Panel Discussion

Fintech, financial inclusion, digital currency, and CBDC

1. Introduction

On August 8, 2023, the inaugural Journal of Finance and Data Science Conference organized by Cheung Kong Graduate School of Business (CKGSB), Tsinghua University PBC School of Finance (Tsinghua PBCSF), and *The Journal of Finance and Data Science* (JFDS) featured a panel on Fintech moderated by Bernard Yeung. The panelists in alphabetical order were Huining (Henry) Cao, Yi Huang, Yiping Huang, and Xiaoyan Zhang. This article summarizes the panelists' and moderator's collective thoughts, organized around several major inquiries.

2. Fintech increases financial inclusion

2.1. A prima

Fintech refers to integrating technology into the product and service offerings of financial institutions to improve their delivery to consumers. The widespread adoption of mobile technology, particularly smartphones (owing to inexpensive chips) and high-speed Internet, paved the way for Fintech. Each adoption adds positively to other users' consumption capital (Stigler and Becker, 1977), and each entry to a platform raises the platform's attractiveness to current and future new members. Following their development, platforms have applied data analytics, algorithms, machine learning, artificial intelligence, and cloud computing to ensure timely assimilation of information and reliable prediction of near-future events and behavior. They offer payment apps, peer-to-peer (P2P) lending apps, investment apps, crypto apps, and robo-advisors, all of which are examples of Fintech applications. These offerings expand users' choice sets and experiences and may enrich their financial literacy.

Tech companies, e.g., Alibaba, Tencent, Google, Amazon, and Apple, initiated the Fintech revolution. The essence of the revolution is combining data, networks, and analytics to expand and deepen the ability of both the supply and the demand side to collect data and codify behavior. Furthermore, smart contracts provide safeguards to protect contractual interests. Ultimately, technological advancement deepens the information content of economic engagements, enables richer and more variegated product offers, and allows more efficient transactions. The spread and scaling up of ideas and operations will not be confined to tech companies. Many financial institutions are becoming tech companies. Exciting new ideas and new equilibria are yet to emerge.

Given that Fintech is an extensive topic, the panel decided to focus on the following sub-topics: financial inclusion, crypto-digital arrangements, and the Chinese e-yuan (e-CNY), which is China's Central Bank Digital Currency (CBDC).

2.2. Fintech and financial inclusion

In leveraging technology to offer innovative financial services, companies find business opportunities for clientele who have been underserved historically or excluded from the traditional financial system. Panelist Xiaoyan Zhang mentioned that Alipay, as a digital platform, enables users to make online and offline transactions securely and conveniently and allows people in remote or underdeveloped regions to access essential financial services.

Many research papers report empirical support for Fintech's impact on financial inclusion. Although we do not offer a survey of the vast literature,[1] we highlight two papers presented at the inaugural Journal of Finance and Data Science Conference in Beijing (the JFDS-Beijing, 2023 Conference) that report directly relevant results. Bian et al. (2023) show that the rise of "buy-now-pay-later" in China, while strategically displacing competing e-payment options, identifies and expands credit to currently underserved customers.

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[1] We apologize to authors who have made significant contributions to the topic of the relationship between Fintech and financial inclusion.

Hong et al. (2022) show that higher Fintech adoption results in higher participation and more risk taking in mutual fund investments at the individual and regional levels.

Fintech raises financial inclusion in a broad sense. The fundamental point is that Fintech can reduce market participants' potential transaction and learning costs and thus expand consumption and investment boundaries. Panelist Yi Huang drew the audience's attention to a number of papers and noted that Fintech simplifies ways to make purchases and transfer money and reduces the reliance on cash and physical access to bank branches. Agarwal et al. (2019) show that adoption of the QR technology in Singapore reduces transaction costs at both the buyer and seller levels, resulting in expanded consumption footprints and enhanced small business entries. Agarwal et al. (2020a) further show that banks change their business strategies in response: they reduce their ATM outlets and promote the usage of credit cards via reduced fees, interest expenses, and expanded credit. These results show that mobile payment technology lowers transaction costs and materially affects the market equilibrium.

