Research Assessment Exercise 2020

Impact Case Study

University: The University of Hong Kong (HKU)
Unit of Assessment (UoA): 21. Economics and Finance
Title of case study: Research into Practice: the analysis and implementation of Financial Technology (FinTech) in contemporary financial markets' efficiency, competitiveness and stability

(1) Summary of the impact

The rapid development of FinTech offers novel solutions to financial market inefficiencies by making finance more available to small business and consumers; yet it has also led to concerns about financial stability, which relies on proper management of financial risks. These practical problems, of global reach and deep significance stimulated the basic research conducted into risk modelling, assessment and management at HKU. Led by Professor Chen **Lin** since 2013, the Centre for Financial Innovation and Development (CFID) has convened a group of experienced researchers in the Faculty of Business and Economics (FBE) to conduct intensive research on 'FinTech and Financial Stability'. The research has contributed to and affects the competitiveness of some of the world's largest companies, FinTech firms, financial institutions and regulators, as well as enhancing financial market stability and soundness. Specific impacts of HKU's research include:

- Introducing (i) a new generation of credit limit models and (ii) high-performance credit risk models with machine learning and deep learning for China Construction Bank (CCB).
- Influencing the curriculum design of internal executive training for CCB.
- Contributing to the configuration of FinTech-related policies on the Currency Board Sub-Committee of the Hong Kong Monetary Authority (HKMA) to maintain and regulate financial stability alongside financial innovation.
- Contributing to the promotion of applied research in the fields of monetary policies, banking and finance that are of strategic importance to Hong Kong and the Asia region, through the Hong Kong Institute of Monetary Research (HKIMR) and the Hong Kong Academy of Finance.

(2) Underpinning research

CFID is one of seven research centres in FBE which organize programmes of research leading to impacts on firms, markets, or policy. Research by Professor **Lin** and the research team at CFID in the past six years centres on crucial issues that address the question of how to maintain financial stability while using FinTech to promote inclusive finance and sustained economic growth. Financial markets rely upon good quality risk assessment of firms and projects when deciding upon the offer of credit. A grand challenge facing all economies in achieving inclusive finance and sustainable development is how to assess risks for consumers and small and medium enterprises (SMEs), and thus to provide adequate financing for them. On the one hand, consumers and SMEs contribute significantly to economic activity and growth (60% of Hong Kong GDP, 80% of employment and 90% of enterprises). On the other hand, only a small portion of consumers and SMEs have adequate access to finance (the global finance gap for SMEs is estimated by the International Finance Corporation as US$5.2 trillion). A major reason is that the traditional banking sector primarily serves listed companies and large firms that possess and can publish detailed financial statements and other "hard information" such as collateral and past credit history. SMEs and consumers mostly possess "soft information" that is difficult to collect, standardize and communicate. At the same time, while FinTech initiatives (such as online peer-to-peer lending) have been expanding credit aggressively, there remain significant concerns about financial risk and stability. There is an urgent demand from the industry for relevant research to address these challenges. This pull factor for impact was picked up by **Lin**'s team at CFID, stimulating the world-class research into FinTech and financial stability that is now published in major international academic journals in the finance and econometric disciplines [**3.1** to **3.4**].

Lin, alongside young researchers, Dr. Ye **Luo** and Dr. Mingzhu **Tai**, built models on the base of theoretical insights and empirical techniques developed in existing studies. Specifically, **[3.1-3.4]** examine bank lending to consumers and small businesses, the base information for financial decisions, effects of risk exposure in bank portfolios, the 2008 banking crisis and macro conditions; all providing insight and guidance for the design and conceptual framework of the models: data, parameter selection and construction; and the incorporation of macro-level factors that make the model capable of dynamic evolution and updating. **[3.5]** and **[3.6]** introduce academic papers from this frontier research in the econometric methods of machine learning that optimize model setup and performance. These complex machine learning methods have also been applied in addressing many practical problems in real banking data: including missing variables, large volume, or high dimensionality. The CFID team has collaborated with CCB to develop a new generation of credit limit models, equipped to convert "soft information" into hard indicators and providing an overall credit capacity for each individual customer, taking into consideration both macro-level and micro-level factors affecting income prospects and uncertainty, individual behavioural characteristics, consumption patterns and the evaluation of financial literacy. The team has also introduced various post-lending credit risk models, featuring (1) machine learning and (2) big financial data, leading to substantial reduction of loan default rates in experimental outcomes using CCB data. The research in the area continues: its outcomes are summarized in a recent joint working paper by **Lin**, **Luo**, **Tai** and CCB collaborators.

