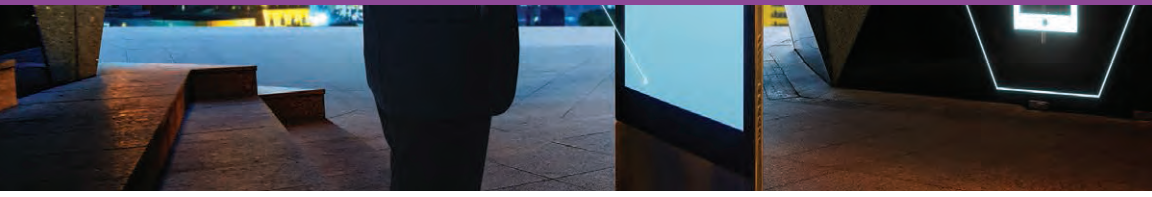
香港中文大學（深圳）
The Chinese University of Hong Kong, Shenzhen

ADBInstitute

CENTRAL BANK DIGITAL CURRENCY AND FINTECH IN ASIA

Edited by Marlene Amstad, Bihong Huang, Peter J. Morgan, and Sayuri Shirai



ASIAN DEVELOPMENT BANK INSTITUTE

ADBInstitute

CENTRAL BANK DIGITAL CURRENCY AND FINTECH IN ASIA

Edited by Marlene Amstad, Bihong Huang, Peter J. Morgan, and Sayuri Shirai

ASIAN DEVELOPMENT BANK INSTITUTE

ISBN 978-4-89974-213-5 (Print)
ISBN 978-4-89974-214-2 (PDF)

Note: In this publication, "$" refers to US dollars.

Asian Development Bank Institute
Kasumigaseki Building 8F
3-2-5, Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan
www.adbi.org

Contents

Tables, Figures, and Boxes

TABLES

FIGURES

BOXES

Foreword

Compared to Western countries, fintech in Asia is advancing at an almost blinding speed. In the People's Republic of China, it has become increasingly difficult to use cash and even credit cards. By contrast, in the United States, many people are still using checks. Although there is tremendous excitement around private sector innovations in fintech, the ultimate question of how far and how fast the financial system evolves ultimately lies with regulators and the official sector. If one learns nothing else from the long history of money, it is that the private sector may innovate, but eventually the government sector regulates and appropriates.[1] Of particular interest to investors worldwide is if and when central banks will enter the fintech fray with their own digital currencies, potentially flattening private sector entrants, much as governments once did in turn to private coinage and later privately issued paper currencies.

The banking sector is perhaps as nervous about government entry into the digital currency space as it is about the intrusion of big tech into the financial sector, most famously in Facebook's planned 2020 launch of its Libra currency. Will the advent of retail central bank digital currency lead to a massive shrinkage in bank demand deposits as consumers turn to the safety and simplicity of government-provided digital assets? Yet, although it has long been well known that central banks have been hard at work in planning new regulations for fintech and in designing their own e-currencies, until now most efforts have been shrouded in secrecy. Thus, the present volume is quite remarkable in that officials and researchers from a broad swath of international financial institutions and Asian central banks have come forth with their perspectives on the regulation of fintech in general, and the future of central bank digital currencies in particular. Moreover, the volume is generally written at a level than can easily be absorbed and digested by practitioners, students, and journalists, not to mention of course researchers in the field. As such, the book provides a well-balanced overview of the research efforts of major Asian central banks in the field of central bank digital currency and fintech. It should serve as an excellent introduction to the major policy issues in this rapidly developing area for policy makers, academics, think tank researchers, and students.

[1] Rogoff, K. 2016. *The Curse of Cash.* Princeton, NJ: Princeton University Press.

One fundamental takeaway from the book is that regulators are going to look hard at the extent to which new digital assets bring genuine new functionality that is useful to consumers but not simply an end-run around existing regulations on financial assets. Another is that the introduction of retail central bank currencies is likely to come gradually in stages, as officials want to be sure that there is a balanced development of fintech that creates opportunities for new financial intermediation and not just new transactions media.

A critical question raised by this book is how central banks and financial authorities will be able to coordinate regulation so that fintech developments in one country do not undermine fiscal and monetary objectives in others. The prospect of a Chinese digital central bank currency with global ambitions raises the issue of international coordination just as much as the regulation of private currencies, such as the Libra.

It is indeed welcome that so many of the participants in this project have been willing to be so transparent in their perspectives and ideas, perhaps giving some hope that the seeds of international coordination on digital central bank currency and fintech might actually be there.

Kenneth Rogoff
Thomas D. Cabot Professor of Public Policy, Harvard University

List of Contributors

Marlene Amstad is an economics and finance professor at the Chinese University of Hong Kong, Shenzhen, and co-director of its Center for Financial Technology.

Kantitat Areechitranusorn is an assistant director at the Payment and Bond Department, Bank of Thailand.

Sukarela Batunanggar is deputy commissioner at the OJK Institute, Indonesia Financial Services Authority.

Hongyi Chen is a senior adviser at the Hong Kong Institute for Monetary and Financial Research.

Sally Chen is a resident representative for Hong Kong, China, at the International Monetary Fund (IMF).

Giulio Cornelli is a research analyst at the Bank for International Settlements.

Vukile Davidson is a member of the secretariat at the Financial Stability Board.

David Emery is a senior manager in the Payments Policy Department, Reserve Bank of Australia.

Tarhan Feyzioglu is a division chief at the IMF.

Jon Frost is a senior economist at the Bank for International Settlements.

Leonardo Gambacorta is head of Innovation and the Digital Economy at the Bank for International Settlements.

Manuk Ghazanchyan is an economist at the IMF.

Yuksel Gormez is a senior economist at the Central Bank of Turkey.

Souvik Gupta is an economist at the IMF.

Bihong Huang is a research fellow at the Asian Development Bank Institute (ADBI).

Chris Ip is an assistant economist at the Hong Kong Institute for Monetary and Financial Research.

Sarwat Jahan is a senior economist at the IMF.

Juan Manuel Jauregui is a senior economist at the IMF.

Byoung-Ki Kim is a principal economist at the Bank of Korea.

Tidiane Kinda is a senior economist at the IMF.

Michinobu Kishi is an associate director-general in the Payment and Settlement Systems Department, Bank of Japan.

Ohik Kwon is an economist at the Bank of Korea.

Bernia Lee is an officer at the Hong Kong Monetary Authority.

Vipichbolreach Long is a special appointee at the IMF.

Elena Loukoianova is a deputy division chief at the IMF.

Peter J. Morgan is a senior consulting economist and vice chair of research at ADBI.

Alexandros Mourmouras is a division chief at the IMF.

Masahiro Nozaki is a senior economist at the IMF.

Kyoko Oishi is a member of the secretariat at the Financial Stability Board.

Jongik Park is an economist at the Bank of Korea.

Simon Paroutzoglou is a research analyst at the IMF.

Tahsin Saadi Sedik is a senior economist at the IMF.

Vijak Sethaput is a deputy director at the Financial Market Department, Bank of Thailand.

Sayuri Shirai is a visiting scholar at ADBI.

Cormac Sullivan is a research analyst at the IMF.

Chananun Supadulya is a deputy director at the Office of Corporate Strategy, Bank of Thailand.

Kasidit Tansanguan is a deputy director at the Office of Corporate Strategy, Bank of Thailand.

Yvonne Tsui is a senior manager at the Hong Kong Monetary Authority.

Wipat Wattanasiriwiroj is a deputy director at the Payment and Bond Department, Bank of Thailand.

Ruihui Xu is an assistant researcher at the Research Institute, People's Bank of China.

Zhong Xu is director general at the Research Bureau, People's Bank of China.

Jiae Yoo is an economist at the IMF.

Longmei Zhang is a deputy resident representative for the People's Republic of China at the IMF.

Feng Zhu is a senior research director at Luohan Academy.

CHAPTER 1

Introduction and Overview

Marlene Amstad, Bihong Huang, Peter J. Morgan, and Sayuri Shirai

1.1 Introduction

"The most important financial innovation that I have seen the past 20 years is the automatic teller machine" (New York Post 2009). This was famously remarked in 2009, following the global financial crisis of 2007–2008 by Paul Volcker, the former governor of the United States (US) Federal Reserve System. While the jury is still out on its long-term impacts, the development of financial technology, or "fintech", over the past decade is nowadays commonly seen to have already radically altered the financial system, and promises to have much greater impact in coming years. This is particularly the case in Asia. Two aspects stand out in the Asian context: (a) the implications of fintech for financial inclusion; and (b) the response by central banks and regulators.

1.2 Fintech and Financial Inclusion

Fintech is broadly defined as advanced technology to improve and automate delivery and use of financial services to consumers and businesses. It covers a broad landscape from digital currencies and payment systems (e.g., mobile phone wallets, cryptoassets, remittance services) to asset management (e.g., internet banking, online brokers, robo-advisors, cryptoasset trading, personal financial management, mobile trading) to alternative finance (e.g., crowdfunding, peer-to-peer [P2P] lending, online balance sheet lending, invoicing, and supply chain finance).

Fintech has become recognized as a promising tool to promote financial inclusion, i.e., access to financial products and services for previously excluded households and small firms, especially in developing and emerging economies. In Asia, fintech has already brought substantial benefits to households and firms by bypassing the traditional "bricks and mortar" banking system and making a variety of financial services available either at lower cost or specifically to those who previously did not have access to them because of their low income, missing credit information, or remote location.

Perhaps most notably, the development of internet-based platforms for alternative finance, including P2P lending and crowdfunding, has revolutionized the access of individuals, startup ventures, and small and medium-sized firms to finance. The use of artificial intelligence and big data to assess the credit risks of those with insufficient traditional data has also contributed to financial inclusion. Certain applications, such as the use of blockchain to bring down the cost of remittances, are already having a significant impact.

Reflecting this role of fintech, the Group of Twenty's (G20) Financial Inclusion Action Plan was updated at the 2014 G20 Leaders' Summit in Brisbane, Australia to include a commitment to implement the G20 Principles for Innovative Financial Inclusion under a shared vision of universal access (BIS and WBG 2016). In 2018, the International Monetary Fund (IMF) and the World Bank developed the Bali Fintech Agenda (IMF 2018), which advances key issues for policy makers and the international community to consider as individual countries formulate their policy approaches.

1.3 The Challenges for Central Banks and Regulators

At the same time, the fintech revolution brings with it a host of potential new risks to financial system stability and challenges for consumer protection. Its broad scope affects central banks and regulatory and supervisory authorities alike. Will banks lose a substantial amount of funds to competing platforms? Will they shrink their balance sheets accordingly, with possible negative effects on economic activity? If banks lose lending business and deposits as a source of funding, will this cut into their profits, potentially making them less stable? If individuals and firms shift from central bank fiat currencies to using cryptoassets for transactions, will this threaten the effectiveness of monetary policy and also reduce central banks' ability to monitor transaction flows? If P2P lending platforms go bust, could this also undermine financial stability?

Cryptoassets could be used as a way to try to circumvent laws against money laundering and terrorist financing. If fintech services are not sufficiently regulated and consumers sufficiently educated, they may suffer unexpected losses, overly high service costs, and loss of privacy of their personal data. The use of artificial intelligence and big data to make credit decisions could lead to the risk of discriminating against consumers.

So far, most studies conclude that in terms of size, fintech has not yet reached a scale that could plausibly threaten financial system stability. Nonetheless, central banks are actively studying potential risks and strategic responses. In some Asian economies, payments have largely moved to noncash modes, heightening the need for a regulatory response by the relevant authorities. One key question is whether central banks should develop their own digital currencies (central bank digital currencies, or CBDCs), and, if they do, whether such currencies should be made available to retail depositors or only in the interbank (wholesale) market. On the one hand, CBDCs could provide depositors with a new safe asset and give central banks even greater capacity to monitor transactions. On the other hand, it is debated whether this would put central banks in direct competition with private banks for retail deposits, which could undermine the private banks' retail base. It remains an ongoing subject of research by central banks.

Financial innovations also force regulators to keep pace in order to fulfill their supervisory mandates. The key is to balance zero tolerance of illicit behavior and concerns about financial stability with allowing innovation to take place. Many regulatory authorities have adopted the approach of "regulatory sandboxes" to monitor the development of new financial products and services before finalizing their approval and appropriate regulations.

This book provides a thorough introduction to principles and developments related to CBDCs and fintech in Asia. The first part of the book covers CBDC theory, regulatory aspects, economic digitalization, financial inclusion, and the role for small and medium-sized enterprises (SMEs). In the second part, selected case studies offer an in-depth review of recent fintech developments in major Asian economies including Australia; the People's Republic of China; Hong Kong, China; Indonesia; Japan; the Republic of Korea; and Thailand. The book is based on a joint conference at the Shenzhen Finance Institute of the Chinese University of Hong Kong, Shenzhen with the Asian Development Bank Institute (ADBI).

1.4 Chapter Summaries

Part I | Digital Currency and Fintech Principles and Foundations

Chapter 2, "Money and Central Bank Digital Currency" by Sayuri Shirai, provides an overview of the concepts and features of both central bank and private sector money and focuses on their actual performance in selected developed and emerging economies. In addition, the chapter touches on newly-emerged private sector money

or digital coins (cryptoassets) that utilize distributed ledger technology (DLT), such as Bitcoin. The chapter also focuses on the potential application of DLT to central bank money issued to the general public or financial institutions, as well as Sweden's initiative to issue deposit accounts and prepaid payment methods to the general public.

Chapter 3, "Regulating Fintech: Objectives, Principles, and Practices", by Marlene Amstad, provides an overview and key elements on the ongoing debate of whether and how to regulate fintech. It reviews the objectives of financial regulation (investor protection, market integrity, and safeguarding financial stability) in the context of recent fintech developments, and covers three guiding principles many regulators follow (legal certainty, technology neutrality, and proportionality). The chapter ends with a synopsis of current fintech regulatory practices (ignore or wait-and-see; same risk, same rules ["duck typing"]; coding or dedicated regulation).

Chapter 4, "SME Finance in Asia: Recent Innovations in Fintech Credit, Trade Finance, and Beyond", by Giulio Cornelli, Vukile Davidson, Jon Frost, Leonardo Gambacorta, and Kyoko Oishi, gives an overview of recent trends in the financing of SMEs in Asia. While SMEs are an important contributor to employment and gross domestic product in Asia, they often face significant credit constraints. Recently, in the context of Asia's rapidly digitalizing economy, both incumbents and new entrants are developing innovative means of providing SME finance. This includes the growth of fintech credit, big-tech providers, and new initiatives in trade finance.

Chapter 5, "The Digital Revolution in Asia and Its Macroeconomic Effects", by Tahsin Saadi Sedik, Sally Chen, and colleagues at the IMF, presents an overview of Asia's digital landscape, based on some key findings related to the rates of digitalization, automation, and e-commerce. It also depicts the relationship between both traditional and digital finance and analyzes the macroeconomic implications of digitalization in terms of productivity and policy. The platform-based economy and fintech are identified as new economic growth drivers, although financial inclusion still needs to be improved across most countries in the region. Policy makers can help boost economic productivity by launching social safety nets, digital identification, adaptation of technology in tax systems, and appropriate legislation for P2P platforms.

Chapter 6, "Money and Finance in the Digital Age: Some New Developments", by Feng Zhu, discusses fintech credit and digital currencies by reviewing several key issues in these two areas of the ongoing fintech revolution. It argues that the rise and the recent decline of platform-based credit intermediation demonstrates

that such innovations may benefit society, but their emergence might bring some new risks as well. Big tech may prove to be a healthier, more reliable, and more sustainable business model. Private cryptoassets cannot yet be considered money since they face some notable technological constraints on fulfilling their core functions, as well as a perceived trust deficit. However, they raise the issue of what constitutes money, and whether privately issued money can bring additional value to society. CBDCs may be a solution to the rising expectations for a new form of money in the digital age.

Part II | Digital Currency and Fintech Applications in Asia

Chapter 7, "Fintech and Central Bank Digital Currency in Australia", by David Emery, describes Australia's fast real-time retail payments system called the New Payments Platform (NPP), which was launched in February 2018 by a consortium of 13 financial institutions, including the Reserve Bank of Australia. The NPP operates on a 24/7 basis and allows financial institutions to provide immediate funds availability to payment recipients, even when the payer and payee have accounts with different financial institutions. The author argues that there is no strong case for the Reserve Bank of Australia to issue a retail CBDC given that the safer Next Generation Banknote series is available and the safer NPP, whose deposits are protected by the Financial Sector Claims Scheme, is running.

Chapter 8, "Regulating Fintech for Sustainable Development in the People's Republic of China", by Zhong Xu and Ruihui Xu, reviews regulations and supportive approaches of the PRC government for ensuring the sustainable development of fintech. The rapid rise of fintech in the PRC inevitably has generated financial risks. For the prevention and resolution of financial risks, the government has implemented many regulations for fintech applications, including P2P lending, third-party payment, and cryptoassets. Additional measures such as financial standardization, fintech infrastructure development, and investor protection have also been strengthened to promote sustainable fintech development in the PRC. The government is trying to strike a balance between encouraging fintech innovation and strengthening regulation.

Chapter 9, "Fintech Development in Hong Kong, China", by Yvonne Tsui, Hongyi Chen, Chris Ip, and Bernia Lee, sheds light on the accelerated fintech development of Hong Kong, China. It summarizes the activities and initiatives spearheaded by the Hong Kong Monetary Authority including Open Application Programming Interface for banks, Faster Payment System and Common QR Code Standard

for retail payments, trade finance, and virtual banking. Overall, striking a good balance between market players, regulators, and stakeholders has been a key point for fintech development there.

Chapter 10, "Fintech Development and Regulatory Frameworks in Indonesia", by Sukarela Batunanggar, outlines the fintech landscape and discusses the regulatory framework adopted by the Indonesia Financial Services Authority. Indonesia has big opportunities regarding the digital economy, in terms of the size of its economy, population, and the number of internet and mobile phone users. At the same time, it is imperative for the regulatory framework to achieve the right balance between encouraging innovation and preserving the integrity of the financial system and ensuring customer protection.

Chapter 11, "Project Stella and Impacts of Fintech on Financial Infrastructure in Japan", by Michinobu Kishi, summarizes the Bank of Japan's (BOJ) ongoing Project Stella, a joint research project launched in late 2017 with the European Central Bank (ECB) to study the possible use of DLT for the financial market structure, including large-scale real-time gross settlement (RTGS) systems such as BOJ-NET and TARGET2 adopted by the BOJ and ECB, respectively. In particular, the chapter highlights the results of Phase 1 (applicability of DLT to the RTGS systems) and Phase 2 (applicability of DLT to the delivery versus payment systems) of the project.

Chapter 12, "Fintech, Cryptoassets, and Central Bank Digital Currency in the Republic of Korea", by Ohik Kim, Jongik Park, and Byoung-Ki Kim focuses on the Republic of Korea's fintech development, as well as the growing popularity of cryptoassets. It also summarizes the government's countermeasures to cope with the overheating of the cryptoasset market and intensified speculative activities from the first half of 2017 to early 2018, including the prohibition of initial coin offerings in September 2017 and financial institutions' purchasing of cryptoassets in December 2017. The chapter also describes the Bank of Korea's current stance concerning CBDCs after examining the pros and cons and the recent test of the application of DLT to the retail payment and settlement systems.

Chapter 13, "Project Inthanon and the Project DLT Scripless Bond", by Chananun Supadulya, Kasidit Tansanguan, Vijak Sethaput, Wipat Wattanasiriwiroj, and Kantitat Areechitranusorn, introduces the two initiatives on DLT launched by the Bank of Thailand in 2018. Project Inthanon is a proof-of-concept for wholesale domestic and cross-border funds transfer using CBDCs, while the Project DLT scripless bond is an initiative to increase the efficiency of the saving bond

registration and sales processes. The chapter discusses project design, key findings, and future consideration of both projects. It concludes that DLT demonstrates promising potential in enhancing efficiency of the financial infrastructure by enabling direct transfers of digital value among parties, immutable record keeping and programmable automation using smart contracts. However, further explorations on technological capacity, governance arrangements, and regulatory issues are needed before moving these proof of concept systems forward to the production level.

The annex, "Central Bank Digital Currency: A Historical Perspective", by Yuksel Gormez, starts with revisiting the definition of money and shows that electronic money is not a new concept. Gormez explains the spectrum of money from a historical perspective and argues that technology can enhance the way we deal with it, but it will never change its fundamental nature. The author argues that central banks that have perfectly addressed all the fundamental problems of money and financial service provision can issue digital currencies with no hesitation. All others should follow a sequential path to sustain price and financial stability under a seamless wholesale payment system infrastructure serving the citizens in a fully-functioning market economy with some local characteristics.

REFERENCES

Bank for International Settlements (BIS) and World Bank Group (WBG). 2016. *Payment Aspects of Financial Inclusion*. BIS and WBG.

International Monetary Fund (IMF). 2018. The Bali Fintech Agenda. Washington, DC: IMF. https://www.imf.org/en/Publications/Policy-Papers/Issues/2018/10/11/pp101118-bali-fintech-agenda (accessed 3 September 2019).

New York Post. 2009. The Only Thing Useful Banks Have Invented in 20 Years Is the ATM. 19 December. https://nypost.com/2009/12/13/the-only-thing-useful-banks-have-invented-in-20-years-is-the-atm/ (accessed 5 August 2019).

PART 1

Digital Currency and Fintech Principles and Foundations

CHAPTER 2

Money and Central Bank Digital Currency

Sayuri Shirai

2.1 Introduction

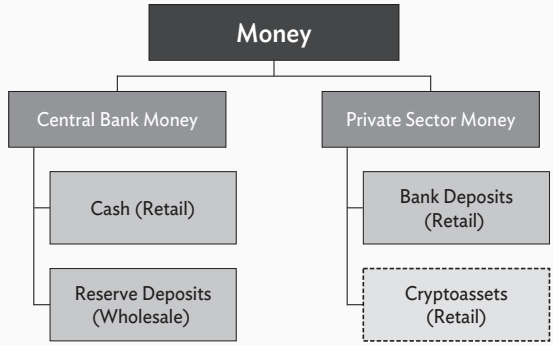
Money is a financial instrument functioning as a medium of exchange, a unit of account, a store of value, and a standard of deferred payment. Its role as a medium of exchange allows efficient transactions of goods and services, bypassing an inconvenient barter system. The unit of account enables the value of all goods and services to be expressed in common criteria, thereby easing the comparison of goods and services and facilitating their transactions. The store of value refers to any asset whose value can be maintained in the future, thereby enabling financing spending at a later date. In addition to these three basic functions, the standard of deferred payment is an additional important function of money since it enables purchasing goods and services in the present by paying back debt in the future. To meet these four functions, money must be durable, portable, divisible, and difficult to counterfeit.

In the contemporary monetary system, the general public, i.e., firms and individuals, tend to associate cash (central bank notes and coins) with money. A central bank has the sole right to issue paper notes (fiat money) and distribute them through commercial banks. While coins are issued mostly by governments to supplement central bank notes, in many cases, they are also distributed to the general public by a central bank through commercial banks. Therefore, this chapter regards both notes and coins, or cash, as central bank money. In addition to cash, a central bank issues money to designated financial institutions, mainly commercial banks, in the form of reserve balances or current account balances, i.e., reserve deposits. In addition, Sweden's central Riksbank has been investigating issuing deposit accounts to the general public (this initiative is described later as part of the central bank digital currency [CBDC] proposals).

The coverage of money now also includes private sector money (Figure 2.1), which has increasing importance in our daily lives and corporate sector activities. The most important private sector money is bank deposits, which can be used to make payments using ATMs, internet banking, and/or debit cards.

Bank accounts can also be used to pay credit card companies by allowing them to debit payments. The development of digital wallets and cashless devices that enable payments through smartphone apps has enabled faster and more efficient retail payments.

Figure 2.1: Classification of Money



Source: Prepared by the author.

In addition, new types of private sector money based on distributed ledger technology (DLT) have emerged over the past decade. These are called digital coins, cryptoassets, cryptocurrencies, encrypted currencies, or virtual currencies. The first and most famous example is Bitcoin, which has garnered considerable attention globally because of its potential to serve as a new payment tool and, thus, become part of private sector money. Central banks and governments across the globe have not regarded these digital coins as money and have warned the general public to use them with great caution because of the high volatility in their value and, thus, the high degree of risk involved; nevertheless, they have been paying close attention to them. Some central banks have also experimented with issuing their own digital coins, i.e., CBDC, along with the Swedish initiative to issue potential bank accounts to the general public.

This chapter reviews the concepts and definitions of money by differentiating between central bank and private sector money, as well as shedding light on their developments; it also summarizes recent CBDC proposals. The chapter comprises five sections. Section 2.2 clarifies the concepts and features related to central bank money and focuses on the performance of cash and reserve deposits in four selected

developed economies (the eurozone, Japan, Sweden, and the United States [US]) and two major emerging economies (India and the People's Republic of China [PRC]). Section 2.3 clarifies the concepts and features related to private sector money. The features of digital coins are also discussed as part of private sector money. Section 2.4 sheds light on the details related to CBDC proposals. Section 2.5 concludes.

2.2 Central Bank Money Performance

2.2.1 | Concepts of Central Bank Money

Central bank money refers to the liability of the balance sheets of central banks—namely, money created to fulfill the four functions described earlier. Cash used to be the most important means of payment. The number of outstanding coins issued is much smaller than the number of outstanding central bank notes in circulation due to the smaller units, so coins are used only for small purchases. Meanwhile, the development of the banking system and technological advances have given rise to interbank payments and settlement systems where commercial banks lend to each other. A central bank manages interbank payments and settlements through monitoring the movements of reserve deposit balances. The amount of cash is based on the quantity demanded by the general public, which is associated with transaction demand (normally proxied with nominal gross domestic product [GDP]), as well as the opportunity cost (normally a deposit rate paid by the commercial bank to the general public). Thus, a central bank supplies cash passively in response to demand. A central bank provides commercial banks with cash by withdrawing the equivalent amount from their reserve deposit accounts; commercial banks then distribute the acquired cash to the general public on demand through windows of bank branches and/or ATMs.

Reserve deposits can be divided into *required reserves* (the amount set under the statutory reserve system) and *excess reserves* (the amount in excess of required reserves). Banks use reserve deposits to lend to each other in the interbank market. In normal times, when the effective lower bound is binding, the central bank pays a (positive) interest rate on excess reserves, which forms a floor for the short-term, market-determined interest rate corridors, while the ceiling is formed by a discount rate charged by the central bank when lending to commercial banks against collateral. The floor in the market interest rate can be established because no commercial banks should be willing to lend to each other at a rate below that on excess reserves.

Both cash and reserve deposits are the safest and most liquid financial instruments held by commercial banks, and together constitute *reserve money* (base money or the monetary base [M0]). Cash is regarded as legal tender by governments for all debts, public charges, taxes, and dues in their respective economies. The value of cash is stable in an economy where a central bank successfully conducts monetary policy in accordance with the price stability mandate (mostly at around 2% in developed economies) and, thus, avoids high inflation or serious deflation. The value of reserve deposits is also stable and is equivalent to cash in a one-to-one relationship.

2.2.2 | Differences between Cash and Reserve Deposits

While both cash and reserve deposits constitute central bank money, they have different features (Table 2.1). For example, reserve deposits are *digital currency*, which is available in digital form, in contrast with physical, visible cash. Moreover, cash is used mainly by the general public (thus called "retail central bank money"), is available around the clock, and is usable anywhere within an economy where the legal tender status prevails. In contrast, reserve deposits are available only to designated financial institutions, such as commercial banks (thus called "wholesale central bank money"). Wholesale central bank money is not necessarily available 24 hours a day or 365 days a year, depending on the computer network system managed by each central bank. With technology advances, central banks have been making efforts to enable faster and more efficient transactions.

Table 2.1: Main Features of Central Bank Money and Private Sector Money

		General Public	Anonymous	Traceable	Peer-to-Peer	24 Hours/365 Days	Interest Rate
Central Bank Money	Cash	O	O	X	O	O	X
	Reserve Deposits	X	X	O	X	Δ	O
Private Sector Money	Bank Deposits	O	X	O	X	Δ	O
	Digital Tokens (Cryptoassets)	O	O	O	O	O	O

Source: Prepared by the author.

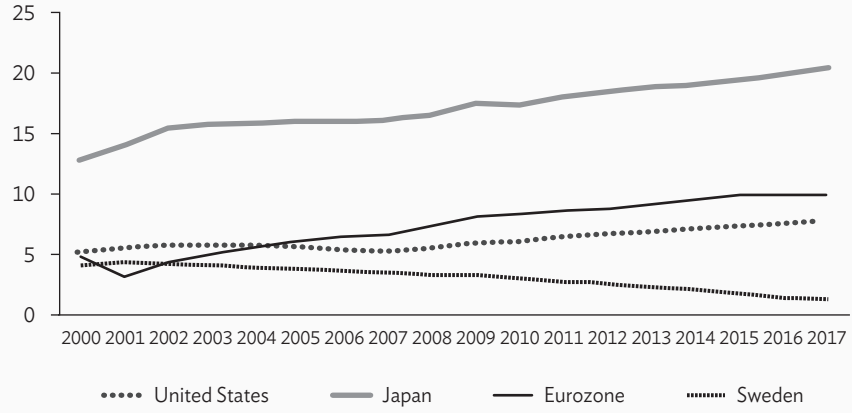
From the perspective of users (the general public), the most important difference between cash and reserve deposits is that cash is *anonymous* and cash transactions are *non-traceable* since they cannot be monitored by the issuing central bank. In contrast, all transactions based on reserve deposits are *traceable* by the order of their time sequence, since they are a digital representation of money that records all footprints. Reserve deposits are *non-anonymous*, since information such as the ownership of money in respective accounts and the amounts transferred from one account to the other is fully available to the central bank via a registry. In addition, cash provides a *peer-to-peer* settlement form, while central bank-intermediated reserve deposits are non-peer-to-peer settlements. Because of its anonymity and non-traceability, cash is often preferred by the general public who wish to maintain privacy, but is often used for money laundering and illegal activities and tax evasion purposes. Cash handling costs are high when considering not only the direct fees (i.e., the cost of paper and design fees to prevent counterfeiting), but also the associated security and personnel costs and payment services by commercial banks, shops, firms, and individuals.

From the perspective of an issuer (a central bank), the most important difference between cash and reserve deposits is the presence or absence of an interest rate. Cash is an interest-rate-free instrument, while a positive or negative interest rate can be applied to reserve deposits. It is known that a negative interest rate can be a monetary policy tool under the effective lower bound, as has been adopted, for example, by the European Central Bank (ECB), the Bank of Japan, and Sweden's Riksbank. A central bank can apply a negative interest rate to excess reserves, which can be more effective if commercial banks pass the increased costs on to their retail bank deposits. This is likely to happen when the general public no longer uses cash, i.e., mainly uses private sector money or bank deposits and, thus, is unlikely to substitute it for bank deposits in order to avoid a negative interest rate.

2.2.3 | Performance of Central Bank Money in Developed and Emerging Economies

Central bank money performance is examined by focusing on cash and reserve deposits separately. Cash is likely to rise as economic activities (proxied by nominal GDP) grow, reflecting transaction demand. Reserve deposits also tend to rise when greater economic activities are associated with the deepening of the banking system and, hence, an increase in deposits. Thus, this chapter measures cash and reserve deposits by dividing these data by GDP in order to examine the trend excluding the direct impact coming from greater economic activities.

Figure 2.2: Cash in Circulation in Developed Economies (% of GDP)



GDP = gross domestic product.

Sources: CEIC, US Federal Reserve of St. Louis, and International Monetary Fund.

Figure 2.2 shows cash in circulation as a percentage of nominal GDP for the period 2000–2017 in developed economies (the eurozone, Japan, Sweden, and the US). Sweden's ratio of cash to nominal GDP has declined steadily since 2008, suggesting that it is the most cashless society in the world.

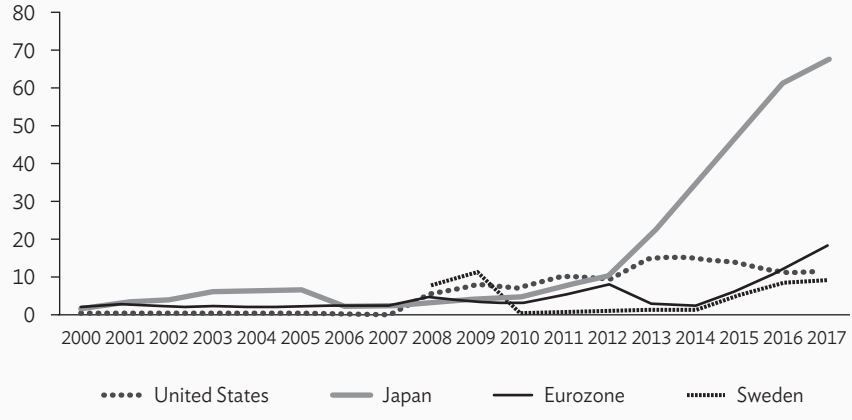
It is interesting that the Swedish cash to nominal GDP ratio continued to drop even after a negative interest rate policy was adopted on the repo rate, i.e., the rate of interest at which commercial banks can borrow or deposit funds at the central bank for 7 days, from February 2015 (–0.1% initially in February 2015, deepening to –0.25% in March 2015, then further to –0.35% in July 2015 and to –0.5% in February 2016, before increasing to –0.25% in January 2019 as part of normalization). This indicates that substitution from bank deposits to cash did not happen in Sweden despite a negative interest rate.

In contrast, the cash to nominal GDP ratios have risen over time in the eurozone, Japan, and the US. These trends were maintained after massive unconventional monetary easing, i.e., quantitative easing in the three economies and the negative interest rate policy in the eurozone and Japan. Japan's cash to nominal GDP ratio has been always higher than those of the eurozone and the US, suggesting that cash is more frequently used in Japan as a means of exchange and store of value.

This may reflect that Japan's inflation has remained more or less stable at around 0% or in the moderately negative territory since the late 1990s. Japan's preference for cash may also reflect its longstanding low interest rate dating from when the Bank of Japan implemented a series of monetary easing after the collapse of the stock and real estate bubbles in the early 1990s (see Shirai 2018a, 2018b for details). It is also interesting that cash is growing rapidly in the US, even after the monetary policy normalization that has taken place since December 2015 with a continuous increase in the Federal Reserve funds rate.

Regarding reserve deposits, Figure 2.3 exhibits the ratios of reserve deposits to nominal GDP for the period 2000–2017 in the same four economies. These ratios in the four economies rose after the global financial crisis of 2008–2009, perhaps reflecting the quantitative easing tool adopted in the presence of the effective lower bound. The US currently faces a decline in the ratio because the Federal Reserve began to reduce the amount of reinvestment on redeemed bonds from October 2017, after having recorded a peak in October 2014 when the process of "tapering", or a gradual decline in the amount of financial asset purchases, was completed, so that the amount of outstanding reserve deposits reached the maximum of around $2.8 trillion. The ECB initiated net purchases of financial assets from June 2014 and introduced a large-scale asset purchase program in March 2015, but completed net purchases in December 2018 after tapering.

Figure 2.3: Reserve Deposits in Developed Economies (% of GDP)

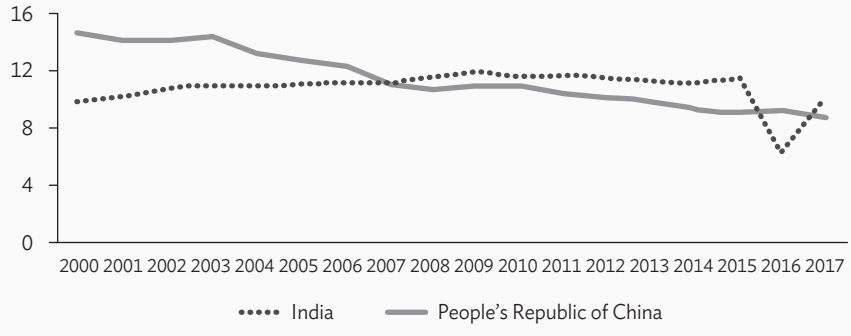


GDP = gross domestic product.

Sources: CEIC, Bloomberg, US Federal Reserve of St. Louis, Riksbank, and International Monetary Fund.

From 2019, a full reinvestment strategy will be maintained so that the size of the ECB's balance sheet remains the same. Sweden adopted quantitative easing in 2015–2017 and has since continued to engage in a full reinvestment strategy to maintain its government bond holdings. Currently, therefore, the Bank of Japan is the only central bank among developed economies to continue asset purchases and, thus, expand reserve deposits and the balance sheet, although the pace of net purchases dropped substantially following a shift from the monetary base control to the yield curve control in September 2016.