2.3. The DNA journey

The panelists opined that Fintech's journey in raising financial inclusion starts with e-payments, spreads to e-credits, and then advances to multiple financial services.

E-payments leave transaction trails. Tech companies (e.g., Alibaba, Tencent, Amazon, and Apple) run exchange platforms leading to voluminous mobile payments worldwide. These platforms possess individualized and aggregate transaction records that are explorable and exploitable, with obvious consequences. Quoting Shin (2019), panelist Yi Huang referred to these records using the term DNA, which denotes data, network, and analytics. Frost et al. (2019) consider digitization-driven changes in financial intermediation. They argue that big-tech firms often start with payments and expand into providing credit, insurance, savings, and investment products directly or in cooperation with financial institution partners. Focusing on credit, they show that big-tech firms lend more in countries with less competitive banking sectors and less stringent regulations than in other countries. This is an expandable approach: Agarwal et al. (2020b) show that, using the unstructured data of a consumer's social and mobile footprints, they can predict a large Fintech lending firm's loans (which are based on the Fintech firm's proprietary loan-level data). They find that the mobile footprints of individuals outperform the credit score in predicting loan approvals and defaults.

2.4. The consequence

Clearly, big-tech companies can use their platform residents' transaction records to identify their credit needs and their probability of paying back debts (i.e., their creditworthiness). Data for collateral substitution emerges.

Indeed, Gambacorta, Huang, Li, Qiu, and Chen (2020) show that large technology firms (big techs) use massive amounts of data to assess firms' creditworthiness and limit the reliance on collateral in solving asymmetric information problems in credit markets. They use Ant Group's data to show that big-tech credit does not correlate with local business conditions and house prices but reacts strongly to changes in firm characteristics, e.g., transaction volumes and network scores used to calculate firm credit ratings. By contrast, collateral or non-collateral-based bank credit responds significantly to local house prices, which are indicators of clients' operational environment. The authors conclude that "a greater use of big-tech credit—granted based on machine learning and big data—could reduce the importance of collateral in credit markets."

This development is akin to water filling in cracks. The platform borrowers are mostly middle- or low-income individuals or small businesses. Frost et al. (2019) suggest that big-tech lenders do not replace the role of big banks. Tech companies and banks play a complementary role, each serving a different class of clientele. However, panelist Yi Huang points out that potential borrowers with high credit scores can later obtain credit and experience business growth. Hence, some of big tech's small borrowers could be future big corporations.

Empirically, digital lending has been growing, even during the COVID-19 period. However, the ratio of digital lending to a country's credit stock is still small (Cornelli et al., 2020).

2.5. From credits to financial services

Big-tech companies expand into providing investment products and services, e.g., offering digital wealth management. They lower the barriers to investment and provide easily accessible investment options, even for those with limited funds. Panelist Xiaoyan Zhang pointed out that in China, Yu Ebao, a money market fund launched in 2013, allows individuals to invest their spare cash, which is particularly beneficial for individuals with small savings who might not have access to traditional investment opportunities.

Xiaoyan Zhang provided further the example of Zhi Xiao Bao, a Chinese company that uses artificial intelligence to deliver personalized financial advice to users. It acts as a virtual financial advisor, helping them make informed decisions and manage their money more effectively. Panelist Yi Huang, drawing insights from Guo (2023), pointed out that an investment platform can use robot advisors and communicate via live-streaming and articles to help clients increase their financial literacy, leading to long-lasting improvements in their portfolio investment decisions, raising diversification, and mitigating excessive trading.

2.6. Key drivers

Panelist Xiaoyan Zhang discussed the key drivers of Fintech in extending financial inclusion.

IT infrastructure certainly plays a key role; it offers inexpensive accessibility to high-speed Internet and enables the widespread usage of mobile devices in society. WeChat Pay and Alipay are popular because their apps are widely installed on the population's mobile devices. The growth of Fintech services and the extension of financial services to previously hard-to-reach people naturally follow.

Government regulations also play a crucial role in promoting Fintech growth. Governments encourage Fintech innovation by establishing regulatory sandboxes and providing funding opportunities and tax incentives for R&D, and so on. As Fintech companies often deal with sensitive financial and personal data, governments enact regulations to ensure data privacy and protect consumer rights.

