such evidence, this paper used NYSE's Trade and Quote (TAQ) database for two full years, 2019 and 2020, ensuring this data is widely-available for all investors, and restricting attention to the 101 stocks that were constituents of the S&P 100 index on December 31, 2020. Based on this database, the paper considers a large number of predictor variables representing a broad range of features indicative of the short-term trading environment for a particular stock. The main predictors can be grouped into three categories: transaction volume variables are related to the stock's trade intensity; transaction imbalance variables, such as the price change and buy-sell imbalance, are related to the stock's trade asymmetry; and transaction speed and cost variables such as stock trading turnover ratio. By using different machine learning algorithms, including penalized linear regression (LASSO), random forest, FarmPredict linear regression, and gradient boosted trees (GBT), the authors find that out-of-sample predictability exists universally in all 101 stocks and all the time periods, even for the highly volatile environment of March and April 2020 caused by the Covid-19. As shown in Figure 2, all methods have similar consistent predictability performance, except OLS. For the median stock in the sample, a 10.5% out-of-sample R^2 for predicting 5-second returns can be achieved using merely past trade quote data and an accuracy of 64% for predicting the direction of the next trade.

> "The main predictors can be grouped into three categories: transaction volume variables are related to the stock's trade intensity; transaction imbalance variables, such as the price change and buy-sell imbalance, are related to the stock's trade asymmetry; and transaction speed and cost variables such as stock trading turnover ratio.

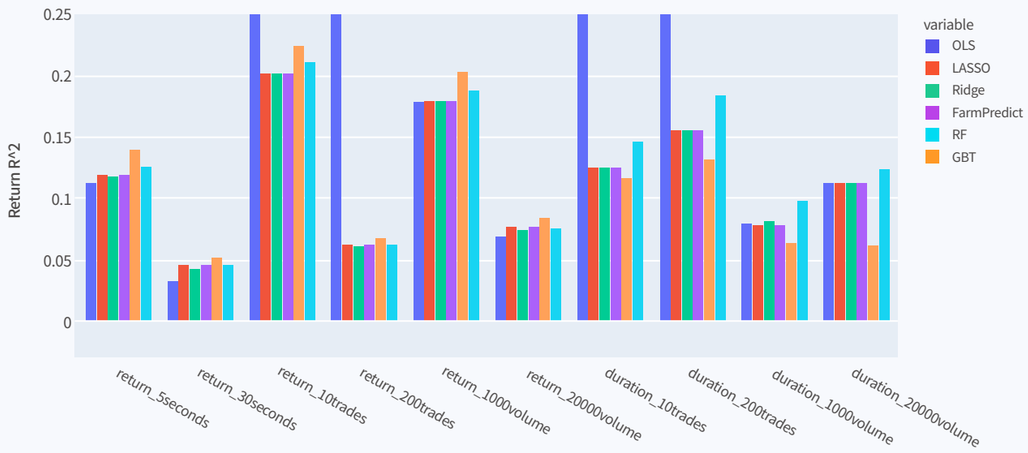


Figure 2: Comparison of Predictability Performance Using Different Machine Learning Methods
Source: Average performance for INTC (Intel Inc.) return and duration predictions over 505 days from 2019 to 2020.

Having confirmed the existence of predictability, this paper also studies the prediction performance for individual stocks and its distribution. As shown in Figure 3, the boxplots summarize the accuracy and duration distribution over 101 data points where each point is the average daily performance of a stock aggregated over 505 days in 2019 and 2020. The left panel is prediction accuracy rate distribution; the right panel is durations R^2 distribution. This figure shows that for both accuracy and duration, 5-second prediction is largely outperforming the benchmark with higher accuracy and an approximately 10% out-of-sample R^2 median. Furthermore, we can see that irrespective of the type of clock (calendar, trade, or volume), the predictability weakens as the horizon increases, while the durations predictability are improved.

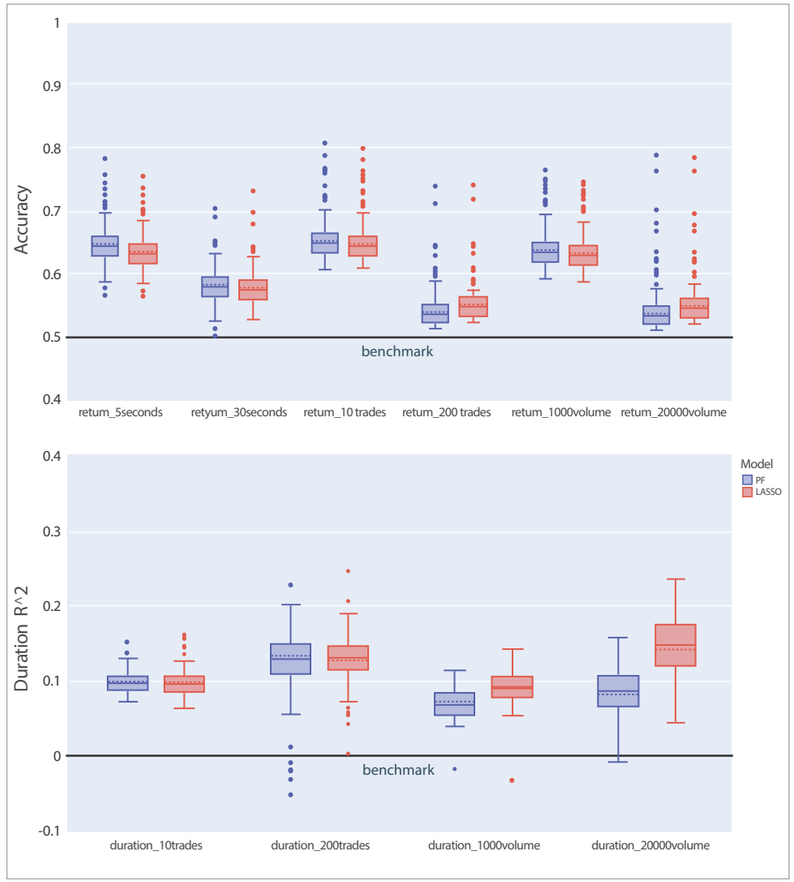


Figure 3
Distribution of Individual Stock Average Out-of-Sample Returns Directional Accuracy and Durations R^2