Figure 2.4: Cash in Circulation in the People's Republic of China and India (% of GDP)

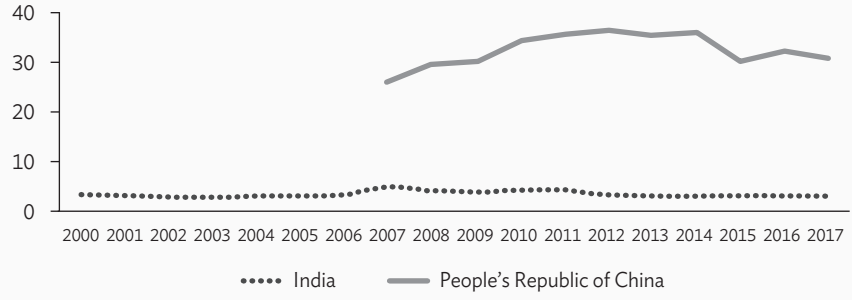


GDP = gross domestic product.

Sources: CEIC, People's Bank of China, and International Monetary Fund.

In the case of emerging economies (India and the PRC), Figure 2.4 shows their cash to nominal GDP ratios for the period 2000–2017. The ratios in the two economies have not risen as occurred in the eurozone, Japan, and the US, even though the amount of cash in circulation has grown rapidly in line with nominal GDP, reflecting transaction demand. In particular, a declining trend in the ratio in the PRC is noticeable, which likely reflects a shift in the general public's money from cash to bank deposits or other cashless payment tools in line with the deepening of the banking system and an increase in the number of depositors at commercial banks, as will be pointed out. A sharp drop in the ratio in India in 2016, meanwhile, reflected a temporary decline in cash after the government suddenly implemented a currency reform. India's government banned the Rs100 and Rs500 notes and instead introduced a new Rs500 note and issued new Rs2,000 notes for the first time.

Figure 2.5: Reserve Deposits in the People's Republic of China and India (% of GDP)



GDP = gross domestic product.

Note: Data for the People's Republic of China only available from 2007.

Sources: CEIC, People's Bank of China, and International Monetary Fund.

This currency reform was meant to fight corruption and money laundering and/or illegal activities, but severely disrupted economic activities by creating serious cash shortages. While the cash ratio recovered somewhat in the following year, it appears that the ratio was lower than the past trend, suggesting a moderate shift from cash to bank deposits or cashless payment tools. Meanwhile, reserve deposits in these two economies have remained stable (data are available only from 2007 in the case of the PRC); this makes sense, since the central banks have not conducted quantitative easing like those in developed economies (Figure 2.5).

2.3 Private Sector Money Performance

2.3.1 | Concepts of Private Sector Money and Bank Deposits

Private sector money mainly takes the form of bank deposits or deposits held by the general public at commercial banks (so-called "retail private sector money"), as shown in Table 2.1. Bank deposits are liabilities for commercial banks and are financial assets for the general public. While bank deposits are not legal tender, their values are denominated in legal tender and can be exchanged at a one-to-one value and are, thus, stable. Nonetheless, they are riskier than cash because the issuers are private institutions that could go bankrupt and might not fully reimburse

cash from bank deposits (although the deposit insurance system guarantees up to a specific amount of bank deposits per depositor). Similar to reserve deposits, bank deposits are *non-anonymous*, and transactions are *traceable* since the issuing commercial banks can trace all transactions by their time sequence, as shown in Table 2.1. Bank deposits are also digital currency, so a positive interest rate can be applied. A negative interest rate is technically applicable, but commercial banks generally refrain from charging it for fear of losing clients. Thus, banks may increase charges on their services (such as ATM use and transfer fees) instead of directly charging a negative interest rate. Real-time fast settlement systems are increasingly available 24 hours a day, 365 days a year for retail bank depositors in many countries, including the PRC, India, Japan, the Republic of Korea, Singapore, Sweden, Switzerland, Turkey, and the United Kingdom (UK).

The size of bank deposits is generally much larger than that of central bank money due to the large number of financial institutions and their sheer asset sizes, as shown later. This is also because bank deposits can be expanded through the *money creation* activities of commercial banks, which generate deposits and loans. Namely, new bank deposits are created when commercial banks extend new loans to firms and individuals, which in turn deposit those proceeds and, thus, increase the size of bank deposits. Commercial banks are the major entities engaging in money creation as depository institutions.

The money stock or money supply is defined as a group of safe assets that the general public can use to make payments or to hold as short-term investments. The money stock can be measured in a narrow or a broad sense (normally using M1, M2, M3, M4, etc.) and is comprised of cash, bank deposits, and other liquid assets. M1 is a narrow measure of money and is comprised of cash, demand (or checkable or transaction) deposits, and traveler's checks. Demand deposits can be withdrawn immediately without penalty so that both cash and demand deposits are viewed as a proxy for spending for goods and services in the economy. Broad measures of money, such as M2, cover M1 plus less-liquid bank deposits, such as savings deposits, small-denomination time deposits, and retail money market fund shares. The detailed components of M2 and broader measures of money (such as M3, M4) can differ among central banks, depending on financial market conditions. Some countries include M2 plus long-term time deposits and foreign-currency deposits of residents in the measure of M3. M4 could include M3 plus certificates of deposit, repos, and securities with a maturity of less than 5 years held by nonbank firms and individuals. It should be noted that various cashless payments, such as digital wallets and prepaid payment systems, do not add to the measures of money since they do not create it (credit cards are not included since they are loans).

2.3.2 | Monetary Policy Relating Private Sector Money with Central Bank Money

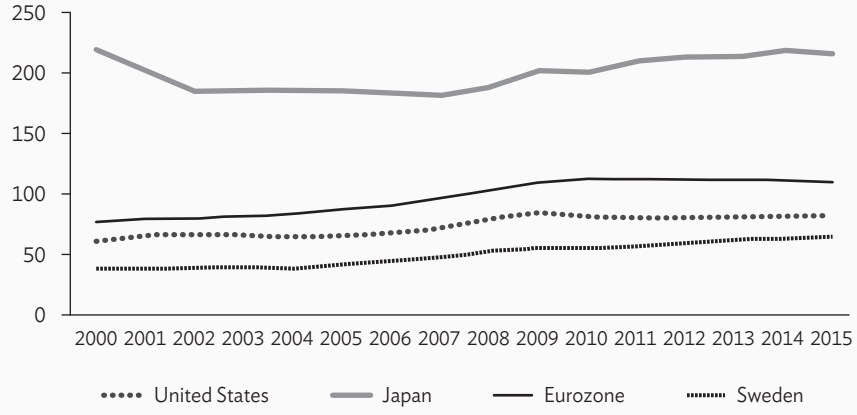
Central bank money, especially reserve deposits, and private sector money (bank deposits) are associated through central bank monetary policy. In normal times, a central bank attempts to influence commercial banks' money creation activities and money stock. In a recessionary (or expansionary) phase, the central bank attempts to cut (or increase) the short-term market interest rate by purchasing (or selling) government securities in the open market, or alternatively, by increasing short-term liquidity-providing operations and loans to commercial banks at a lower (higher) interest rate against collateral. The resulting increase (or decline) in liquidity to the interbank market expands (or reduces) the size of reserve deposits and the monetary base. Bank deposits and money stock will then increase (or decline) as long as commercial banks extend (or contain) new loans to the general public and, thus, create (or reduce) new bank deposits.

Since the global financial crisis of 2008–2009, central banks in developed economies, such as the eurozone, Japan, Sweden, the UK, and the US, have adopted quantitative easing or large-scale asset purchases in the face of the effective lower bound on short-term interest rates. Quantitative easing directly increases the size of reserve deposits and the monetary base. If commercial banks increase bank loans as a result of quantitative easing, an increase in the money stock may expand aggregate demand and, thus, inflation. Alternatively, quantitative easing could increase aggregate demand and money stock by raising various asset prices, such as stocks and real estate, or promoting portfolio rebalancing effects—even if a substantial increase in reserve deposits or the monetary base may not augment the money stock proportionally (McLeay et al. 2014).

2.3.3 | Performance of Bank Deposits in Developed Economies and Emerging Economies

The performance of private sector money is based on bank deposits, which may rise when economic activities expand, as firms and individuals may increase the number of and access to bank accounts. As with central bank money, bank deposits are measured as a percentage of nominal GDP to examine the trend after excluding the direct impact of economic activities. Figure 2.6 exhibits the ratios of bank deposits to nominal GDP in the same developed economies (the eurozone, Japan, Sweden, and the US) for the period 2000–2015.

Figure 2.6: Private Sector Bank Deposits in Developed Economies (% of GDP)



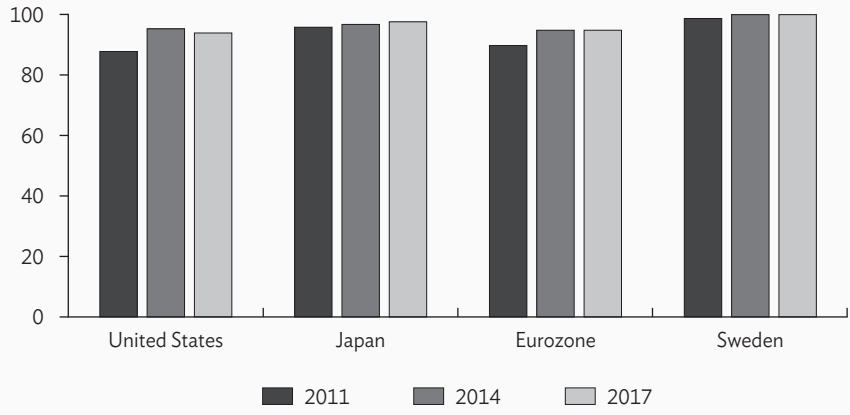
GDP = gross domestic product.

Sources: CEIC, datamarket.com, European Central Bank, and International Monetary Fund.

Japan's ratio has remained the highest among the four economies, suggesting that its financial system is bank-dominant with ample deposits held by individuals and firms. About half of households' financial assets have been allocated to bank deposits in Japan, and this ratio has remained roughly the same, even after the retail deposit rate dropped to nearly 0% as a result of quantitative easing or yield curve controls (Shirai 2018a, 2018b). The eurozone faces the second-highest ratio, mainly reflecting the large bank deposits held by German individuals. Like Japanese individuals, German individuals are highly risk-averse, so about 40% of their financial assets are allocated to cash and bank deposits. In contrast, Sweden faces the lowest ratio, suggesting that the financial system is less bank-dominated, and commercial banks are more dependent on wholesale financing rather than retail deposits.

All four economies have experienced a rising trend with regard to the ratio of bank deposits to nominal GDP, especially after the global financial crisis. This trend does not appear to reflect a deepening of the banking system. Figure 2.7 refers to the percentage of respondents who reported having an account (by themselves or with someone else) at a bank or another type of financial institution or reported personally using a mobile money service in the past 12 months in 2011, 2014, and 2017. Figure 2.7 indicates that these ratios remained roughly the same over the period, suggesting that the banking systems were already well developed in these

Figure 2.7: Deposit Account Ownership (% aged 15 years old or above)

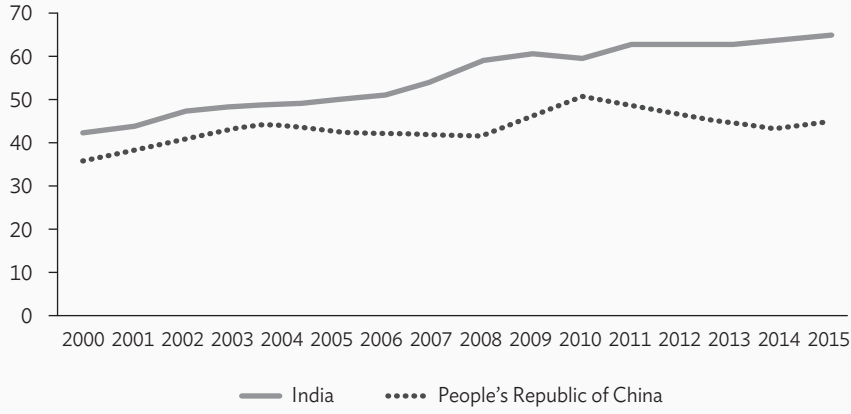


Source: World Bank (The Global Findex Database 2017).

economies so that most of the general public already had access to bank accounts and other cashless payment tools. As a result, a large increase in the number of deposits (a sign of banking sector deepening) did not take place during the periods surveyed. Namely, the rising trend in the bank deposits to nominal GDP ratio appears to reflect other factors, such as amplified risk-averse behavior and the resultant shift away from risky assets. Bank deposit growth may also have happened as part of money creation driven by unconventional monetary easing, although the growth rates of bank deposits (hence, the monetary base) were much smaller than those of reserve deposits in the four economies, suggesting a decline or sluggish money multiplier effect.

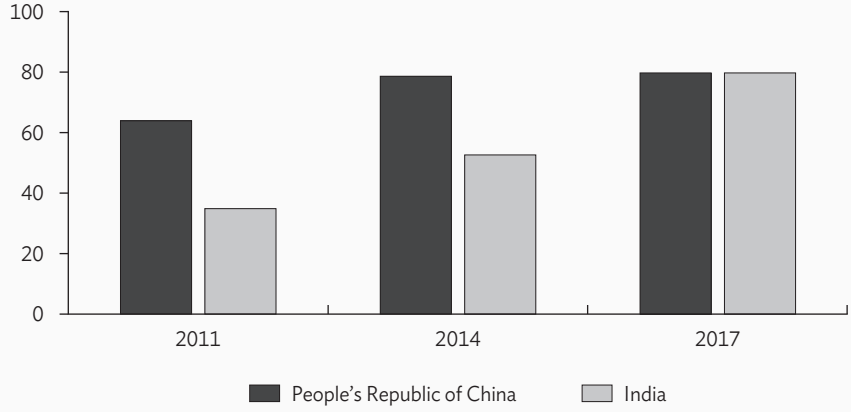
Emerging economies may have different developments. Bank deposits as a percentage of nominal GDP steadily increased in India from 2011 to 2015. The ratio also increased in the PRC despite fluctuations during that period (Figure 2.8). This may reflect deepening of the banking system in the two economies so that the general public significantly gained access to bank accounts or mobile payment services in 2011, 2014, and 2017 (Figure 2.9). The increased use of digital wallets using mobile phones may have contributed to an increase in the number of depositors and increased access to the banking system. Given that their reserve deposits to nominal GDP ratios remained the same, an increase in the bank deposits to nominal GDP ratio indicates that money-creation activities were greater than those in the developed economies.

Figure 2.8: Private Sector Bank Deposits in the People's Republic of China and India (% of GDP)



GDP = gross domestic product.
Sources: datamarket.com (taken from the World Bank) and International Monetary Fund.

Figure 2.9: Deposit Account Ownership (% aged 15 years old or above)



Source: World Bank (The Global Findex Database 2017).

2.3.4 | Private Sector Money and Digital Tokens

In addition to existing central bank money and private sector money, there is newly-emerging private sector money in the form of digital tokens (or cryptoassets, cryptocurrencies, encrypted currencies, or virtual currencies). These tokens are generally issued by independent "miners" (or nodes) based on DLT, which records transactions between two parties, shares the information among network participants, and synchronizes the data electronically in a traceable and unfalsifiable way. The innovative nature of this technology lies in the way transactions (such as the payment or transfer of digital coins) are verified by unknown, independent third parties (nodes), without relying on a central manager or register (such as a central bank or a commercial bank). Blockchain is a type of distributed ledger where each transaction between two parties is proven to be true using encryption keys and digital wallets; then, the numbers of the transactions are recorded on a new electronic distributed ledger, which is then connected through a chain (using hash functions) to previous, proven distributed ledgers using the proof-of-the-work process such that data falsification is difficult.

The first and most famous private sector digital token based on the blockchain technology is Bitcoin, introduced in 2008 by Satoshi Nakamoto. There are currently over 2,000 digital tokens, whose features vary substantially. These tokens have their own units of account that are universal across countries using the same tokens, with systems that enable instantaneous cross-border transfers of token ownership. Those tokens can be exchanged for some goods and services in many countries.

One of the attractive features of digital tokens is their similarity to cash, since peer-to-peer transactions can be made instantaneously and are available 24 hours a day, 365 days a year (see Figure 2.1, Table 2.1). All the transactions are anonymous, like cash, but are technically traceable, in contrast to cash. Unlike cash, meanwhile, digital tokens are digital money, so a positive or negative interest rate can be applied. Although this interest rate-bearing feature makes digital tokens superior to cash, one distinct feature of cash over digital tokens is the relative ease of verifying peer-to-peer transactions. This is partly because cash is designed by a central bank (or a government in the case of coins) in a way that is not easily falsified, and partly because cash recipients (such as commercial banks, shops, and individuals) just need to check carefully whether cash received is authentic, while digital tokens require more complicated verification approaches.

Central banks and regulatory authorities around the world so far do not regard these private digital tokens as money and have called for greater caution by the general public in using or investing in them because of the extreme volatility in their values and their limited use as a medium of exchange. Also, consumers and investors are not well protected since a regulatory framework is almost nonexistent. Nonetheless, DLT has the potential to apply to many different fields, not only for payment and settlement systems, but also for promoting trade finance, insurance, and other fintech services; tracking producers of industrial/agricultural products and commodities; and the ownership of real estate and precious metals. As the technology evolves day to day, and various new digital tokens have been issued with diverse features, DLT could conquer technical and legal problems in the future, such as 51% attack and double-spending problems; scalability; substantial energy consumption; substantial volatility in the values; vulnerability to cyberattacks; and potential money laundering and illegal activities.

According to CoinMarketCap,[1] the size of the market capitalization of existing digital coins is estimated to have reached about $113 billion by the end of January 2019, of which Bitcoin accounted for about 54% of the total. The size of digital tokens remains much smaller than central bank money and private sector money since their use as a payment tool remains limited. Moreover, money creation is not permitted by digital token exchanges and developers (since a banking license is necessary and no financial authorities have issued one so far). Thus, they have generated little threat to both central banks and commercial banks issuing traditional money.

There has been an interesting development by the Swiss Financial Market Supervisory Authority (FINMA). In February 2018, FINMA published guidelines regarding the regulatory framework for initial coin offerings (ICO). An ICO refers to a mechanism in which investors transfer funds in the form of cryptocurrencies to the organizer and, in return, receive a quantity of blockchain-based digital tokens that are created and stored in a decentralized form (either on a blockchain specifically created for the ICO or through a smart contract on a pre-existing blockchain). In December 2018, furthermore, the Swiss Parliament permitted fintech financial services providers (companies limited by shares, corporations with unlimited partners, or limited liability companies, in addition to the requirement that companies have registered offices and conduct business activities in Switzerland)

[1] Data are available from https://coinmarketcap.com/

to accept public deposits of up to SwF100 million under the conditions that those deposits are neither invested nor paid an interest rate. FINMA began to accept license applications from 2019. This means that fintech companies are not allowed to engage in money creation using digital coins, but are given greater opportunities to expand their businesses.

2.4 Central Bank Digital Currency Proposals and Prospects

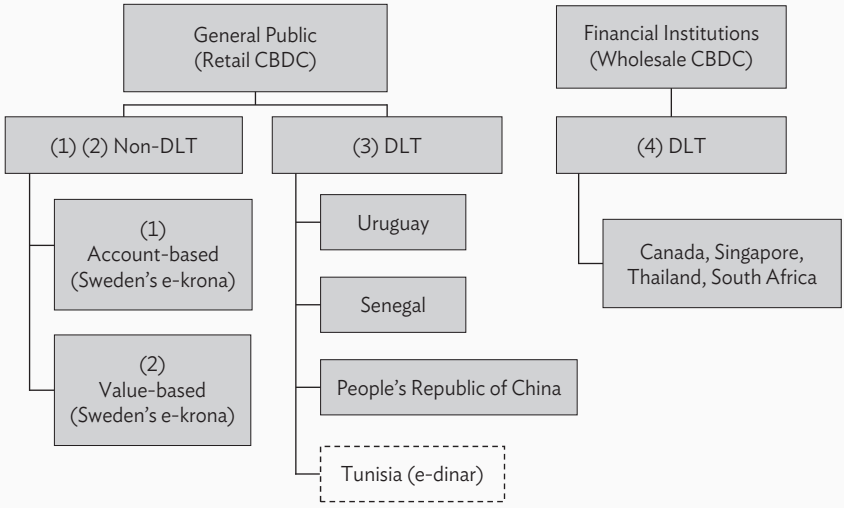
The emergence of private sector digital tokens issued to the general public has prompted intense debate over whether they could become money in the future. In addition, another heated debate has risen about whether central banks should issue their own digital tokens. The idea of central banks issuing digital tokens—nowadays called central bank digital currency (CBDC) proposals—can be classified into "retail CBDC" (issued for the general public) and "wholesale CBDC" (issued for financial institutions that hold reserve deposits with a central bank). CBDC could be a new interest-bearing liability for central banks.

2.4.1 | Four Proposals on Central Bank Digital Currency

It is interesting that the International Monetary Fund (IMF) has begun to examine the potential innovative nature of digital coins and has supported CBDC proposals. Christine Lagarde, the former managing director of the IMF, for example, urged central banks in November 2018 to consider CBDCs, since they could satisfy public policy goals, including financial inclusion, security and/or consumer protection, and privacy in payments (Lagarde 2018).

The ideas on CBDC discussed around the world can be divided into proposals that are based on DLT and those that are not. CBDC proposals can be further differentiated between retail CBDC and wholesale CBDC. Figure 2.10 classifies all the CBDC proposals into the following four types: (1) account-based retail CBDC without DLT; (2) value-based retail CBDC without DLT; (3) retail CBDC based on DLT; and (4) wholesale CBDC based on DLT. The first two proposals are currently being examined by Sweden's Riksbank. All these CBDCs are digital currencies, as described in detail below.

Figure 2.10: Central Bank Digital Currency Proposals



CBDC = central bank digital currency, DLT = distributed ledger technology.

Source: Prepared by the author.

2.4.2 | Motivations Leading to the Central Bank Digital Currency Proposals

Before investigating the four proposals, it is important to examine their importance for some central banks.

Safe Liquid Payments

Central banks find it necessary to provide safe, liquid payment instruments to the general public, just as central banks have been doing for financial institutions using reserve deposits for a long time. This is relevant to the first two proposals (1) and (2) without recourse to DLT, and which are being seriously considered by Riksbank. Given that most of the general public in Sweden no longer uses cash, Riksbank has found it important to provide a safe, liquid payment instrument to both the general public and financial institutions for the sake of fairness in a democratic society. This reflects the concerns that private sector issuers may exploit their privileged positions, possibly by increasing fees and lending interest rates and misusing the

information obtained from tracking transactions if the general public solely depends on private sector money. Also, if several private sector issuers or cashless payment providers go bankrupt as a result of systemic financial crises, the general public may incur improper payment and settlement systems and encounter large losses. As a result, the payment and settlement systems, as well as the financial systems, may become less stable and safe.

Table 2.2 indicates that central bank notes in circulation have dropped to around 1% in Sweden as well as in Norway, while those in terms of GDP have exhibited a declining trend in Australia, Denmark, Sweden, and Norway. According to Riksbank's survey, only 13% of Swedish citizens used cash for their most recent purchase in 2018, down from 39% in 2010. Sweden is more enthusiastic about retail CBDC than Norway and has already published the first e-krona report in September 2017 and the second e-krona report in October 2018 and announced its intention to experiment with the e-krona project in the future in the 2019 report.

Promoting Cashless Payments

Some economies, especially emerging ones, wish to reduce the cost of printing and managing cash and contain the associated crimes by promoting cashless payment. The third proposal (retail CBDC based on DLT) pertains to this motivation. Substantial money has been spent in each economy, not only on direct paper and design fees (spent to reduce counterfeits) but also on the personnel and transportation costs needed to handle cash, as well as on security fees. DLT has the potential to reduce cash-handling costs since all the transactions can be made using a digital representation of money and are traceable. The informal or shadow economy is large in many emerging economies, making it difficult to tax economic activities and cope with illegal and unreported activities. Thus, a shift in central bank money from cash (physical money) to digital currency is one way to formalize the economy so that it becomes more tax-based, transparent, and efficient. DLT enables anonymity, but CBDC might reduce the possibility of executing unreported transactions and crimes.

Financial Inclusion

Financial inclusion is another important motivation for some emerging economies regarding retail CBDC proposals based on DLT. There are still many low-income people or people living in rural areas who are unbanked and without access to commercial banks and the internet and, thus, use cash as their main payment method. Retail CBDC might promote digitization of the economy and, thus, economic and social development.

Table 2.2: Cash in Circulation in Selected Economies

	Cash to Nominal GDP Ratio (%)				
	2000	2005	2010	2015	2017
Japan	12.8	16.0	17.4	19.4	20.4
United States	5.7	6.0	6.5	7.8	8.2
Eurozone	4.8	6.2	8.3	9.9	9.9
Sweden	4.1	3.8	3.0	1.7	1.3
Norway	3.1	2.6	2.1	1.7	1.5
Denmark	2.8	3.0	2.9	2.9	2.9
United Kingdom	3.2	3.3	3.8	4.0	4.1
Canada	3.2	3.2	3.4	3.7	3.9
Australia	3.9	3.6	3.5	4.1	4.1
Singapore	6.8	6.9	6.9	8.1	9.5
Republic of Korea	3.4	2.8	3.4	5.5	6.2
PRC	14.6	12.7	10.9	9.0	8.7
India	9.8	11.1	11.7	11.4	10.1
	Cash (in billions of local currency)				
Japan	67,620	83,773	86,856	103,120	111,508
United States	584	785	980	1,416	1,607
Eurozone	338	521	795	1,038	1,112
Sweden	98	111	105	73	58
Norway	47	52	54	53	48
Denmark	37	47	53	60	62
United Kingdom	34	46	60	76	84
Canada	35	45	57	75	84
Australia	27	35	48	67	74
Singapore	11	15	22	34	42
Republic of Korea	21,425	26,136	43,307	86,757	107,908
PRC	1,465	2,403	4,463	6,322	7,065
India	2,129	4,082	9,070	15,699	16,974

GDP = gross domestic product, PRC = People's Republic of China.

Sources: CEIC, US Federal Reserve of St. Louis, and International Monetary Fund.

DLT and Fintech

The use of DLT, as in the third and fourth proposals, may promote a technological environment and foster fintech. Many emerging economies develop global financial centers and regard fintech as one of the most promising routes for this objective. While those economies may find it difficult to develop banking systems and capital markets that are comparable to those in developed economies, fintech services are new and innovative, and the general public may be more eager to use them given that the banking system and capital markets are still in the early processes of development. These emerging economies may have a greater chance of success in DLT and associated fintech development, as seen in the recent activities in the Shenzhen area in the PRC.

Retail CBDC

Shifting from cash to digital currency through issuing retail CBDC may enhance monetary policy, such as a negative interest rate policy under the effective lower bound, because of limiting the scope of cash substitution that could emerge to avoid a negative interest rate. This motive could be fulfilled in the case of the first, second, and third proposals.

Efficiency and Financial Stability

The efficiency and financial stability gains are feasible, especially with regards to the fourth proposal. Wholesale CBDC has the potential to improve the existing wholesale financial systems—including interbank payments and settlement systems, delivery versus payment systems, and cross-border payments and settlements systems—by speeding up and rationalizing the clearing and settlement processes and possibly reducing the associated cost of transactions and cost of developing and/or upgrading computer systems. The wholesale financial system could be more stable as a result of limiting the chances of data manipulation and removing single-point-of-failure problems from the system. Moreover, wholesale CBDC may be able to improve efficiency by technically broadening account eligibility to financial institutions that normally do not have access to reserve deposits, such as insurance firms, pension funds, and other nonbank financial institutions.

2.4.3 | First and Second Proposals: CBDC without Distributed Ledger Technology

Sweden's Riksbank has been the only central bank so far to actively consider the first two proposals over the past 2 years under the e-krona project. The first proposal, i.e., account-based retail CBDC, is the issuance of a digital currency to the general public in the form of directly providing an account at the Riksbank. The second proposal, i.e., value-based retail CBDC, is the issuance of a digital currency for which the prepaid value can be stored locally on a card or in a mobile phone application (digital wallets).

All the transactions of both e-krona proposals are *traceable* since an underlying register enables the recording of all transactions and owner identification (Table 2.3). This technical feature is regarded as important among central banks to preventing money laundering and criminal activities. Under the value-based system, a register examines whether a payer has sufficient e-krona to transfer, and all cards and digital wallets must be registered so that both payers and payees can be identified in the same manner that users of private sector bank cards and "Swish" (a fast mobile payment system) can be identified. Thus, transactions under the two proposals are *non-anonymous*, with the exception being a prepaid e-krona card, where e-krona are already stored and can be used as cash. This is allowed if the payment amounts to less than €250 (to be lowered to €150 by 2020), as set by the European Union, on the condition that there is no suspicion of money laundering or terrorist financing.

For the first and second proposals to be practical, Riksbank has stressed the need to develop an e-krona payment and settlement platform for the general public by interacting with several other systems and entities, including commercial banks and other firms. Riksbank plans to experiment with the second proposal first since a value-based CBDC is classified as e-money in Sweden's existing financial regulation and, thus, is consistent with the mandate of promoting a safe and efficient payment system so that experimentation can be feasible in the current legal framework. On the other hand, the first proposal is more complicated since Riksbank may need the Parliament to revise the existing central bank act (Sveriges Riksbank Act) in order to provide a clear mandate to issue an account-based retail CBDC. Riksbank may need to draw up proposals for the amendments before conducting any experimentation.

Table 2.3: Features of Central Bank Digital Currency Proposals

				General Public	Anonymous	Traceable	Peer-to-Peer	24 Hours/365 Days	Interest Rate
Account-based	Non-DLT	Retail	Sweden	O	X	O	X	O	O
Value-based	Non-DLT	Retail	Sweden	O	Δ	O	Δ	O	Δ
Digital Token	DLT	Retail	Uruguay	O	O	O	Δ	O	O
Digital Token	DLT	Wholesale	Canada, Singapore, South Africa, Thailand, eurozone, Japan	X	O	O	Δ	O	O

DLT = distributed ledger technology.

Source: Prepared by the author.

Most central banks, including Norway's Norges Bank, have not expressed interest in these Swedish proposals, mainly because of concerns that commercial banks may lose retail deposits to the central bank and, thus, their financing. This concern, however, can be mitigated if a central bank pays a lower interest rate to the general public (and financial institutions) than commercial banks. Another concern is that bank runs may be exacerbated in the event of a crisis. In addition, central bank notes in circulation have continued to rise in most countries except for Sweden and Norway, although those in terms of GDP have dropped in some economies, as mentioned before. Thus, there is no urgent reason for other central banks to examine account-based and value-based CBDC proposals at this stage.

As for monetary policy, it is possible for Riksbank to technically impose a positive or negative interest rate on the first and second e-krona proposals. In Sweden, however, such an interest rate can be applied to account-based e-krona from a legal standpoint but not to value-based e-krona since the latter is regarded in legal terms as e-money and, thus, should be a noninterest-bearing instrument according to the e-money directive.

2.4.4 | Third Proposal: Retail CBDC Based on Distributed Ledger Technology

Under the third proposal, i.e., retail CBDC based on DLT, CBDC has the features of anonymity, traceability, availability 24 hours a day and 365 days a year, and the possibility of an interest rate application (Table 2.3). The proposal is relatively popular among central banks in emerging economies, mainly because of the motivation to take the lead in the rapidly emerging fintech industry, to promote financial inclusion by accelerating the shift to a cashless society, and to reduce cash printing and handling costs. Some countries, including the PRC, Ecuador, India, Israel, Lithuania, the Marshall Islands, Tunisia, and Uruguay have expressed interest and/or conducted experiments in some cases, although enthusiasm from the Reserve Bank of India appears to have waned in 2019.

Cases of Countries That Have Considered or Experimented with the Third Proposal

Ecuador

The Central Bank of Ecuador, which adopted the US dollar as legal tender in 2000, was a frontrunner in terms of issuing retail CBDC in 2014. The central bank allowed users to open accounts with their identification numbers and transfer money between US dollars and digital token accounts via a mobile app. The government pressed for this initiative as it could save the cost of replacing old US dollar notes with new ones (about $3 million). However, the retail CBDC initiative turned out to be unsuccessful because of the limited number of users, and underlying accounts were deactivated in 2017. This reflected the fact that many citizens trusted the US dollar more than the new digital token.

Uruguay

A practical experiment conducted was the case of the Central Bank of Uruguay 6-month pilot study in 2017 on instantaneous payments and settlements systems using retail CBDC. Converting U$20 million to digital currency, the project involved about 10,000 mobile phone users, 15 enterprises such as shops and gas stations, ANTEL (a state-owned telecommunications provider), and a few fintech firms and payment solutions providers. No commercial banks were involved in this study. Users were required to download an app from the national payments company Red Pagos to create a digital wallet and then register it for no charge. Each user (or firm) could place up to U$30,000 (U$200,000 for firms) as e-pesos in the digital wallets, which could then be used to pay bills, receive payments, or transmit money in an easy and secure way. All the transactions were anonymous, traceable,

and safe so that double-spending and falsification were prevented. The pilot study was completed without any technological difficulties, and the Central Bank of Uruguay concluded that issuing retail CBDC benefitted from lower costs, financial inclusion, the prevention of crime and tax evasion, and customer protection, although the experiment was performed on a limited scale. No clear initiatives for actual implementation have been announced.

People's Republic of China

The People's Bank of China (PBC), the central bank of the PRC, established the Institute of Digital Money in 2017 and has been examining the possibility of issuing CBDC along with the yuan through commercial banks in a so-called two-tiered system. Yao Qian of the PBC wrote a report (Qian 2018) that a digital currency could be integrated into the existing banking system, with commercial banks operating digital wallets for the retail CBDC and the general public able to conduct peer-to-peer transactions, as with cash. The report indicated that the digital tokens would use a distributed ledger in a limited way such that their ownership could be verified directly by the issuing central bank. The report concluded that blockchain technology is not suitable for this purpose due to scalability problems. There are several reasons why the two-tiered system is prioritized in the PRC. First, it is relatively easy to replace cash since the PBC supplies it to the general public on demand through commercial banks. Second, the existing banking system is unlikely to be overturned, so commercial banks have incentives to provide CBDC to the general public, provided the deposit rate paid by a central bank is lower than the interest rate paid by commercial banks (Qian 2018). The PBC has not yet announced any clear plans to conduct a practical experiment.

Tunisia

Tunisia's initiative was promoted directly by the government, so it may not be accurate to regard it as a CBDC. Tunisia took the lead in issuing retail DLT-based digital tokens for its government initiative. La Post—a Tunisian government financial institution, but not categorized as a bank—issued a blockchain-based digital version of the Tunisian dinar (the "e-dinar") in 2015 as a part of the government's e-Tunisia initiative, with support from a Swiss-based software company and local fintech firms. This is so far the first and only successful case of a digital coin being issued by a government body or a central bank in the world. The digital tokens are currently listed on global cryptoasset exchanges and can be used in Tunisia to transfer funds, pay for goods and services, pay salaries and bills, and manage official identification documents with limited costs, i.e., transferring funds between virtual accounts and a postal account, and between different virtual accounts, etc.

New digital tokens are issued in a decentralized manner through the proof-of-stake process by miners (developed to cope with Bitcoin's energy-intensive proof-of-work process that requires a large number of calculations) with simple mechanisms that validate a new block.[2] The issuer also claims that the number of tokens could be sufficient for all residents across the globe despite the maximum number set. The anonymity of transactions is maintained. So far, the digital token appears to have not yet been actively utilized to the extent envisaged in Tunisia.

Marshall Islands

Another government-led initiative is in the Marshall Islands, where the US dollar has been the official currency since 1982, and no central bank exists. In 2018, the government floated the idea of introducing its own blockchain-based digital token called "sovereign" (SOV) as a second legal tender supplementing the US dollar. The parliament passed the Sovereign Currency Act in February 2018 to authorize the issuance. The digital token is to be issued in a decentralized manner by third parties through initial coin offerings (ICOs) with the cap of 24 million tokens in order to avoid inflation, with support from a fintech startup in Israel. The main motivation behind this initiative is to prepare for a scheduled decline in grants provided under the US Compact Trust Fund (established by the US government to compensate Marshallese citizens affected by the nuclear tests conducted near the country) after 2023 and acquire new revenue sources. Thus, the issuing of ICOs by the government is being considered as an additional revenue source. Nevertheless, the IMF vehemently warned against issuing the SOV since it might steer the money laundering activities through the country's sole domestic bank that already faces the risk of losing its last US dollar-based banking relationship as a result of heightened due diligence by US banks (IMF 2018). Moreover, criticism of the retail CBDC proposal has intensified in the Parliament because of the risk of losing the country's reputation after the passage of the Sovereign Currency Act. However, Hilda Heine, the president of the Marshall Islands, survived a no-confidence vote (a 16-16 split) in November 2018, so the government plans to issue the SOV after satisfying the requirements imposed by the IMF, the US, and Europe.