Finally, the growing wealth of individual Chinese investors has brought strong financial demand. Investors are drawn to Fintech companies offering disruptive solutions and innovative business models that have the potential to generate high returns. In addition, these models allow them to make direct investment decisions.[2] Furthermore, Fintech investments provide opportunities for diversification because they may be less correlated with traditional asset classes.

2.7. Seeing the future?

Big-tech companies currently dominate the development of Fintech, particularly in terms of increasing financial inclusion. Their platform networks, data, and analytics allow them to develop their acumen in spotting business opportunities and developing strategies and products to capture them. Their products—e.g., lending, wealth management instruments, and even financial advisory—cater to smaller clients than hose served by traditional financial institutions.

To gauge the future, the panelists together raised a few important questions.

- How scalable and sustainable is digital lending?

Fintech companies have moved into the spaces that are "traditionally" underserved or even unserved by banks. However, banks can replicate the "data, network, and analytics" framework that drives the result. Banks themselves have a significant network and can code, collect, and collate their clients' data (including credit card data).[3] With intelligent application of data analytics and machine learning, they can become a "tech company" in the "body" of a bank, as shown by, for example, Singapore's DBS. Indeed, Frost et al. (2019) and Agarwal et al. (2020a) have already hinted that banks can replicate big-tech companies' capabilities by investing in machine learning and intelligent data analytics.

Government intervention can easily expand the payment network. For example, Singapore's government introduced PayNow in 2017, making banks' private customer payment systems interoperable. The result is that all Singapore residents with mobile phones have a C–C, B–C, and B–B payment system on hand. The U.S. is introducing a similar system, FedNow, very shortly. The DNA framework can lead to expanded lending, both in terms of inclusiveness and the substitution of data for collateral. Open banking is another step that raises data portability with non-trivial consequences.

It will be interesting to observe how these developments change financial intermediation. Many anticipate greater competition, which benefits borrowers and perhaps expands financial inclusion. However, information-based lending will differ from collateral-based lending regarding risk premium pricing and maturity. All these changes will lead to significant changes in financial intermediation and market behavior. The future is awaiting innovative entrepreneurs' imaginations and financial economists' research.

- *Pertinent regulatory and financial stability issues*

One issue is whether modern analytic-based lending will reduce or increase discrimination, an important issue in financial inclusion. On the one hand, data-based decisions, unlike face-to-face decisions, could mitigate discrimination. Kabir and Ruan (2023) examine an experiment in adopting anonymous loan applications in an online platform in Singapore. They show that anonymization at the beginning phase of credit consideration reduces the racial gap in initial (i.e., first-time) loan offers but does not impact post-lending performance. This result, and other similar papers, leads us to expect that data-based interactions that mitigate the influence of gender/race/appearance influence will raise merit-based credit offers. On the other hand, it is well known that machine learning could be characterized as "black-box-in and black-box-out." We should be wary of potential statistical discrimination in this domain.

The simplest and most tempting regulatory action involves leveling the playing field in the sense that big-tech companies currently face fewer leverage constraints than banks. Although this may appear to give tech companies an advantage, the extra freedom may induce lower trust and thus raise their cost of capital. It will be interesting to observe how regulators will level the playing field. Moreover, as changes continue to emerge, the nature of the optimal equilibrium regulations remains unclear. The world is awaiting good research on this issue.

Financial decisions based on data and data analytics could have fault lines leading to new regulatory issues. Data-based decisions could be manipulated. Given the current technology, textual analyses and machine learning can encode a wealth of information into

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[2] A speculation is that Chinese are averse to agency problems and that they strongly prefer direct retail investment decisions. This speculation awaits empirical investigation.

[3] There are many reasons, ranging from economics to organizational factors, for banks to leave some potential clients behind, including severe information asymmetry, credit rationing, and organizational inertia. These underserved potential clients might obtain their credit via private borrowing or lending clubs. Many of these are grounded on relations based on bias or collateral-based decisions. Data-based lending decisions may be an answer to these biases.

data points. Indeed, researchers have now managed to convert qualitative textual content, such as regulatory announcements, news articles, and earnings reports, into quantitative data, e.g., Bybee et al. (2021) propose measuring the state of the economy via textual analysis of business news. Inputting such data into financial decisions is a natural step.