Moreover, the authors investigate if any differences in predictability can be explained by stock-level characteristics and the market environment. The results of panel regressions indicate that stocks with smaller nominal share prices, that are less liquid, and less correlated with the aggregate market can be better predicted. Such stock characteristics can explain three quarters of the 5-second return R^2 variability, together with fixed effects. Also, the predictability for durations is higher under liquid and volatile market conditions.

Finally, the authors also quantify the importance of the timeliness of the data to see how fast high frequency predictability fades away for a typical stock in the sample. Figure 4 shows how return predictability varies with time horizon. The left panel plots return predictability R^2. This is very short lived, disappearing at the 200-seconds point, which means the returns are only predictable in just three minutes. The right panel shows the prediction accuracy rate, which also does not survive over 200 seconds. Since the predictability of returns vanishes to 0 in just five minutes, this paper can quantify the value of the timeliness: approximately 80% of the overall predictability is achieved by relying on the most recent 10 milliseconds, 10 transactions, or 10 lots transacted. By introducing a small artificial delay in the sample, the average out-of-sample R^2 drops from 14% to 2.5% after a 10ms delay. The results suggest the extreme value of timely data and partly explain why data latency is so highly valued by high-frequency market participants. Following a similar pattern, if a trader were able to acquire advance information for a more

accurate prediction, such knowledge could boost directional accuracy from 68% up to 79%, and return predictability from 14% up to 27%. The authors reveal that some high-frequency trading firms go to extreme lengths to reduce the distance of their interaction with stock exchanges. However, the distance between New York and Chicago is about 700 miles, which means a firm trader can at most shorten the distance to 700 miles which needs 8 milliseconds for a roundtrip at light speed. Thus, a new technology's ability to speed up the signal transmission is so valuable for those firms.

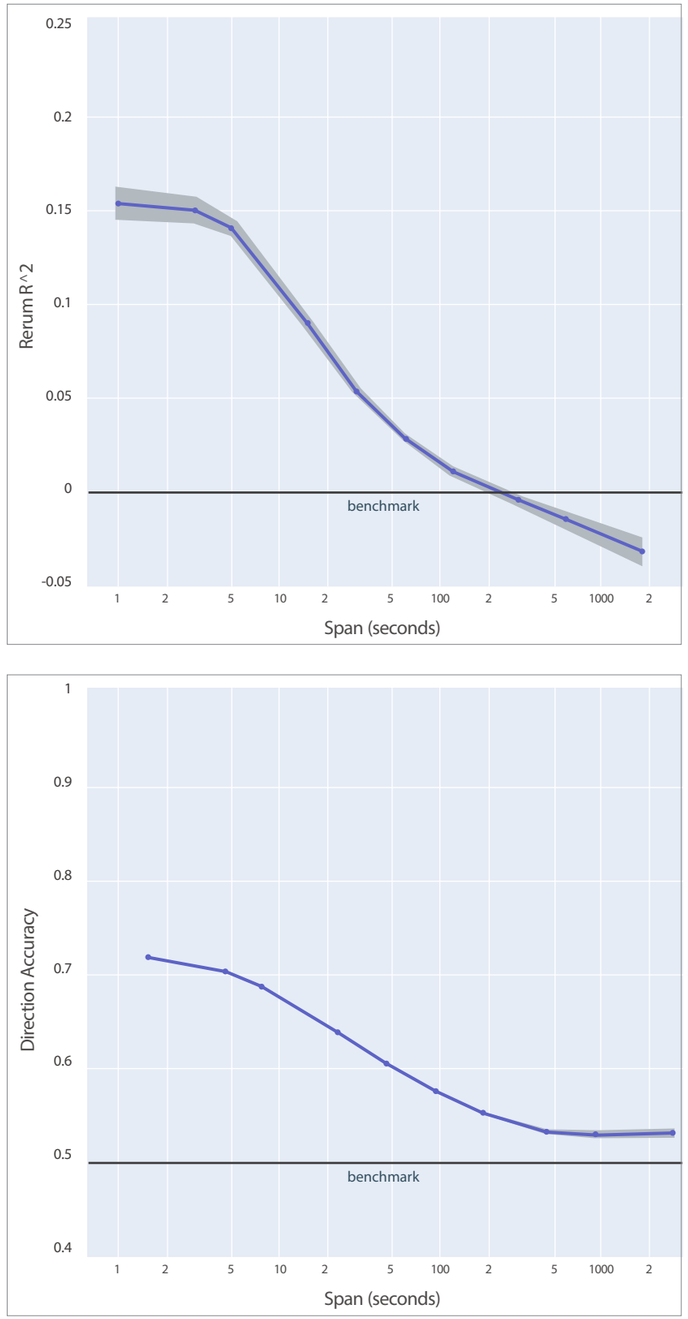


Figure 4

Pred ictability Lifespan: Returns Prediction Performance as a Function of the Time Horizon

Note: The shaded areas depict 95% confidence intervals over 505 days for INTC.