[2] In the proof-of-state process, every node can stake a portion of their held cryptoassets in the network. Since this is like storing cryptoassets as collateral, those assets cannot be used. If a transaction is bad, the staker (the node that offers cryptoassets) would face a decline in its stake. If a node stakes a greater amount, the longer they leave it in the network, the greater its chances of being chosen to validate a new block and receive rewards (an interest rate of up to 0.65% per day).

Venezuela

In Venezuela, the government claims that it has issued a government-sponsored digital coin. The digital coin, called the "petro", was issued in 2018 and is backed by a barrel of oil from the country's substantial reserves. The digital coin is complementary to the bolivar as legal tender. The main purpose of issuing a digital coin is to circumvent the financial sanctions imposed by the US on the grounds of corruption and human rights violations and to obtain funds from abroad by attracting foreign investors in the face of severely disrupted economic and financial conditions—not targeting the general public. US President Donald Trump has reacted to this initiative by prohibiting transactions using the digital coin. The government has already required distributors of oil products and air carriers to set up digital wallets to pay and receive funds in petros in 2018 and plans to use the digital coin in its oil exports in 2019. Due to insufficient information, it is not clear whether the digital coin has actually been issued and is functioning. Some media report that investors in the petro have only received petro certificates, not digital coins.[3]

Viewpoints of Developed Economies on Retail CBDC Based on DLT

In sharp contrast to emerging economies, central banks in developed economies—including the US Federal Reserve, the Bank of Japan, Bundesbank, the European Central Bank, and the Swiss National Bank—are not enthusiastic about DLT-based retail CBDC (for example, see Cœuré [2018]). This reflects the fact that existing retail payments and settlements systems have become more efficient, faster, and available 24 hours a day and 365 days per year, so there is no strong case for promoting the proposal. Second, the use of cash is not yet declining in many developed economies (Table 2.2) with the exception of Sweden and Norway. Third, almost all citizens are banked in developed economies, so financial inclusion is not an urgent issue that should be tackled by a central bank. Fourth, many central banks do not wish to create competition between central bank money and private sector money and impose hardships on the existing banking system or amplify the resultant financial stability risk. Finally, central banks in developed economies are generally more cautious on retail CBDC than those in emerging economies, perhaps because of fear of losing their reputation in cases of unsuccessful implementation of the initiative. Limited public interest and support for the proposal is also another factor discouraging these central banks.

[3] For example, see the report released in 2018 (https://coinhub.news/cs/article/bitcoincom-maduros-promotion-of-the-petro-yet-to-yield-results).

For these reasons, central banks in Australia, Denmark, and Norway, whose cash in circulation as a percentage of GDP has been dropping as shown in Table 2.2, have not decided to promote retail CBDC at this stage after carefully examining the pros and cons. Their retail payment and settlement systems are already highly efficient, immediate, and convenient, so they prefer existing private sector money issued by traditional financial institutions (Bank of Israel 2018; Mancini-Griffoli et al. 2018). The central bank in Israel also issued a report in November 2018 regarding retail DLT-based CBDC and concluded that the actual implementation should be postponed until other major central banks in developed economies take the lead, although several potential advantages were identified. The US Federal Reserve also does not support the retail CBDC idea proposed by Koning (2014, 2016).

2.4.5 | Fourth Proposal: Wholesale CBDC Based on Distributed Ledger Technology

The fourth proposal (wholesale CBDC) is the most popular among central banks because of the potential to make existing wholesale financial systems faster, cheaper, and safer. The Bank of International Settlements also shares the view that wholesale CBDC could potentially benefit the payment and settlement systems (Bech et al. 2018).

Some experiments have been already conducted or examined by central banks since 2016, such as those in Canada (Project Jasper), Singapore (Project Ubin), Japan-Euro Area (Project Stella), Brazil, South Africa (Project Khokha), and Thailand (Project Inthanon). Among the central banks, those in Canada, Singapore, South Africa, and Thailand have experimented with the proposal by involving several private financial institutions, fintech firms, consultants, and/or technology firms. The main purpose of these experiments was to promote the central banks' understanding of the DLT systems and their applicability in the existing wholesale financial markets, such as real-time gross settlement systems, delivery versus payment systems, and cross-border interbank payments and settlements systems.

The two frontrunner central banks are the Bank of Canada and the Monetary Authority of Singapore, which launched a series of wholesale CBDC initiatives in 2016–2017 in the areas of interbank payment and settlement systems (real-time gross settlement systems) and delivery versus securities systems, etc. Both Canada and Singapore have concluded that their experiments successfully transferred digital tokens on a distributed ledger in real time and in reasonable volumes.

Nevertheless, these central banks have not taken further steps toward implementation because of their view that the current technology is not yet able to protect privacy. Also, these central banks believe that the process of verifying transactions could be faster and most cost-efficient if the verifier is centralized (either through a group of selected commercial banks or a central bank), but then this approach would end up being similar to the existing centralized system (not necessarily becoming superior to the existing system). In addition, their current wholesale payments and settlements systems are already efficient enough, so no strong advantages can be expected from the CBDC initiative.

Subsequently, the Bank of Canada, the Bank of England, and the Monetary Authority of Singapore worked jointly with financial institutions based on Project Jasper and Project Ubin to assess whether wholesale CBDC could enhance the access, speed, and transparency of cross-border payments and settlements. The three central banks published a joint report in November 2018 and concluded that further work on implementation and policy challenges would be required by both industry and regulators despite significant room for improvement in the cross-border payments space (Bank of Canada, Bank of England, and Monetary Authority of Singapore 2018).

Regarding securities clearing and settlement systems, the Deutsche Bundesbank and Deutsche Börse jointly developed a DLT-based securities settlement platform that enables the delivery-versus-payment settlement of digital tokens and securities (Deutsche 2016). Meanwhile, the US Federal Reserve has not shown strong interest in issuing wholesale CBDC, mainly because of the view that the financial system is already efficient and sufficiently innovative.

2.5 Conclusions

This chapter conducted an overview of the concepts and features of central bank money and private sector money. Their performance was also examined by focusing on selected developed economies and emerging economies. So far, central bank money has been sufficiently provided. Private sector money (mainly bank deposits) is growing and is much greater than central bank money. Meanwhile, digital tokens, such as Bitcoin, can be considered as newly emerged private sector money. While their use as alternative payment tools remains limited, greater attention has been paid to their emergence because of the underlying DLT that could enable a decentralized verification of transactions while maintaining attractive features

similar to cash. Some central banks and commercial banks have expressed unease about the emergence of digital coins and their popularity, partly because of their high volatility. Their concerns may also reflect the potential loss of users from cash and bank deposits to the fintech firms that develop the digital coins. However, the size of the newly emerged private sector money remains limited, so it is likely to take time before such digital coins are a threat to commercial banks and central banks.

Meanwhile, some central banks have examined the potential application of DLT and issued their own digital coins to the general public or financial institutions under the CBDC proposals. However, no central banks so far have found strong advantages of issuing their own digital coins because of several technical constraints. One isolated move is noticeable in the case of Sweden's Riksbank, which has been considering the issuance of deposit accounts or prepaid payment tools to the general public in the face of declining use of cash—just like all central banks issue deposits to financial institutions. While this movement has garnered a lot of attention among some central banks, others have shown little interest in similar initiatives because of the potential shift of retail deposits from commercial banks to a central bank. Given that technology has been progressing rapidly in the settlement and payment areas, as well as DLT, it is possible that central banks may increase their interest in retail and wholesale CBDC proposals based on DLT and consider implementation soon.

REFERENCES

Bank of Canada, Bank of England, and Monetary Authority of Singapore. 2018. Cross-Border Interbank Payments and Settlements. Ottawa: Bank of Canada.

Bank of Israel. 2018. Report of the Team to Examine the Issue of Central Bank Digital Currencies. November. Jerusalem: Bank of Israel.

Bech, M. L., and R. Garatt. 2017. Central Bank Cryptocurrencies, *BIS Quarterly Review*. September: 55–70.

Cœuré, B. 2018. Future of Central Bank Money. Speech by a member of the Executive Board of the ECB at the International Center for Monetary and Banking Studies, Geneva, 14 May.

Deutsche Bundesbank. 2016. Joint Deutsche Bundesbank and Deutsche Börse Blockchain Prototype. Press release, 28 November. Frankfurt: Deutsche Bundesbank.

International Monetary Fund (IMF). 2018. Republic of the Marshall Islands 2018 Article IV Consultation. Press Release; Staff Report; and Statement by the Executive Director for Republic of the Marshall Islands, IMF Country Report No. 18/270 September.

Koning, J. P. 2014. Moneyness. Blog post, 19 October, http://jpkoning.blogspot.com/.

———. 2016. Fedcoin: A Central Bank Issued Cryptocurrency. R3 Report, 15 November.

Lagarde, C. 2018. Winds of Change: The Case for New Digital Currency. Prepared for delivery by IMF Managing Director, Singapore Fintech Festival, 14 November. Washington DC: IMF.

Mancini-Griffoli, T., et al. 2018. Casting Light on Central Bank Digital Currency. IMF Staff Discussion Note SDN/18/08, November. Washington, DC: IMF.

McLeay, M., A. Radia, and R. Thomas. 2014. Money Creation in the Modern Economy. *Bank of England Quarterly Bulletin* Q1: 14–27.

Qian, Y. 2018. Technical Aspects of CBDC in a Two-Tiered System. Materials presented at ITU Workshop on Standardizing Digital Fiat Currency (DFC) and its Applications, New York, 18–19 July.

Riksbank. 2018. The Riksbank's E-Krona Project Report 2. October. Stockholm: Riksbank.

Shirai, S. 2018a. *Mission Incomplete: Reflating Japan's Economy*. Second Edition. Tokyo: Asian Development Bank Institute.

———. 2018b. Bank of Japan's Super-Easy Monetary Policy from 2013–2018. Asian Development Bank Institute Working Paper No. 896. Tokyo: Asian Development Bank Institute.

CHAPTER 3

Regulating Fintech: Objectives, Principles, and Practices

Marlene Amstad*

3.1 Introduction

Two events have shaped the financial system over the past 10 years: the global financial crisis and the rise of the digital finance ecosystem, broadly labelled as financial technology or fintech.[1] Both raised questions about appropriate regulatory response. The lessons learned after the crisis have been widely discussed and the response broadly agreed upon—though not yet fully implemented[2]—in the global regulatory framework Basel III. However, whether and how to regulate fintech is still in its early stages and is a topic of an active policy and academic debate.

In the context of recent fintech developments, this chapter reviews the objectives of financial regulation, covers key guiding principles regulators follow, and ends with a suggested synopsis of the current regulatory practices. Given the very diverse and rapidly developing fintech landscape, it is beyond the scope of this article to aim for completeness; rather, the goal is to offer an overview and focus in each section on a few key regulatory elements. In that, it identifies three core objectives, three guiding principles, and three regulatory practices.

* Marlene Amstad is with the Chinese University of Hong Kong, Shenzhen, and also serves as vice chair of the Board at the Swiss Financial Market Supervisory Authority (FINMA). The views expressed in this chapter are those of the author and do not necessarily represent those of FINMA.

1 Different terms are used, among which the most prominent ones are cryptocurrencies, cryptoassets, and digital assets; less common is virtual or distributed ledger technology (DLT) asset. The terms fintech and digital finance will be used interchangeably in this chapter.

2 See Hohl et al. (2018) for a recent review on implementation of the Basel framework for 100 jurisdictions. Special focus is given to how implementation is shaped following the principle of proportionality (covered in section 3.3).

3.2 Objectives

A precondition of good regulation is clarity about needs and goals. The finance literature commonly gives at least three forms of market failures for which regulation is needed: information asymmetry, importance of externalities (moral hazard), and monopoly power (Armour et al. 2016; Brunnermeier et al. 2009; Freixas and Rochet 2008). From these, among others, core objectives such as investor and consumer protection, financial stability, and market integrity take shape.[3] While the hierarchy of goals varies in each jurisdiction, most regulators cover these core elements in some form. This section touches on each in the context of fintech. While the introduction of fintech poses new challenges and opportunities, the core objectives of regulation likely can also provide appropriate guidance, both on whether or not and how to regulate digital finance.

3.2.1 | Reduce Information Asymmetry: Investor and Consumer Protection

Information asymmetries motivate investor protection or, more broadly, protection of consumers of financial services. Digital finance introduces possibilities to both increase and decrease information asymmetry.

Risks of Increased Information Asymmetry

A key risk for information asymmetry lies in the code that underpins digital finance. While disclaimers testify to the need for some financial and legal knowledge, the ability to know whether the code, public or otherwise, does what it promises is a potential additional obstacle. This is particularly the case when a code (or proof of work or consensus finding, as is present in distributed ledger technology [DLT]) substitutes a third party. This seems more than a theoretical risk as illustrated by initial coin offerings (ICOs), which may offer the possibility for the governance and protection of investors to be executed by a computer code ("smart contracts") instead of the traditional legal mechanisms of a non-digital initial public offering (IPO).

[3] While several additional objectives are discussed, like the contribution to financial sector competitiveness, those can, in many cases, be achieved indirectly via a successful implementation of the aforementioned investor protection, financial stability, and market integrity.

Indeed, Cohney et al. (2018) investigated the top 50 ICOs in 2017 regarding the promises[4] made by promoters and found that the code and disclosures often do not match.

One of the key characteristics of fintech versus traditional finance is that it operates differentially, entailing elements of decentralization, summarized as DLT. While the additional challenge of digital knowledge is largely undisputed, the impact of decentralization is controversial. On the one hand, decentralization may increase information asymmetry, e.g., when comparing an ICO with an IPO. At least in their early days, ICOs often did foresee a less restrictive set of rules for the information-providing issuer and did not involve an underwriter that could potentially soften any asymmetries. By contrast, in an IPO, it is generally mandatory to file a registration statement in the form of a publicly available prospectus, as well as a private filing for the regulator.[5] On the other hand, decentralization may, over time, lower information asymmetries following the traditional Hayek argument (1945) that says decentralized markets process information better than a centrally-planned economy and thus allocate resources more efficiently. It is yet too early to tell whether the emergence of digital platforms will eventually facilitate frictionless decentralization and deepen coordination.

Opportunities to Lower Information Asymmetry

Digital finance can also lower information asymmetries in several ways, not least under the rubric of financial inclusion. Some fintech initiatives particularly aim at not only lowering costs, but also lowering information asymmetries in providing financial product access to a broader audience. The information asymmetry can potentially be lowered on both the supply as well as the demand sides of financial services.

On the demand side, proximity to a well-developed commercial area used to be a determining factor for the breadth of financial products and services, as well as the competitiveness of their prices. Digital technology has changed that, as consumers in remote and less-developed regions are empowered to enjoy equal access to financial products and services and information allowing for less costly comparisons, and to build a credit history simply by, for example, using their mobile phones.

---

4 Specifically, the authors checked whether, if ICO white papers so promised, the code actually restricted the supply of their cryptoassets and the transfer of those allocated to insiders according to a vesting or lockup plan. Further, they investigated whether ICO promoters used code to retain the power to modify the smart contracts, and, if so, whether they disclosed this in natural language.

5 Such documentation provides financial statements of the company, the background of the management, insider holdings, any legal problems faced by the company, etc.

In underbanked regions with no legacy system like bank branches, these developments have been particularly fast and impactful, in some respects even leapfrogging traditional markets, with the People's Republic of China as an oft-cited example (Institute of Digital Finance 2018; Luohan Academy Report 2019).

On the supply side, banks might be more willing to provide credit to customers they know better through data collections and to tailor their services closer to their needs. Meanwhile, the promise of technology goes beyond that and may potentially lower the entrepreneurship disparities between regions, gender, income, and age. However, as a precondition for this, the World Bank (2018) identifies many skill-related obstacles that can hamper inclusive growth, including limited access to education, lack of a basic social safety net, and weak institutions. One of the most well-known examples of overcoming these obstacles is M-Pesa launched in 2007 in Kenya, which innovated on the back of existing infrastructure by using SIM cards, allowing basic phones, even without the functionality of applications, to provide financial services.[6]

3.2.2 | Financial Stability

In addition to ensuring the solvency and liquidity of individual financial institutions, regulation aims at the soundness of the financial system as a whole. Stability risks are usually associated either with the relative size or the connectivity of a financial market participant, that is, being either "too big to fail" or "too interconnected to fail".

In terms of threats through size, the Committee on the Global Financial System and the Financial Stability Board (CGFS and FSB 2017), among others, concluded that, at this stage, the size of fintech-era credit in many jurisdictions is still small enough to limit the systemic impact. At the same time, a range of benefits and risks was identified in cases where fintech might grow further. Particularly, the recent entry of large technology firms (big tech) presents new and complex trade-offs between financial stability, competition, and data protection (BIS 2019).

[6] The FinAccess household survey carried out by the Central Bank of Kenya, the Kenya National Bureau of Statistics, and FSD Kenya found in 2019 that 83% of Kenyans had access to formal financial services, up from 29% in 2006. These positive advances were also attributed to the growth of mobile money platforms like M-Pesa (FSD Kenya 2019).

In terms of risks related to connectivity, cybersecurity[7] emerged as a key challenge for regulators and is as much related to financial stability as it is to market integrity (covered in the next section). However, it is notoriously difficult to quantify cyber-risks' overall impact as data are scarce due to lack of common measurement standards and firms' small incentive to report. Early, widely cited estimates are annual global losses of almost $600 billion (McAfee 2018), with cybercrime being the second-most reported economic crime with 32% of organizations affected (PwC 2016).

The financial sector is a favorite target for cybercrime according to several industry reports. Cybercrimes come in different formats, including data theft,[8] asset theft,[9] and (Distributed) Denial of Service attacks.[10] The attacks are far from being limited to banks and increasingly also involve securities dealers, particularly in the context of fintech. Cyberattacks on fintech firms (mainly online exchanges allowing the trading of cryptocurrencies and providing wallet services) have resulted in at least $1.45 billion in losses since 2013 (Bouveret 2018).[11]

Given its world-spanning nature, cybersecurity has triggered a series of international initiatives from the Group of Twenty (G20), the Financial Stability Board, the Committee on Payments and Market Infrastructures, and the International Organization of Securities Commissions, all expressing the need to monitor cyber-risk arising from fintech and issuing guidance for regulatory responses.

---

7 Defined by Cebula and Young (2010) as, "operational risks to information and technology assets that have consequences affecting the confidentiality, availability, or integrity of information or information systems."

8 For example, in one of the biggest data breaches in history, over 80 million accounts at JP Morgan were affected in 2014.

9 At least 10 attacks using fraudulent SWIFT messages causing initial losses of $171 million for Union Bank of India in July 2016, $81 million for the Bangladesh Central Bank in February 2016, and $60 million for Far Eastern International Bank (Taipei,China) in October 2017 (estimated losses as reported by ORX news and Financial Times).

10 In the US in 2012, the websites of Bank of America, PNC, JP Morgan, US Bancorp, Wells Fargo, BBT, Capital One, HSBC, Region Financial, and SunTrust were targeted and disrupted. In 2013 in the Czech Republic, the central bank, three large banks, and the stock exchange were disrupted, with estimated damages of $500,000. In Norway on 8 July 2014, seven major financial institutions were attacked, leading to disrupted services during the day. In Finland in 2014, three banks (Op Pohjola, Danske Bank, and Nordea) suffered Distributed Denial of Service attacks that rendered their online services unavailable and, for one bank, prevented customers from withdrawing cash and making card payments.

11 The largest initial losses occurred at Coincheck in January 2018 with $534 million and MT Gox in January 2014 with $470 million.

The worry is shared among the industry as illustrated in a recent survey where only 42% of respondents considered their institution to be extremely or very effective in managing cyber-risk (Deloitte 2016). Yet, in a 2019 global survey (risk.net 2019) among chief risk officers and operational practitioners, the first, second, and fifth[12] among the top 10 major operational risks were related to cybersecurity.

3.2.3 | Market Integrity

The third core objective of regulation and supervision is to maintain market integrity. Whether digital or not, trust is the basis of financial transactions, emphasizing the need to safeguard the system from illicit activities and fraud. New technologies have the potential to spur financial innovation, efficiency, and inclusion, and, at the same time, create new risks to market integrity, making zero tolerance of illicit behavior as much in the interest of a truly innovative industry as regulators and supervisors.

Among the several risks to market integrity from fintech, money laundering stands out. The recommendations by the independent inter-government body, the Financial Action Task Force (FATF), are recognized as the global anti-money laundering and counter-terrorist financing standard. In 2014, the FATF issued recommendations focusing on digital currencies. With the rise of anonymity-enhanced digital currencies and the emergence of other virtual asset ecosystems, including ICOs, the approach broadened since 2015. Particularly, in October 2018 and June 2019, the FATF amended Recommendation 15 on New Technologies to clarify definitions and to specifically describe how countries and obliged entities must prevent the misuse of virtual assets for money laundering and terrorist financing and the financing of proliferation (FATF 2019), a step welcomed by the G20 and the Financial Stability Board, with the latter further exploring the possible implications of decentralized financial technologies and how regulators can engage other stakeholders.

Remaining vigilant to existing and emerging risks to market integrity has further elements. With increased importance of data, corresponding privacy issues are heightened. While these hurdles are particularly high for individuals, they often show the classic privacy paradox (Barnes 2006; Athey, Catalini, and Tucker 2017), where people claim to be very concerned about their own privacy, while largely ignoring these risks in their online behavior.

[12] No. 1: data compromise; No. 2: IT disruption; No. 5: theft and fraud.

The European Union in May 2018 was among the earliest jurisdictions to implement tight consumer safeguards around data disclosure with their General Data Protection Regulation, which requires firms to report a data breach within 72 hours and provide customers with access to their own data, in some cases enabling them to correct or erase it. Failure to comply with the requirements can lead to fines up to €20 million or 4% of global annual turnover, whichever is higher. With digital technology being part of the problem as well as the solution (e.g., via encrypting), regulation and supervision must be especially alert to strike the right balance in order to inform and protect the privacy of financial market participants.

3.3 Principle-based Regulation

To achieve the objectives covered in the previous section, many regulators use a broad set of principles and outcome-focused rules ("principle-based") rather than detailed prescriptions ("rules-based"). Overall, the principle-based regulatory approach seems to have somewhat gained in importance in the light of fintech developments. One reason might be that it adapts more easily and cost-effectively to new and quickly developing business models, due to its less-demanding frequency and volume of legislation adaptations.

While the principles, their implementation, and their hierarchy vary, at least the following three have emerged across different jurisdictions and are widely accepted among regulators: legal certainty, technology neutrality, and proportionality (or often also referred to as risk-based). In the following, we cover each of these principles in the context of fintech. All principles aim toward a level playing field for market participants: make sure that everyone is on the same page legally (Section 3.3.1), treat technologies equally (Section 3.3.2), and find a balance between risk exposure and regulatory requirements. All three principles keep or even heighten their relevance in the context of digital finance.

3.3.1 | Legal Certainty

A key principle to any regulation is to provide legal certainty. This includes a robust definition of regulatory perimeters as well as transparent application of the law. Unclear terminology and classification encourage regulatory arbitrage and ultimately hamper a robust legal framework and financial innovation, alike. It therefore comes as no surprise that many fintech projects are eager to be regulated as this instills

the legal certainty needed to attract investors. Further, there is a risk that coding regulator approaches at an early stage of development is normative and might even intentionally or unintentionally steer innovation from the public sector.

In the context of fintech at least three challenges to legal certainty arise. First, the high speed of development of fintech in terms of different business models and from basically nil to taking center-stage in discussions on the financial system within just a decade contrasts with the usually time-consuming procedures for new regulatory rules commonly embedded in a system of public consultation of the most important involved stakeholders. The second challenge pertains to the number of involved government institutions. Financial regulation in many jurisdictions involves a variety of institutions (including the central bank, financial supervisory bodies, other government departments such as the tax administration, legislative and anti-money laundering regulator). The scope of different regulatory authorities ("regulatory perimeter"), which varied significantly even before the digital age, potentially overlaps even more when regulating digital asset activities. This is illustrated by the finding that, on average, three distinct national bodies per jurisdiction have issued official statements on digital assets, including warnings (Cambridge Centre for Alternative Finance 2019). The third challenge is, vis-à-vis regulators and market participations, fintech increasingly mandates computer science and coding knowledge in addition to the usual legal and financial market knowledge.

One possible answer to all three challenges is regulatory sandboxes. While the format of sandboxes varies significantly in different jurisdictions (Cambridge Centre for Alternative Finance 2019), they usually allow testing new business models without immediate full-fledged legislation. In addition, further attempts to provide legal certainty have been undertaken in several jurisdictions in the form of either a fintech license (usually for a dedicated business model, or, in a few cases, in the form of a horizontal license covering several financial services banks, insurance and asset managers, and financial infrastructure at once) or legislation covering distributed ledger technologies (DLTs).

3.3.2 | Technology Neutrality

Technology neutrality entails regulators looking through the technology and focusing mainly on the functionality that a financial service provides. For example, with the onboarding of new clients, which is a key element in financial services, a technology-neutral regulation defines specific requirements regarding anti-money laundering, regardless of whether the on-boarding is done non-digitally at the classic bank counter or through a dedicated online solution.

Several reasons bolster technology-neutrality as a key regulatory principle. First, technological change is very fast and getting faster. It might be neither possible nor efficient to constantly review and update regulations accordingly. As of mid-2019, there are over 2,500 different cryptocurrencies available[13] and the term DLT is only a placeholder for a diverse set of functionalities and parameters.[14]

Another reason for regulators to abstain from picking one technology over the other is that taking sides invokes potential responsibility. The risk of unwillingly being perceived as an implicit guarantee may lower industry incentives to identify imperfections and flaws in the technology favored by a regulator. In the extreme, it could even cause the industry to innovate less as the official technology has an advantage.

3.3.3 | Proportionality

The Basel framework sets minimum regulatory requirements for internationally active banks in the traditional framework. Within these limits, it allows national authorities proportionality in setting lower regulatory requirements for financial services that are of limited risk due to factors such as firm size, systemic importance, complexity, and risk profile. The concept of proportionality aims to limit public intervention in the form of regulatory duties and particularly to avoid excessive compliance costs or regulatory burdens for smaller and non-complex banks (BCBS 2019; Lautenschläger 2017).

Some of the new business models of fintech engage only in one particular aspect of banking (e.g., payments), insurance (e.g., convenience in processing refunds), or asset management (e.g., advisory). Also, at least some are of relatively small size and, so far, limited systemic importance (Ch. 2.2). This raises the question of the extent to which fintech should be required to live up to a full-fledged banking, insurance, or infrastructure license, or whether it could be regulated only for the specific function of its business model. Two key criteria regarding the risks fintech pose are whether it is involved in maturity transformation and whether deposits are on the balance sheet and directly accessible by the fintech company. In that context, the limit between providing only a pure software solution and actual financial services has been tested by digital finance.

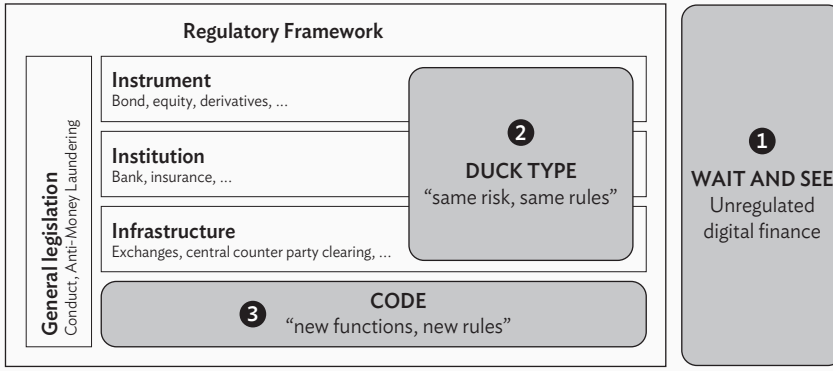
13 Coinlore.com. Number of all coins retrieved July 2018.

14 E.g., Rauchs et al. (2018b) introduce a DLT landscape map that differentiates 12 systems.

3.4 Regulatory Practices in Fintech: A Synopsis

In the traditional regulatory framework, a few aspects, such as conduct and anti-money laundering regulations, apply to the full financial universe. However, in most aspects, the regulatory framework differs by instrument, institution, and infrastructure (Figure 3.1). Where does fintech fit into this landscape? The answer is not trivial as fintech encapsulates a broad spectrum of activities. A one-size-fits-all regulatory approach risks stifling innovation and discouraging new market entrants. Accordingly, Claessens et al. (2018) for fintech credit and Kaal (2018) for ICOs, both find that the current regulatory responses differ widely across types of fintech activities and jurisdictions. This section shows how, despite these differences, regulators essentially have three options in this regard: wait and see, duck type, or code (Amstad 2019).

Figure 3.1: A Synopsis for Regulatory Options in Fintech



Source: Amstad (2019).

3.4.1 | Wait and See: "Keep It Unregulated"

The first option is to leave fintech largely unregulated. In the early days of fintech, regulators in most jurisdictions chose "wait and see". Bitcoin, as a catalyst of the fintech ecosystem, started in 2008 with the seminal paper by Satoshi Nakamoto.

However, many jurisdictions had their initial statements issued only in 2013 (Cambridge Centre for Alternative Finance 2019).[15] At that time, some fintech companies felt hampered in their activities as they could not benefit from the legal certainty of regulation, a criticism that contrasts with the sometimes anti-government approach of at least some fintech activities.

The aggregate market capitalization of cryptoassets skyrocketed from $30 billion to over $800 billion in early January 2018, before falling back to around $200 billion (Cambridge Centre for Alternative Finance 2019). With increased fintech-era volumes, levels of fraud, inappropriate market practices, and Ponzi schemes also increased. Hesitant to overregulate, but increasingly seeing the need for a response to ensure investor and consumer protection and market integrity, several jurisdictions resorted to issuing warnings to the market. In detailing the case of ICOs, Zetzsche et al. (2018) documented the issuance of warnings as likely the least interventionistic of all regulatory options.

To wait and see was the predominant option as long as the market volume in fintech stayed low. However, a range of benefits and risks were identified in cases where fintech might grow further (CGFS and FSB 2017). If regulation seems appropriate, the fundamental question arises as to whether fintech's risks and rewards can be integrated into the existing framework, or whether a new paradigm is required.

3.4.2 | Duck Type: "Same Risk, Same Rules"

The second option is to "duck type"[16] fintech rules into the existing regulation. Some fintech models are essentially digital or crypto representations of an instrument, an institution, or a financial infrastructure platform. A straightforward approach to regulating these models is to focus on their economic function or, more specifically, their underlying risk. The same risk—whether digital or not—would need the same regulatory answer, be it reporting requirements, a license, or a ban. This strategy refers to the famous Howey test,[17] and is often simplified as the "duck test" that says, "if it looks like a duck, swims like a duck, and quacks like a duck, then it probably is a duck."

15 Cambridge Centre for Alternative Finance (2019): "the first official report mentioning cryptoassets by a regulatory authority was published in 2011 by the French AML regulator Tracfin, followed by the European Central Bank in 2012. By 2014, 93% of analyzed jurisdictions. Interestingly, the vast majority (75%) of, the same year the market experienced the largest bubble since the inception of Bitcoin in 2009."

16 I borrow the term "duck-typing" from computer programming.

17 It goes back to a case in the Supreme Court in 1946, which created a test that looks at an investment's substance, rather than its form, as the determining factor for whether it is a security.

Duck-typing regulation applies two widely used, previously mentioned regulatory principles: it is principle-based, as it regulates the same risk with the same rule, and it is technology-neutral as it focuses on the economic function. An example is the ICO guidelines by the Swiss Financial Market Supervisory Authority (FINMA): "In assessing ICOs, FINMA will focus on the economic function and purpose of the tokens (i.e., the blockchain-based units) issued by the ICO organizer" (FINMA 2018). Accordingly, ICOs are classified into payment, utility, and asset tokens. Compliance with respective existing regulations and, in all cases, with anti-money-laundering legislation is required. Duck typing regulates the function, rather than the instrument, institution, or infrastructure platform. However, fintech innovations may also lead to new functionality. Regulators need to identify these new functions and, if need be, code them into new regulations that specifically address them.

3.4.3 | Code: "New Functionality, New Rules"

The third option is to code fintech using regulations that are specifically tailored to new functionality made possible through technological innovation. Duck-typing regulation works as long as fintech operates in the same way as traditional finance. Despite technological change, the underlying core risks in financial markets, such as market, credit, liquidity, and operational risks, have remained largely the same.

However, with ongoing financial innovation, new combinations of risks might emerge. Alternatively, the core risks might show in forms only made possible through using new technology. Both scenarios might need additional specific regulations. Similarly, new risks stemming from interconnected financial markets were brought to the forefront during the global financial crisis. While underlying risks would stay the same, it became clear that safeguarding individual financial institutions is insufficient and a separate additional macroprudential layer is necessary.

Indeed, current research suggests that fintech might lead to new functionality based on, among other elements, on: (a) the specific features of blockchain technology; (b) the new combination of business models; and (c) new digital operational challenges. In the following we provide examples for each characteristic.

(a) *Blockchain technology.* Cong and He (2019) demonstrated that blockchains have profound economic implications on consensus generation, industrial organization, smart contract design, and anti-trust policy. Specifically, in the traditional system—largely due to contract incompleteness—sellers cannot

offer prices contingent on the success of delivering the goods. In contrast, blockchains, via decentralized consensus, enable agents to contract based on service outcomes and to automate contingent transfers. They conclude that this new functionality can deliver higher social welfare and consumer surplus through enhanced entry and competition, yet it may also lead to greater collusion. Consequently, they suggest an oft-neglected regulatory solution to separate usage and consensus generation on blockchains, so that sellers cannot use the consensus-generating information for the purpose of sustaining collusion.

Another example for functionality made possible through blockchain is the "fork", as an either accidental or intentional change in protocol. Biais et al. (2017) illustrated that forks might be an integral part of blockchain applications, leading to orphaned blocks and persistent divergence between chains.[18] Again, it is not straightforward to see a direct analogy to a fork in the non-digital world and therefore how to mirror it using current regulations, at least taking into consideration whether dedicated regulations are needed.

New functionality might also arise from decentralization, which, for example, allows for greater ease in benefitting from regulatory arbitrage. Makarov and Schoar (2018) found that price movements in cryptocurrencies are largely driven not by transaction costs or differential governance risk, but rather by avoiding regulation.

(b) *New combination (of business models and jurisdictions).* Fintech is characterized by a strong and increasing cross-segment expansion instead of limiting itself to the value chain of a classic bank or insurance company. Rauchs et al. (2018a) found that 57% of cryptoasset service providers were operating across at least two market segments to provide integrated services for their customers. This led some to declare fintech a new asset class. Findings by Hu, Parlour, and Rajan (2018) support this view, showing that cryptocurrencies are highly correlated among each other—likely driven by Bitcoin serving as vehicle currency in the cryptocurrency space—but are largely orthogonal to traditional assets. It is still too early to tell whether cryptocurrencies' distinct behavior is a testament to the rise of a new asset class justifying its own regulation.

(c) New digital operational risks can appear across the digital financial services and market value chain. Digital technology also enables the generation and analysis of vast amounts of customer and transaction data, i.e., "big data", which introduces its own set of benefits and risks that should be managed (G20 2016).

[18] They also show how forks can be generated by information delays and software upgrades.

An additional need for dedicated regulation may arise from the fact that digital blockchain records must be enforced in the physical world. "While blockchains can keep track of transfer of ownership, proper enforcement of possession rights is still needed, except in the case of (fiat) cryptocurrencies" (Abadi and Brunnermeier 2019). The enforcement of rights and duties in fintech may differ from those found in traditional assets.

3.4.4 | Current Regulatory Practices

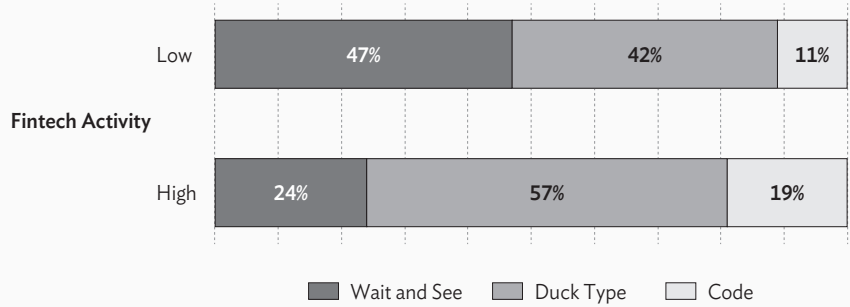
To gauge the importance of each of the three previously mentioned regulatory answers, we use a survey done by the Cambridge Centre for Alternative Finance (2019) and map their categories in the above-suggested synopsis. The survey includes 108 jurisdictions. The categorization applies to secondary market activities.