Historically, "pump and dump" has been a concern. In the current era, "manipulation and scheme" is a similar issue. Social media can be manipulated to affect public opinion and politics. The unscrupulous could manipulate social media to influence short-term artificial price movements to their advantage. Likewise, equally unscrupulous individuals can engage in manipulative transactional behavior to trap creditors.

Even if they are free of manipulation, data-based credit decisions are different from traditional lending decisions. In a paper presented at the JFDS-Beijing 2023 Conference, Su (2023) conducts a theoretical investigation of the macroeconomic implication of big-tech lending. An intuitively appealing conjecture is that big-tech lending leads to more efficient allocation, greater instability at the individual level, and, thus, a higher default rate.

New tools such as machine learning and artificial intelligence allow sharp short-term predictions and very intelligent policymaking. For example, one may be able to train machines with data and economic theoretical rules to predict crises (Fouliard et al., 2023), enabling policymakers to forestall them. However, human beings act and react to policies—true behavior parameters are hard to identify and may even be an artificial construct for analytical purposes. How free such a tempting policy practice is of the Lucas critique (1976) deserves attention.

3. Crypto instruments and transactions

3.1. Crypto and distributed ledger

The panel's second focus is on crypto instruments and transactions. In 2008, after the Lehman crisis, Bitcoin emerged based on blockchain, a part of the distributed ledger technology. (Not all distributed ledgers are blockchains.) Some may read Bitcoin as a private sector generated virtual currency devoid of government control. However, its transaction speed is slow, the volume is small, and its "value" has been volatile. It did not meet common-sense criteria for money: unit of account, medium of exchange, and store of value. Bitcoin is currently seen as in the virtual asset class. However, it still could be a means for concealing transactions or even money laundering. China has banned crypto transactions.

Panelist Henry Cao pointed out that blockchain and, more generally, distributed ledger create code-based trust and allow people to exchange value in a trustless environment. It has many potential applications in supply chain finance, cross-border payments, non-fungible tokens, Web 3 applications, and decentralized finance.

3.2. Fruitful exploration

The panel's conversation focused on crypto transactions. Panelist Henry Cao led the discussion. Although China has banned centralized trading of crypto assets in mainland China, it does allow crypto assets trading in Hong Kong Special Administrative Region under the recent new regulations established in 2022. Thus, Hong Kong's experience will determine whether crypto asset trades can affect financial stability. Hong Kong is also seeking to introduce stablecoins to the Hong Kong dollar and potentially overseas renminbi (RMB) and thus may find new uses for RMB, which may boost the currency's influence in global finance.

Moreover, China encourages applications of federated blockchain in supply chain finance, taxation certificates, and commercial papers. These applications and potential new ideas can facilitate the diffusion of distributed ledger technology among young people in China.

3.3. Appling the distributed ledger technology

The application of distributed ledger technology in initiating cryptocurrencies provides a useful illustration of the technology's potential. Distributed ledger opens new possibilities to increase transactional and contractual efficiency. The world is awaiting meaningful applications of the distributed ledger. In the future, many traditional financial services such as stock trading, futures and derivatives trading, banking, assets management, and insurance can all be implemented on a global distributed ledger, which will reduce cross-border transaction costs significantly. These developments will need more research by the relevant regulatory parties. The panel members anticipate many exciting developments in this direction.

4. CBDC and policy considerations

Finally, the panel focused on CBDCs, which many central banks are currently exploring or developing. According to surveys by the Bank for International Settlements (BIS), a wide range of policies motivate such activities, including financial inclusion, implementation of monetary policy, cross-border payment, and financial stability.

Panelist Yiping Huang suggested that one direct trigger was the recent development of cryptocurrencies and stablecoins. Most central bankers have regarded cryptocurrencies such as Bitcoin as digital assets more than as digital currencies. However, Facebook's release of a white paper on stablecoin Libra in June 2019 significantly changed these perceptions. Libra could potentially become an international payment instrument for 3 billion people in more than 100 countries. Although the plan for Libra subsequently collapsed, it prompted central banks to realize that they faced an important choice: regulating private digital currencies or developing their own CBDCs.