Conclusion

This paper studies three basic prediction problems over ultra-short high-frequency horizons, namely predictions of returns, transaction direction, and durations. The authors examine these questions using a range of machine learning methods, and relying on the complete transaction and quote update data of the S&P 100 stocks over two full years from 2019 to 2020. They quantify the predictability and find a large amount of predictability exists universally in every stock and consistently over time. With the LASSO and Random Forest methods, they isolated the three most important factors for driving predictability: transaction imbalance, short horizon past return, and limit order book imbalance. Moreover, this paper investigated how predictability depends on stock characteristics and market environments, and how fast it vanishes in the timeliness of the data. By sample simulation and comparison, the majority of the predictability lies in the most up-to-date few milliseconds, or a few trades, and decreases quickly when a small delay is introduced. This indicates the ability of high-frequency traders to make short-term imperfect predictions on the sign of the incoming order, or that a new technology, which can speed up message transformation, can be very useful in prediction.

Quantitative Investing and Price Informativeness

Presenter : Xuezhong (Tony) He
Author of the article : Yuanqiong Xia

This article summarizes and discusses Professor Xuezhong (Tony) He's conference keynote presentation "Quantitative Investing and Price Informativeness" delivered on May 14, 2021 at the 6th PKU-NUS Annual International Conference on Quantitative Finance and Economics.

Motivation

Quantitative investing (QI) and quantitative mutual funds becomes popularity for great availability of machine-processable information and more flexible AI- based algorithms. Quantitative investing is a process of extracting information from quantitative analysis of price information and making investment decisions based on systematic, rule-based criteria. Professor He introduced some stylized facts about quant funds discovered by Abis (2020). The stylized facts as follows. Comparing to no-quant funds, the emergence of quant funds has increased the total net assets of the market and the total number of funds, quant funds are younger and smaller, quant funds have lower management fees, quant fund have higher holding turnover, quant funds hold more stocks exposed to the book-to-market and momentum factors and less to the size factor, and less cash, and quant funds experience large outflows during recessions.

However, what is the effect of increasing popularity of QI on market efficiency and stability? There is limited research about quant funds, unlike mutual funds. On the one hand, there are some positive effect of quant funds. Easley (2016) regarded quant funds as “information collection mechanisms”. Kirilenko and lo (2013) thought that quantitative investing was a calculated and emotionless approach to avoid managers’ behavioral biases that reduce inefficiencies and market instability. On the other hand, there are also some negative effect of quant funds. Following Mondria et al. (2022), quantitative institutions might not interpret price information perfectly, injecting endogenous noise due to noisy price interpretations. This is because the strategy quant funds used is a crowded strategy, which means that when analyzing past data in a similar fashion and this fashion may have some errors, QI may come to similar signals to forecast future returns and make similar trading decisions. Therefore, the noisy interpretations or interpretation error can be correlate among institutions. Such correlations among quantitative funds can distort information aggregation, exacerbate instability and induce systematic noise into asset prices, demoting price informativeness.

> **Professor He’s objective in this paper is to develop an equilibrium model of asset and asset management market of quantitative investing and to use this model to understand how does the increasing popularity of quantitative investment affect price informativeness.**

Professor He’s objective in this paper is to develop an equilibrium model of asset and asset management market of quantitative investing and to use this model to understand how does the increasing popularity of quantitative investment affect price informativeness. So, he studies a stylized static trading setting with two layers of investment structure. As in his paper, he considers a group of rational retail investors (i.e., households) who can either invest in a risky asset directly, or indirectly through a group of quantitative institutions, and the equilibrium price is jointly determined by the trading from household and quantitative institutions on behalf of fund investors.

Basic Setup

In Professor He’s model, there are two types of assets available, a riskless asset, and a risky asset. The riskless asset pays zero interest with perfectly elastic supply. The risky asset has a payoff, and the payoff is normally distributed. As in the standard noisy rational expectations equilibrium, there is a per capita supply of the risky asset, and the supply is also normally distributed.

The economy features two types of competitive agents, retail investors and quantitative institutions. Retail investors can either trade as “fund investors” through quantitative institutions or invest directly as “households” on their own account. There are also some quantitative institutions, who invest in the best interest of fund investors similar to Gârleanu and Pedersen (2018).

There are two key assumptions in the model. First, both retail investors and institutions have fundamental information or expected value about the payoff of the risky asset. However, quantitative institutions have extra information which is concurrent price. This is because institutions are able to purchase real time comprehensive quote and trade data due to their economic scale. In today's high frequency markets, there are many instances where this occurs. For example, purchasing fast data (along with practices such as colocation of trading terminals with exchange computers) gives rise to a practice called “latency arbitrage” whereby some traders are able to see market data before other traders.

Second, Professor He incorporates the imperfect interpretation of price information into the framework to address the concern that increasing quantitative investing may impede market quality due to institutions’ reliance on similar fashion. Different form standard assumptions in REE mode, information in asset prices cannot be fully understood by market participants in practice so that institutions can only interpret the information from price data with additional noise. Professor He models this imperfection of price interpretation by including a noise term to the price information of quant institutions. The noise term including a common error in institutions’ investment decisions, and a specific error for personal behavioral biases. Common error means to capture the idea that in processing price data, investors may suffer a common cognitive error. When there are more quantitative funds, this leads quantitative funds to analyze past data in a more similar fashion and come to more similar conclusions about investment, the common additional noise term becomes bigger, the strategies become more crowded and this common cognitive noise becomes more significant.

Exogenous Financial Market Equilibrium

As illustrated in Figure 1 (a), there are two layers, retail investors and quantitative institutions. Retail investors who can either trade through quantitative institutions as fund investors or invest directly on their own account as household. In an exogenous equilibrium, the fraction of fund investors or institutionalization level is given as a constant, μ. The number of quantitative institutions is also given as a constant, M.