The importance of each category varies depending on the level of activity of the fintech industry in a jurisdiction. The classification between the "high" and "low" level of cryptoasset activities is based on the number of cryptoasset firms operating, the number of ICOs launched, and the level of mining activities recorded. Of the jurisdictions with low fintech activity, the main regulatory answer is, with almost 50%, "wait and see". If this is not an option, then duck typing is 42% of regulation, while only in 10% of the jurisdictions would code a bespoke fintech answer.

Meanwhile, "wait and see" is an option only for 24% of jurisdictions that face an active fintech industry. Here, the predominant strategy of regulators with 57% is to duck type existing regulations. In already a fifth of the cases, the regulators even adapt by coding tailor-made regulations (Figure 3.2).

Table 3.1 presents an overview of several countries' new regulations and licenses ("coding") introduced since 2015. It further illustrates that, as of now, the way in which public policy balances risks and benefits differs quite a bit, as no consensus has emerged so far.

Figure 3.2: Regulatory Answers



Notes: "Wait and see" (outside the financial regulatory framework) represents "other existing or unregulated", "Code" represents "bespoke", and "duck type" represents "retrofitted or prohibited". These regulatory responses only apply to secondary market activities. The classification between "high" and "low" levels of cryptoasset activities is based on the number of cryptoasset firms operating in the country, the number of ICOs launched, and the level of mining activities recorded in the country.

Source: Author's representation based on an expanded sample of 108 jurisdictions by the Cambridge Centre for Alternative Finance (2019).

Table 3.1: Selected Features of Dedicated Fintech Credit Policy Frameworks

Jurisdiction	Tax Incentives	Regulations[a]	Licensing/ Authorization[a]	Investor Protections[a]	Risk Management Requirements[a]
Australia	–	–	–	–	–
Brazil	–	✓	✓	✓	–
Canada	–	–	–	–	–
Chile	–	–	–	–	–
PRC	✓	✓	✓	✓	✓
Estonia	–	–	–	✓	–
Finland	–	✓	✓	–	–
France	✓	✓	✓	✓	✓
Germany	–	–	–	–	–
Japan	✓	–	–	–	–

continued next page

Table 3.1: ***Continued***

Jurisdiction	Tax Incentives	Regulations[a]	Licensing/ Authorization[a]	Investor Protections[a]	Risk Management Requirements[a]
Rep. of Korea	–	–	–	–	–
Mexico	–	✓	✓	–	✓
Netherlands	–	–	–	✓	–
New Zealand	–	✓	✓	–	✓
Singapore	–	–	–	–	–
Spain	–	✓	✓	–	✓
Switzerland[b]	–	✓	✓	✓	✓
United Kingdom	✓	✓	✓	✓	✓
United States	–	–	–	–	–

PRC = People's Republic of China.

[a] Specific rules for fintech credit that are separate from pre-existing rules for other financial intermediaries.

[b] New rules effective from 2019.

Source: Adapted from Claessens et al. (2018).

3.5 Conclusion

Regulators and supervisors face a challenging balancing act to stay innovation-friendly and, at the same time, show zero-tolerance for criminal behavior. As with previous non-digital forms, fintech regulations need to be motivated by a clear set of objectives and guiding principles for their implementation. The traditional core objectives of non-digital financial regulation as investor and consumer protection, market integrity, and safeguarding financial stability, keep their relevance also for fintech. In the very early days and at small volumes of fintech, wait-and-see approaches were dominant. In cases where regulation seemed appropriate, however, similar activities were treated in similar ways to limit incentives for regulatory arbitrage. At the same time, regulators would be well-advised to remain alert to the limits of duck typing and aim to identify early on new functionalities that may require conceptually distinct regulation of technology-enabled finance.

In harnessing the benefits of financial innovation, while containing risks, it will be instrumental that all relevant stakeholders such as regulators, the fintech industry, and academia engage in an open dialogue to assure a common understanding of fintech activities and business models, as well as the motivation and implementation of regulatory measures, alike.

REFERENCES

Abadi, J., and M. K. Brunnermeier. 2019. Blockchain Economics. National Bureau of Economic Research (NBER) Working Paper No. 25407.

Amstad, M. 2019. Regulating Fintech: Ignore, Duck Type or Code. *Voxeu.com*, 23 March.

Armour, J., et al. 2016. *Principles of Financial Regulation*. Oxford: Oxford University Press.

Athey, S., C. Catalini, and C. E. Tucker. 2017. The Digital Privacy Paradox: Small Money, Small Costs, Small Talk. National Bureau of Economic Research (NBER) Working Paper No. 23488.

Bank for International Settlements (BIS). 2019. Big Tech in Finance: Opportunities and Risk. In *BIS Annual Economic Report 2019*. Basel: BIS.

Barnes, S. B. 2006. A Privacy Paradox: Social Networking in the United States. *First Monday* 11(9).

Basel Committee on Banking Supervision (BCBS). 2019. Proportionality in Banking Regulation and Supervision—A Survey of Current Practices. March. Basel: BCBS.

Biais, B., C. Bisière, M. Bouvard, and C. Casamatta. 2018. The Blockchain Fork Theorem. Toulouse School of Economics Working Paper No. 17–817.

Bouveret, A. 2018. Cyber Risk for the Financial Sector: A Framework for Quantitative Assessment. International Monetary Fund Working Paper 18/143.

Brunnermeier, M., A. Crockett, C. Goodhart, A. D. Persaud, and H. S. Shin. 2009. The Fundamental Principles of Financial Regulation. *Geneva Reports on the World Economy* 11. Paris: International Center for Monetary and Banking Studies.

Cambridge Centre for Alternative Finance. 2019. *Early Lessons on Regulatory Innovations to Enable Inclusive FinTech: Innovation Offices, Regulatory Sandboxes, and RegTech.* Cambridge, UK: University of Cambridge.

Cebula, J. J., and L. R. Young. 2010. A Taxonomy of Operational Cyber Security Risks, Technical Note CMU/SEI-2010-TN-028, Software Engineering Institute, Carnegie Mellon University.

Claessens, S., J. Frost, G. Turner, and F. Zhu. 2018. Fintech Credit Markets around the World: Size, Drivers and Policy Issues. *BIS Quarterly Review* September.

Cohney, S., D. Hoffman, J. Sklaroff, and D. Wishnick. 2018. Coin-Operated Capitalism. *Columbia Law Review* 119(3): 591–676.

Committee on the Global Financial System and Financial Stability Board (CGFS and FSB). 2017. FinTech Credit: Market Structure, Business Models and Financial Stability Implications. CGFS Papers, May.

Cong, W., and Z. He. 2019. Blockchain Disruption and Smart Contracts. *Review of Financial Studies* 32(5): 1754–1797.

Deloitte. 2016. *Global Risk Management Survey*, 10th edition.

Financial Action Task Force (FATF). 2019. *Guidance for a Risk-Based Approach to Virtual Assets and Virtual Asset Service Providers.* Paris: FATF.

Financial Market Supervisory Authority (FINMA). 2018. Guidelines for Enquiries Regarding the Regulatory Framework for Initial Coin Offerings. Bern: FINMA.

Freixas, X., and J.-C. Rochet. 2008. *Microeconomics of Banking*. MIT Press.

FSD Kenya. 2019. *FinAccess Household Survey 2019.* Nairobi: FSD.

Group of Twenty (G20). 2016. High-Level Principles for Digital Financial Inclusion.

Hayek, F. 1945. The Use of Knowledge in Society. *The American Economic Review* 35(4): 519–530.

Hohl, S., M. C. Sison, T. Stastny, and R. Zamil. 2018. The Basel Framework in 100 Jurisdictions: Implementation Status and Proportionality Practices. *FSI Insights on Policy Implementation* 11.

Hu, A. S., C. A. Parlour, and U. Rajan. 2018. Cryptocurrencies: Stylized Facts on a New Investible Instrument. Available at SSRN: https://ssrn.com/abstract=3182113.

Institute of Digital Finance, Peking University. 2018. *Digital Inclusive Finance Index Report 2011–2017.* Beijing: Institute of Digital Finance.

Kaal, W. 2018. Initial Coin Offerings: The Top 25 Jurisdictions and Their Comparative Regulatory Responses. Working paper, University of St. Thomas School of Law.

Lautenschläger, S. 2017. Is Small Beautiful? Supervision, Regulation and the Size of Banks. Speech at International Monetary Fund Seminar, Washington, DC, 14 October.

Luohan Academy Report 2019. Digital Technology and Inclusive Growth. Luohan Academy.

Makarov, I. and A. Schoar. 2018. Trading and Arbitrage in Cryptocurrency Markets. Working paper. Available at SSRN: https://ssrn.com/abstract=3171204.

McAfee. 2018. Economic Impact of Cybercrime: No Slowing Down. Santa Clara, United States.

PwC. 2016. Global Economic Crime Survey 2016: Adjusting the Lens on Economic Crime. http://www.pwc.com/crimesurvey (accessed July 2017).

Rauchs, M., A. Blandin, K. Klein, G. Pieters, M. Recanatini, and B. Zhang. 2018a. *2nd Global Cryptoassets Benchmarking Study*. Cambridge, UK: Cambridge Centre for Alternative Finance, University of Cambridge.

Rauchs, M. et al. 2018b. *Distributed Ledger Technology Systems: A Conceptual Framework.* Cambridge, UK: Cambridge Centre for Alternative Finance, University of Cambridge.

Risk.net. 2019: Top Operational Risks for 2019. Survey. 14 March. https://www.risk.net/risk-management/6470126/top-10-op-risks-2019 (accessed 18 August 2019).

World Bank. 2018. Universal Finance Access by 2020. http://www.worldbank.org/en/topic/financialinclusion/brief/achievinguniversal-financial-access-by-2020 (accessed 18 August 2019).

Zetzsche, D. A., R. P. Buckley, D. W. Arner, and L. Föhr. 2018, The ICO Gold Rush: It's a Scam, It's a Bubble, It's a Super Challenge for Regulators. European Banking Institute (EBI) Working Paper Series No. 18. EBI.

CHAPTER 4

SME Finance in Asia: Recent Innovations in Fintech Credit, Trade Finance, and Beyond

Giulio Cornelli, Vukile Davidson, Jon Frost, Leonardo Gambacorta, and Kyoko Oishi*

4.1 The Importance of SME Finance in Asia[1]

Small and medium-sized enterprises (SMEs) play an important role in the Asian economy (Table 4.1). Although estimates vary, several sources suggest that SMEs account for over 95% of all firms, contribute to 50%–70% of employment, and constitute 30%–60% of various countries' gross domestic product (GDP).[2]

Despite their importance to the economy, SMEs in Asia often have a difficult time obtaining external finance. A joint study by the Organisation for Economic Co-operation and Development and the Asian Development Bank found that SMEs in Asia trail global peers in access to financial services, specifically with respect to credit (OECD and ADB 2014). In addition, they are roughly half as likely to apply for loans as global peers, and are also more likely to have relied on retained earnings over external financing for investment.

* The views expressed are those of the authors and not necessarily of the Bank for International Settlements or the Financial Stability Board. With thanks to Stijn Claessens and Costas Stephanou for comments, and Adam Majoe and Toby Miller for editorial support.

1 This chapter draws on examples from specific firms. These are for illustrative purposes only. They are not exhaustive and do not imply any statement with regard to any firm, product, or service.

2 According to the SME Finance Forum, SMEs comprise 98% of enterprises and employ 50% of the workforce in Asia and the Pacific (Ata 2014). The Asian Development Bank estimates that SMEs account for more than 96% of all Asian businesses and provide two-thirds of private sector jobs (ADBI 2019). Notably, the definition of SMEs differs across countries. Most define them based on thresholds for employment, capital, and revenue.

One reason for SMEs' reluctance to borrow may be due to stricter requirements from banks; in Asia, SMEs are roughly 50% more likely to be required to provide collateral for loans. By contrast, in Europe, loans to SMEs are mainly in the form of credit lines that are typically uncollateralized. Moreover, most countries in Europe have mutual guarantee institutions, which are nonprofit organizations that allow small firms to improve their borrowing capacity (see Columba, Gambacorta, and Mistrulli [2010] for the Italian case). Banks may also be less willing to lend to SMEs in Asia as the risks and transaction costs are high relative to returns.

Table 4.1: SMEs in Asia are Highly Significant Contributors to the Economy

Economy	SME Share of Employment (%)	SME Contribution to GDP (%)	Data Year
People's Republic of China	64.7	60.0	2011, 2013
Hong Kong, China	47.0	–	2012
India	40.0	37.5	2015, 2013
Indonesia	97.0	60.3	2009, 2013
Japan	69.7	43.7	2012
Republic of Korea	87.7	47.6	2012
Malaysia	65.0	35.9	2014
Philippines	63.7	35.7	2013, 2009
Singapore	68.0	45.0	2012
Taipei,China	78.0	30.0	2011
Thailand	80.3	39.6	2014
Viet Nam	46.8	40.0	2012, 2011

– = not available, GDP = gross domestic product, SME = small and medium-sized enterprise.

Source: Asian Development Bank Institute (2019).

4.2 Fintech Credit and SME Financing

Against the backdrop of SMEs struggling to obtain conventional sources of financing, emerging financial technological innovations in Asia have changed traditional models such that they may help to bridge the funding gap. In recent years, fintech[3] and big tech[4] firms have increasingly stepped in to provide funding to SMEs.

In particular, fintech credit has expanded rapidly. According to data from the Cambridge Centre for Alternative Finance (CCAF),[5] global debt-based alternative finance (fintech credit) volumes grew by 26% in 2017, from $287 billion in 2016 to $373 billion in 2017. If big tech credit is added to that, then the growth was even more rapid (Figure 4.1), and the provision of total fintech credit stood at $543 billion globally in 2017. Most of these volumes ($492 billion) are in the People's Republic of China (PRC) and elsewhere in Asia.

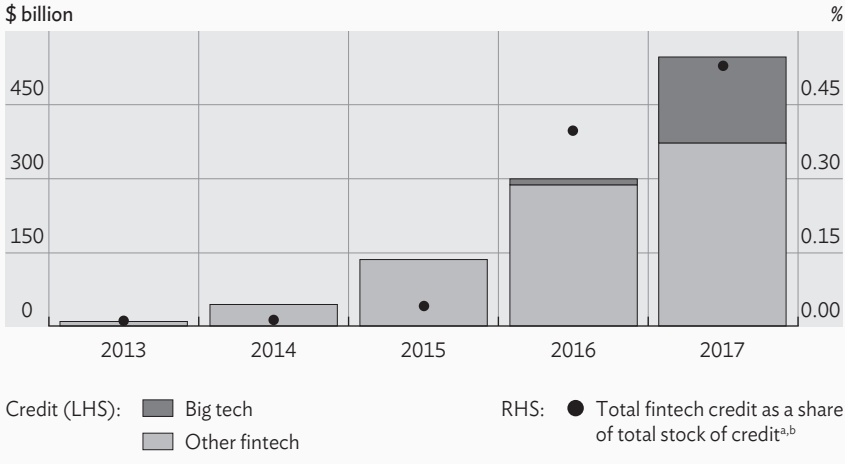
Although still a small proportion of the total, fintech credit is becoming an economically relevant source of finance to SMEs in certain countries around the world, including the PRC and other parts of the Asia and the broader Pacific region (FSB 2019b). While data on aggregate SME financing volumes are not available for the PRC, WDZJ.com estimates that fintech credit made up 13% of new lending to the private sector in the first 5 months of 2018. In Australia, fintech credit volumes stood at over $1 billion in 2017, mostly in the form of business balance sheet lending, peer-to-peer (P2P) funding, and invoice trading (CCAF 2018). In the Republic of Korea, India, and Japan, fintech credit stood at $652 million, $220 million, and $190 million, respectively, most of which was to small businesses (CCAF 2018).

[3] Fintech credit refers to credit through online (nonbank) platforms. This includes all credit activity facilitated by online platforms that are not operated by commercial banks (CGFS and FSB 2017; Claessens et al. 2018). Depending on the economy, these platforms can be referred to as peer-to-peer (P2P) lenders, loan-based crowdfunders, or marketplace lenders.

[4] A rapidly growing subset of fintech credit, which is generally not captured in standard data sources, is big tech credit, i.e., credit provided by large technology companies whose primary business is digital services, rather than financial services (Frost et al. 2019).

[5] As mentioned previously, data on big tech credit are scarce, and are not included in those from the Cambridge Centre for Alternative Finance (CCAF). As such, volumes have been estimated based on publicly available data. Aggregate data on returns and net losses are generally not publicly available. Microdata on losses are available to big tech firms themselves, and can be used for empirical analysis (Frost et al. 2019).

Figure 4.1: Global Volume of New Fintech and Big Tech Credit Has Grown through 2017



LHS = left-hand scale, RHS = right-hand scale.

[a] Total fintech, defined as the sum of fintech and big tech credit divided by the sum of total fintech credit and total credit to the private non-financial sector.

[b] Average calculated for a selected set of countries.

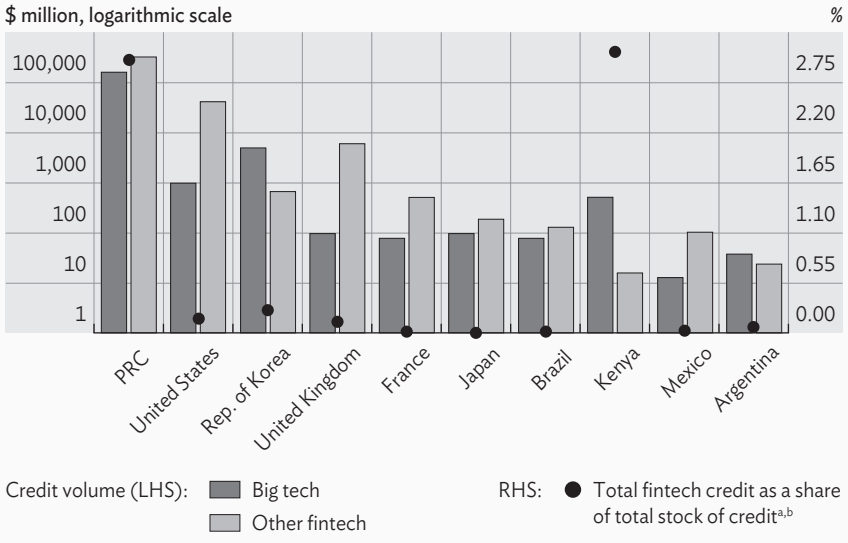
Note: Figures include estimates.

Sources: Cambridge Centre for Alternative Finance and research partners, big tech companies' financial statements, Frost et al. (2019).

For both big tech and other fintech credit, the PRC remained by far the largest market in 2017, with a volume of $163 billion and $321 billion, respectively (90% of the global volume). In the Republic of Korea, big tech credit comprised $4.9 billion (mostly from Kakao Bank and KBank), with other fintech credit being $653 million. While total fintech credit was only 0.5% of outstanding credit at a global level in 2017, this was much higher in the PRC, at 3.0% (Figure 4.2).

As of 2018, there was evidence that fintech credit platforms are becoming economically relevant in Indonesia, with Rp9.21 trillion ($650 million) in loans disbursed to 1.43 million borrowers as of July 2018 (KPMG 2018). Big tech players like Grab and Go-Jek also have extensive lending in Indonesia and other countries in Southeast Asia, including to car buyers. Recently, these firms have begun offering consumer credit for purchases in stores (Tani 2019).

Figure 4.2: Total Fintech Credit Varied by Economy in 2017



LHS = left-hand scale, PRC = People's Republic of China, RHS = right-hand scale.

[a] Total fintech credit (including big tech credit) divided by the sum of total credit to the private non-financial sector. The latter includes total fintech credit.

[b] Selected countries.

Notes: Figures include estimates. Bars are sorted by total fintech credit volume. Logarithmic scale.

Sources: Cambridge Centre for Alternative Finance and research partners, big tech companies' financial statements, Frost et al. (2019).

4.2.1 | Innovative Uses of Data in Credit Analysis

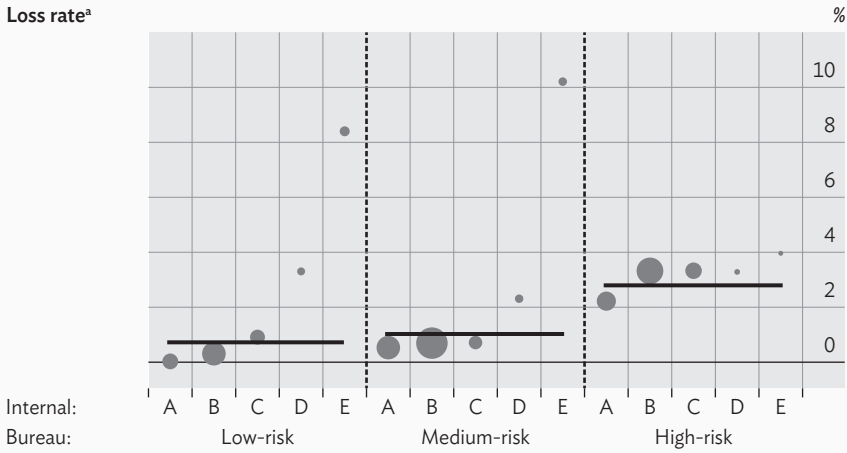
Fintech and big tech firms have a number of specific advantages compared to incumbent financial activities, including their access to data and networks (FSB 2019a; BIS 2019; Stulz 2019); in some cases, this can allow them to adapt to the unique challenges and needs of SMEs. Compared to banks, fintech and big tech firms have been better able to use alternative sources of data and technology to supplement traditional credit information. This has helped SMEs previously disadvantaged by limited credit history and has the potential to address a key problem in many Asian countries that lack comprehensive credit bureau coverage.

The credit scoring approach of big tech firms may provide an advantage over incumbent banks, where it is common to rely heavily on traditional information sources like audited financial statements, collateral, and loan officer judgment to approve or reject a potential borrower. The use of machine learning could aid the direct and rapid assessment of credit risk. In particular, it can improve underwriting, draw on information from relationships between customers, and, in some cases, prevent human bias from entering the decision. The greater data resources could open the possibility that big tech lenders lend to borrowers who were previously shut out of the formal bank credit market.

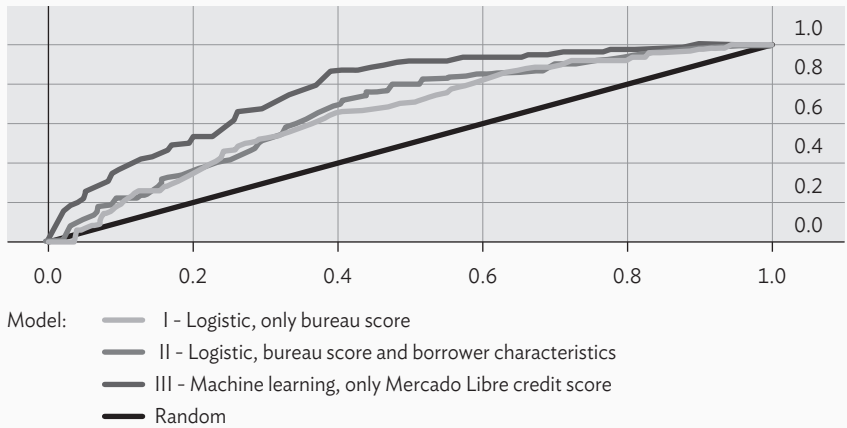
As an example from outside Asia, using data from Mercado Libre in Argentina, Frost et al. (2019) suggest that big tech firms' machine learning-based credit scoring applied to small vendors from a wide variety of platform data outperforms models based on credit bureau ratings and traditional borrower characteristics. As shown in Figure 4.3, Mercado Libre's internal ratings (A to E) can be compared with those of the credit bureau (low-risk to high-risk), which banks rely on, but augment with other borrower characteristics and soft information (Figure 4.3, top panel). For a given bureau rating (e.g., low-risk), the expected loss rate is strictly in line with the internal rating, i.e., the patterns of the dots show that the internal rating increases with expected loss. Conversely, for a given internal rating (e.g., C, D, or E), the loss rate is not strictly in line with credit bureau risk. For example, the dot associated with internal rating D in the low-risk bureau category indicates a higher risk than the internal rating D in the medium-risk bureau category. Moreover, the internal rating has a broader range, covering losses from 0.0% to 10.2%; the bureau rating ranges from 0.7% to 2.8%.

Most importantly, by using the internal scoring model, Mercado Libre can provide credit to the profiles assessed as high-risk by the bureau. The size of the dots in the left-hand panel of Figure 4.3 is proportional to the share of the firms in the rating distribution; a substantial number of clients are in the credit bureau high-risk category. Because banks use a mix of credit bureau information, hard information from financial statements, and soft information from loan officers, this segment may have much less access to traditional banking services. With its more granular scoring model, Mercado Libre offers 30% of its credit to this category. Further, the internal rating system based on machine learning techniques and data obtained from the e-commerce platforms can outperform simple models based on bureau score and borrower characteristics in predicting defaults (Figure 4.3, bottom panel).

Figure 4.3: Credit Assessment for SMEs and Big Data Analytics



Receiver operating characteristics (ROC) curve[b]



SME = small and medium-sized enterprise.

[a] The loss rate is the volume of loans more than 30 days past due relative to the origination volume. In its use to date, the internal rating of Mercado Libre is better able to predict such losses. It segments the originations into five different risk groups versus the three clusters identified by the bank bureau. The size of the dots is proportional to the share of the firms in the rating distribution.

[b] True positive rates versus false positive rates for borrowers at different thresholds for a logistic model with (I) only the credit bureau score, (II) a logistic model with the bureau score and borrowers' characteristics, and (III) a machine learning model with the Mercado Libre credit score. A random model is included for comparison purposes. The ROC curve shows that the machine learning model has superior predictive power to both the credit bureau score only and the credit bureau score with borrower characteristics.

Source: Frost et al. (2019).

Similar credit assessment models are used by fintech and big tech lenders in the Asia and Pacific region, and there is evidence that these may enhance credit access; for instance, Hau et al. (2018) find evidence that PRC fintech credit mitigates supply friction and allows firms with a lower credit score to access credit.[6] Fintech credit may also serve firms that do not have access to collateral, such as new firms whose primary assets are intangible intellectual property. While fintech credit may thus enhance financial inclusion, it may also go to marginal borrowers, who may have lower creditworthiness.

While available evidence thus suggests that innovative uses of data can aid credit assessments and potentially enhance inclusion, there are questions as to whether this performance is superior to bank models that also use soft information, and whether it can be sustained over full business and financial cycles. In particular, many new credit assessment models rely on a relatively short time series of information, and have not yet been tested in a downturn (Claessens et al. 2018). Globally, policy makers recognize the paradox of limited access to finance due to insufficient data on SMEs in an age when it is significantly more available, and note that technology is increasingly reconciling this paradox (Carney 2019).

4.2.2 | Trade Finance

Another area where technology can play a notable role in transforming business practices is in trade finance. The growing importance of Asia in world trade emphasizes small businesses' need for expanded access to finance. SMEs contribute over 40% of exports in major economies like the PRC and India (Table 4.2). Asia is now responsible for roughly one-third of global trade, trailing only Europe, while Asian firms account for roughly half of the world's supply chain exports, which involve trade in parts and components (WTO 2016).

Despite SMEs' existing participation in Asia's trade, their presence is restricted by access to finance. In an Asian Development Bank survey, SMEs report limited funding as a common reason for refraining from trade in the global supply chain, with 60% saying that they did not proceed with a trade because of lack of finance. Importantly, ADBI estimates that a 10% increase in trade finance is associated with a 1% increase in employment (ADBI 2019).

[6] Similarly, for consumer lending, Tang (2019) finds that fintech credit complements bank lending for small-scale loans in the United States, and Jagtiani and Lemieux (2018) find that Lending Club has penetrated areas that are underserved by traditional banks. De Roure, Pelizzon, and Tasca (2016) find that fintech credit serves a slice of the consumer credit market neglected by banks in Germany.

Table 4.2: Trade Finance to SMEs Has Particular Importance in Asia

Economy	SME Share of Exports (%)	Data Year
People's Republic of China	41.5	2011
India	42.4	2013
Indonesia	15.7	2013
Republic of Korea	18.8	2012
Thailand	26.3	2014

SME = small and medium-sized enterprise.

Source: Asian Development Bank Institute (2019).

In trade finance, technology-driven changes to business models can expand access to financial services with growth potential for Asia's SMEs by modernizing inefficient processes and reducing the role of costly intermediaries. Similarly, technological innovations have the potential to transform invoice financing by leveraging the digitalization of commerce to make accounts receivables more easily priced and traded.

The complexity and paperwork-intensive nature of trade finance transactions has made distributed ledger technologies (DLT) an attractive option in the Asia and Pacific region. DLT could help digitize and automate the trade supply chain and make checks much quicker, more efficient, and less costly. DLT could also improve processes via smart contracts, which operate like traditional contracts, but can be executed automatically without the need for intermediaries or paper-based processes. Using DLT to create single digital records for customs clearance could in principle help lower fees and reduce barriers to trade.

According to estimates by the World Economic Forum and Bain & Company, DLT could increase new trade by $1 trillion globally (WEF and Bain 2018). In particular, the study shows that such use of DLT would reap material benefits in the Asia and the Pacific region, which accounts for a large share of the global trade finance gap.[7]

[7] The World Economic Forum estimates that the global trade finance gap was around $1.5 trillion in 2017, of which close to 40% of this gap is attributed to the Asia and Pacific region (WEF and Bain 2018).

There have been several public and private sector initiatives that attempt to promote DLT technology in a way that would benefit SMEs. The Hong Kong Monetary Authority, the Monetary Authority of Singapore, and the People's Bank of China have actively promoted the private sector using DLT to address trade finance issues (MAS 2017; King 2018). These proposals aim to reduce the risk of fraud and duplicate financing; improve operational efficiency by allowing for verification of information by users rather than by a single trusted party; and increase the speed of transactions and reduce the need for paper reconciliation (FSB 2019c). Moreover, incumbent banks have piloted DLT solutions to trade windows, for instance, for trade between New Zealand and the Republic of Korea (ASB 2018). In Thailand, 22 banks have teamed up to form the Blockchain Community Initiative, whose goal is to reduce the time it takes to issue letters of guarantee (Lorenzo 2019). This consortium was established under the auspices of the Bank of Thailand's regulatory sandbox. Eleven banks in India have also established a similar consortium that promotes blockchain for SME financing solutions (Manikandan 2019).

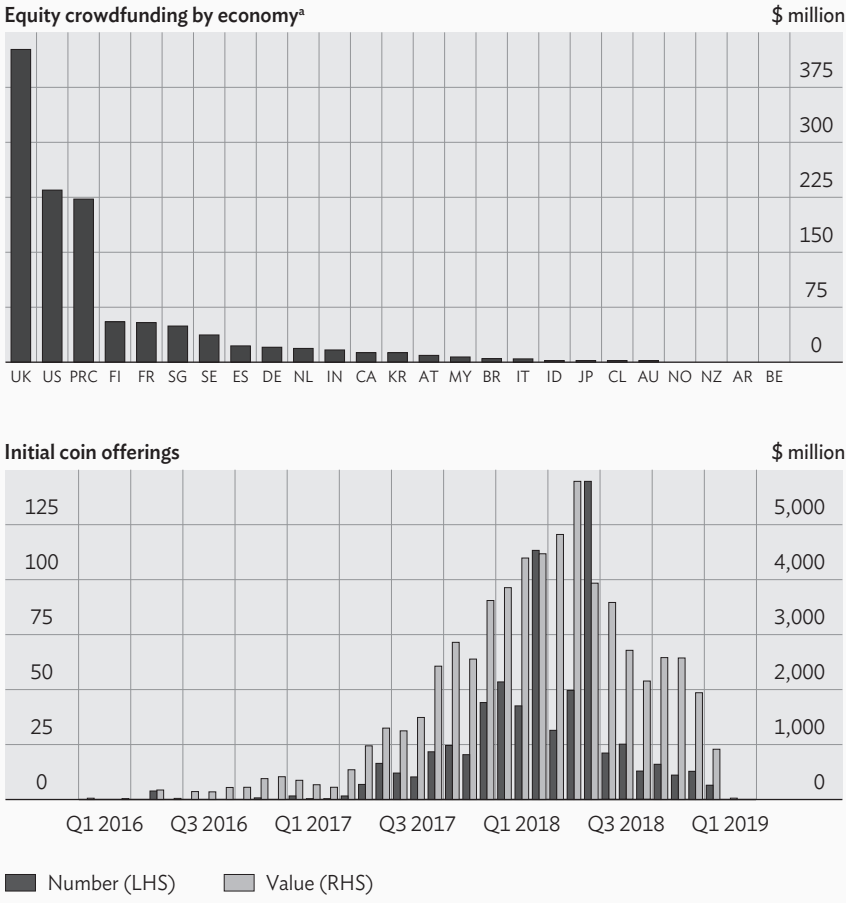
While using DLT in areas such as trade finance and letters of guarantee has the potential to significantly reduce processing times and overhead costs compared to conventional processes, the extent to which these advantages play out in practice has yet to be tested.

4.2.3 | Other Forms of Fintech Financing

Equity crowdfunding and initial coin offerings (ICOs) are further potential sources of finance to businesses, including to SMEs. Equity crowdfunding allows investors to take an equity stake in firms. This form of finance is especially widespread in the United Kingdom and, to a lesser extent, the United States and the PRC (Figure 4.4, top panel). ICOs, meanwhile, involve the sale of a cryptoasset ("coin") or a digital representation of value. There have been significant governance problems in this sector, including widespread dissemination of fraudulent information to investors in so-called "whitepapers". If these issues can be addressed, some authors posit the potential for ICOs to aid SME financing in the future (OECD 2019). ICOs raised $3.9 billion in the first 2 months of 2018, but only $285 million in the corresponding period in 2019 (Figure 4.4, bottom panel).

More generally, the use of mobile money from big tech has had a significant impact on financial services in emerging markets, including for micro SMEs. Mobile money transactions now account for 7% of GDP in Asia, compared to close to 20% of GDP in sub-Saharan Africa and less than 2% of GDP in other regions (IMF 2019).

Figure 4.4: Equity Crowdfunding and Initial Coin Offering Volumes



AR = Argentina, AT = Austria, AU = Australia, BE = Belgium, BR = Brazil, CA = Canada, CL = Chile, DE = Germany, ES = Spain, FI = Finland, FR = France, ID = Indonesia, IN = India, IT = Italy, JP = Japan, KR = Republic of Korea, LHS = left-hand scale, MY = Malaysia, NL = Netherlands, NO = Norway, NZ = New Zealand, PRC = People's Republic of China, RHS = right-hand scale, SE = Sweden, SG = Singapore, UK = United Kingdom, US = United States.

[a] Top 25 countries; 2017 data.

Sources: Cambridge Centre for Alternative Finance, Coinschedule.

While most use cases are related to remittances, broader uses are increasingly common, including for the payments for goods and services. In some cases, these operators also provide savings, loan, and insurance products.

4.3 Conclusion

SMEs play an important role in the Asian economy but generally have a difficult time obtaining external finance due to a number of factors on both the supply and demand side, including the lack of financial statements or insufficient documentation, higher demand for collateral from Asian banks, and the limited presence of mutual guarantee institutions to mitigate asymmetric information problems. Fintech innovations in Asia have changed traditional funding models, which may help bridge the funding gap. As shown in this chapter, fintech finance has rapidly expanded in several Asian countries through online lending platforms, lending by big tech firms, and more recently, new forms of trade finance, equity crowdfunding, and ICOs.

In addition to new sources of funding, technology can also help improve access to credit for small firms in Asia, with innovative use of machine learning technologies and data in credit analysis by fintech and big tech firms providing an advantage over traditional banks. Central banks and governments in several countries are more actively intervening, often with the private sector, to promote new technologies to increase funding opportunities for SMEs. These actions include grappling with the private and public benefits and the rights related to information.

While several legal and regulatory challenges remain and the resilience of these new funding models have not yet been tested in a downturn, new technologies have already started to transform SME financing.

REFERENCES

Asian Development Bank (ADB). 2019. *Fintech for Asian SMEs*. Manila: ADB.

Ata, A. 2014. The Role of SMEs in Asia's Economic Growth. SME Finance Forum, April.

Auckland Savings Bank (ASB). 2018. ASB Makes New Zealand Exporting History with First Bank-Led Blockchain Trade. Press release, 2 November.

Bank for International Settlements (BIS). 2019. Big Tech in Finance: Opportunities and Risks. In *Annual Economic Report, 2019*. June, pp. 55–79.

Cambridge Centre for Alternative Finance (CCAF). 2018. *The 3rd Asia Pacific Region Alternative Finance Industry Report.* November. Cambridge, UK: CCAF.