(3) References to the research

[3.1] Levine, R., **Lin, C.** & Xie, W. (2018). Corporate resilience to banking crises: the roles of trust and trade credit. *Journal of Financial and Quantitative Analysis*, *53*(4), 1441-1477. Journal ranking: 3.99*.

[3.2] Jiang, L., Levine, R. & **Lin, C.** (2016). Competition and bank opacity. *The Review of Financial Studies*, *29*(7), 1911-1942. Journal ranking: 12.52*.

[3.3] Levine, R., **Lin, C.** & Xie, W. (2016). Spare tire? Stock markets, banking crises, and economic recoveries. *Journal of Financial Economics*, *120*(1), 81-101. Journal ranking: 13.64*.

[3.4] Houston, J. F., **Lin, C.**, Lin, P. & Ma, Y. (2010). Creditor rights, information sharing, and bank risk taking. *Journal of Financial Economics*, *96*(3), 485-512. Journal ranking: 13.64*.

[3.5] Chernozhukov, V., Fernández-Val, I. & **Luo, Y.** (2018). The sorted effects method: discovering heterogeneous effects beyond their averages. *Econometrica*, *86*(6), 1911-1938. Journal ranking: 17.64*.

[3.6] Liang, F., Jia, B., Xue, J., Li, Q. & **Luo, Y.** (2018). An imputation–regularized optimization algorithm for high dimensional missing data problems and beyond. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, *80*(5), 899-926. Journal ranking: 6.41*.

*Journal rankings from academic ranking specialist https://www.scimagojr.com/index.php

(4) Details of the impact

The team's far-reaching research work has had extensive impact on the strategies and practices of FinTech companies and traditional banks. As seen above, co-creation of research and the development and testing of innovative FinTech modelling with CCB has delivered significant early impact [**5.1**]. It also carries significant implications for policymaking with respect to regulating and/or promoting financial innovation and managing financial risk. Impact arises in significant areas:

- The credit model development has helped CCB and other financial institutions improve credit risk assessment. Unlike traditional models setting a credit limit for each type of product that an individual uses, this model introduces a personal-level credit limit, measuring the overall credit capacity of individual borrowers, across all products. This is a very significant innovation. As individual customers have access to a variety of credit products (such as credit cards, mortgage

loans, consumption instalment loans), risk management based on product-level credit limits fails to capture the interaction of customers' different credit activities. This problem has become more severe as lending sources and products, especially online lending, have proliferated in recent years. The new model's credit assessments can be effectively used by large banking conglomerates via a centralized risk management system.

> *"This is the first time that the expected growth and volatility of income of individual customers, their behavioral traits and other human capital factors have been included in a credit model. The model is also the first risk-limits management model that is customer centered, while traditional risk management is product centered. .. The HKU team's expertise in related economic, finance and econometric theories and methodologies are the foundation of this project. In particular, the model is built on the team's research on banking stability and cutting-edge econometric methods in machine learning that help optimize the model setup and performance."* [**5.1]**

- The model helps CCB expand its business and market share with SMEs and consumers. CCB has over ¥23.22 trillion in assets and ¥13.78 trillion in outstanding loans. As a core risk management guideline in the bank, the model applies to over 800 million of the bank's individual customers, accounting for ¥6 trillion of debt. That amount is expected to rise dramatically with full introduction of the novel, more efficient and effective risk management model. By integrating across different credit products and improving risk assessment accuracy, it is estimated that the new credit limit model expands available credit for over 99% of customers: the median lifetime limit is expanded from ¥1,245,000 to ¥5,378,000. Furthermore, as the model is extended to the risk management practice for SME customers, it will further service over 70 million businesses, which contribute around one billion jobs and generate over ¥260 trillion in revenues per year.

- The scope and reach of the innovation is immense. Already it has impacted on the systems of a massive Asian bank. The model has been initially applied in CCB's centralized risk management system to coordinate screening, pricing, origination and monitoring across different business sectors. It will be further standardized by the team to a patent-protected, commercial FinTech product that could be used by other financial institutions with diverse retail credit businesses. CCB will also propose this methodology to financial regulators, including the Peoples Bank of China (PBoC) and China Banking Regulatory Commission (CBRC), for application in the supervision of national financial stability. The impacts above are strongly supported by the letter from CCB [**5.1**]. They illustrate the multiple pathways whereby research and impact interact and create a cycle of knowledge mobilization.