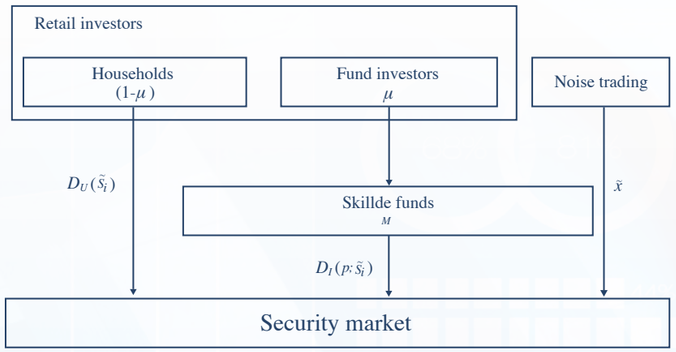


Figure 1a: Asset and asset management market structure for exogenous equilibrium. Among retail investors, fund investors invest through the institutions, while the rest are households who invest directly in the security market.

Figure 1a: Asset and asset management market structure for exogenous equilibrium.

Note: He, X., Kang, J., & Zhou, X. (2022). Quantitative Investing and Price Informativeness.

When the total demand of risky asset equals to the total supply, the economy reaches the equilibrium, and we can calculate the expected equilibrium asset price. By defining price informativeness, there is a trade-off between direct and indirect effects of institutionalization for price informativeness. Directly, institutionalization brings more informed capital with superior price information, generating an “informed capital effect” and improving price informativeness. Indirectly, imperfect interpretation of asset prices injects systematic noise into equilibrium outcomes due to common error in institution’s price processing, generating a “price interpretation effect” and reducing price informativeness. Therefore, the price informativeness depends on the trade-off between informed capital effect and noise interpretation effect.

As showed in Figure 3, institutionalization leads to a hump-shaped relationship to information efficiency (the left panel) and a U-shaped relationship to return volatility (the right panel). Particularly, when institutionalization level (μ) is relatively high or fund similarity (ρ) is relatively high, the negative noise interpretation effect dominates the trade-off, making the price less informative and more volatile when more investors invest through skilled funds.

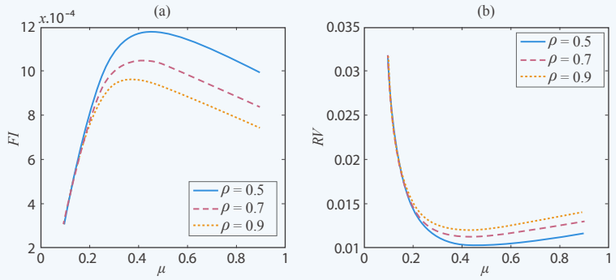


Figure 3: Implications of institutionalization for market quality in exogenous equilibrium. The left (right) panel shows equilibrium price informativeness (return volatility) with respect to the level of institutionalization, μ, for different fund uniqueness $\rho = 0.5,0.7,0.9$, where the parameter choices for the precision of fundamental value, private infbnnation, noise interpretation and noise trading are $\tau_v = 25, \tau_\varepsilon = 5$, $\tau_z = 2500$ and $\tau_x = 25$, respectively, and the risk averse coefficient $\gamma = 2$.

Figure 3: Implications of institutionalization for market quality in exogenous equilibrium.

Note: He, X., Kang, J., & Zhou, X. (2022). Quantitative Investing and Price Informativeness.

Endogenous Financial Market Equilibrium

In endogenous case, as shown in Figure 2b, each retail investor can endogenously decide whether to spend search cost to find skilled funds and invest as an "expert allocator" or invest directly on his own account as a "household". Intuitively, the search cost decreases with the increasing number of the skilled funds and increases with the increasing number of expert allocators. Each quantitative manager can endogenously decide whether to spend information cost to acquire current price information for being a skilled quantitative institution. Different from exogenous case, the number of skilled funds is determined by the model endogenously. Therefore, the fraction of investors invests through skilled funds and the institutionalization level are determined by the model endogenously. Expert allocators and skilled funds will negotiate a fee, while unskilled institutions follow the same fee structure. As in Gârleanu and Pedersen (2018), the fee is set through a Nash bargaining, and the fee is influenced by the bargaining power of the expert allocators and skilled funds. In an interior equilibrium, investors have an indifference curve, in this curve, investors are indifferent between searching for a skilled manager and investing directly. Quant fund managers also have an indifference curve where managers are indifferent between becoming skilled and staying unskilled.

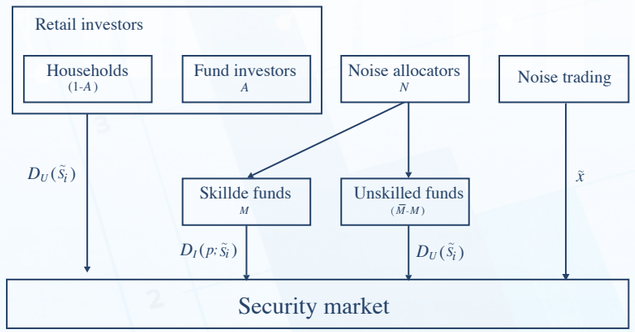


Figure 2b: Asset and asset management market structure for endogenous equilibrium. Among institutions, some are skilled funds (with current price information) and the others are unskilled (without current price information). In addition to noise allocators (who randomly choose between skilled and unskilled managers), among retail investors, fund investors invest through the institutions while the rest are households who invest directly in the security market.

Figure 2b: Asset and asset management market structure for endogenous equilibrium.

Note: He, X., Kang, J., & Zhou, X. (2022). Quantitative Investing and Price Informativeness.