The persisting concern of central banks stemming from the Libra issuance is that a popular foreign cryptocurrency, and/or that of a private entity, may become a widely adopted means of transaction, even a unit of account, and a store of value. Thus, domestic fiat money and the government's ability to manage its own economy would substantially diminish. There are many important considerations. First, central banks must prevent or at least restrict illegal activities, e.g., tax evasion and money laundering for unlawful activities. Transactions connected with these activities are often conducted via cryptocurrencies. Second, central banks must retain their options for effective capital flow management, exchange rate management, and monetary policy. Having sovereignty over their country's "money" is crucial in retaining these options. Third, one of the government's fundamental roles is maintaining a stable, value-enhancing monetary and financial system that facilitates a smooth and inclusive economic growth path. Allowing foreign or privately engineered "money" to displace government-controlled home money is unacceptable; these parties will not adopt a benevolent attitude to caring for the home economy.

Although perhaps these concerns may be extreme, nevertheless, the interest of central banks in CBDCs has increased visibly since 2019.

4.1. The form and the distribution of CBDCs

Before the panel further discussed central banks' considerations on whether to launch CBDCs, they jumped forward slightly to consider the form of CBDCs and the institutional arrangements for distributing them.

CBDCs can be account-based or token-based. The former is more tedious to use but gives the issuing central bank holistic access to transaction information. A token-based CBDC is similar to a central bank-sponsored legal tender; it is much easier to use than an accounting-based CBDC. However, although it is not impossible, the government would need to exert much more effort to track all transactions under a token-based CBDC than under an account-based CBDC.

A CBDC is a central bank's liability. The central bank can make a CBDC directly available to all the residents of a country, just as it does with government-sponsored paper money. In this case, the country's money is the sum of the CBDC held (that is the monetary base or narrow money). Alternatively, the central bank can distribute CBDCs in a tiered system; that is, CBDCs are distributed to financial institutions, just as bank reserves are, and financial institutions can distribute them according to their credit and deposit arrangements with clients. A bank's lending, equity, and reserve deposits in the central bank would involve some stipulated ratios. Thus, a bank can make its lending a "multiple" of its reserves and equity, and the total bank balance sheet exceeds that of the central banks. In this case, the sum of bank balance sheets is a form of board money and is a multiple of the monetary base, which comprises CBDC and the traditional type of bank deposits in the central bank. Simply put, under the former arrangement, the CBDC becomes the narrow money circulating in the country. Under the latter arrangement, there are both narrow and broad definitions for money; money in circulation could greatly exceed the narrow money.

In deeming whether to issue a CBDC, a central bank can choose the appropriate arrangement to mitigate the negative factors and retaining the positive aspects. We describe these factors below, assuming that the central bank can create and distribute CBDCs in any of the above forms.

4.2. Positive and negative considerations in issuing CBDCs

First, we collate the general views before focusing on China's considerations in particular.

4.2.1. Positive considerations

During the introduction of the current session, the panel members explained the three vital reasons why central banks would not allow foreign or privately engineered cryptocurrencies to displace their home fiat currencies.

Panelist Yiping Huang, in particular, offered additional insights. There are several commonly proposed positive reasons for launching a CBDC. First, electronic fiat money can raise transaction efficiency, especially in international payments. (However, as explained earlier, a government can improve transaction efficiency by fostering interoperable mobile payment channels.)

Second, digitalizing currency can relax monetary policy constraints at the zero lower bound, e.g., using a negative interest rate. This arises if the central bank hosts residents' digital currency accounts and pays interest.

Third, through digitization, the government can acquire transactional information more readily than before. This can help collect taxes and gauge the country's economic trends from the national to the most microscopic levels. The result could be more efficiently targeted and effective public policies, including direct income redistribution.