- The research has already entered into the second stage with progress made to introduce post-lending credit risk models that improve the performance of loan default prediction. Unlike traditional models based on simple statistical models and traditional data such as credit reports and earnings reports, the enhanced models feature new machine learning techniques such as deep learning and broader features of economic and financial behaviour, firms' and owners' internet footprints, which according to the CCB lead to substantial reductions of loan default rates as large as 67.36%, translating to an estimated saving in millions RMB.

  > *"Taken together, the new model can meet the rising demand of fast mobile internet banking and financial services for SMEs that requires an automatic, data-driven system to learn from data and make real time decisions by its own. We are highly satisfied with the outputs of this project and greatly benefit from it. We will continue our collaboration with the HKU team to further the development of the dynamic risk management system."* [**5.2**]

- The research has helped CCB renovate and enhance the curriculum of their executive training programme. Specifically, the research generates rich resources and data for executive training, across and related to a broad range of topics in FinTech, Financial Innovation, and Artificial Intelligence. The training motivates industrial professionals to reflect on their existing practices,

to understand new trends and developments in the industry, and to adopt new mindsets and approaches to improve their performance **[5.3]**. According to the trainees,

> "*Professor Lin has used his expertise in advanced theories and case studies to illustrate the effect of big data and FinTech in managing financial risks and promoting inclusive finance, which has influenced their daily practice in risk management and legal compliance*". [**5.3**]

The model development and training programme has also led to a strategic alliance between CCB and FBE for future collaboration in the co-creation model of impact generation **[5.4]**.

- **Lin** serves on the Currency Board Sub-Committee of the Exchange Fund Advisory Committee (EFAC) for HKMA **[5.5]** and contributes his research insights to the discussion of important monetary policies in Hong Kong. The EFAC plays a key role in initiating and reviewing monetary policy in Hong Kong. A key responsibility is to guarantee an effective and transparent policymaking mechanism, with crucial impact on the sustainability of monetary policy, stability of the financial market and Hong Kong's status as an international financial centre. Based on research and analysis of how macro factors influence borrowers' behaviours in the development of the credit model, **Lin** has been able to share his views on how policymakers can take into consideration the micro-level impact of policies on firms' and individuals' borrowing and spending activities, as well as the spill over effects within production or social networks, and thus better design the monitoring and early warning system in face of significant macro events.

- **Lin** also serves as a member of the Council of Advisers for the Hong Kong Academy of Finance and HKIMR under HKMA **[5.6]**, which is a government funding agency to review and approve proposal of research in the fields of monetary policy, banking and finance that are of strategic importance to Hong Kong and the Asia region. Professor **Lin** is the only academic member who sits on both Councils for Monetary Research and Applied Research. [**5.7**].

  > *"[Professor Lin] has used his expertise in banking and financial stability to help assess research proposals in the allocation of significant annual funding to support research focusing on the macro economy and financial system of China, Hong Kong and the Asia Region. … his work has made important impact to the research community, the financial industry and policy formulation."* [**5.7**: chairman of HKIMR]

Besides contributing to the policy-related research, he also facilitates the knowledge exchange between researchers, regulators, policy makers and industry practitioners, such as convening the Tenth Annual International Conference on the Chinese Economy on "China Financial Reform and Economic Transformation" in 2019 **[5.8]**. The conference brought together academics and regulators (PBoC, International Monetary Fund, the Ministry of Finance, HKMA, and U.S. Federal Reserve) to exchange ideas on the implications of financial reform and financial innovation on economic transformation and to provide policy guidance.

(5) Sources to corroborate the impact

[5.1] Supporting letter from CCB Risk Management Department on Phase I of the Project.
[5.2] Supporting letter from CCB Risk Management Department on Phase II of the Project.
[5.3] Thank-you letter from CCB trainees.
[5.4] Agreement between CCB and HKU Faculty of Business and Economics regarding Strategic Alliance in Impact Research Collaboration.
[5.5] The EFAC Currency Board Sub-Committee Membership: https://www.hkma.gov.hk/eng/about-us/the-hkma/advisory-committees/the-exchange-fund-advisory-committee/the-currency-board-sub-committee/
[5.6] HKIMR Council of Advisers: https://www.aof.org.hk/research/HKIMR/about-hkimr/council-of-advisers-for-monetary-research
[5.7] Supporting letter from the Chairman of HKIMR.
[5.8] HKIMR, Programme on the *Tenth Annual International Conference on the Chinese Economy* on "China Financial Reform and Economic Transformation", 2019.