After calculation and simulation, the findings as in the figure5. Figure 5(a) illustrates that for given fraction of the expert allocators and fund management fees, cheaper access to price information will incentive funds to collect price information. Therefore, the fraction of the skilled funds increases as the information cost decreases.

As showed in Figure 5(c). For exogenously given trading strategy similarity (ρ), higher institutionalization can benefit price informativeness. However, higher institutionalization brings more crowded strategy, and a cheaper information cost also promotes the fraction of the skilled quant funds, leading to a more crowded market. As a result, the trading strategy similarity (ρ) is increased, which demotes price informativeness under the same institutionalization level. Thus, the total impact of institutionalization on price informativeness is negative as in Figure 5(c) black line. In general, this negative effect due to more crowded market dominates the trade-off, making price less informative, a different mechanism from the one in the exogenous equilibrium.

Professor He further points out that an increasing in information processing capacity can potentially overcome this problem so that the reduction in the information cost can make price more informative. With immense progress in computing, quantitative funds with high-frequency technology and access to consolidated tapes to provide real time price information have muscled out traditional funds from their previous pre-eminence in equity market dealing. As a result, financial institutions' ability to deal with comprehensive data has been improved significantly. This can be characterized by an decrease in the variance of additional noisy term or an decrease in the variance of common errors in price interpretation. Figure 5(d) shows that the institutionalization instead promotes the price informativeness when information process capacity increases. Comparing Figure 5(c) and 5(d), with relatively higher information process capacity, the noise in information interpretation is lower, which decrease the negative impact from the more crowded market.

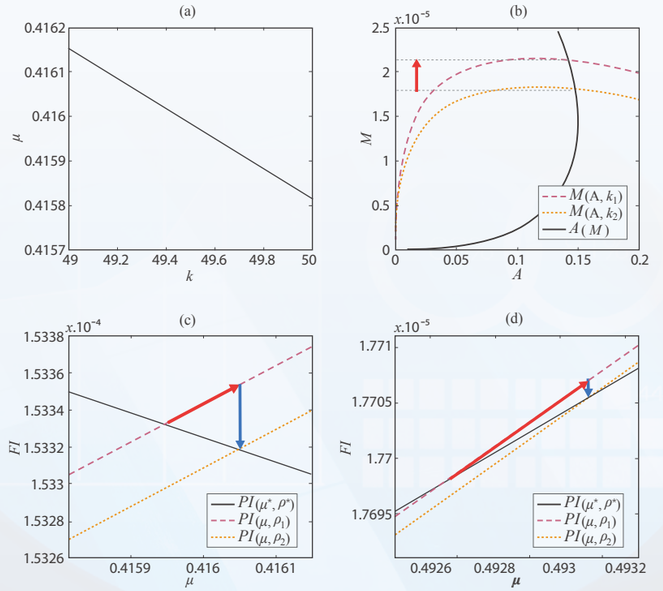


Figure 5: Implications of institutionalization for market quality in endogenous equilibrium. Panel (a) shows the equilibrium institutionalization level μ with respect to information cost k. The parameter choices for the precision of noise interpretation is $\tau_z = 2.5\times10^5$, the fraction of noise allocator $N = 0.3$, the total number of funds $\bar{M} = 4 \text{ X } 10^{-5}$, the bargaining power of skilled quantitative institutions $\Psi = 0.497$; the searching cost is determined by $c(M,A) = 8.9 \times 10^{-7} \times (A/M)$ and the fund uniqueness is defined by $\rho(M,\bar{M}) = M/\bar{M}$. respectively. The other parameters remain the same as in Figure 3. Panel (b) shows how investor's indifference curve (black solid line) and manager's indifference curve (dotted puik line for k=49.3 and yellow line for k = 49.6) jointly determine the endogenous equilibrium for asset and asset management market, the other parameters remain the same as in Panel (a). Panels (c) and (d) show the change in the equilibrium price informativeness with respect to institutionalization via the change in fund uniqueness when the information cost decreases from $k = 49.6$ (dotted yellow line) to $k = 49.3$ (dotted pink line) for given $\tau_z = 2.5 \times 10^5$ (panel (c)) and when the precision of noise interpretation increases from $\tau_z = 2.5\times10^5$ to $\tau_z = 2.5\times10^6$ (panel (d)). The other parameters remain the same as in Panel (a).

Figure 5: Implications of institutionalization for market quality in endogenous equilibrium.

Note: He, X., Kang, J., & Zhou, X. (2022). Quantitative Investing and Price Informativeness.

> With immense progress in computing, quantitative funds with high-frequency technology and access to consolidated tapes to provide real time price information have muscled out traditional funds from their previous pre-eminence in equity market dealing.

Conclusion

The main takeaways are that with imperfect price interpretation, quantitative investing can affect price informativeness through two distinct economic mechanisms. Directly, it brings more informed capital with superior price information, improving price efficiency. Indirectly, due to common error in institution's price-processing, imperfect price interpretation injects systematic noise into equilibrium outcomes, reducing price efficiency. Given exogenous fund market structure, relatively high investors' capital flows to quantitative funds can make the indirect effect dominate, reducing price informativeness. In an equilibrium with endogenous determined asset and fund market structure, apart from lowing information cost inducing more capital flows to quantitative funds, lowering information cost further motivates the formation of quantitative funds. This endogenous strategy crowding makes noise information interpretation become more correlated, distorting information aggregation and demoting price informativeness. From this model, the policy implications are limited information process capacity can be harmful for market and an improvement in information processing capacity can relieve the problem and improve price efficiency and market stability.