4.2.2. Negative considerations

However, these advantages come with a price. A CBDC impacts the private sector's financial institutions and can affect economic behavior considerably. First, if residents can hold a CBDC in the central bank, as in the case of keeping a "bank" account, they will shift their money to the CBDC at any sign of bank vulnerability. Thus, financial intermediaries will be highly exposed to rapid bank runs. In addition, the banking system is a full reserve system. A central bank will have to be more vigilant in safeguarding financial stability and against banks' moral hazard behavior than ever under a CBDC. This will negatively affect the money multiplier, the cost of capital, and risk taking.

Second, concentrating transactions at the CBDC level may create significant operational risks for the central bank.

Third, concentrating transactions at the CBDC level may shift the duty of knowing your client and anti-money laundering to the central bank. The burden is nontrivial, and it remains unclear whether central banks can match the private sector's capability in this regard.

Fourth, if a central bank has micro-level transaction details and can access all residents' deposits, it may be tempted or pressured to conduct fiscal redistribution policies. The well-drawn line between fiscal and monetary policies would become blurry.

4.3. China's case

Panelist Yiping Huang opined that a critical issue for the central banks' thinking on CBDCs is whether they would address the main "pain points" of their financial systems. For instance, whereas central banks in developing countries focus on the impact of CBDCs on the efficiency and safety of domestic payment services, central banks in advanced economies emphasize their effect on the efficiency and safety of cross-border payments.

In China, the efforts of the People's Bank of China (PBC) to develop its own CBDC, the e-CNY, provide an interesting case study. The PBC is one of the pioneers in this area, exploring the idea from 2014 onward and experimenting with the e-CNY from 2019. The e-CNY is a retail CBDC, loosely coupled with bank accounts. It is token-based, and the distribution is a two-tier system, whereby it is first distributed to major banks and tech companies, which in turn distribute e-CNY to the public. The PBC does not pay interest on e-CNY accounts.

This clever design keeps the current monetary system intact and mitigates the negative factors mentioned above. In particular, the design avoids significant disintermediation of banks.

Furthermore, in the initial stage, the primary function of e-CNY is for small-amount payment activities, substituting mainly for currency in circulation. It has a transaction ceiling, which mitigates the risks of rapid runs among e-CNY wholesale distributors.

However, it is questionable whether a retail CBDC is required in China, given its already very advanced mobile payment service, with the two leading service providers WeChat Pay and Alipay. An important concept for understanding the PBC's efforts is "contestability"—the existence of the e-CNY could help ensure the competitiveness and inclusiveness of private payment services. For example, with programmability in e-CNY tokens, many entities could develop apps to compete for the business currently hosted on tech platforms or by big banks. This motivation is clearly behind the efforts of Sweden's Sveriges Riksbank to develop an e-krona, despite Sweden already being a cashless society.

There are pending questions. For instance, it is hard to draw definitive conclusions regarding the impacts of CBDCs on financial stability. Although introducing CBDCs may allow central banks and other financial regulators to monitor risks and take action in real time, it may also create means for market participants to react quickly, such as during bank runs.

4.4. Monetary policy

There are some discussions about the benefits of CBDCs for implementing monetary policy. As mentioned earlier, with CBDCs' programmability, it would be easier for central banks to implement negative interest rates. It could also create better ways of implementing "structural monetary policy," i.e., monetary policy instruments targeting specific economic sectors or enterprises. In theory, central banks can monitor and even direct flows of funds. However, although these are all potential functions that CBDCs could perform, these functions are probably not the most important motivations for central banks. Negative interest rates and structural monetary policies are unconventional policies.

However, CBDCs constitute a significant innovation in the financial system, and their significance should not be underestimated. In the perceivable future, two areas deserve very close watch. One is the effect of CBDCs on the transformation of financial intermediation, especially in relation to banks. CBDCs could change forms of investment and ways of collecting and processing data. The other area that requires ongoing attention is the effect of CBDCs on the reconstruction of the international payment system. Using CBDCs, countries could potentially engage in point-to-point cross-border payments with much greater rated speed, improved safety, and reduced costs. The BIS pilot project mBridge provides an important example. The main challenge is which legal system applies for such cross-border payments.

5. Conclusions

Advances in information technology have changed the world. With high-speed Internet, cloud computing, machine learning, artificial intelligence, and deep smartphone penetration, human beings have greatly enhanced their ability to codify, store, and process information. In addition, technological improvements help recognize, quantify, and predict outcomes. Our lives, organizations, and societies have substantially changed forever as a result.