Carney, M. 2019. Enable, Empower, Ensure: A New Finance for the New Economy. Speech at the Mansion House, London. June.

Claessens, S., J. Frost, G. Turner, and F. Zhu. 2018. Fintech Credit Markets around the World: Size, Drivers and Policy Issues. *BIS Quarterly Review.* September.

Columba, F., L. Gambacorta, and P. E. Mistrulli. 2010. Mutual Guarantee Institutions and Small Business Finance. *Journal of Financial Stability* 6(1): 45–54.

Committee on the Global Financial System (CGFS) and Financial Stability Board (FSB). 2017. Fintech Credit: Market Structure, Business Models and Financial Stability Implications. May.

De Roure, C., L. Pelizzon, and P. Tasca. 2016. How Does P2P Lending Fit into the Consumer Credit Market? Deutsche Bundesbank Discussion Papers, No. 30.

Financial Stability Board (FSB). 2019a. FinTech and Market Structure in Financial Services. February. FSB.

———. 2019b. Evaluation of the Effects of Financial Regulatory Reforms on Small and Medium-Sized Enterprise (SME) Financing. Consultative Document. June. FSB.

———. 2019c. Decentralised Financial Technologies: Report on Financial Stability, Regulatory and Governance Implications. June. FSB.

Frost, J., L. Gambacorta, Y. Huang, H. Shin, and P. Zbinden. 2019. BigTech and the Changing Structure of Financial Intermediation. BIS Working Paper Series, No. 779.

Hau, H., Y. Huang, H. Shan, and Z. Sheng. 2018. Fintech Credit, Financial Inclusion and Entrepreneurial Growth. Unpublished working paper.

International Monetary Fund (IMF). 2019. FinTech in Sub-Saharan African Countries: A Game Changer? February.

Jagtiani, J. and C. Lemieux. 2018. Do Fintech Lenders Penetrate Areas that Are Underserved by Banks? *Journal of Economics and Business* 100: 43–54.

King, R. 2018. PBoC Launches First Phase of Blockchain Trade Financing Platform. *Central Banking*. 20 September.

Lorenzo, D. 2019. Thailand Launches Blockchain Letters of Guarantee Network for 22 Banks. *Thailand Business News*. 4 June.

Manikandan, A. 2019. ICICI, Kotak, Axis among 11 to Launch Blockchain-Linked Funding for SMEs. *Economic Times*. 28 January.

Monetary Authority of Singapore (MAS). 2017. Singapore and Hong Kong Launch a Joint Project on Cross-Border Trade and Trade Finance Platform. November.

Organisation for Economic Cooperation and Development (OECD). 2019. *Initial Coin Offerings (ICOs) for SME Financing.* Paris: OECD.

OECD and ADB. 2019. ADB-OECD Study on Enhancing Financial Accessibility for SMEs: Lessons from Recent Crises. April.

Stulz, R. M. 2019. FinTech, BigTech, and the Future of Banks. Fisher College of Business Working Paper No. 2019-03-020.

Tang, H. 2019. Peer-to-Peer Lenders Versus Banks: Substitutes or Complements? *The Review of Financial Studies* 32(5): 1900–1938.

Tani, S. 2019. In Fintech Race, Go-Jek App Extends Consumer Credit to Offline Stores. *Nikkei Asian Review*. 3 June.

World Economic Forum (WEF) and Bain & Company (Bain). 2018. Trade Tech: A New Age for Trade and Supply Chain Finance. September.

World Trade Organisation (WTO). 2016. *World Trade Report 2016: Levelling the Trading Field for SMEs.* Geneva: WTO.

CHAPTER 5

The Digital Revolution in Asia and Its Macroeconomic Effects

Tahsin Saadi Sedik, Sally Chen, Tarhan Feyzioglu, Manuk Ghazanchyan, Souvik Gupta, Sarwat Jahan, Juan Manuel Jauregui, Tidiane Kinda, Vipichbolreach Long, Elena Loukoianova, Alexandros Mourmouras, Masahiro Nozaki, Simon Paroutzoglou, Cormac Sullivan, Jiae Yoo, and Longmei Zhang*

5.1 Introduction and Main Findings

The digital revolution is underway. While digitalization and automation are not new, they have accelerated in recent years, and a new wave of innovation—triggered by advances in artificial intelligence, robotics, computing power, and cryptography, as well as the explosion of big data—is reshaping the global economy. More so than during past periods of innovation, including the spread of personal computers in the 1980s and the rise of the internet in the 1990s, today's technological advances are multiple and overlapping, creating synergies and accelerating outcomes. The digital revolution is affecting all sectors, with far-reaching social and economic impacts. The new technologies are general purpose, with the potential to transform the global economy, boost productivity, and fundamentally alter the way we live and work, much as the steam engine and electricity did. But in the process, these technologies may also cause substantial disruptions and dislocations. This chapter focuses on whether the digital revolution in Asia is driving growth or disrupting it.

5.1.1 | Key Findings

First, Asia has been at the forefront of the digital revolution, although with heterogeneity across the region:

- There are Asian players leading nearly every aspect of digitalization, while at the same time some economies are lagging behind. In fact, the region's economies have the highest dispersion in terms of the adoption of digital technologies—

* This chapter was prepared by the authors under the guidance of Kenneth Kang and Koshy Mathai. Substantial inputs were provided by Gee Hee Hong and Todd Schneider. Alessandra Balestieri and Socorro Santayana provided production assistance.

not surprising given that Asia covers the entire income spectrum. Nonetheless, at any given income level, Asian economies are at the frontier relative to their global peers; moreover, digitalization is accelerating even for relatively poor Asian economies.

- Automation via industrial robots is one area in which Asia is clearly at the forefront, although it is limited to a few Asian economies. With Asia being the "factory to the world," it is perhaps to be expected that a full two-thirds of the world's industrial robots are employed in the region. The use of robots has accelerated since 2010. The People's Republic of China (PRC) is now the single biggest user, accounting for some 30% of the market; further, in 2016, the PRC, Japan, and the Republic of Korea each employed more robots than the United States (US). But this is not just because production volumes are high in Asia. Robot density (the number of industrial robots per 1,000 workers) is high and rising fast in several Asian economies, attesting to their rapid and extensive adoption. Indeed, the Republic of Korea and Singapore are the global leaders in robot density, followed by Germany and Japan. Finally, Asia is a leader not only in the use of robots, but also in their production—Japan and the Republic of Korea are the world's top two producers, with market share of 52% and 12%, respectively.
- E-commerce and financial technology (fintech) are other areas in which Asia leads. For instance, the PRC accounted for less than 1% of global retail e-commerce about a decade ago, but that has grown to more than 40%, and the penetration of e-commerce (as a percentage of total retail sales) now stands at 15%, compared to 10% in the US. E-commerce penetration is lower in the rest of Asia, but it is growing fast, particularly in India, Indonesia, and Viet Nam. In terms of fintech, Asian economies have made significant progress, in many cases leapfrogging into new types of technology. For example, in 2016, mobile payments made by individuals for consumption purchases totaled $790 billion in the PRC, 11 times the size of such payments in the US. Asia has also been a leader in cryptoassets, including initial coin offerings. Finally, some small states in the region have even been approached by private investors to adopt cryptoassets as the legal tender, raising serious legal and regulatory concerns.

A second key finding is that Asia has already benefited immensely from digitalization. This chapter finds that the diffusion of technological innovation has been the key driver of growth in per capita gross domestic product (GDP) in Asia over the past 2 decades, with digital innovation alone accounting for nearly 30%. The digital component of GDP, proxied most narrowly by the share of the information and communication technology (ICT) sector, is relatively large in

many Asian economies—Asia is home to seven of the world's top 10 economies in terms of the ICT share of GDP. The sector has also been growing substantially faster than overall GDP—twice as fast in India and Thailand, and nearly four times as fast in Japan. Digitalization has also boosted the productivity of non-ICT sectors. Innovation in Asia is tilted toward the digital sector, further highlighting its potential to boost future growth.

Third, e-commerce has the potential to support growth and rebalance economies. For consumers, e-commerce may translate into better access to a wider range of products and services at lower prices, ultimately boosting consumption. For firms, e-commerce could also provide new business opportunities and access to larger markets and may thus support investment. The econometric analysis shows that participation in online commerce is associated with a more than 30% increase in total factor productivity at the firm level in Asia. Innovation, human capital, and, to some extent, access to finance seem to be behind online firms' stronger performance. Finally, the chapter finds that firms engaged in e-commerce also export 50% more, relying on their skilled labor force and capacity to innovate. Interestingly, e-commerce seems to be especially beneficial for small firms in Asia.

Fourth, digitalization presents opportunities for improving public finance in Asia. Government adoption of digitalization can, by improving reporting of transactions, increase value-added tax (VAT), tariffs, and other revenue. The analysis indicates that if Asian economies were to move halfway to the global frontier, import-VAT revenue could rise by 0.6% of GDP. Digitalization can also improve the efficiency of public spending, including via the targeting of social assistance, by reducing inclusion and exclusion errors. More generally, digitalization can improve public financial management systems.

Fifth, the chapter finds the impact of robots on employment depends on country-specific conditions. Using an approach pioneered by Acemoglu and Restrepo (2017a), the chapter analyzes the impact of robot use on employment across a large sample of economies in Asia, Europe, and the Americas. Contrary to some observers, the chapter finds no evidence that robots destroy jobs on net—that is, the productivity-enhancing (and thus job-creating) effects of industrial robots have offset the displacement effect (that is, the destruction of old jobs). Restricting attention to Asia, however, there is a slight negative impact on overall manufacturing employment, and particularly so in certain heavily-automated sectors like electronics and automobiles. Furthermore, like others, this chapter finds that workers with medium-level education are more vulnerable to displacement than those with either low or high education levels. Interestingly, in Japan, with its

aging population and declining labor force, increased robot density in manufacturing is associated not only with greater productivity, but also with local gains in employment and wages. Japan's experience suggests that other Asian economies facing similar demographic trends in the future, such as the PRC, the Republic of Korea, and Thailand, may also benefit from automation.

Finally, the chapter finds that economies with a greater propensity for technological leapfrogging have also tended to see declining traditional financial infrastructure, particularly bank branches. Unlike US tech companies, Asian tech giants, especially in the PRC, have become key providers of financial services, putting competitive pressures on traditional financial institutions.

Neither the opportunities nor the challenges related to digitalization have yet become fully apparent. Some economists have questioned the ability of technological progress to keep propelling the economy forward, arguing that the low-hanging fruit has mostly been picked, and further advances will become increasingly difficult. Others argue that the new technologies are not widely diffused, complementary innovations and production processes that will boost productivity have not been fully developed, occupations may need to be redesigned, and the capital investments required to implement new technologies have not yet been made. It is worthwhile recalling that it took more than 2 decades for electricity to substantially increase productivity.

5.1.2 | Striking the Right Balance

While the digital revolution is inevitable, the outcome—utopian or dystopian—will depend on policies. To realize the potential of the digital revolution, comprehensive policies and fresh thinking are needed. For policy makers, the first hurdle is to accept that the digital revolution is inevitable. Policy responses will need to strike the right balance between enabling digital innovation and addressing digitalization-linked risks. Policy priorities differ across Asia (and the world), as economies' initial conditions are different. Policies to harness digital dividends include revamping education to meet the demand for more flexible skill sets and lifelong learning, as well as new training, especially for the most adversely affected workers; reducing skill mismatches between workers and jobs; investing in physical and regulatory infrastructure that spurs competition and innovation; and addressing labor market and social challenges, including income redistribution and safety nets. But considering the inherent global reach of these technologies, regional and international cooperation will be key to developing effective policy responses.

Policies to soften the labor market impact of new technologies can improve welfare. The more willing society is to support the necessary transition and those who are left behind, the faster the pace of innovation that society can accommodate, while still ensuring that the outcomes improve welfare, with all members better off. With the right policies, the digital revolution could be a new engine of growth and prosperity for Asia and the world.

This chapter first surveys the Asian digital landscape. It then revisits the debate on the sources of growth in Asia, focusing on the role of digital innovation. The chapter then turns to analyzing four specific topics: automation and the future of work; e-commerce as a new engine of growth; digitalization of financial services; and digitalization to strengthen public finance. The final section concludes with a discussion on policy challenges.

5.2 Asia's Digital Landscape

Asia has made significant strides in the digitalization of consumption, production, and innovation. While the PRC has been the global trendsetter in many aspects of digitalization, many economies in Asia have advanced significantly. Nonetheless, a digital divide still exists, with only a select few economies adopting digitalization at the highest level of sophistication. The impact of digitalization has also been far-reaching, with fintech already starting to impact traditional banking, e-commerce supplanting smaller businesses, and governments adopting digitalization to improve public finance.

5.2.1 | Defining and Measuring the Digital Economy

The digital economy can be defined in a narrow or broad sense. The narrow definition refers to the ICT sector only or the "digital sector," including telecommunications, the internet, services, and hardware and software. The broad definition includes both the ICT sector and parts of traditional sectors that have been integrated with digital technology, often called the "digital economy." The lack of a generally agreed-upon definition of the "digital economy" or "digital sector" is a hurdle to measuring both concepts. In the future, as digitalization penetrates an increasing number of activities and sectors, the boundaries between the digital and physical worlds will be blurred, and the entire world economy may be considered to be digital.

Reflecting different definitions, there are a range of measures of the digital economy; unsurprisingly, these provide very different size estimates (Zhang and Chen 2019). In addition, there are also many blended indices that include the enabling conditions for driving digitalization (such as ICT infrastructure and mobile penetration) and indicators for certain digital industries (such as e-commerce transactions). For the purpose of this chapter, the analysis mainly uses the narrow definition because of data availability. However, the chapter also uses other measures to capture developments in specific areas such as robotics and e-commerce. A blended index has also been created for the purpose of the chapter.

5.2.2 | Supply

Asia's digital sector is growing, as detailed in Figure 5.1. Not surprisingly, economies such as Taipei,China, the Republic of Korea, and Japan have a large ICT sector. From 2005 to 2015, the ICT to GDP ratio in Taipei,China almost doubled from 9.3% to about 18% of GDP, while the Republic of Korea's increased from 7.5% to about 10% of GDP. Major economies that are members of the Association of Southeast Asian Nations, such as Malaysia, Singapore, Thailand, and the Philippines, are also among the global leaders in the ICT sector.

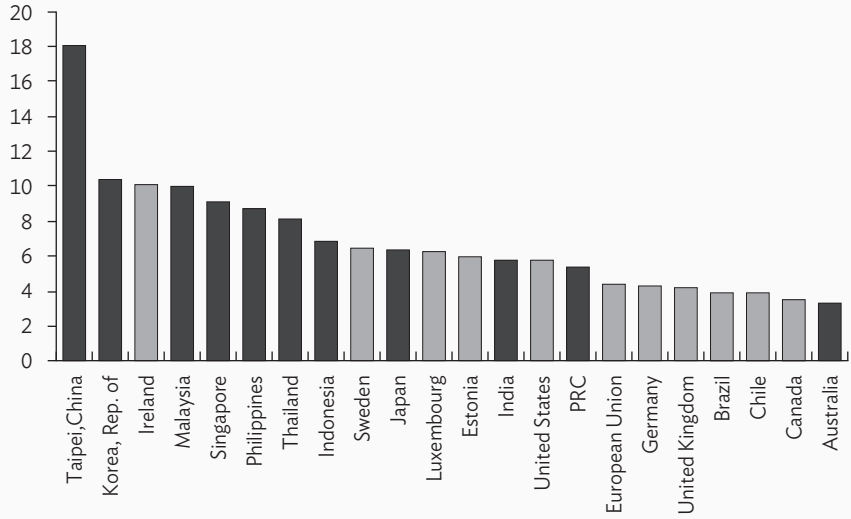
Asia is the world's largest supplier of ICT goods[1] and services, accounting for about half of global exports. Within Asia, the PRC's contribution is about 60% (including Hong Kong, China) and has contributed to more than half of ICT export growth over the past decade, followed by the Republic of Korea. Most of the contribution comes from goods exports, but services are starting to gain momentum (Figure 5.2).

5.2.3 | Use of Digital Technologies

Asia has the highest dispersion of economies in terms of the adoption of digital technologies. Economies such as the Republic of Korea and Japan are global trendsetters not only in the adoption of technology, but also in its production.

[1] ICT goods exports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods.

Figure 5.1: ICT Sector as a Share of GDP, 2015 (% of GDP)

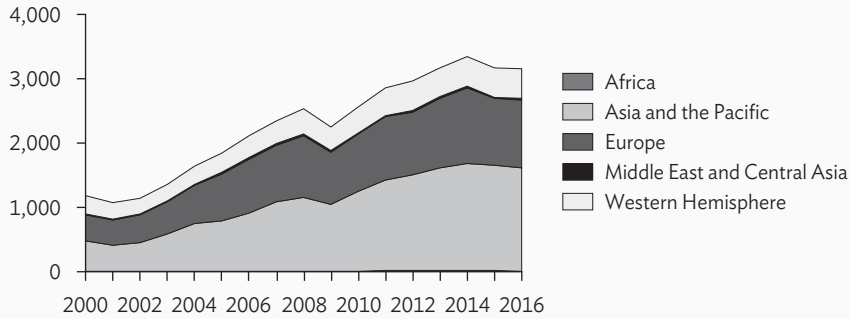


GDP = gross domestic product, ICT = information and communications technology, PRC = People's Republic of China.

Note: Canada and Ireland data are from 2014.

Sources: European Commission; CEIC Data Company; and IMF staff calculations.

Figure 5.2: Exports of ICT Goods and Services ($ billion)

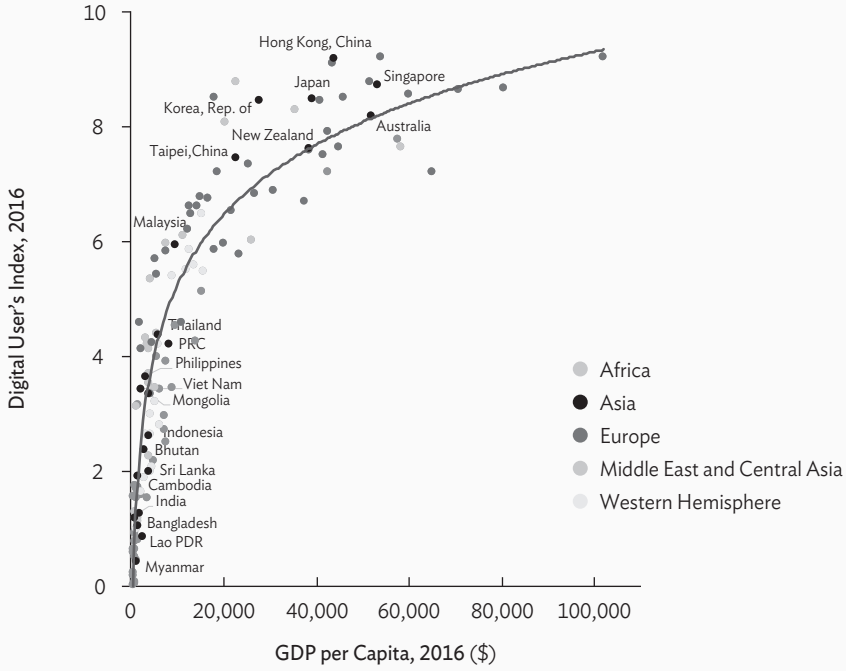


ICT = information and communications technology.

Sources: World Bank. World Development Indicators; United Nations Conference on Trade and Development; and International Monetary Fund staff calculations.

On the other side of the spectrum, there are economies such as Myanmar and the Lao People's Democratic Republic, which rank low in digital adoption. Between these extremes lie Bangladesh and Cambodia, which are rapidly adopting certain aspects of digitalization. Nonetheless, at any given income level, Asian economies generally have adopted digitalization more than their global peers (Figure 5.3).[2]

Figure 5.3: GDP per Capita and Digital Use (index, 0–10)



GDP = gross domestic product, Lao PDR = People's Democratic Republic, PRC = People's Republic of China.

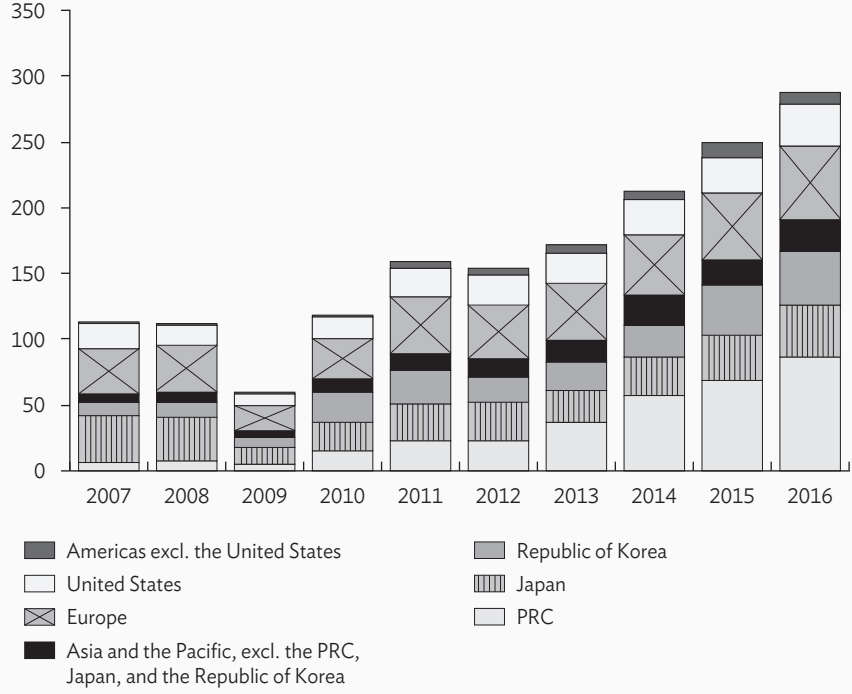
Sources: International Monetary Fund, World Economic Outlook; International Telecommunication Union; and IMF staff calculations.

[2] Figure 5.3 is based on the Digital User's Index, which is a composite index created by International Monetary Fund staff that consists of the average of six indicators: mobile phone subscriptions in terms of subscriptions per 100 population; percentage of individuals using the internet; percentage of households with a personal computer; percentage of households with internet access; fixed broadband internet access in terms of subscriptions per 100 population; and mobile-broadband subscriptions per 100 population.

Fewer digitalized economies in Asia appear to be catching up. Digital convergence is likely given the accelerating speed of adoption by those at the lower end of the spectrum.

The use of higher-end digitalization products, such as robotic equipment, is limited to a few select Asian economies. Over 60% of the world's industrial robots are used in Asia, but the PRC remains the dominant global player, with twice as many as the second-largest consumer, the Republic of Korea (Figure 5.4). On average, 7.4 robots operated per 1,000 employees in manufacturing worldwide in 2016, but the comparable figures were 63 in the Republic of Korea, 49 in Singapore, and 30 in Japan, far exceeding the global average (Figure 5.5).

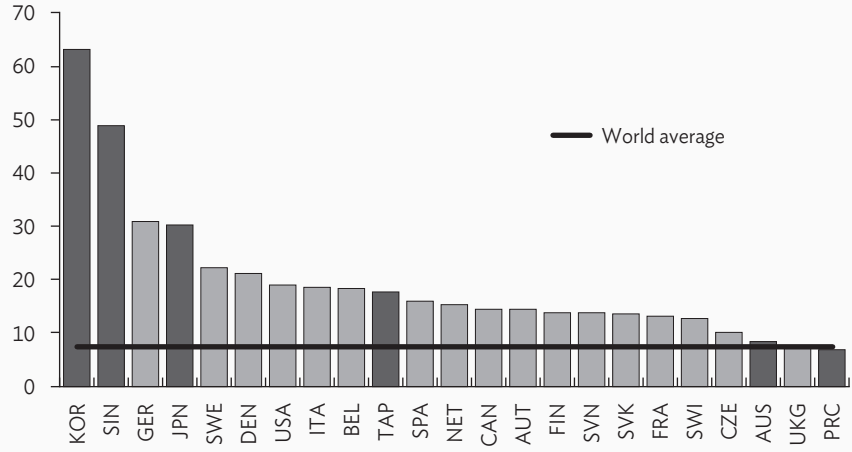
Figure 5.4: Worldwide Destination of Industrial Robots by Region (thousands of units)



PRC = People's Republic of China.

Sources: International Federation of Robotics (2017); and International Monetary Fund staff calculations.

Figure 5.5: Robot Density in Manufacturing, 2016
(number of industrial robot stock per 1,000 employees)



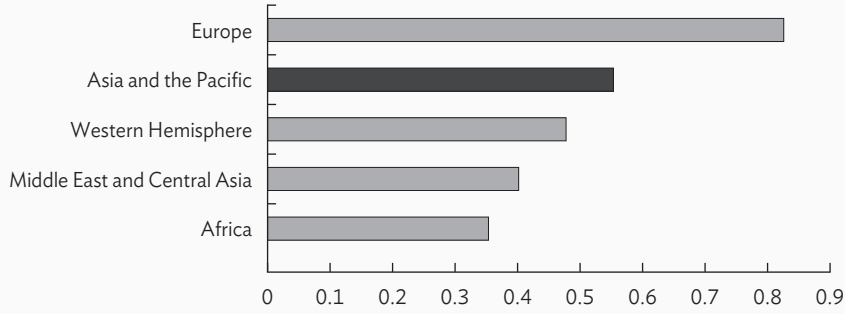
AUS = Australia; AUT = Austria; BEL = Belgium; CAN = Canada; CZE = Czech Republic; DEN = Denmark; FIN = Finland; FRA = France; GER = Germany; ITA = Italy; JPN = Japan; KOR = Republic of Korea; NET = Netherlands; PRC = People's Republic of China; SIN = Singapore; SPA = Spain; SVK = Slovakia; SVN = Slovenia; SWE = Sweden; SWE = Switzerland; TAP = Taipei,China; UKG = United Kingdom; USA = United States.

Source: International Federation of Robotics (2017).

Asia is second only to Europe in digital payments, with implications for traditional banking. However, practices vary across the region (Figure 5.6). For example, in Thailand, the launch of a government-backed electronic money transfer service forced banks to waive fees for retail e-transactions in April 2018, and mobile banking is replacing internet banking. E-money is also gaining ground in Indonesia and Malaysia, while in other economies, banks are reducing the number of physical branches and shifting toward digital banking. Although the fintech revolution may not eliminate the need for traditional brokers and bankers, it has the potential to significantly reduce the costs and time involved in cross-border banking transactions, increasing banks' efficiency.

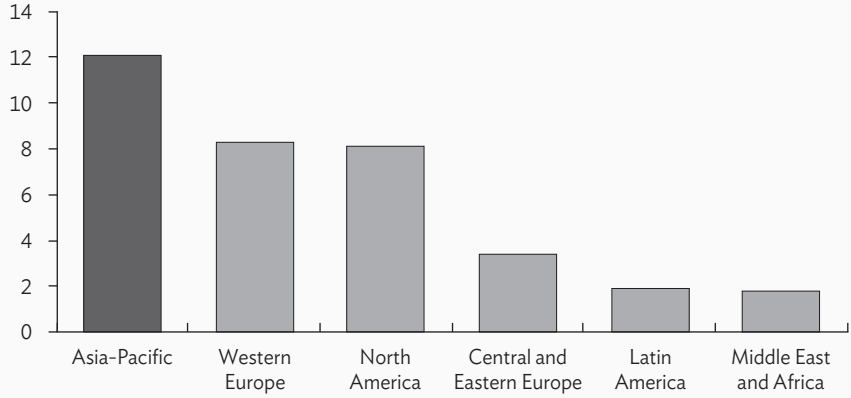
E-commerce is already large in Asia but has room to grow, given still low e-shopper penetration. Globally, Asia dominates other regions in terms of the share of retail sales that occurs via e-commerce (Figure 5.7). Internet connectivity and mass adoption of mobile technologies have made it easier for e-commerce companies

Figure 5.6: Share of Population That Made or Received Digital Payments in 2016 (% of population aged above 15 years old)



Source: World Bank, Global Findex database (2017).

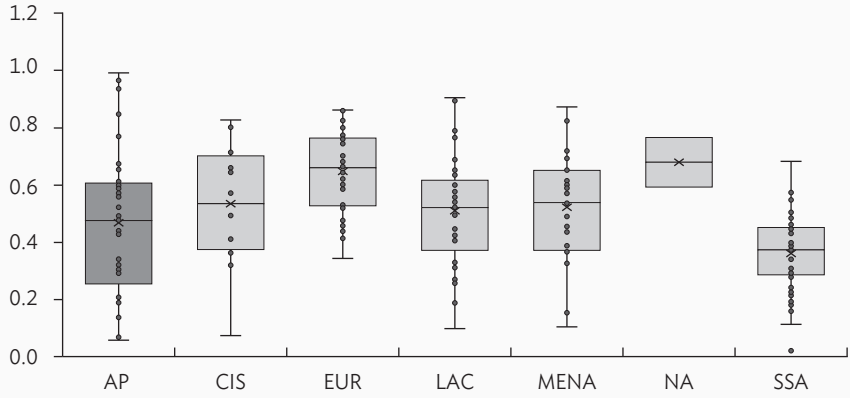
Figure 5.7: E-Commerce Sales, 2016 (% of total retail sales)



Sources: ystats.com; and International Monetary Fund staff calculations.

to target consumers. For example, increasingly, online shoppers in the PRC are buying via their mobile devices. However, this trend is not limited to the PRC, as the Republic of Korea, Japan, and India are also among the top 10 economies in the world in terms of e-commerce sales (as a percentage of retail sales). Economies that are not among the global trendsetters are also seeing rapid growth—Indonesia, for example, witnessed a four-fold increase in its e-commerce sales (as a percentage of retail sales) in a span of 4 years between 2014 and 2017.

Figure 5.8: Digital Government across Regions
(Digital Adoption Index for governments, latest available year)



AP = Asia and the Pacific; CIS = Commonwealth of Independent States; EUR = Europe; LAC = Latin America and the Caribbean; MENA = Middle East and North Africa; NA = North America; SSA = sub-Saharan Africa.

Note: The boxes depict the first, second, and third quartile of the normal distribution.

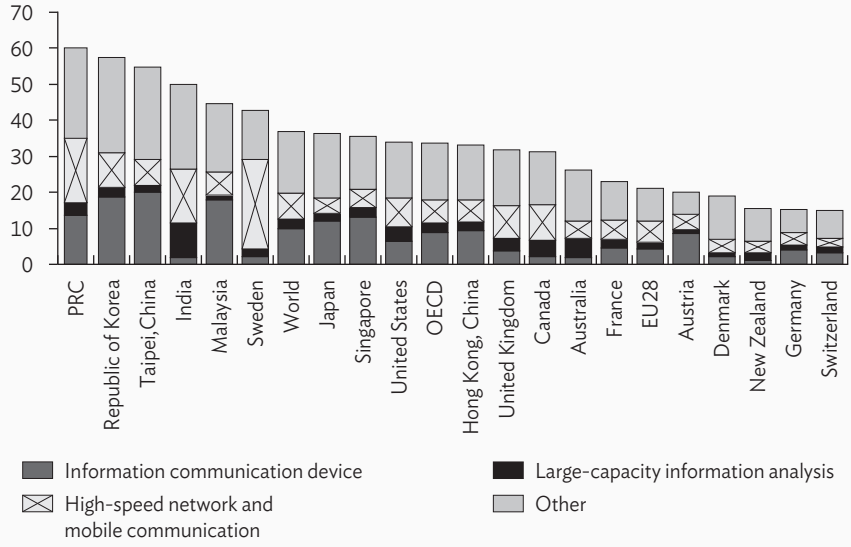
Source: Fiscal Affairs Department, International Monetary Fund.

Some Asian economies are at the forefront of digital business and digital government, while others have room to do more. Overall, Asian economies run the gamut in terms of government adoption of digital technologies, but trail economies in North America and Europe (Figure 5.8). Nonetheless, the top three global leaders in terms of digital adoption are from Asia: the Republic of Korea, Singapore, and Japan. Malaysia, India, and the PRC also perform better than the European average.

5.2.4 | Innovation

Innovation in Asia is tilted toward ICT. The top five economies in terms of the ICT share of patents are all in Asia: the PRC, the Republic of Korea, India, Malaysia, and Taipei,China. Japan and Singapore also outperform the US and the Organisation for Economic Co-operation and Development (OECD) average (Figure 5.9). This is a promising indication that the ICT patents may ultimately develop into digitalization products that may propel growth, but this transition has yet to take place.

Figure 5.9: Specialization in ICT-related Patents, 2012–2015
(patents in ICT as % of total IP5 patent families)



ICT = information and communications technology, IMF = International Monetary Fund, IP = intellectual property, OECD = Organisation for Economic Co-operation and Development, PRC = People's Republic of China.

Sources: OECD, and Innovation Micro-data Lab: Intellectual Property; and IMF staff calculations.

5.3 Asia's Growth: From Perspiration to Digital Inspiration

A classic question in the literature is whether Asia's remarkable growth has been driven more by factor accumulation or by technological progress—in other words, by "perspiration" or "inspiration". This section offers a new twist on this question by focusing on the role of digital technologies in particular. The analysis finds that the diffusion of technological innovation has been the driver of growth in Asia since the 1990s, with innovation in the digital sector accounting for around 28% of growth in per capita GDP. Rapid accumulation of human capital has also contributed, but interestingly, and in contrast to the past, capital deepening has not, suggesting that Asia has transitioned to rely more on technological progress to drive economic growth.

Asia has maintained remarkably high growth rates, accounting for nearly two-thirds of global growth. Much of the debate on Asia's strong growth performance has centered on whether this growth reflects increases in total factor productivity (TFP) or factor accumulation (Young 1992). Early research using data for 1965–1990 found that most, and in some cases all, growth had come from factor accumulation, especially capital. Krugman (1994) popularized the zero TFP growth thesis and provocatively argued that Asian growth was mainly a matter of perspiration rather than inspiration—of working harder, not smarter. This section takes a fresh look at this debate, focusing on the role of digitalization.

To tackle this issue, the respective contributions of the various sources of growth are calculated using the accounting framework presented in Jones (2002), which allows estimation of the contribution of the digital sector using a (semi-) endogenous growth accounting framework. In this framework, growth in labor productivity (that is, increases in output per worker) is divided into capital intensity (or capital deepening), rising labor quality (or human capital per worker), and growing TFP, or the stock of ideas and/or knowledge. This last term is proxied by the frontier economies' contribution to research, measured by research and development (R&D) intensity (the share of workers doing research) in both ICT and non-ICT sectors, and population growth.

One of the main pillars of this framework is that growth in TFP depends on new ideas. The production of new ideas is related to the number of researchers, their efficiency, and the stock of existing ideas. Unlike physical and human capital, which are rivals in use, ideas can be shared by all (that is, they are non-rival). While capital deepening and rising education attainment (measured by years of schooling as a proxy for human capital) have bounded effects on output per person, higher R&D intensity in employment can raise TFP and thus support GDP growth on a more sustained basis. For economies with still-low R&D intensity, such as the PRC, the number of researchers can increase for a while, even as population growth slows.

5.3.1 | Asia's Rising R&D Intensity

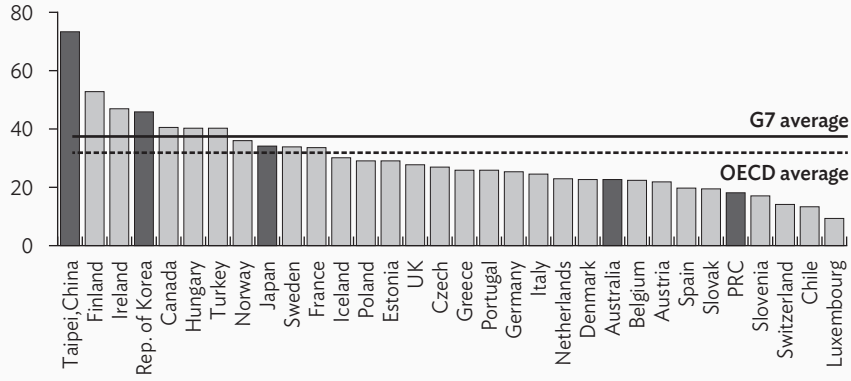
While technological developments have historically been concentrated in a few large industrialized economies, mainly the US and Europe, Asia is increasingly contributing to the global stock of ideas, as the region's R&D intensity has increased significantly. Jones (2002) and Fernald and Jones (2014) focused on the US and use the Group of Five economies (France, Germany, Japan, the United Kingdom, and the US) in constructing a measure of the global stock of R&D ideas.

This section adds the evolving role of emerging market economies, particularly in Asia. Thus, the PRC, the Republic of Korea, and Taipei,China have been added as contributors to global knowledge. Since size matters in the Jones (2002) and Fernald and Jones (2014) framework, and since the creation of new ideas is ultimately a function of population, it stands to reason that Asia, with its large and fast-growing population, should also increasingly contribute to global knowledge.