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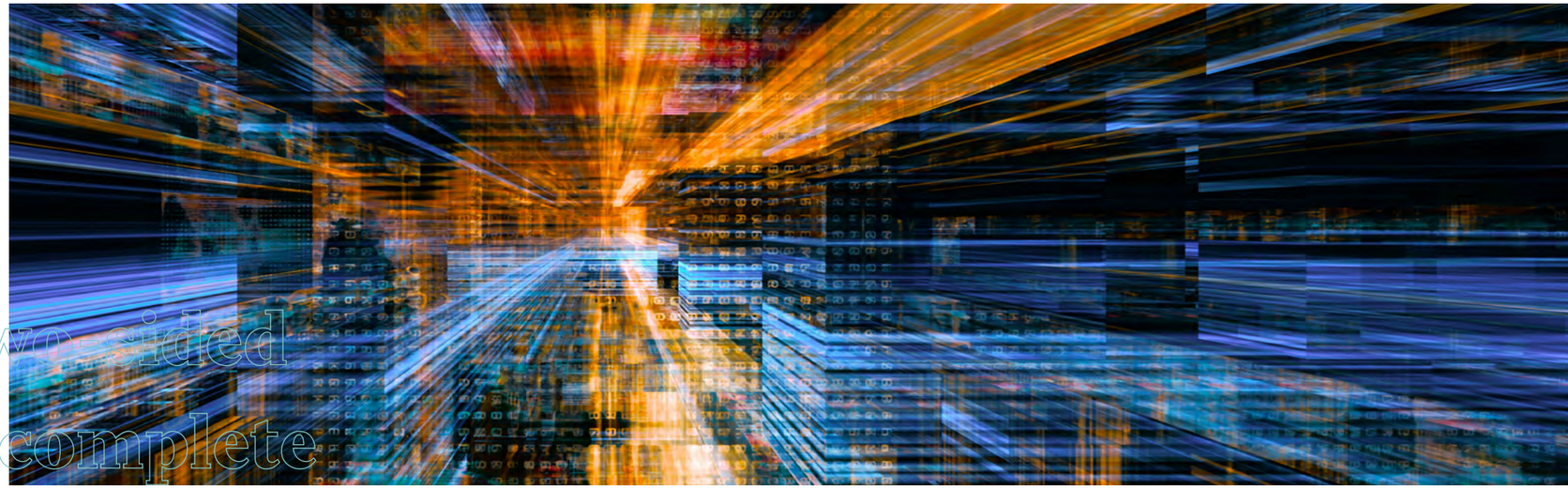
Stability and Efficiency of Two-Sided Matching Market

Author of the paper : Qingmin Liu

Author of this article : Tianye Lin

This article summarizes Professor Qingmin Liu's keynote speech delivered on May 15th, 2022 at the 6th PKU-NUS Annual International Conference on Quantitative Finance and Economics. The title of the paper is "Stability and Efficiency of Two-Sided Matching Market". It shows the importance of the cooperative theory with incomplete information. The findings can be widely used in matching markets such as labor market matching, marriage matching, and buyer-seller matching.



Two-sided Incomplete Information

To illustrate main findings of this paper, I would like to use the example of the labor market where workers and firms are looking for each other to form a one-to-one matching. Since this is a paper on game theory, I will introduce each part of the game first. There are workers and firms which are called ***players*** in the game. Each player has its ***type***, which means the characteristic of this player. For example, some workers are more skilled in computer coding but others are better at communication; some firms ask their employees to work overtime while others do not. A player's type is his or her private information and cannot be found out by other workers and firms. Therefore, players can only form ***beliefs*** about the probability of their opponents being of certain types. Despite that, they know the ***payoff*** structure of each pair of combinations. That is, although a player does not know others' types, he or she does know the income and profit of any type of worker and firm, as long as they are matched.

The game researched by this paper is called the two-sided incomplete information and is extended from the early work of one-sided cases. The essential difference between them is that a one-sided incomplete information game allows one side of players has information superiority over the other side. In the labor market example, it means that workers can perfectly distinguish firms' types but firms cannot tell the difference between workers. But in the two-sided case, such an advantage disappears. Both sides have to "guess" their opponents' type.

Beliefs are changing over time. Before the labor market opens, players have initial beliefs. Given that, workers can choose between finding a job (being matched with a firm in the game) and staying unemployed (staying unmatched). Each firm also has to decide whether to match with a worker or stay unmatched. After seeing the matching result (which worker is matched with which firm), players will update their beliefs. For example, a worker used to believe that all firms only require workers with high education, but he may turn to believe that some firms still want to employ workers with lower education after seeing that all people are employed.

The changing belief raises two questions. The first is: After the belief changes are ex-ante optimal decisions also ex-post optimal for players? The answer is not always. For example, workers may resign after being employed for only several months. In a game, such behavior is called ***deviation***. This paper only focuses on the ***stable*** result where every player thinks he or she cannot become better off by (1) stopping matching with anyone or (2) matching with others who also would like to deviate. The second question is: can ex-ante optimal decisions lead to the ex-post efficient result of the whole economy? Here, an efficient result means maximizing the total payoff of all players. The answer is yes, but conditionally. This paper would like to refine reasonable beliefs to achieve that.

Before talking about the belief refinement, I would like to introduce an example of a two-sided incomplete information game show in the Figure 1. There are two types t_i and t'_i for the worker and two types t_j and t'_j for the firm. Each pair of numbers in the matrix is the payoff of a pair of worker and firm, e.g. the payoffs of them are both 1 when a type t_i worker is matched with a type t_j firm. In addition, the payoff is 0 for unmatched players. Assume that the initial belief (t_i, t_j) and (t'_i, t_j) is 0.3, and those of (t_i, t'_j) and (t'_i, t'_j) is 0.2. All the following illustration is based on this example.