"Finance," broadly speaking, is the central processing unit of a modern economy. It consists of two parts: a system that processes information to guide resource allocations, and a payment system. First, in the former case, ideally, individuals, corporations, and organized markets work to guide savings to the best uses to optimize general returns and redistribute risks based on the most effective collection and utilization of information. (The process, when perfect, will enable people to optimize while behaving trustworthily and acting trustingly, knowing that others are behaving trustworthily as well.) Second, in the latter case, the payment system ideally operates in a manner akin to cholesterol-free blood vessels, enabling frictionless flow of funds.

The finance world as we know it is far from perfect. The advent of IT could be the right medicine to improve information access, processing, and the flow of funds with fewer frictions. However, changes do not come automatically and will entail adjustments.

The JFDS-Beijing 2023 Conference panel's discussion on Fintech's impact on financial inclusion, cryptocurrency trading, and central bank digital currencies offered useful pointers on what Fintech entails.

The first point is the intertwined nature of the development of payment technology and financial inclusion. Advances in payment technology do more than make payments inexpensive and efficient; they leave deep data trails. Innovative organizations, such as big-tech platform companies, adopt a powerful DNA approach to collate and process information. With their sharpened understanding and prediction of individual and capital market users' behavior, they offer variegated financial services and products benefiting users and suppliers, particularly those previously not well served by the market.

Second, many governments are working on the interoperability of payment systems, either directly or via the issuance of electronic national money. Their work creates programmable data trails and instruments. It can raise market contestability and profoundly change financial intermediation domestically and internationally.

Third, although cryptocurrencies initially received considerable attention, it is their technological basis—the distributed ledger—that will enable profoundly improvements in the efficiency of many financial activities, such as trading financing, insurance, and others.

These developments have far-reaching implications. Traditional financial institutions have been searching for complementarity among their old business models, modern technology, and increasingly tech-savvy customers. More changes will come—capital market participants are changing their behavior, and analysts, accountants, lawyers, and investors are using the new technologies to sharpen their ability to identify investment opportunities and prices, distribute risk, monitor savers' shifting preferences, and fund users' behavior. Moreover, the improvements in payment efficiency will spread from domestic to international flows, impacting the global monetary system.

However, these changes will not be smooth necessarily, and the new equilibrium is hard to fathom. On the one hand, these changes could introduce new vulnerabilities. Increased efficiency could be accompanied by increasingly fluid customers and greater fund mobility, thus, requiring financial institutions to become more agile in managing their exposures. There may be newfound capabilities to manipulate the market, evade monitoring, regulations, and controls, or to conduct harmful regulatory arbitrage. In the aggregate, all of these possibilities could affect financial market stability. On the other hand, the increasing ability to collect and analyze information enhances the government's ability to track undesirable economic patterns and economic behavior at both the micro and macro levels.

New operation risks (e.g., cybercrimes) could arise and powerful IT could fundamentally generate black-box-in–black-box-out biases that harm social subgroups.

This is both an exciting time and a nervous time. Fintech generates both benefits and concerning developments. Academics, as a community, have a duty to understand the phenomena, help make positive changes, and warn our societies of potential dangers.

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Huining (Henry) Cao
Cheung Kong Graduate School of Business, China
E-mail address: hncao@ckgsb.edu.cn.

Yi Huang
Fanhai International School of Finance, Fudan University, China
E-mail address: huang_y@fudan.edu.cn.

Yiping Huang
National School of Development, Peking University, China
E-mail address: yhuang@nsd.pku.edu.cn.

Bernard Yeung [*]
Southern University of Science and Technology, China
Asian Bureau of Finance and Economic Research, Singapore
NUS Business School, Singapore

Xiaoyan Zhang
Tsinghua University PBC School of Finance, China
E-mail address: zhangxiaoyan@pbcsf.tsinghua.edu.cn.

[*] Corresponding author. Southern University of Science and Technology, China.
E-mail addresses: byeung@nus.edu.sg, yeung@sustech.edu.cn (B. Yeung).