R&D efforts, whether measured in terms of expenditure or number of researchers, have risen globally in recent decades. Asian economies have seen especially rapid growth in R&D, particularly in the PRC, the Republic of Korea, and Taipei,China. The R&D-expenditure-to-GDP ratio and the share of researchers in total employment (R&D intensity) are both higher in Japan, the Republic of Korea, and Taipei,China than in, for example, the US. Asia, however, still has scope for growth—R&D intensity in the PRC, for instance, has more than doubled since 2000, but is still at relatively low levels.

Asia's R&D intensity in the digital sector and associated patents have increased even faster, but important heterogeneity exists. The share of researchers working in the digital sector ranges from 18% in the PRC to 23% in Australia, 34% in Japan, 46% in the Republic of Korea, and 73% in Taipei,China, as against an OECD average of 30% (Figure 5.10).

Figure 5.10: Share of ICT Researchers (% of total number of researchers)



ICT = information and communications technology, ISIC = International Standard Industrial Classification, PRC = People's Republic of China, UK = United Kingdom.

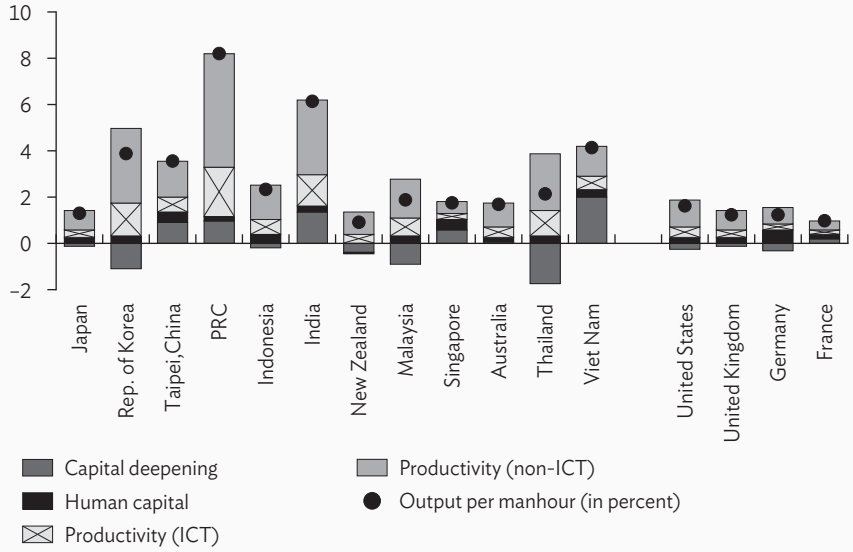
Sources: Organisation for Economic Co-operation and Development, Research and Development Statistics: Business Enterprise R-D Expenditure by Industry - ISIC Rev. 4; and International Monetary Fund staff calculations.

5.3.2 | Results

While earlier literature found that factor accumulation was the key driver of Asia's growth in the 1960s, 1970s, and 1980s, this section finds that TFP growth (or technological progress) explains most of the economic growth over 1995–2016, although the results vary across countries. In developed economies, which are closer to the global frontier and have older populations with greater human capital, factor accumulation played a more limited role than in emerging and developing economies.

Increases in human capital contributed 11.9% to per capita income growth on average, with the contribution ranging from –0.5% in New Zealand to 27% in Singapore. For some economies in the region, especially those that were affected by the Asian financial crisis, the process of capital deepening made a negative contribution to per capita income growth, ranging from 78.6% in Thailand to 7.2% in Indonesia (Figure 5.11).

Figure 5.11: Sources of Economic Growth, 1995–2016 (percentage points)



ICT = information and communications technology, PRC = People's Republic of China.

Sources: Organisation of Economic Co-operation and Development; Fernald and Jones (2014); and International Monetary Fund staff estimates.

More interestingly, the analysis for this section finds that innovation in the digital sector contributed to around 28% of per capita growth over 1995–2016, with contributions ranging between 12% (Singapore) and 49% (Thailand). Since the analysis uses the narrow definition (based on the OECD framework), the share of researchers working on the digital sector could be underestimated. Thus, the contribution of the digital sector to per capita growth could be higher if a broader definition of digitalization were used. In addition, these estimates do not capture the overall contributions from the digital sector to growth, since those from digital capital stock could not be estimated due to data availability issues across economies.

Looking forward, the digital sector will likely be an even more important driver of growth in Asia. Indeed, assuming current trends continue, innovation in the digital sector could account for 36% of Asia's economic growth within 15 years.

This section has estimated the contribution of the digital sector to Asia's per capita growth over the past 25 years. Technological progress is found to have been the main driver of Asia's per capita growth, and digital technological progress is especially important, accounting for between 12% and 49% of per capita growth.

The next four sections dig more deeply into specific aspects of the digital revolution, starting with automation and the future of work.

5.4 Automation and the Future of Work in Asia

This section analyzes the impact of robot use on employment across a large sample of economies in Asia, Europe, and the Americas. The analysis finds no evidence that robots destroy jobs on net. Restricting attention to Asia, however, there is a slight negative impact on overall manufacturing employment, particularly in certain heavily-automated sectors. Furthermore, the analysis finds that workers with medium-level education are more vulnerable to displacement than those with either low or high education levels. Interestingly, in Japan, with its aging population and declining labor force, increased robot density in manufacturing is associated not only with greater productivity, but also with local gains in employment and wages.

Automation, like other technological changes, brings both opportunities and challenges. By reducing costs and improving productivity, it may boost economic growth at a time of lackluster productivity growth and demographic headwinds.

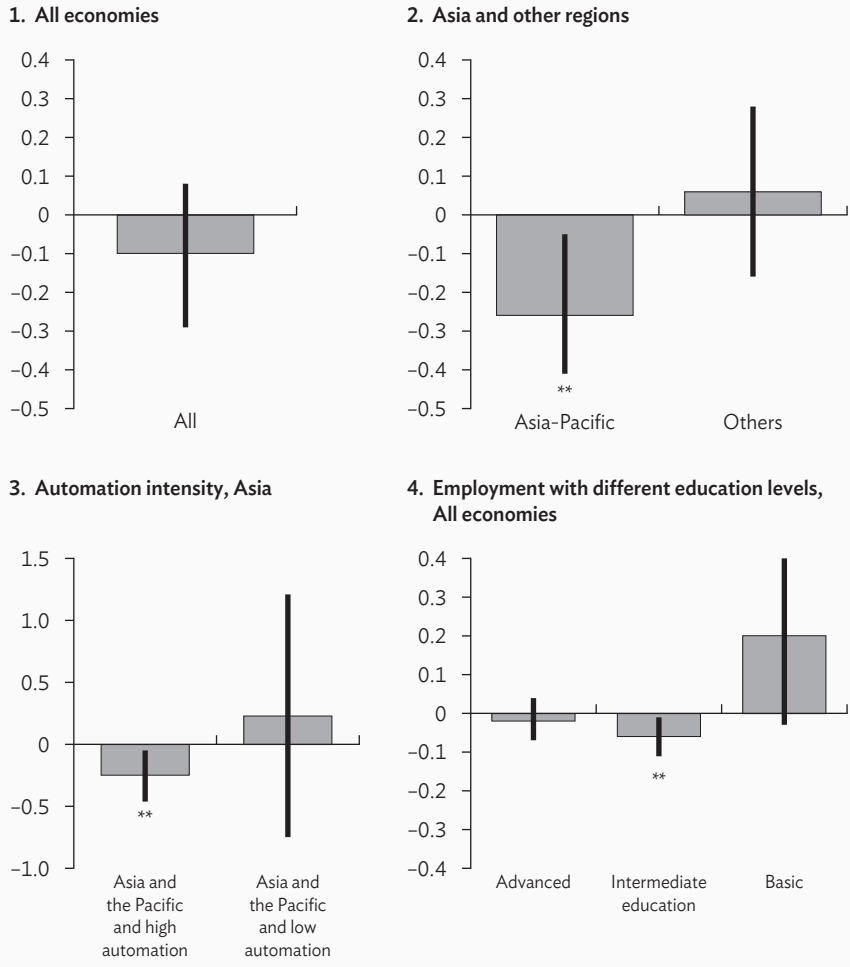
But the fear is that it may disrupt labor markets in transition as it takes over tasks and makes traditional jobs obsolete. One of the most discussed examples of automation technologies is the use of industrial robots. In 2016, there were about 1.8 million industrial robots—machines that are automatically controlled and reprogrammable to perform physical, production-related tasks—operating in the world, and their use has been growing at double-digit rates in recent years (International Federation of Robotics 2017). More importantly, they are becoming more flexible, safer, and cheaper.

Many economies in Asia have been at the forefront of automation using industrial robots. More than half of the estimated operational stock of industrial robots is in Asia (1 million units out of a total of 1.8 million units in 2016). These robots are used almost exclusively in manufacturing, with automotive manufacturing being by far the most automated subsector. In several Asian economies, the rise of industrial robots in recent years has also been driven by their use in the manufacturing of computers and electronics.

Automation can have two opposing effects on employment. On the one hand, robots may displace jobs, as they replace human labor and reduce labor demand directly. But on the other hand, they may also increase labor demand by boosting productivity and facilitating expanded production (Acemoglu and Restrepo 2017a). Furthermore, the employment impact of industrial robots may also indirectly reach across industries, as a productivity boost in one sector may have positive spillovers across supply chains, thus raising total production and income in the overall economy (Autor and Salomons 2018).

The analysis for this section finds a negative impact of robots on manufacturing employment in Asia, but not in the world overall (Figure 5.12). Following the framework of Acemoglu and Restrepo (2017a), the analysis finds that robot penetration is not significantly associated with net employment losses in a sample of 14 manufacturing subsectors in 40 economies in Asia, Europe, and the Western hemisphere for the period 2010–2014. This suggests, contrary to some observers' worst fears, that the job-creating productivity effect of automation might have offset the displacement effect even at the industry level. When restricting attention to Asia, however, the analysis finds that the increased use of robots is associated with lower employment growth. One more robot per 1,000 employees is associated with a 0.26 percentage point decrease in employment growth in manufacturing sectors. The negative employment effect estimated for Asian economies is driven by highly-automated sectors and economies, such as manufacturing of automotive components, plastic and rubber products, and electronics, where robot density was already relatively high in 2010 and has been increasing rapidly since then.

Figure 5.12: Estimated Effect on Employment Growth, 2010–2014
(percentage points, associated with one more robot per 1,000 workers)



Notes: Figure is based on regressions of the changes in employment on the changes in robots per 1,000 employees during the period 2010–2014. Charts 1, 2, and 3 are based on 14 manufacturing subsectors in 40 economies, and chart 4 is based on economies for which education breakdown of employment data is available. Intermediate education refers to workers with upper secondary and post-secondary non-tertiary education. Bars show the estimated total effects calculated based on the estimate coefficients for each specified group in the horizontal axis. Error bars refer to the 95% confidence interval: ** $p<0.05$.

Sources: International Federation of Robotics; World Input-Output Database; International Labour Organization; and International Monetary Fund staff calculations.

This suggests that as automation intensifies, the job displacement effect may start to outweigh the productivity effect at least in the short run at the sectoral levels; a critical mass of robots may be needed before the impact becomes apparent. Also, it is important to note that employment data do not capture jobs created outside the sectors (for example, companies providing robotics repair and maintenance services).

The impact of automation, however, depends on country-specific conditions. For example, in Japan, whose demographics dictate a declining labor force, increased robot density in manufacturing is associated not only with greater productivity, but also with local gains in employment and wages. Specifically, panel regressions using estimated prefecture-level robot density show that Japanese prefectures with higher exposure to robots had higher productivity and employment growth. The analysis for this section finds that those prefectures more exposed to robots have sizable positive effects on local labor market outcomes as well as productivity—an increase of robot density by 1% corresponds to a 15% increase in TFP growth for all samples, and of 6% in a manufacturing subsample.[3] In addition, employment growth is also positively correlated—a 1% increase in robot density leads to a 0.2% increase in employment growth. Japan's experience suggests that other Asian economies facing similar demographic trends in the future, such as the PRC, the Republic of Korea, and Thailand, may also benefit from automation.

Automation has an uneven impact on employees with different skill levels (Figure 5.12, panel 4). Automation will render many jobs obsolete, and many will be created and changed. Jobs that are most susceptible to automation tend to involve routine and manual tasks, most prevalent in manufacturing. Those jobs have traditionally been performed by workers with mid-level skills or in the middle of the pay scale (Autor, Levy, and Murnane 2003). Several studies have documented that the use of industrial robots has a negative impact on middle- or low-skilled workers, with little effect on high-skilled jobs (Graetz and Michaels 2015). The analysis here also supports an uneven impact: penetration of industrial robots is negatively related to employment growth for workers with secondary education, while there is no significant relation for those with higher education. For workers with upper-secondary education (for example, high school), a standard deviation increase in robot penetration at the economy level (equivalent to about 0.12 more robots per 1,000 employees in an economy over the period of

[3] For more details, see IMF (2018).

2010–2014) is associated with a decrease in employment of about 0.24 standard deviations (or about a 0.01 percentage point decrease in employment in the sample) on average across the sample economies.

The challenge is how to manage the transition. Automation will help increase productivity (Graetz and Michaels 2015), and, as noted above, it may be necessary in the face of population aging. Acemoglu and Restrepo (2017b) found that economies with more pronounced demographic changes tend to invest more in automation technologies, and that helps mitigate the potential negative effect of aging on productivity and output. The challenges with automation, however, involve supporting those who are more vulnerable to changes and in need of a transition to new jobs. The analysis suggests that automation-induced labor market changes may already be happening in some highly automated sectors in Asia. As automation intensifies, there will be a bigger transition necessary, and more workers may need new jobs, especially those who are less skilled. It is thus imperative to provide training and retraining opportunities to help workers adapt and acquire skills that will be in demand. Policies that help create more flexible labor markets, such as active labor market policies, can help absorb employment displacement related to automation.

Neither the opportunities nor the challenges have become fully apparent, as robots have not yet been widely used. As with past technologies, productivity effects await complementary innovations. For example, to boost productivity, firms need to redesign production processes and occupations. As these changes are slow, the impact of automation on productivity may even follow a "J-Curve," that is, productivity may even decline before it ultimately increases (Brynjolfsson, Rock, and Syverson 2017).

5.5 E-Commerce as a New Engine for Growth

E-commerce can support growth. The econometric analysis shows that participation in online commerce is associated with a more than 30% increase in TFP at the firm level in Asia. Innovation, human capital, and, to some extent, access to finance account for online firms' better performance. Finally, the analysis for this chapter finds that firms engaged in e-commerce also export 50% more, relying on their skilled labor force and capacity to innovate. Interestingly, e-commerce seems to be especially beneficial for small firms in Asia.

E-commerce can boost private consumption and investment. For consumers, e-commerce may translate into better access to a wide range of products and services at lower prices, ultimately boosting consumption. Two studies by McKinsey in the PRC and Indonesia highlight that e-commerce generates new consumption. In the PRC, one study shows that out of $100 in internet spending, close to 40% represents incremental (new) consumption, while the remaining 60% is diverted from traditional offline retail channels (Dobbs et al. 2013). In Indonesia, about 30% of online commerce spending is new consumption, capturing previously untapped needs (Das et al. 2018). For firms, e-commerce could also provide new business opportunities and access to larger markets, supporting investment.

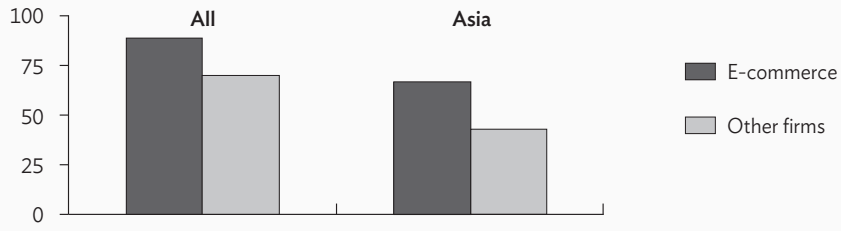
E-commerce has great potential to improve labor and capital productivity, including for small and medium-sized enterprises. Fast-growing cross-border e-commerce is also gaining traction, bringing greater potential to increase participation in regional and global value chains and support international trade. The empirical literature on the impact of e-commerce on firm activity is limited, but existing evidence suggests an overall positive effect on firm performance.

5.5.1 | Evidence from Firm-Level Data Highlights the Benefits of E-commerce for Productivity

This section provides a novel analysis of performance differences between firms engaged in e-commerce and other firms. It relies on World Bank Enterprise Surveys (WBES) and uses a comprehensive sample of developing economies, including several Asian economies during 2006–2012. The WBES data include information on firms' inputs and outputs as well as various characteristics of firms such as age, size, foreign ownership, and export status.

Firms with online activities differ on many fronts from other firms. Evidence from the WBES suggests that firms engaged in e-commerce activities tend to have a more educated labor force and better access to finance, and they innovate more than other firms. For instance, a larger portion of online firms, relative to other firms, introduced new products or processes, used technology licensed from a foreign company, spent on R&D, or acquired internationally recognized quality certifications. Possibly reflecting the above factors, e-commerce firms tend to enjoy higher sales, value added, stock of capital, and exports than non-e-commerce firms.

Figure 5.13: Labor Productivity (average, $'000)



Note: Labor productivity is the ratio of value added to the number of employees.
Sources: World Bank, Enterprise Surveys; and International Monetary Fund staff calculations.

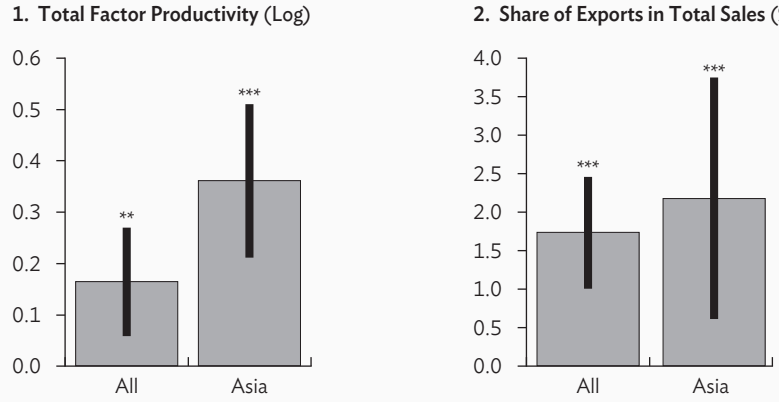
Firms with online activities have higher labor productivity. A first look at labor productivity, defined as the ratio of value added to the number of employees, highlights that firms with online activities (sales or purchases) have higher labor productivity (Figure 5.13). In Asia, firms engaged in online activities seem to have sizably higher labor productivity—on average 50% higher than other firms.

Firms with online activities, including small firms, also have higher TFP. To capture a more complete picture of the performance differential between firms with online activities and other firms, this section analyzes those differences in TFP. Comparing the distribution of TFP between the two groups confirms that firms with online activities have higher productivity, particularly in Asia. Interestingly, e-commerce seems to be especially beneficial for small firms in Asia.

Controlling for firms' characteristics confirms the results presented in the analysis here (Figure 5.14, panel 1). The suggestive evidence that firms (including small and medium-sized ones) involved in e-commerce are more productive holds after controlling for several firm characteristics (age, size, foreign ownership, and export status) that are also known to affect performance. Consistent with the earlier evidence presented here, the potential impact of e-commerce on firm productivity seems to be greater in Asia than in other developing regions.

Innovation, human capital, and to some extent access to finance seem to support online firms' greater performance. The higher productivity of firms with online activities seems to occur through their more highly skilled labor force, faster pace of innovation, and, to some extent, better access to finance, which allows these firms to deliver products and services with internationally recognized quality certification.

Figure 5.14: Estimated Impacts of E-Commerce Participation on Productivity and Exports



Notes: These figures illustrate coefficients and confidence intervals from two firm-level estimations: (a) the impact of e-commerce participation on total factor productivity controlling for firms' age, size, foreign ownership, and export status; and (b) the impact of e-commerce participation on the share of exports in total sales controlling for firms' size, age, and foreign ownership. The error bars refer to the 95% confidence intervals around the estimated coefficients. For Asia, the estimated coefficients imply that participation in e-commerce is associated with more than a 30% increase in total factor productivity and an increase in the share of exports to total sales by about two units, corresponding to a 50% rise.** $p<0.05$; *** $p<0.01$.

Sources: World Bank Enterprise Surveys; and International Monetary Fund staff calculations.

E-commerce firms also export more, relying on their skilled labor force and capacity to innovate (Figure 5.14, panel 2).[4] Firms with e-commerce activities generate a larger share of sales revenues from exports, particularly in Asia, highlighting the potential of e-commerce to promote cross-border trade. A better-skilled labor force and a higher quality of products seem to support higher exports by firms with online activities. The role of skill premia in supporting export activities seems particularly important in Asia.

E-commerce, therefore, has the potential to support growth and economic rebalancing by boosting consumption and supporting new industries, especially smaller firms in Asia.

[4] For more details, see Kinda (2019).

5.5.2 | Platforms Can Magnify the Benefits of E-Commerce but also Raise Competition Issues

Platforms can create positive externalities, including through network effects. Platforms have great potential to amplify the economic benefits of e-commerce. In addition to increased competition within the market and pressure to lower prices, including through reduced search costs, a broader geographical reach of suppliers, and savings in supply chain management, platforms bring about additional advantages through network effects. As illustrated in the section above, firms with online activities also have better access to finance. For instance, Ant Financial Services Group, an affiliate company of the PRC Alibaba group, collects information from Taobao, an e-commerce platform that is a subsidiary of Alibaba, to extend the credit frontier to firms not served by traditional banks. By enabling small and medium-sized enterprises to access advanced ICT infrastructure, data centers, applications, and processes usually available to the most productive firms, platforms can further help firms boost their productivity. A higher number of providers or customers using a platform tends to enhance its efficiency, including through using big data to better customize products and services, attracting more providers and customers (same-side network effect).

Platforms can also raise competition issues. While e-commerce can provide various benefits, economies of scale and exclusive access to information platforms pose anti-competitive concerns, particularly when e-commerce platforms become large. Network effects also make it challenging for retailers and vendors to switch platforms, reinforcing their market power and exacerbating the risk of anti-competitive practices.

Overall, the development of a platform economy has brought significant benefit to consumers, but it also poses many challenges as new issues emerge. Designing the proper policy response remains an open question, especially in the areas of taxation, competition, and data privacy. As a dynamic area of economic development, further research and regulatory experiments would be needed to establish a formal framework for the platform economy.

5.6 Digitalization of Finance in Asia

Fintech can support growth and poverty reduction by strengthening financial development, inclusion, and efficiency. Fintech also poses risks to the financial sector, however. While the use of fintech in Asia is heterogeneous, the analysis for this section finds evidence of convergence. It also finds that fintech is positively associated with financial inclusion yet demonstrates that it also has a potentially disruptive impact on traditional financial services.

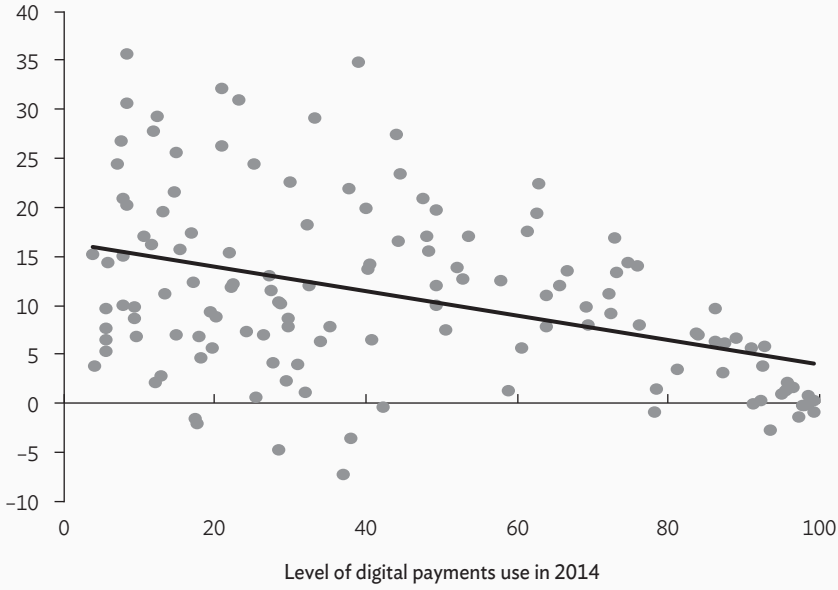
In Asia, digitalization of finance has been growing faster than the global average. Three of the five economies identified as having the highest rate of fintech adoption globally are in the region (the PRC, India, and Australia). Fintech activities are widespread and have grown rapidly in frontier economies such as Mongolia and Bangladesh, as well as in emerging markets such as Malaysia and Thailand. The growth of fintech activities in Asia has been fueled by a dramatic rise in funding. Since 2010, investments have picked up, led by the PRC, but also in Southeast Asia by Singapore, Malaysia, and Thailand. Cumulative fintech equity funding reached about $28 billion in 2017, with two-thirds of that growth captured by the PRC.

However, the development of fintech has not been uniform. Economies have adopted a wide range of technologies based on consumer needs, level of development, regulatory stance, and existing financial and technological infrastructure. For example, while mobile payments have grown rapidly in the PRC, Australia has instead experienced growth in contactless card payments, building on existing infrastructure and experience with the use of cards for secure payment. Similarly, several economies have not developed mobile money products that operate by monetizing pay-as-you-go phone credit, as "postpaid" monthly phone contracts have become standard (replacing prepaid phone credit).

The empirical work shows evidence of convergence (Figure 5.15). Using data on digital payments between 2014 and 2017, the analysis finds economies catching up to the frontier of universal access to digital payments. Economies with low levels of digital payment in 2014 have significantly higher growth rates over 2014–2017. This initial evidence of convergence is surprising given the wide underlying heterogeneity in the technologies and business models used.

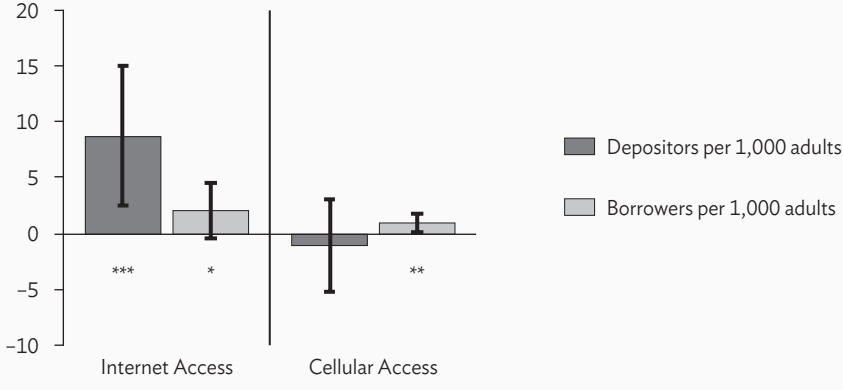
The econometric evidence indicates that digital financial services can boost financial inclusion (Figure 5.16). These results are particularly relevant for Asia, where nearly 30% of the population still lacks access to even a basic savings account.

Figure 5.15: Change in Share of Population Using Digital Payments, 2014–2017 (percentage points)



Sources: World Bank, Global Findex database 2017; International Monetary Fund, World Economic Outlook; and International Monetary Fund staff calculations.

Figure 5.16: Technological Development and Financial Inclusion (marginal impact of increase, after controls, including country fixed effects)



Source: International Monetary Fund staff calculations.

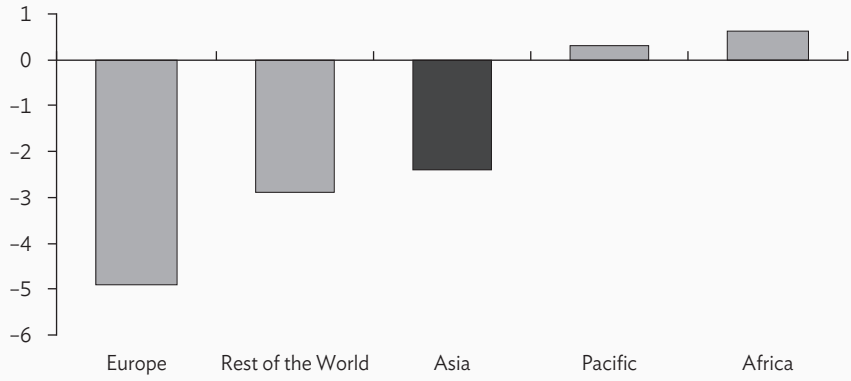
Furthermore, given the existing evidence that greater inclusion in the financial system has positive effects on growth, poverty, and inequality, there is potential for greater adoption of mobile technology for financial inclusion to translate into positive macroeconomic outcomes. In addition to direct benefits, fintech has complementary benefits given its role in facilitating other digital activities such as e-commerce.

The econometric results also highlight the potentially disruptive nature of fintech innovations (Figure 5.17). Specifically, they suggest that economies with a greater propensity for technological leapfrogging in moving to cellular technologies have also tended to see falling levels of traditional financial infrastructure, particularly bank branches. Specifically, there is a negative association between the adoption of new technology without widespread adoption of prior technology and traditional financial infrastructure. This is particularly pronounced in Europe and the Western hemisphere. However, in Africa, as well as the Pacific, the picture is more mixed, and technology may complement traditional means of financial services delivery, even after controlling for relatively lower levels of income and cellular access. The empirical results are supported by developments at the country level, where many economies in the region have seen an increase in digital banks and a corresponding decline in their physical presence.

However, fintech also faces challenges in promoting economic development or financial inclusion. Much of the use of fintech has replicated patterns seen in the use of conventional financial products. For example, in Bangladesh, while 20% of the population report having a mobile money account, this masks a large disparity between men (30%) and women (10%). There are gaps across Asia regarding the use of fintech based on both gender and position on the income distribution. This suggests that, without attention from policy makers, there is a risk of a digital divide rather than a digital dividend from financial services, at least in the near term.

Fintech may also pose risks to the financial sector if its applications undermine competition, monetary policy transmission, financial stability and integrity, and consumer and investor protection. The unique blend of large hybrid technology and/or financial companies that dominate service provision could have spillover effects on the financial system. The development of financial services outside the boundaries of the supervisory and regulatory framework may lead to new risks. Technologies, while accelerating the speed and volume of financial transactions, could also amplify the impact of spillovers. And to the extent that services are increasingly offered by specialized firms along the payments chain, as opposed to large, vertically integrated intermediaries, there may be fewer controls for the processing of data and the management of risks.

Figure 5.17: Leapfrogging and Financial Infrastructure
(marginal impact of increase in leapfrogging variable on bank branches per 100,00 adults by geographic region)



Sources: International Monetary Fund, Financial Access Survey; World Bank, World Development Indicators; and International Monetary Fund staff calculations.

5.7 Digitalization to Strengthen Public Finance

Digitalization is transforming markets quickly and presents important opportunities and challenges for public finance, both in terms of revenue and expenditure. In taxation, more transactions could be subject to fairer taxes. On the other hand, digital platforms can erode tax bases by shifting transactions to sectors of lower taxation or compliance, and even abroad. In expenditure, digitalization can improve the effectiveness of public spending in Asia, particularly in the targeting of social safety nets, as long as robust design and legal and technological institutions address privacy and cybersecurity concerns.

5.7.1 | Taxation: Opportunities and Risks

Digitalization presents opportunities for improving tax collection in Asia. Digitalization can lead to better reporting of transactions in international trade, increasing VAT and tariff revenue. It can also lead to better reporting of financial account transactions and to improved cross-country collaboration, both of which could increase income and wealth tax revenues through better reporting of offshore wealth and its related income.

5.7.2 | Methodology

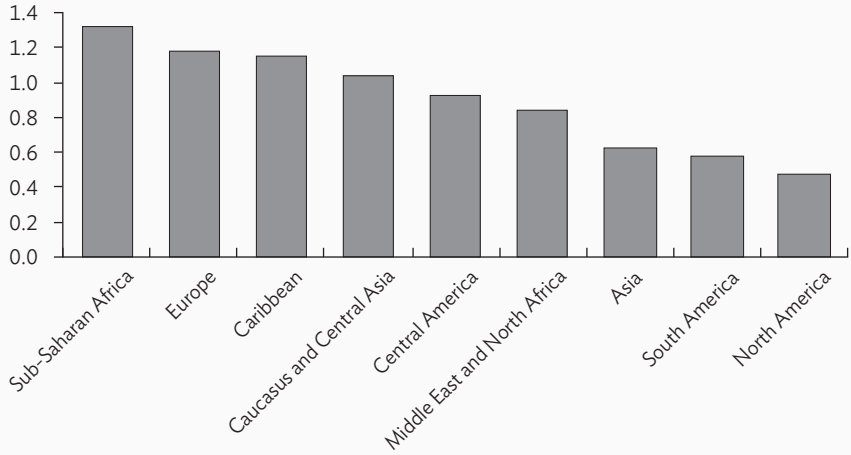
Using the estimates of the analysis developed in Chapter 2 of the IMF's April 2018 *Fiscal Monitor*, this section quantifies possible improvements in tax compliance and the likely increase in revenues associated with them. The model estimates the average gains of reducing the gap with the frontier in digitalization by 50%, measured by the United Nations (UN) Online Service Index. This variable assesses the scope and quality of public sector online services, including for tax submission and registration of businesses. Using bilateral trade data, the model estimates the impact of an improvement in digitalization in reducing the misreporting of prices of imports. Misreporting of prices is measured as the difference between the declared value of imports at destination and exports at origin.

First, the difference in price (misreporting) is regressed on a gravity model that takes into consideration country and time fixed effects, as well as other economic and institutional variables. The regression includes the variable that measures the level of digitalization (UN Online Service Index). After estimating that regression, the effect of higher digitalization on revenue related to international trade can be estimated. With that, and the appropriate tax rates, the increase in revenue is computed. The section uses the expected higher reported prices of imports to estimate the additional VAT revenue. Using tariff rates (instead of VAT rates), the model then estimates the increase in tariff revenue. Finally, the analysis uses another model that estimates the increase in wealth and income taxes related to undeclared offshore wealth. Using tax rates on wealth, income, and inheritance, it estimates country-specific revenue increases based on financial returns and the country's proportion of offshore deposits, as well as on offshore wealth.

5.7.3 | Results

Estimates of increased import-VAT revenue suggest benefits from technology adoption. According to the model, for Asian economies, the estimated increase in the VAT is 0.6% of GDP. It is much lower than in other regions, with several regions expected to benefit by more than 1% of GDP. It is higher, however, than for economies in the Western hemisphere. For ASEAN countries, the gains are estimated at 1.2% of GDP, while for Pacific island countries the gains are estimated at 2.5% of GDP (Figures 5.18 and 5.19). Median gains are lower for developed and emerging economies, at 0.1% and 0.7%, respectively, and are lower in Asia than worldwide. However, for low-income countries the estimate is slightly higher at 1.8% of GDP.

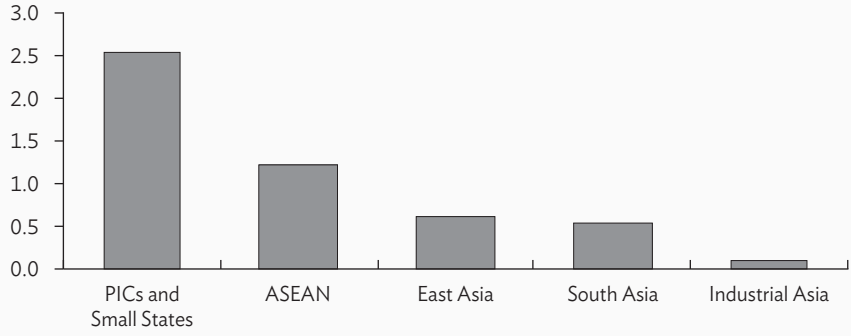
Figure 5.18: Potential Import-VAT Revenue Gains from Closing Half the Distance to the Digitalization Frontier, 2016 (% of GDP)



GDP = gross domestic product, VAT = value-added tax.

Sources: International Monetary Fund, April 2017 Fiscal Monitor; and International Monetary Fund staff calculations.

Figure 5.19: Potential Import-VAT Revenue Gains in Asia from Closing Half the Distance to the Digitalization Frontier, 2016 (% of GDP)



ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product, PICs = Pacific island countries, VAT = value-added tax.

Sources: International Monetary Fund, April 2017 Fiscal Monitor; and International Monetary Fund staff calculations.

The results also suggest that digitalization can boost tariff revenues in Asia by 0.2% of GDP on average; as with the VAT, most other regions are estimated to see higher increases, although Asia surpasses Europe and North America. Again, Pacific island countries are estimated to benefit more in the region, with an estimated 0.7% of GDP increase, followed by ASEAN countries, with 0.5% of GDP. The median gain for emerging markets is estimated at 0.2% of GDP, and at 1.1% of GDP for low-income countries. These values are about 0.1% of GDP lower than estimated for other regions.