> The changing belief raises two questions. The first is: After the belief changes are ex-ante optimal decisions also ex-post optimal for players?

	t_j	t'_j
t_i	1, 1	−2,−2
t'_i	−2,−2	−2,−2

Figure 1: Payoff Matrix of the Example

The belief refinement consists of two parts. In the first part, the worker updates the belief using the Bayesian rule:$P(A|B) = P(A) / P(A \cup B)$, where $P(\cdot)$ is the probability of an event. This rule calculates the probability of event A given that event B happens. For example, a worker's belief of event A (t_i, t_j) used to be the initial value 0.3. However, after the worker knows his or her type is t_i (event B), he or she can just ignore any information about t'_i. The belief of event A therefore becomes $P((t_i, t_j)) / P((t_i, t_j) \cup (t_i, t'_j)) = 0.6$.

The author then states the first theorem: As long as the players form their belief using the Bayesian rule and all players don't want to deviate based on their beliefs, the game's result must be optimal for the economy.

This theorem is not strong enough since the Bayesian rule may fail to restrict the belief. In the above example, the worker of each type will choose to stay unmatched, since the expected payoff is negative. So do the firm. Therefore the worker and the firm are not matched i.e. any outcome of the game does not happen, therefore the Bayesian rule fails.

However, if we look deeper, we can discover that a type t_i worker and a type t_j firm would both like to match with each other if they know their opponents' type. But how can they achieve that? Only the firm of type t_j wants to employ a worker so that it can receive the high payoff 1. Therefore, if a worker sees such a firm, he or she should be 100% confident that this firm is of type t_j. And the type t_i worker will match with it. The firm can infer a worker's type in a similar way. The matching of a type t_i worker and a type t_j firm can also raise the total payoff of the economy from 0 to 2. This is exactly what the second theorem of the paper talks about. It is saying that instead of using the Bayesian rule, a player can infer other players' types from their behaviors. Such a belief formation process is more realistic and can make the economy even more efficient.

The realization of matching between a type t_i worker and a type t_j firm requires both have the ability to infer the other player's type. Therefore, this theorem shows that we need the two way information transparency in the job market. Nowadays, workers can infer firms' preferences for employees through the internet. But it is much more difficult for firms to obtain enough information about workers in the market. They have to rely on the audition and the archival materials. This paper's result indicates that an official online platform for storing and sharing workers' information can raise the efficiency of the job market and therefore raise the welfare of the whole economy.

The Big Tech Lending Model

Author of the paper : Wei Xiong Author of this article : Bairu Zhu

This article summarizes and discusses Professor Wei Xiong's conference keynote presentation delivered in August 2021 at the Peking University HSBC Business School.

Recently, there has been a quick rise of technology companies in offering financial services across the world. By using massive amounts of data to improve credit assessments, as well as real-time information and platform advantages to enforce repayment terms, technology companies appear to be doing what traditional lenders have not: making loans to millions of small businesses at attractive rates and experiencing remarkably low default rates. This new type of loan is called Big Tech Lending, and Ant Group is the most famous Big Tech lender in China. In contrast, FinTech is defined as financial innovation based on the use of digital technologies and big data, and in this keynote it mainly involves the traditional financial institutions such as banks. According to Cornelli et al. (2020) , Big Tech credit volume may have been as large as USD 572 billion in 2019, which is at least twice as much as that of Fintech. With the particularly strong Big Tech credit growth, some new questions have been raised.

There are three different views about the type of Big Tech borrowers. First, Big Tech lenders make credit available to borrowers who have great potential but are credit-rationed by traditional banks, allowing them to expand their businesses. Second, FinTech and Big Tech lenders enable borrowers with a particular desire to borrow beyond their means, leading to an excessive borrowing. Third, Big Tech lenders use big data to screen out a new set of borrowers with short-term liquidity needs.

Professor Xiong's research involving a comparison between the Big Tech loans made by Ant Group and loans made by a traditional bank supports this latter view. First, Big Tech loans are small loans with high interest rates to borrowers who are credit-rationed by banks, so there is no direct competition with traditional banks. Second, Big Tech loans have fast repayment and high frequency, which therefore cannot support business expansions or over-borrowing. Third, in contrast to common opinion, there is no significant difference in risk between Big Tech loans and bank loans. Fourth, the credit limit of Big Tech loans is more elastic, while the interest rate is relatively inelastic to measures of risk and alternative excess of credit, indicating that high interest rate is a mechanism to screen borrowers with liquidity needs. Finally, supply and risk of Big Tech loans are stable after the Covid-19 shock.

The data come from a non-top 4 commercial bank in China (Bank X), which can be divided into three groups: Big Tech loans, that is syndicate loans by Ant Group and Bank X, regular loans by Bank X, and FinTech loans by Bank X. As is shown in figure 1, compared with the other two types, Big Tech borrowers tend to be younger, more likely female, better educated, and more likely come from a rural area. Big Tech loans are more likely to be the first business loans, especially the first uncollateralized business loans of their borrowers. Among borrowers who provided credit reports, Big Tech borrowers have a much smaller amount of loans from other institutions. Overall, Big Tech loans make credit more accessible to borrowers who are credit -rationed by traditional banks.

Panel A: Borrower Demographics

	Age	Male	Undergrad	High School	Rural	County	City
Big Tech Borrowers	32.8	66%	38%	30%	31%	29%	40%
FinTech Borrowers	44.2	79%	18%	34%	16%	61%	23%
Regular Borrowers	43.0	83%	12%	26%	20%	58%	22%

Panel B: First Loans

	Number of Borrowers	First Loan	First Business Loan	First Uncollateralized Business Loan
Big Tech Borrowers	31046	27%	81%	91%
FinTech Borrowers	51739	4%	6%	7%
Regular Borrowers	22058	29%	43%	58%

Figure 1 Borrower Characteristics 1

Then Professor Xiong divides the sample into two groups by whether they are collateralized. He finds Bank X's regular loans are mostly collateralized, while Big Tech and Bank X's FinTech loans are mostly uncollateralized. Furthermore, Big Tech loans tend to have a lower credit limit and a much higher interest rate.

Panel A: Overall Statistics

	Number of Loans	Interest Rate	Credit Limit	Loan Size	Maturity (months)	Repay Once
Collateralized						
Big Tech	12,099	9.0%	840,509	135,741	11.2	63%
FinTech	37,917	5.1%	1,186,890	296,619	13.4	93%
Regular	152,991	5.5%	1,277,106	352,571	14.9	90%
Uncollateralized						
Big Tech	843,678	14.6%	71,963	8,367	10.0	15%
FinTech	113,233	8.6%	180,858	99,487	9.9	90%
Regular	34,933	8.5%	183,644	120,284	13.0	71%

Figure 2 Borrower Characteristics 2

After examining the overall statistics, Professor Xiong notes that whether and how quickly a borrower chooses to repay the loan early reflects what the borrower uses the loan for. If the borrower uses the loan to expand business or to borrow beyond their means, it is unlikely that the borrower will repay the loan early. Early repayment is possible only if the borrower uses the loan to meet short-term liquidity needs. The data shows that Big Tech borrowers are more likely to pay back before maturity, so the loans are more suitable for short-term liquidity needs.

Another characteristic of Big Tech loans is frequent borrowing, Because the convenience brought by the technology facilitates fast borrowing and repayment, interest expense per loan is much smaller for Big Tech loans despite their high interest rates.

In order to find whether Big Tech loans bear greater risk, Professor Xiong measures the repayment risk by the percentage of loans being overdue for at least 30 days. As is shown in figure 3, the risk of late payment is concentrated on borrowers without a prior payback record, and for borrowers with a payback record, there is no difference in overdue risk across the three types of loans. After controlling for paying off an existing loan, there is still no difference in the overdue risk, implying that Big Tech loans are more likely to meet liquidity demands.

Panel A: Summary Statistics of Payment Overdue

	Number of Loans			Ever Overdue >= 30days		
	w/o payback record	w payback record	Total	w/o payback record	w payback record	Total
Big Tech	215135	239272	454407	4.2%	1.2%	2.6%
FinTech	4048	64769	68817	1.1%	1.1%	1.1%
Regular	6706	12629	19335	1.5%	1.7%	1.6%

Figure 3 Repayment Risk

A small set of Big Tech borrowers are also able to access Bank X's regular or FinTech loans, so Professor Xiong can create an overlapped sample. He finds the same patterns in the overlapped sample, such as small loans, fast payback, and frequent borrowing, and the result of payment overdue is also the same as before.

Professor Xiong also focuses on interest rate, finding that it is only modestly related to payback record, a strong predictor of risk. Moreover, if the borrower has access to loans from other institutions, the interest rate will be lower, meaning that Big Tech lenders will not compete for borrowers by slashing interest rates; a high interest rate may serve to screen borrowers with liquidity needs.

As is shown in figure 4, while Bank X's regular and FinTech loans displayed strong seasonality around Chinese New Year because of Covid-19 shock, the supply and interest rate of Big Tech loans remained stable across the Covid-19 period in the sample. There is also no evidence of overdue risk rising for Big Tech loans originated after the Covid-19 shock.

In sum, with a fresh and high-quality dataset in China, Professor Xiong successfully displayed a Big Tech lending model, which shows Big Tech lending has a specialized role in serving borrowers' liquidity needs. It will be a good reference for the development and regulation of Big Tech lending in the future.

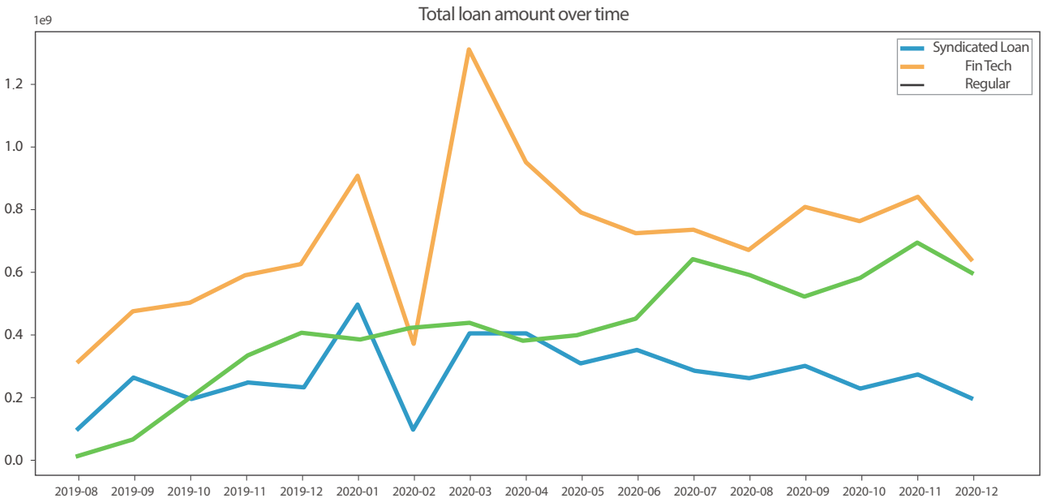


Figure 4 Supply of Loans

In sum, with a fresh and high-quality dataset in China, Professor Xiong successfully displayed a Big Tech lending model, which shows Big Tech lending has a specialized role in serving borrowers' liquidity needs. It will be a good reference for the development and regulation of Big Tech lending in the future.

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