Finally, increases in wealth and income tax revenue related to offshore wealth are estimated at 0.2% of GDP for Asia, also low when compared with other regions. Offshore wealth of Asian economies is estimated at 7.3% of GDP, lower than most other regions, except for North America. Among Asian economies, South Asia has the highest estimates of tax increases, at 0.3% of GDP. Developed economies in Asia have a slightly higher median of estimated gains, even when the proportion of wealth is lower than emerging markets and low-income countries.

One caveat is in order for appropriate interpretation of the results. As previous sections of this chapter have shown, digitalization is a function of GDP per capita, and for each income bracket Asian countries are at the frontier. Therefore, the estimated revenue increase for Asia being less than other regions may simply show that the distance to the frontier is smaller (indeed, zero for some), especially for developed Asian economies.

One should caution against being too optimistic about revenue increases, as digital platforms raise the risk of base erosion from informality and internationalization. In recent years, the development of digital platforms has been quick and large, bringing a transformation in the way of conducting business in many markets. The transformation presents opportunities and risks for taxation. Base erosion shifts transactions and profits from established formal commerce to informal types or abroad. Transactions in the formal sector of the economy can be shifted to other sectors with lower or fewer taxes or to the informal sector and paying no taxes at all. For example, regional peer-to-peer (P2P) platforms like GO-JEK, Grab, and Tujia allow transactions in highly-taxed sectors, like taxi services or hotels, to be transacted with a lower effective level of taxation. P2P platforms also allow an increase in international transactions for agents that would otherwise make only domestic transactions. E-commerce can shift transactions abroad, too, by replacing domestic retail.

Proper legislation can, however, enable digital platforms to share valuable data, formalize informal transactions, and withhold taxes. There are already many cases of P2P platforms withholding funds for tax purposes and reporting payments to authorities in several economies. For example, in India, digital platforms are required to charge and remit service taxes due on the income of sellers. In Australia, drive-sharing platforms are required to have their drivers registered as a business and charge a goods and services tax. There is a variety of tax treatments in the P2P sector, and governments are making many changes as the sector is changing rapidly.

5.7.4 | Improving Social Safety Nets with Digitalization

Digitalization can help governments improve public financial management through various channels. For example, integrated beneficiary databases for social safety nets can facilitate inclusion of the previously unreached population, and digital identification for citizens can reduce benefit leakage. In addition, digital technologies allow governments to track and reduce absenteeism of teachers, doctors, and nurses, while removing "ghost" workers from government payrolls. E-procurement can also trim budgets by promoting competition among contractors. While there would be more channels than listed here, this subsection focuses on the first one—improving social safety nets through digitalization—considering its critical role for inclusive growth in Asia.

There is scope to develop social safety nets in developing Asia. While income inequality has risen in the region since 1990, Asia's public spending on social safety nets has remained at 1.2% of GDP, a level lower than in developing Europe, Latin America, and Caribbean, and sub-Saharan Africa. The main objective of social safety net reforms is to reduce inclusion errors (leakage of benefits, that is, when individuals receive benefits to which they are not entitled) and exclusion errors (when eligible individuals do not receive benefits to which they are entitled). Digitalization can support this objective.

Developing digital social registries is a solution to reduce exclusion errors. Social registries are information systems that support outreach, intake, registration, and determination of potential eligibility for one or more social programs (Leite et al. 2017). As a single gateway for various programs, they lower transaction costs for citizens and governments, thereby helping governments reach out to targeted groups. The Philippines' registry (*Listahanan*), for example, serves as a gateway for as many as 52 social programs, ranging from cash transfers to emergency

assistance, with 75% of the population registered. Social registries appear to have helped expand the coverage of conditional cash transfer programs in Indonesia and the Philippines. While social registries store information to determine potential eligibility such as income and other socioeconomic data, they rely largely on self-reported information from citizens. Thus, reducing inclusion errors would require data verification with other information systems such as civil and land registries. This function has yet to be developed for social registries in Indonesia and the Philippines.

Digital identification (ID) can help governments reduce inclusion errors. Digital ID systems store personal data in digital form and credentials that rely on digital, rather than physical, mechanisms to authenticate the identity of their holder (World Bank 2016). Digital ID can serve as a necessary "key" to connect social registries with regulatory databases, thereby facilitating eligibility verification (Leite et al. 2017). Digital ID also facilitates transition from in-kind to cash-based benefits by linking beneficiaries with their bank accounts for benefit payments, thereby reducing leakages. Developing Asia appears to be in a good position to advance on this front, as many economies already have operationalized digital ID systems.

India's experience with the *Aadhaar* identification system is a case in point. *Aadhaar* is the world's largest biometric identification system, providing a unique 12-digit ID number for 1.2 billion residents in India. It is linked to various social programs, providing authentication for eligible beneficiaries. Before 2015, the subsidy on liquefied petroleum gas in India was subject to substantial leakage, partly because of the government's inability to authenticate beneficiaries. The government attempted to reduce leakages in two ways. First, starting in 2013, beneficiaries' *Aadhaar* numbers were linked to the liquefied petroleum gas program to prevent claims from ghost beneficiaries or multiple claims. Second, the government made electronic transfers of the subsidy directly to the *Aadhaar*-linked bank account of beneficiaries, bypassing dealers. These reforms have reportedly reduced leakage and saved costs, although estimates vary.

5.8 The Role of Policies

While the digital revolution is inevitable, the outcome—utopian or dystopian—will depend on policies. To realize the potential of the digital revolution, comprehensive policies and fresh thinking are needed. For policy makers, the first hurdle is to accept that the digital revolution is inevitable. Policy responses will need to strike the right balance between enabling digital innovation and addressing digitalization-linked risks.

5.8.1 | Policies to Facilitate Technological Advances

Policies should focus on further enhancing productivity; encouraging more R&D in digital and other sectors; promoting the diffusion of global knowledge by incentivizing new and dynamic firms; upgrading physical and soft infrastructure; and improving access to and the quality of education. Policies to increase R&D intensity and speed up the diffusion of innovation in Asia also include protection of intellectual property (patent policy), competition in research grants, and optimal government subsidies. Investment in R&D and human capital are essential not only to build innovation capacity, but also to maximize the absorption of existing innovations.

5.8.2 | Fostering E-Commerce

There is room to improve enabling factors to further boost e-commerce in Asia. Existing digital divides and gaps in key infrastructures and e-commerce legislation are still preventing many Asian economies from fully reaping the potential benefits. Despite its rapid growth, e-commerce, including cross-border e-commerce, could expand faster if various barriers were removed, further supporting international trade, creating more opportunities for businesses, and increasing consumers' welfare:

- *Economic factors and conditions.* A successful e-commerce transaction requires several critical elements, including internet access to allow the user to place an order, secure servers to safeguard payments and personal information, a payment method such as a credit card, e-wallet, or mobile payment, and reliable delivery services for physical goods. While developed economies, including in Asia, have high readiness for e-commerce, emerging and developing economies in the region still have sizable gaps.
- *Legal and institutional environment.* The absence of laws to regulate the e-environment inhibits participation in e-commerce both for consumers and suppliers. For instance, e-transaction laws are essential to make electronic forms of exchange legally equivalent to paper-based transactions, a critical condition for most e-commerce transactions. A lack of consumer protection laws and legislation on privacy, data protection, and cybercrime may prevent potential customers from shopping online. While all developed Asian economies and most emerging and developing economies in the region benefit from legislation covering electronic transactions, consumer protection, data protection, and cybercrime, this legislation is practically nonexistent in Pacific island countries. Enacting appropriate legislative and regulatory mechanisms can lower legal barriers to e-commerce use, raise consumer confidence, and expand domestic and particularly cross-border transactions.

5.8.3 | Policies to Manage the Transition and Reduce Inequality

Policies to harness digital dividends include revamping education to meet the demand for more flexible skill sets and lifelong learning, as well as new training, especially for the most adversely affected workers; reducing skill mismatches between workers and jobs; and addressing labor market and social challenges, including income redistribution and safety nets.

As automation intensifies, more workers will need to find new jobs, especially those who are less skilled. Rethinking education, particularly at secondary or lower levels, may have a far-reaching effect on managing the transition to the new age of automation. For instance, a stronger emphasis should be placed on promoting foundation skills, digital literacy, high-order thinking competencies, and social and emotional skills (OECD 2016). It is also imperative to provide training and retraining opportunities to help workers adapt and acquire skills that will be in demand. This should be preceded by the effort to more precisely identify emerging skills and examine how they can be translated into training programs.

As Korinek and Stiglitz (2018) showed, policies to soften the labor market impact of new technologies can make a difference in terms of improving welfare. The more willing society is to support the necessary transition and provide support to those who are left behind, the faster the pace of innovation that society can accommodate while still ensuring that the outcomes are welfare improvements, with all members of the society better off.

5.8.4 | Digitalization of Finance

Given the widespread adoption of fintech, and the proliferation of different modes of delivery, there is a significant need for international collaboration to learn from and develop best practices. Fintech has implications for the role of market imperfections and cost structures in financial markets that will in turn have implications for financial stability and competition.

Better data are needed for monitoring emerging developments, and greater agility may be needed from regulators and supervisors given the rapid rise of various fintech products. This is particularly true in settings where regulation is unclear or outside traditional lines of reporting.

Meanwhile, promoting lower barriers to entry while maintaining a level playing field becomes a growing issue with the rising dominance of large firms. Regulations should allow for more competition and further reduce the costs of financial intermediation, while helping solve some problems of the current banking environment, such as the too-big-to-fail issue. In addition, regulation could encourage low leverage among new market participants from the beginning, which would allow for the sustainable growth of the industry and improve discipline, while addressing risks arising from money laundering and/or financing of terrorism and cybersecurity threats. Harnessing digital dividends requires a strong cybersecurity framework.

5.8.5 | Policies to Strengthen Public Finance

Policy actions can transform risks into opportunities. Digitalization also allows for an increased monitoring of business transactions that would otherwise be informal. This possibility of data collection is particularly evident in P2P platforms when they replace decentralized informal activities. Moreover, the development of P2P platforms can even present an opportunity for governments to pass legislation requiring the withholding of funds related to transactions. The withholding can be established for income, goods and services, or value-added taxes applicable to sellers. This withholding already seems straightforward for indirect taxes.

Better data sharing is possible with the increased adoption of digital technologies. The OECD and the Group of Twenty have established an automatic exchange of information of nonresident financial accounts. Other useful measures include the establishment of international registers of asset ownership and shareholders, which allows for taxation of capital income on a residence rather than a source basis. A combination of information on assets and capital incomes would allow for the introduction of dual income tax systems under which capital income and wealth would be linked under a single schedule, creating a synthetic capital income tax.

REFERENCES

Acemoglu, D. and P. Restrepo. 2017a. Robots and Jobs: Evidence from US Labor Markets. National Bureau of Economic Research (NBER) Working Paper No. 23285. Cambridge, MA: NBER.

———. 2017b. Demographics and Automation. National Bureau of Economic Research (NBER) Working Paper No. 24421. Cambridge, MA: NBER.

Autor, D. and A. Salomons. 2018. Is Automation Labor-Displacing? Productivity Growth, Employment, and the Labor Share. National Bureau of Economic Research (NBER) Working Paper No. 24871. Cambridge, MA: NBER.

Autor, D., F. Levy, and R. Murnane. 2003. The Skill Content of Recent Technological Change: An Empirical Exploration. *Quarterly Journal of Economics* 118(4): 1279–1333.

Brynjolfsson, E., D. Rock, and C. Syverson. 2017. Artificial Intelligence and the Modern Productivity Paradox: A Clash of Expectations and Statistics. National Bureau of Economic Research (NBER) Working Paper No. 24001. Cambridge, MA: NBER.

Dobbs, R., Y. Chen, G. Orr, J. Manyika, M. Chui, and E. Chang. 2013. China's Retail Revolution: Online Shopping as a Catalyst for Growth. McKinsey Global Institute.

Fernald, J. G. and C. I. Jones. 2014. The Future of US Economic Growth. *American Economic Review, AEA Papers & Proceedings* 104(5): 44–49.

Graetz, G. and G. Michaels. 2015. Robots at Work. IZA Discussion Paper No. 8938. Bonn: Institute for the Study of Labor.

International Federation of Robotics. 2017. *World Robotics, 2017*.

International Monetary Fund (IMF). 2018. Japan – Macroeconomic Implications of Automation. Country Report No. 18/334. Washington, DC: IMF.

Jones, C. I. 2002. Source of U.S. Economic Growth in a World of Ideas. *American Economic Review* 92(1): 220–238.

Kinda, T. 2019. E-commerce as a Potential New Engine for Growth in Asia. IMF Working Paper WP/19/135. Washington, DC: IMF.

Korinek, A. and J. E. Stiglitz. 2018. Artificial Intelligence and Its Implications for Income Distribution and Unemployment. In *The Economics of Artificial Intelligence: An Agenda,* edited by J. Agrawal, J. Gans, and A. Goldfarb. Chicago: University of Chicago Press.

Krugman, P. 1994. The Myth of Asia's Miracle. *Foreign Affairs* 73(6): 62–78.

Leite, P., T. George, C. Sun, T. Jones, and K. Lindert. 2017. Social Registries for Social Assistance and Beyond: A Guidance Note & Assessment Tool. World Bank Social Protection and Labor Discussion Paper No. 1704. Washington, DC: World Bank.

Organisation for Economic Co-operation and Development (OECD). 2016. Skills for a Digital World. Background Paper for Ministerial Panel 4.2. Paris: OECD.

World Bank. 2016. *World Development Report: Digital Dividends.* Washington, DC: World Bank.

Young, A. 1992. A Tale of Two Cities: Factor Accumulation and Technical Change in Hong Kong SAR and Singapore. *NBER Macroeconomics Annual* 7: 13–54.

Zhang, L. and S. Chen. 2019. China's Digital Economy: Opportunities and Risks. IMF Working Paper No. 19/16. Washington, DC: IMF.

CHAPTER 6

Money and Finance in the Digital Age: Some New Developments

Feng Zhu*

6.1 Introduction

The most notable change in the financial landscape in the new millennium, especially after the global financial crisis, has been the increasing application of technology to many financial services and the rise of financial technology (fintech) firms. Fintech penetration has been remarkable; according to Ernst and Young (2019), the adoption rate of fintech services by consumers has risen globally to 64% in 2019, from 16% in 2015 and 33% in 2017, with the People's Republic of China (PRC) (87%) and India (87%) in the lead, followed by the United Kingdom (UK) (71%), the United States (US) (46%), and Japan (34%). The global rate of fintech adoption by small and medium-sized enterprises (SMEs) reached 25% in 2019. The PRC (61%) is by far the frontrunner, followed at some distance by the US (23%) and the UK (17%). The PRC's success has been attributed to the country's widespread use of financial platforms and ecosystems.

Essentially, fintech involves the widespread use of different technologies, mostly digital, to propel financial innovations. These technologies include internet and mobile technology, artificial intelligence, big data analysis, cloud computing, and distributed ledger technology. These innovations have attracted the attention of bankers, market participants, policy makers and researchers alike, and highlighted the need for a better understanding of the ongoing changes.

Fintech firms are unique not only in their reliance on digital technologies, but also in their pursuit of new business models and applications. Among such applications, two major areas stand out: first, the growing scope and depth in digital finance,

* I thank Long Chen for helpful comments and suggestions, and Daniel Rosenberg for thoughtful editorial comments. This chapter is largely based on recent research by myself and my former colleagues at the Bank for International Settlements (BIS). The views expressed here belong to the author and do not necessarily reflect those of Luohan Academy, Alibaba Group, Ant Financial, or the BIS.

especially fintech credit, which has made financing available to those with limited access to bank credit or capital markets, but has also brought with it increased risks; and second, the mercurial rise of cryptocurrencies, including Bitcoin, and even the possibility of central-bank-issued digital currencies emerging in some economies. The digital revolution holds the promise of altering the landscape of money and finance as we know it.

6.2 Digital Finance[1]

Fintech credit, also known as digital or internet finance, can be defined as credit intermediated by nonbank players, but facilitated by electronic platforms and enabled by a range of technologies, new and old, primarily digital. Rapid advances in internet and mobile communications and large-scale information collection and processing have underpinned recent waves of innovations and their applications in finance. Notable characteristics of fintech credit include the use of digital technologies and intense interplays among participants through online and mobile terminals, with a large amount of business and customer information collected and processed for further use.

Fintech credit offers an alternative funding source for small businesses and consumers, improving access for the unserved and underserved segments. But, as highlighted by some recent operational failures and conduct problems, platform-based fintech credit creates challenges for regulators in ensuring adequate consumer and investor protection, and it may potentially have significant implications for financial stability.

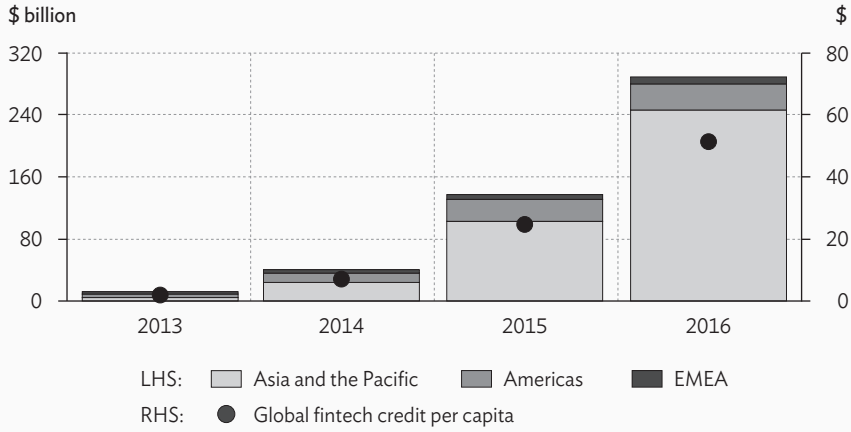
6.2.1 | Fintech Credit: Rapid Growth

Fintech credit has grown rapidly, albeit unevenly, around the world. Per capita, platform-based global fintech credit volume reached $50 in 2016, but its progress has shown great variations across regions, with most of the activity concentrated in Asia and the Pacific, and North America (Figure 6.1, panel A). In Continental Europe notwithstanding, fintech credit has shown signs of decline, which in the PRC might be associated with a regulatory tightening since 2016 (Figure 6.1, panel B).

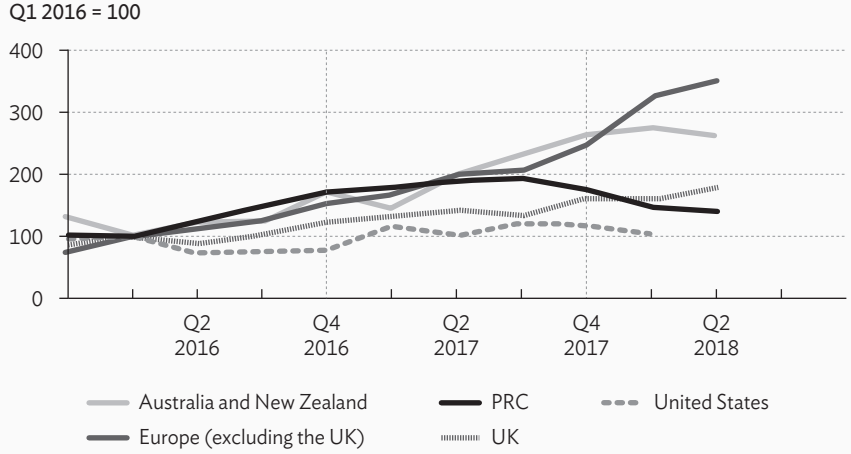
[1] Claessens et al. (2018) provides an overview and analysis of the recent developments of platform-based fintech credit around the world.

Figure 6.1: Rapid Growth of Fintech Credit

A. Global volume of new fintech credit



B. Fintech credit volumes, selected countries



EMEA = Europe, Middle East, and Africa; LHS = left-hand scale; PRC = People's Republic of China; RHS = right-hand scale; UK = United Kingdom.

Note: Data are based on two platforms for Australia and New Zealand, all platforms covered by WDZJ for the PRC, 32 platforms for Europe, 30 for the UK, and five for the United States.

Sources: Claessens et al. (2018); AltFi Data; Cambridge Centre for Alternative Finance and research partners; WDZJ.com.

While making significant inroads in the PRC, the UK, and the US, fintech credit has lagged in many smaller economies. Nevertheless, consumers and small businesses in both developed and emerging economies have increasingly adopted digital financial services as they provide much easier access and tend to be more convenient compared to those provided by traditional service providers.

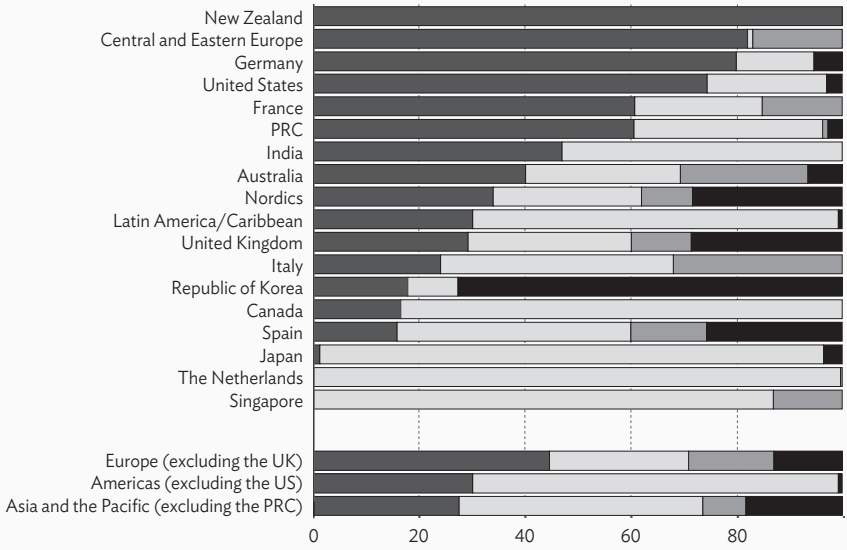
Not only have the level and growth of fintech credit activity varied greatly across economies, but also its composition. 2016 data suggest that platform-based fintech credit was dominated by consumer lending in New Zealand, Germany, the US, France, the PRC, and Central and Eastern European countries. However, business lending seems to be more prevalent in the Netherlands, Japan, Singapore, Canada, and Latin American and Caribbean economies (Figure 6.2, panel A). In the Republic of Korea, real estate lending played a significant role, while in Italy invoice trading was most prominent. For platforms that maintain loans on their balance sheets, business lending dominated (Figure 6.2, panel B). The diverse nature of the use of funds might have reflected the more pressing needs of certain types of borrowers in a particular economy, and possibly some existing deficiencies in those specific credit market segments, which allowed fintech credit operators to make greater inroads.

The PRC is a prominent example, having the largest and most dynamic peer-to-peer (P2P) credit market in the world. While initial business concepts might have been introduced from abroad, existing market demand led to rapid fintech credit expansion and much greater coverage in the PRC.[2] The trading volume reached CNY2.8 trillion in 2017, and the number of participants in P2P lending, i.e., investors and borrowers, rose to 17.13 million and 22.43 million, respectively. P2P lending became a significant source of funds for small firms and consumers: the ratio of new P2P loans to new bank loans rose to almost 40% in June 2016, before falling to less than 10% in June 2018 (Figure 6.3, panel A). Amid fierce competition, market concentration was low and falling. Aimed at meeting the short-term funding needs of small private borrowers, P2P loan interest rates tend to average between private and bank lending rates, with short maturities (Figure 6.3, panel B).

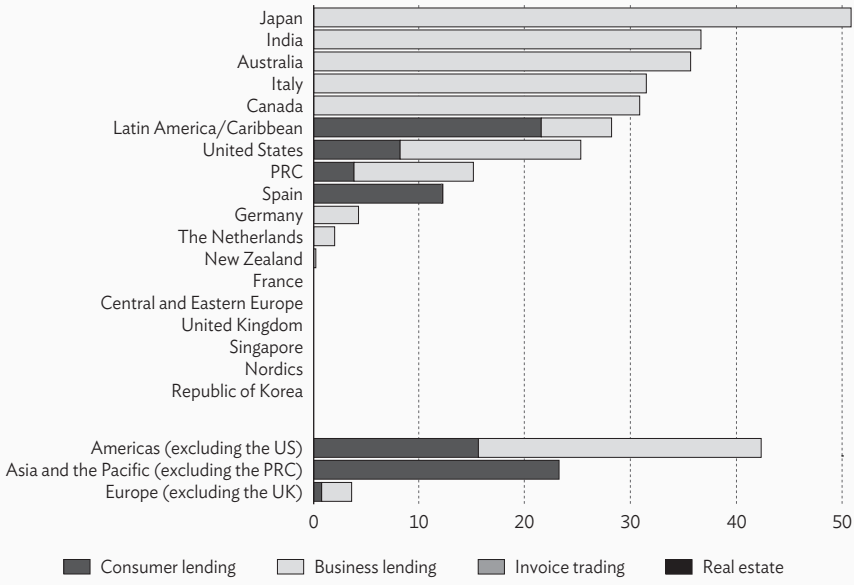
[2] P2P platforms Zopa and Prosper were founded in 2005 in the UK and the US, respectively, followed by the CreditEase P2P platform in the PRC in 2007.

Figure 6.2: Fintech Credit Characteristics Differ across Countries

A. Volumes in 2016 by borrowing sector, ranked by consumer lending (% of total)



B. On-balance lending platform volumes in 2016, ranked by highest share (% of total)

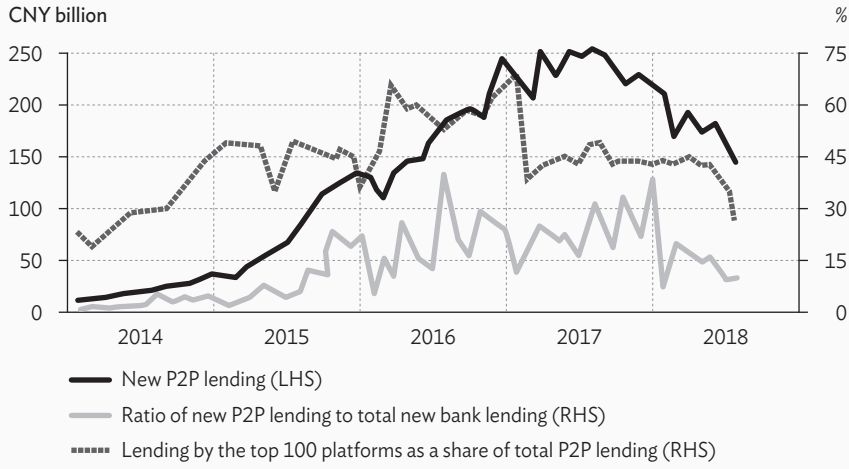


PRC = People's Republic of China, UK = United Kingdom, US = United States.

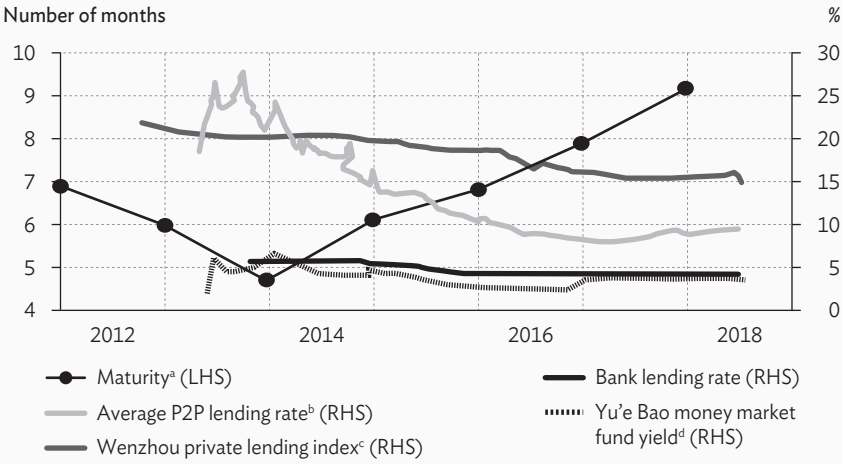
Sources: Claessens et al. (2018); Cambridge Centre for Alternative Finance and research partners.

Figure 6.3: Peer-to-Peer Lending in the PRC

A. Lending volume



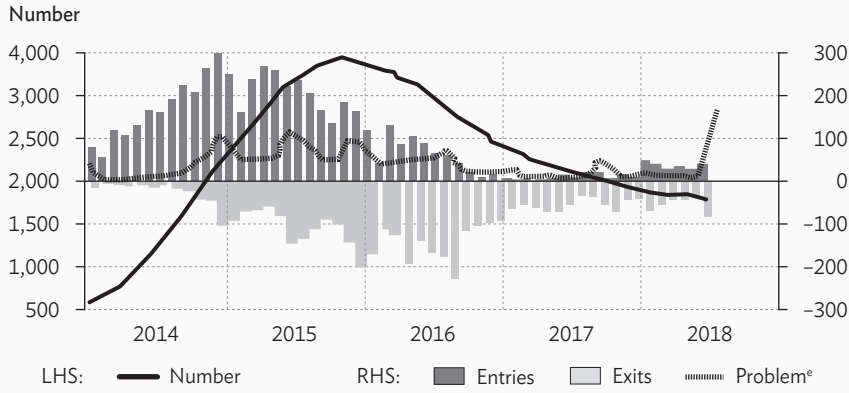
B. Interest rates and maturity



continued next page

Figure 6.3: ***Continued***

C. Consolidation of P2P platforms



LHS = left-hand scale, P2P = peer-to-peer, RHS = right-hand scale.

[a] Average maturity of P2P lending.

[b] 7-day moving average of 1-year rate.

[c] The Wenzhou Index, released by the Wenzhou Municipal Government Finance Office, tracks private lending.

[d] 7-day rate on Yu'e Bao money market fund.

[e] Those that face difficulties in coping with cash withdrawals by lenders are under investigation or have "runaway bosses".

Sources: CEIC; WDZJ.com; Wind database.

Rapid improvement in internet and mobile coverage has allowed consumers, merchants, and investors to actively engage in online commercial and financial transactions. Several unique factors have contributed to the rapid expansion of P2P lending in the PRC. First, the PRC's financial market is less mature compared to those of developed economies. Significant market segments, especially of small and micro firms and consumers, have often been ignored by formal credit intermediaries, who consider them too risky and unprofitable, for the lack of proper credit history or adequate collaterals. With limited alternative investment opportunities, many retail investors have been attracted by the promise of higher returns. Second, recognizing the social benefits of inclusive finance, the PRC regulators have tended to provide a more permissive environment for fintech innovations in an early stage. But many platforms lack the information and ability to assess and limit credit risks; in many cases, P2P lending has morphed into illegal financing. Amid rising failures, P2P platforms in the PRC have come under stringent regulatory oversight, and their existence as a viable business model has been called into question.

On the other hand, "big-techs", i.e., large technology firms such as Amazon, Ant Financial, Facebook, and Tencent, have become increasingly involved in financial services. In the PRC, some big-techs have already become large players in digital credit intermediation, taking advantage of growing business synergies in e-commerce, payment services, asset management, or social media. Such integrated businesses have allowed big-techs to collect, process and analyze a massive amount of data, enabling better risk analysis as well as credit scoring previously unavailable to much of the population. Big-techs in the PRC have strived for greater efficiency and, above all, better use of digital technology to integrate finance with serve real-life needs.[3] Data suggest that, in 2017, credit provided by big-techs as a percentage of total fintech credit reached elevated levels in the Republic of Korea (81.4%), Argentina (58.1%), Brazil (40.8%), the PRC (31.5%), and Japan (22.9%). The US (2.4%) and the UK (1.3%) big-techs played a much less prominent role in lending compared to P2P platforms or "marketplace lending". Moreover, the PRC led in terms of total fintech credit per capita, with $372, followed by the US ($126), the Republic of Korea ($115), and the UK ($110).

6.2.2 | Benefits and Drivers of Fintech Credit

Rapid fintech credit growth has helped provide alternative funding sources for small businesses and households, especially in those economies with a less sophisticated financial sector. These market segments have typically been underserved and often ignored by traditional lenders. Fintech credit, if well developed and properly managed, may significantly improve the efficiency of financial intermediation, supporting financial inclusion. Under intense competitive pressure from fintech firms, many banks have turned to digital innovations to improve the existing services, often in cooperation with fintech firms. Fintech credit may also enhance the resilience of a financial system if it remains solid in the event of a banking crisis or severe idiosyncratic shocks to traditional lenders, promoting financial stability.

To support sound and sustainable fintech credit growth, it is essential to understand its drivers and potential risks. Claessens et al. (2018) provide a comprehensive overview of the global development of platform-based fintech credit. A key finding is that the main factors driving fintech credit resemble those affecting traditional credit intermediation. In particular, higher fintech credit activity is positively

[3] Chen (2016) illustrates a "310" experience for loans by Ant Financial, i.e., 3 minutes to apply, 1 minute to receive the money, and zero staff interference. He emphasizes the importance of "finlife".

associated with an economy's income level. Fintech credit is negatively associated with the competitiveness of its banking system, as a bank monopoly might imply inefficiencies, which can be reduced by fintech credit competition. Yet, fintech credit volumes are higher in economies with less stringent banking regulation. Clearly, the stage of development and the financial market structure of an economy matter.[4]

6.2.3 | Risks and Regulatory Challenges

The rapid rise of digital finance has raised several pressing challenges for regulators, who seek to balance potentially substantial benefits from fintech innovations against possible emerging risks, especially as digital finance becomes more closely interwoven with the traditional financial sector. First, frequent irregularities and frauds involving P2P lending platforms have led to significant losses by consumers and investors. Better regulatory oversight and access to public safety nets may help fintech credit firms reduce vulnerability to investor pull-out and to runs. Second, as fintech operators' role in finance grows and more traditional lenders join fintech platforms, the benefit of diversified funding sources would be limited should fintech credit be strongly correlated with traditional forms of credit. Third, intense competition among P2P platforms and with banks in pursuit of broader market coverage of less privileged and financially more deprived (i.e., riskier) borrowers could lower lending standards. Fourth, P2P platforms often do not have enough information on borrowers active on their platforms. Since small fintech investors tend to be poorly informed and prone to herd behavior, their search for yield may encourage excessive risk-taking. In contrast, big-techs have privileged access to an abundance of information, and they are capable of collecting, processing and analyzing large datasets, paving the way for enhanced risk prevention and management.

There have been growing concerns with rising fintech credit losses and higher default rates in some economies. In the PRC, the initial permissive and often supportive regulatory environment spurred rapid P2P credit growth, with lending platforms operating simple matching models, whereby investors bid for contracts offered by borrowers. From around 2012 onward, platforms moved to more complex structures where investor funds were pooled.[5]

[4] Frost et al. (2019) find that big-tech credit has been driven by essentially the same factors as other fintech credit, with the easing of regulation playing a greater role.

[5] See Shen and Li (2018).

Many platforms started to provide guarantees on loan principal and interests, and promised "rigid redemptions" to attract investors. Significant operational failures followed inappropriate practices and frauds, including Ponzi schemes.

As risks rose and defaults surged, the number of problem platforms soared to 114 in June 2015. Following the failure of Ezubao in December 2015, the PRC regulators tightened regulations and implemented a clean-up. Three major guidelines were issued in 2016 and 2017, establishing the basic regulatory framework for digital finance. P2P platforms would be restricted to information intermediation and they could no longer collect funds from lenders. Since mid-2017, regulators requested a clear reduction in the numbers of internet finance institutions in operation and of borrowers and investors, and the scale of existing stock of lending. Many platforms came under scrutiny, with the number dropping to 2,448 in 2016, and 1,931 in 2017, from a peak of 3,448 in 2015 (Figure 6.3, panel C). The clean-up was extended as the number of problematic platforms surged again in June 2018. In December, regulators requested that all platforms other than those "strictly in compliance with regulations" to exit the business or close down. In April 2019, the plan for a pilot registration program was unveiled for consultation, setting high filing standards. The industry has consolidated: there have been no new entries since August 2018, and the number of operating P2P platforms dropped to 646 in September 2019.

As recent experiences in the PRC and elsewhere reveal significant risks and vulnerabilities of P2P lending platforms, a better approach is needed to support digital inclusive finance and help small investors and borrowers, as well as safeguard financial stability. Above all, encouraging innovations and competition could lead to substantial efficiency gains. Allen and Gale (2004) show that the relationship between competition and financial stability is more complex than usually assumed, and that sometimes competition increases stability, stating, "in a second-best world, concentration may even be socially preferable to perfect competition and perfect stability may be socially undesirable". Sound regulatory policies require careful assessment of all different factors. Besides a solid regulatory and supervisory framework, fintech credit firms capable of active risk management and sound business practices should be encouraged, especially those with a business model based on big data and rigorous risk analysis.

6.3 Digital Money

Technology has always played an important role in the history of money. Although money commonly known today generally assumes two forms, i.e., cash and bank deposits, it has evolved from commodity money, such as cattle, salt, shells, gold, silver and copper, to fiat money that possesses no intrinsic value on its own, e.g., notes in paper or electronic form. Technological advances facilitated payment, allowing credit cards, ATMs, and automated clearing houses to emerge in the 1960s and 1970s. Real-time gross settlement (RTGS) systems for interbank payments appeared in the 1980s; by 2016, over 90% of developed economies and 75% of emerging economies adopted RTGS. Latest innovations include internet and mobile (P2P) payments.

The rise of digital currencies is another example of fintech innovations that have captured the attention and imagination of market participants and policy makers alike. Yet money is more than a means of payment. While cryptocurrencies face the important questions of whether they can be genuinely considered as privately-issued money and how they should be properly regulated, there are intense ongoing debates on the future, or the lack of it, of digital currencies issued by central banks. The core issue remains to be trust, although much discussion focuses on technicalities.

6.3.1 | Are Cryptocurrencies Money?

Cryptocurrencies, or digital or virtual currencies created by private individuals or entities, date back to the 2009 release of Bitcoin, the world's first cryptocurrency. Invented by an anonymous entity under the name of Satoshi Nakamoto and created through a "mining" process, Bitcoins are stored and exchanged online through blockchain, a distributed ledger technology (DLT) that allows them to be transferred on a P2P network without any intermediary or a centralized administrator (e.g., central banks). Each transaction is verified by all network nodes through cryptography and recorded in the blockchain. Bitcoins can be exchanged for any national currencies, goods, or services. So far, over 4,000 alternative cryptocurrencies have been created, including Ethereum, Litecoin, Ripple, and Zcash.

But what is money in the first place? A 2012 Bank of Canada note defines money as, "any asset that is widely accepted as a means of making payments or settling debts", and stresses that, "the value of money depends on the confidence of those who use it".

Lagos (2008) defines money as, "an asset that serves as a medium of exchange".[6] For privately-issued cryptocurrencies to be money, a first test would be how well they serve its three core functions: medium of exchange, store of value, and unit of account. In addition, to be accepted by all, they need to gain public trust, and they should improve on the existing forms of money in some dimension, e.g., allowing safer, faster, cheaper and more efficient transactions, and providing better security, and stronger user protection.

Medium of Exchange (Payment Instrument)

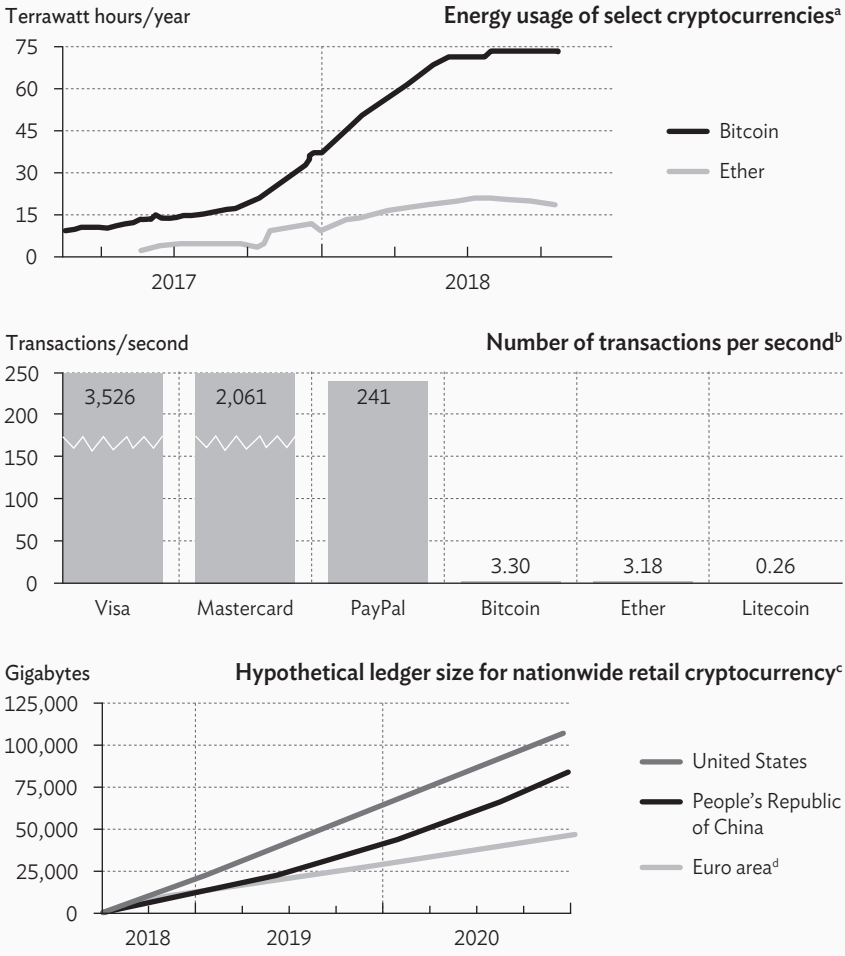
The most important role of money is to facilitate transactions. Without money, transactions must be conducted by barter, which requires a double coincidence of wants between two parties, the small likelihood of which can hamper trade. To serve as an efficient medium of exchange, cryptocurrencies need to be universally accepted, easily accessible, convenient, and low cost. Already, money in electronic form appears to have gained popularity for its efficiency and convenience as a means of payment, and the rapid rise of third-party or nonbank internet or mobile payment, such as Alipay and Wechat Pay in the PRC, PayTM in India, M-Pesa from Kenya, and Paypal in the US, is a testament to its success. Public safety might have also improved as physical risks diminish or move into cyberspace.

Current technology constraints imply that private cryptocurrencies are still of limited supply and their acceptance is restricted with limited circulation. Fiat money, either in paper or electronic form, is made at rather low costs. In contrast, cryptocurrencies are costly to produce, as they consume huge amounts of computing power and electricity, and large-scale mining has to be located in areas near low-cost energy sources (Figure 6.4, top panel).[7] Further, cryptocurrencies have difficulties in coping with very large numbers of transactions. In 2017, credit cards handled far more transactions per second than major cryptocurrencies (Figure 6.4, middle panel).

[6] Lagos (2008) further distinguishes "outside money" that is, "either of a fiat nature (unbacked) or backed by some asset that is not in zero net supply within the private sector of the economy. Thus, outside money is a net asset for the private sector"; and "inside money" as, "an asset representing, or backed by, any form of private credit that circulates as a medium of exchange. Since it is one private agent's liability and at the same time some other agent's asset, inside money is in zero net supply within the private sector."

[7] See Carstens (2018a). It was reported that in April 2019, local police in Tianjin, the PRC, confiscated 600 Bitcoin mining computers over electricity theft. The PRC is considering shutting down the country's virtual currency mining activities due to environmental concerns. In June, authorities in Iran seized about 1,000 Bitcoin mining machines following a surge in power consumption.

Figure 6.4: Energy Consumption and Scaling Issues



[a] Estimated.

[b] Data for 2017.

[c] The displayed hypothetical size of the blockchain/ledger is calculated assuming that starting from 1 July 2018, all noncash retail transactions of either the People's Republic of China, the United States, or the euro area are processed via a cryptocurrency. Calculations are based on information on noncash transaction numbers from CPMI (2017) and assume that each transaction adds 250 bytes to the ledger.

[d] Belgium, France, Germany, Italy, and the Netherlands.

Sources: BIS. 2018. *Annual Economic Report 2018*; CPMI. 2017. *Statistics on Payment, Clearing and Settlement Systems in the CPMI Countries*; www.bitinfocharts.com; Digiconomist; Mastercard; PayPal; Visa; BIS calculations.

If all noncash retail transactions were processed via a cryptocurrency, the size of the blockchain could rise very rapidly (Figure 6.4, bottom panel).

Carstens (2018b) points out that cryptocurrencies are currently prone to congestion and do not scale like sovereign money. With blockchain-based digital currencies, each transaction needs to be recorded; over time, the record-keeping of all past transactions accumulates to substantial file volumes. To accommodate the rapid expansion in blockchain size, cryptocurrencies need to cap the number of transactions processed at any point in time. Once the limit is reached and the system congests, transaction fees would spike, resulting in long queues of unprocessed transactions, as happened to most cryptocurrencies in late 2017 (Figure 6.5). In contrast, fiat money can scale easily and no records need to be kept. Another technical issue is the nonfinality of payment, i.e., transactions that have been successfully recorded in the blockchain can be cancelled retroactively. Transaction reversals can also occur due to "forking", when cryptocurrencies split into subnetworks of users, so individual payments through cryptocurrencies may not be final. On the other hand, transactions with fiat money cannot be reversed without the consent of both parties.

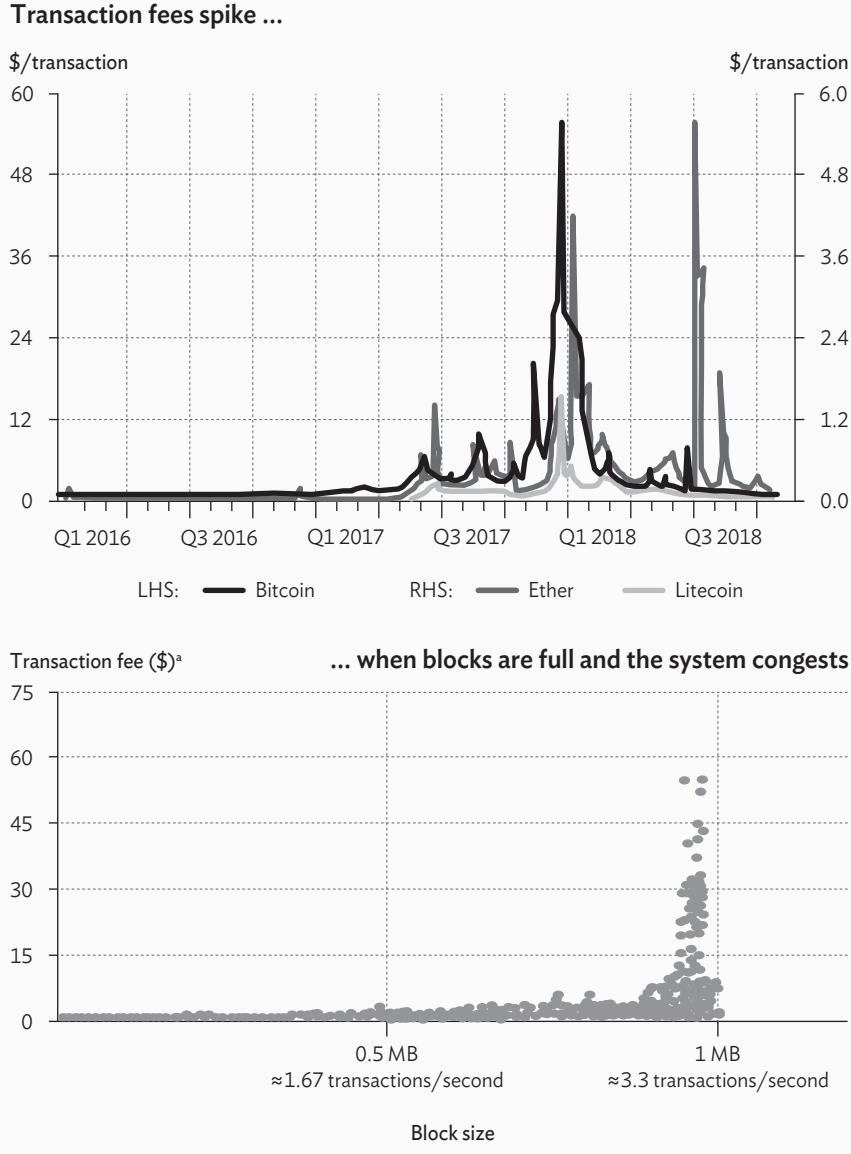
A sovereign money serves as an anchor of trust and has positive network externalities: the more it is used, the more benefits it bestows to users, and the more it gets trusted and desired. Because cryptocurrencies cannot scale like sovereign money, such externalities get lost: the more users a cryptocurrency has, the greater the likelihood that the system gets congested and becomes less useful to all users. Unless technological advances manage to successfully tackle this issue, it is unlikely that cryptocurrencies can be a substitute for sovereign money in the near future.

Store of Value

Money should be a liquid asset that is secure, durable, of stable and universally-recognized value that can be readily exchanged for other assets at any time. There are numerous assets that can serve as store of value, including precious metals, real estate, and artwork. In the not-so-distant past, a currency was pegged to gold or silver, and its value depended on a government's ability to maintain the peg. While these assets can be subject to large fluctuations of value depending on, e.g., shocks to demand and supply of the underlying asset, fiat money may lose value and depreciate with inflation.

Cryptocurrencies (e.g., Bitcoin, Ether, and Litecoin) created through mining are digital assets whose value is hard to assess. They are subject to large short-term fluctuations in value, in comparison with more traditional assets such as gold (Figure 6.6, top panel).

Figure 6.5: Transaction Fees Over Time and in Relation to Transaction Throughput



LHS = left-hand scale, MB = megabyte, RHS = right-hand scale.

[a] Transaction fee paid to miners over the period 1 August 2010–22 October 2018; daily averages.

Sources: BIS (2018), *Annual Economic Report 2018*; www.bitinfocharts.com; BIS calculations.

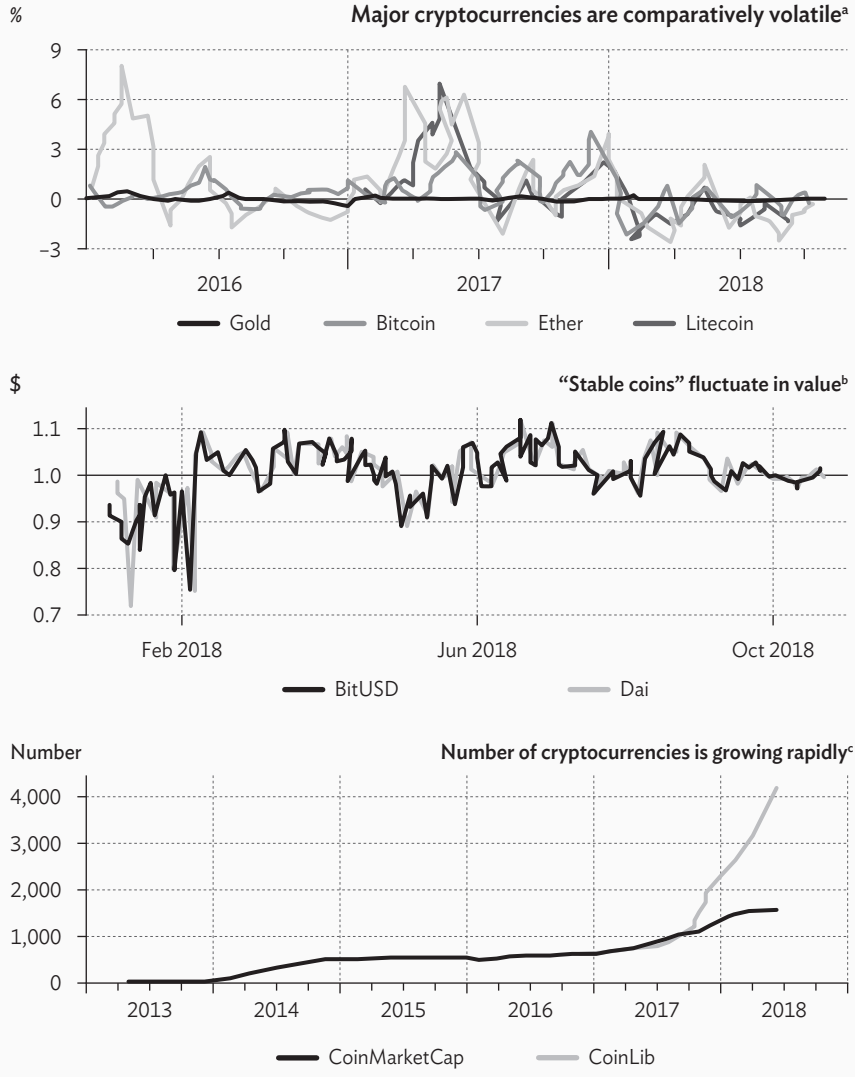
Unlike cryptocurrencies tied to an algorithm, stable coins, designed to reduce excessive volatility, are pegged to a stable asset or basket of assets that include sovereign money, other cryptocurrencies, and commodities. Redeemable stable coins are backed with benchmark assets. Nevertheless, stable coins such as BitUSD and Dai still show significant daily fluctuations (Figure 6.6, middle panel). The surging number of cryptocurrencies has made their valuation harder to track, making it difficult for users to agree on one cryptocurrency of which the value is recognized and accepted by all (Figure 6.6, bottom panel). It is possible that, over time, a small number of winners emerges from the competition and gains critical mass for circulation.

Unit of Account

National currencies are divisible into standard nominal units used for valuing assets, goods, and services. Digital currencies can provide a common, standard measure for trade in goods and services. Yet, in practice, no cryptocurrencies appear to have been used as a primary unit of account, as prices are still quoted in sovereign currency units, even with transactions via digital currencies. Essentially, cryptocurrencies were not created to serve as benchmarks to measure the value of other assets and goods and services. That function has been overwhelmingly assumed by national currencies, or by a major reserve currency such as the dollar.

Cryptocurrencies appear to have technical issues in fulfilling the three primary functions of money, especially their deficiency as a means of payment and store of value. Nevertheless, with further technological breakthroughs, some of these issues are not insurmountable. Indeed, DLT-based currencies might be promising. A fundamental question is what makes money "money"? For some, money is information, or more precisely, memory as a means of recording past transactions. Kocherlakota (1998) suggests that, "money is technologically equivalent to a primitive version of memory". He finds that in some cases, memory dominates money, which exists due to its limited ability to keep track of past transactions. As Kocherlakota (1996) asserts, "money may only be an imperfect substitute for high quality information storage and access", and, "the government's monopoly on seignorage might be in some jeopardy as information access and storage costs decline". If money is indeed societal memory, then digital currencies might have a significant role to play. Yet, cash itself does not contain a physical record of all past transactions, it only represents the net position of the money holder's past transactions, and it has the advantage of anonymity and costless recording relative to cryptocurrencies.

Figure 6.6: Volatility of Select Cryptocurrencies and Number of Cryptocurrencies



[a] 30-day moving averages of daily returns.

[b] Daily price minimum.

[c] Based on monthly snapshots from two different providers. CoinMarketCap includes only cryptocurrencies with a minimum 24-hour trading volume of $100,000; CoinLib does not use a threshold.

Sources: BIS (2018), *Annual Economic Report 2018*; www.bitinfocharts.com; www.coinlib.io; www.coinmarketcap.com; Datastream; BIS calculations.

Some argue that money is trust or a social relation, which allows it to be widely accepted for circulation. In most economies, governments are seen as more trustworthy than private entities, their monopoly implies that only sovereign money is accepted as legal tender.[8] A key attribute of sovereign money is government backing, and a monetary authority can further promote trust by maintaining stable currency values through price and exchange rate stability. But such trust can be abused: intentional debasement of money by governments is not uncommon in human history, and mismanagement of monetary, financial, or fiscal policies has often led to unstable currency values. However, by reinforcing trust in the financial system with good governance and the right mix of economic policies, a central bank can enhance the acceptability of sovereign fiat money by individuals and firms, domestic and foreign.

A related issue is government monopoly of outside money, often through legal restrictions on private issuance. Economic theory is not entirely clear about its comparative advantage and costs. Hayek (1976) argues for the abolition of government monopoly, favoring free competition of private money as the way to achieve macro (price) and financial stability by imposing discipline on public policy. Halfway between government monopoly and private money is the "real bills doctrine", which essentially requires that money supply changes passively in line with the needs from real transactions in goods and services. According to Sargent and Wallace (1982), the doctrine asserts that, "unrestricted intermediation either by private banks or by a central bank has beneficial effects" and market forces would prevent excessive credit creation by private banks. Under such a rule, inflationary over-issue is impossible provided money is issued on loans made to finance real transactions (Humphrey 1982).

Private money has been common in human history. There were cases in which it worked well as a safe and widely accepted means of payment, e.g., in Canada from the early 19th century to 1935 and in Scotland in the early 19th century.

[8] There are exceptions. In Hong Kong, China, the Hong Kong Monetary Authority authorizes three local commercial banks (HSBC, Standard Chartered Bank, and the Bank of China) to issue banknotes. Banknotes in Macau, China are issued by Banco Nacional Ultramarino and the Bank of China. In the UK, besides the Bank of England, seven retail banks can print their own banknotes. The Bank of England has the monopoly over issuance in England and Wales, and it regulates issuances in Scotland and Northern Ireland.

However, private issuance tended to be plagued with issues of misconduct, distrust, and failures of even well-intended issuers. In fact, the earliest paper money "Jiaozi" (交子) emerged first in the form of promissory notes issued by merchants in the 10th century in Chengdu. But by 1024, widespread fraud and failures forced the government to license and regulate its issuance with the newly-founded Jiaozi Bureau (交子務).

A more recent example was the free banking era of 1837–1863 in the US, where money could be issued by almost anyone: states, municipalities, private banks, railroad and construction companies, stores, etc. An estimated 8,000 different types of paper money were printed by 1860, some with colorful names like red dogs, shingles, shinplasters, and stump tails. It was alleged that free banking encouraged dishonest bankers to set up unreliable and untrustworthy "wildcat banks", in order to defraud the public by issuing notes they would not redeem in gold or silver as promised. But in Rolnick and Weber's 1982 view, most free bank closings and noteholder losses were caused by capital losses banks suffered from substantial drops in the price of the state bonds that made up a large part of bank portfolios. In both cases, a private note would become worthless once its issuing bank went bankrupt. Eventually, the National Bank Act came into effect in 1863, and free banking was taxed out of existence by the federal government in 1865.

Cryptocurrencies are privately issued tokens based on blockchain, essentially a continuously growing list of records distributed across and managed by P2P networks, without the intervention of a central authority or server. Data are organized in blocks, which are linked securely via cryptography. Like any DLT, an update needs to be independently constructed and recorded by each node, and agreed upon through a consensus algorithm, before being saved separately on each node. This process and the blockchain's append-only structure reduce the reliance of digital currencies on third parties such as the government, injecting an element of trust.

While fintech firms have made great inroads in providing safe, efficient, and cost-effective means of payment, e.g., through Alipay, WeChat Pay, or PayTM, cryptocurrencies, on the other hand, are rarely used in retail payment transactions, and their transaction volumes pale in comparison with existing payment methods. Private cryptocurrencies are vulnerable to cybercrimes and they have been exposed to fraud and illegal activities such as money laundering. Fraud is also quite common in initial coin offerings, where cryptocurrencies are auctioned in exchange for participation rights in a startup business venture.

6.3.2 | Libra and Public Trust

Libra, a permissioned blockchain digital currency announced by Facebook in June 2019, has attracted much attention. In a world of expensive, slow, and sometimes unreliable cross-border payments, Libra could become an efficient payment tool, and a serious challenge to traditional modes of cross-border money transfer. Despite the enthusiasm it has generated, it might not constitute money. The ambitious idea faces significant challenges and one key issue is trust.

According to Facebook, Libra serves inclusive finance by expanding low-cost financial services to the less privileged. Although there are still insufficient details, Libra as a cross-border payment instrument appears to have several distinct features. First, like backed or redeemable stable coins, each Libra cryptocurrency will be supported by a corresponding basket or reserve of assets, mainly composed of bank deposits and short-term government bonds. The provision of asset reserves attempts to minimize volatility, cultivate trust, and allow Libra to edge closer to money, beyond the mere provision of payment services, as with Alipay, Paypal, or WeChat Pay. In this aspect, Libra may bear some resemblance to US free banking era bank notes, or currencies operated under a currency board, and Facebook's ability to redeem Libra is essential. Second, Libra aims to become a supranational currency facilitating cross-border transactions, as will be reflected in the composition of its asset reserves. The availability of a widely accepted global instrument of payment might diminish the mistrust associated with the use of unfamiliar foreign currencies. Third, Libra is based on open-source blockchain technology, and an association of the blockchain network nodes will provide the framework for network and reserve management. This could help address concerns with any dominant role of Facebook in running Libra and enhance trust among users and regulators.

The issuance of Libra can benefit from a digital network with billions of active users, allowing it to be closely integrated into users' real-life scenarios. Nevertheless, there are heightened uncertainties. First, there is no reason why people should trust Facebook or an association of its partners more than any other major coin-issuing entity or the state. Second, once circulated, Libra might be subject to stringent regulatory oversight by distinct jurisdictions that have very different views and rules on cross-border capital flows and on digital currencies and payments. For instance, Libra's circulation as a means of payment implies cross-border data sharing, yet there is no guarantee of (or trust in) the safe and responsible use of data by private entities, and there is a lack of international consensus on the standards, rules, and adequate framework to address issues such as privacy, data protection, or

national security. There is still a long journey before Libra can be considered as a valid substitute for sovereign money, despite the potential benefits that it might bring, especially in terms of cross-border payment efficiency.

6.3.3 | Prospects for Central Bank Digital Currencies

Central bank digital currencies (CBDCs) are gaining support for several reasons. First, the demand for money in digital form is rising in some economies amid accelerated obsolescence of paper currency and coins, as witnessed in the PRC and Sweden. Already in 2017, the ratio of the value of banknotes and coins in circulation to GDP was 10.7% in the euro area, 9.5% in the PRC, 8.2% in the US, but merely 5.1% in Indonesia, 4.3% Turkey, 3.8% in Brazil, 3.4% in South Africa, and 1.3% in Sweden. According to Sveriges Riksbank's survey, in Sweden, the use of cash in purchases dropped to below 13% in 2018 from 39% in 2010. Second, existing payment systems are notorious for low efficiency and high costs. Money transfers, especially cross-border, tend to be slow and expensive. Third, there are claims that CBDCs facilitate monetary policy implementation in economies where nominal interest rates hit the zero lower bound. While CBDCs apparently can add little to bank reserve management already in electronic form, they may enable a central bank to more easily implement negative interest rate targets. Fourth, CBDCs are seen as a potentially useful tool for enhancing inclusion, especially in emerging economies where the existing financial infrastructure remains largely inadequate.

According to Bech and Garratt (2017), CBDCs are, "an electronic form of central bank money that can be exchanged in a decentralised manner known as peer-to-peer, meaning that transactions occur directly between the payer and the payee without the need for a central intermediary".[9] BIS (2018) defines CBDCs as new variants of central bank money different from physical cash or central bank reserve/settlement accounts. While cryptocurrencies issued by private entities are still a long shot to be considered valid substitutes for money, their rise pose a significant challenge to state monopoly and to the continued existence of sovereign money in the present form.

[9] Bech and Garratt (2017) and BIS (2018) provide a taxonomy of money through a "money flower" based on four key properties: issuer (central bank or not); form (digital or physical); accessibility (widely or restricted); and technology. They distinguish two types of CBDCs: a general purpose, widely-used retail payment instrument; and a wholesale digital settlement token with its access restricted to institutions engaged in wholesale payment.

Central banks, on behalf of the government, can play a major role in the process of digitalizing money, especially by enhancing trust. There are different ways that a government can intervene. One route is by setting clear rules and setting up adequate supervisory frameworks, while offering qualified private digital money providers access to central bank reserves. Implicit in the licensing of the selected digital currencies and the setup of a safety net is the government pledge to back them up in the eventuality of failures. Alternatively, a central bank can directly provide a digital currency, either issued by itself alone, or in collaboration with private entities. In principle, CBDCs work like digital cash: a central bank issues its CBDC for circulation among economic agents, with no further involvement. CBDCs will be more readily considered by the general public to enjoy fiscal support and therefore some trust.

Currently, many central banks are exploring the prospects of a CBDC denominated in national currency units, including Project Jasper of the Bank of Canada, the joint Project Stella of the Bank of Japan and the European Central Bank, Project Ubin of the Monetary Authority of Singapore, the e-Krona project of the Sveriges Riksbank, and Project Inthanon of the Bank of Thailand. BIS (2018) finds that the strengths and weaknesses of a general purpose CBDC would depend on specific design features. Barontini and Holden (2019) find that most central banks are conducting research into CBDCs, and many are progressing from conceptual work to experimentation and proofs-of-concept. Yet the benefits and costs of CBDCs are not entirely clear, and motivations for CBDC issuance are largely idiosyncratic.

In 2014, the People's Bank of China (PBOC) set up a team to explore the possibility of launching its own digital currency, intended to reduce circulation costs of paper money and boost control of money supply. In August 2019, the PBOC revealed that it was "almost ready" to issue sovereign digital currency, based on a two-tier system in which it provides digital money (M0) while banks and other institutions distribute it to the general public. These institutions must hold 100% reserve with the PBOC, of which the CBDC is still its liability. The design of the CBDC would resemble a cryptocurrency only in limited ways, and it would not solely rely on the blockchain technology that is still incapable of handling large transaction volumes. Nevertheless, only a limited number of central banks are implementing the pilot stage. In the foreseeable future, central banks are likely to maintain a cautious approach to CBDC issuance.

6.4 Conclusion

Fintech innovations have significantly changed our daily life, as well as the monetary and financial landscapes. They may yield large benefits to society, derived from, for instance, a significant broadening and deepening of financial inclusion, as well as the creation of new financial assets, new means of payment, and, consequently, a new, arguably more efficient and convenient lifestyle. Nevertheless, new risks might emerge, which are not limited to cyber-risks, data control, and privacy issues, since some conventional financial sector risks move from the physical to digital space. In order to reap the rewards of digital finance, regulatory oversight should be balanced with adequate support for innovations. Controlled experiments, sandboxes, and international cooperation might be helpful.

Currently, private cryptocurrencies are not considered money, especially as they face technological constraints on fulfilling money's core functions, and they still need to deal with a perceived trust deficit. Again, they raise the eternal issue of what constitutes money, and whether that issued by private entities can bring additional value to the society. Also, if memory indeed dominates money, digitalization may be beneficial. In any case, the future of money will undoubtedly be shaped by technological advances. Already, national authorities are proceeding, albeit cautiously, with CBDCs, which might solve rising challenges from technological innovations to a perceived lack of trust in private cryptocurrencies.

REFERENCES

Allen, F. and D. Gale. 2004. Competition and Financial Stability. *Journal of Money, Credit, and Banking* 36(3).

Bank for International Settlements (BIS). 2018. Central Bank Digital Currencies. A Report by the Committee on Payments and Market Infrastructures and Markets Committee, March. Basel: BIS.

Barontini, C. and H. Holden. 2019. Proceeding with Caution – A Survey on Central Bank Digital Currency. *BIS Papers* 101 (January). Basel: BIS.

Bech, M. and R. Garratt. 2017. Central Bank Cryptocurrencies. *BIS Quarterly Review*. September. Basel: BIS.

Carstens, A. 2018a. Money and Payment Systems in the Digital Age. Speech by General Manager, Bank for International Settlements, at the Finance and Global Economics Forum of the Americas University of Miami Business School, 1 November.

———. 2018b. Money in a Digital Age: 10 Thoughts. Speech by General Manager, Bank for International Settlements, at Lee Kuan Yew School of Public Policy, Singapore, 15 November.

Chen, L. 2016. From Fintech to Finlife: The Case of Fintech Development in the PRC. *PRC Economic Journal* 9(3): 225–239.

Claessens, S., J. Frost, G. Turner, and F. Zhu. 2018. Fintech Credit Markets around the World: Size, Drivers and Policy Issues. *BIS Quarterly Review* September: 29–49.

Ernst and Young. 2019. *Global FinTech Adoption Index 2019*. New York: Ernst and Young.

Frost, J., L. Gambacorta, Y. Huang, H. S. Shin, and P. Zbinden. 2019. BigTech and the Changing Structure of Financial Intermediation. *BIS Working Papers* 779 (April).

Hayek, F. 1976. *Denationalisation of Money*. London: Institute of Economic Affairs.

Humphrey, T. 1982. The Real Bills Doctrine. Federal Reserve Bank of Richmond. *Economic Review* 68(5): 3–13.

Kocherlakota, N. 1996. Money is Memory. *Federal Reserve Bank of Minneapolis Staff Report* 218.

———. 1998. Money is Memory. *Journal of Economic Theory* 81: 232–251.

Lagos, R. 2008. Inside and Outside Money. In S. Durlauf and L. Blume, eds. *The New Palgrave Dictionary of Economics*. London: Palgrave Macmillan UK.

Sargent, T. and N. Wallace. 1982. The Real-Bills Doctrine Versus the Quantity Theory: A Reconsideration. *Journal of Political Economy* 90(6): 1212–1236.

Shen, Y. and C. Li 2018, 网络借贷风险缓释机制研究 (Research on the Risk Relief Mechanism of Internet Financing), Institute of Digital Finance, Beijing University.

PART 2

Digital Currency and Fintech Applications in Asia and the Pacific

CHAPTER 7

Fintech and Central Bank Digital Currency in Australia

David Emery*

7.1 Introduction

This chapter focuses on two current issues relating to the payments system in Australia. The first is practical and in operation: the New Payments Platform (NPP), probably the most important piece of finance technology to emerge in retail payments in Australia in the last 20 years. The second is hypothetical and could remain that way for some time: the concept of a central bank digital currency (CBDC).

7.2 Fintech in Australia

The word "fintech" gets used often without necessarily having a clear definition. The Financial Stability Board (FSB) describes it as a "technology-enabled innovation in financial services", which makes it a very broad concept. Rather than attempting to describe the entire landscape of fintech in Australia, I am going to focus on one key fintech development.

7.2.1 | New Payments Platform

The NPP (Figure 7.1) is a collaboration between authorized deposit-taking institutions in Australia and the Reserve Bank of Australia (RBA) that flowed out of the Strategic Review of Innovation in the Payments System (the Strategic Review) conducted by the RBA in 2010–2012.[1]

* The views expressed in this chapter are those of the author and not necessarily those of the Reserve Bank of Australia. Use of any results from this chapter should clearly attribute the work to the author and not to the Reserve Bank of Australia. Any errors are the author's own.

1 See https://www.rba.gov.au/payments-and-infrastructure/payments-system-regulation/past-regulatory-reviews/strategic-review-of-innovation-in-the-payments-system/ for more details on the Strategic Review.

The Strategic Review featured a multistage consultation process with stakeholders.

In June 2012, the RBA published the conclusions to the Strategic Review (see RBA 2012). One of the key outcomes was that certain gaps in the payments system were identified, in particular:

- end-users' inability to make retail payments with the recipient having visibility and use of those funds in near-to-real time;
- the lack of availability of many payments outside normal banking hours;
- the inability to send any significant amount of data with a payment. Australia's direct entry system allows only 18 characters of information to be transmitted with a payment. This is a particular challenge for business users, limiting their ability to integrate payment processes into their broader business; and
- the lack of an easy way of addressing electronic payments, with the need to correctly enter the Bank State Branch (the Australian equivalent of sort codes or bank codes) and account number details, rather than more intuitive or convenient means of addressing payments such as phone numbers, e-mail addresses, or other identifiers.

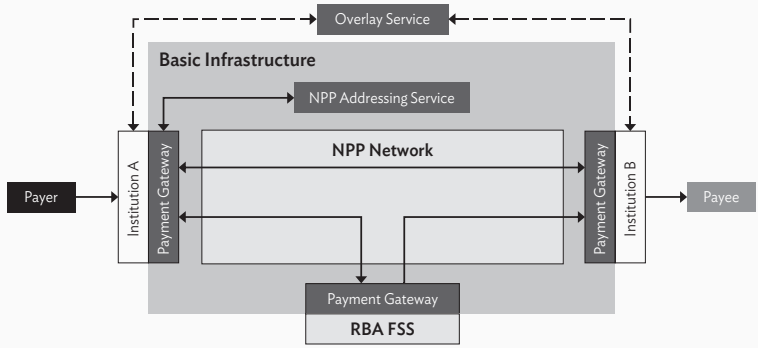
The Payments System Board (PSB), which determines the RBA's payments policy, identified that since there appeared to be barriers to cooperative innovation in the industry, it would set out some strategic objectives every few years, the initial set of which reflected the gaps identified in the Strategic Review:

- the ability to make real-time retail payments;
- the ability to make and receive low-value payments outside normal banking hours;
- the ability to send more complete remittance information with payments; and
- the ability to address payments in a relatively simple way.

In setting the strategic objectives, the PSB was aiming for the industry to agree upon a solution, but in a way that gave the industry control over the approach. This was, in effect, a challenge to the industry to address these issues.

The industry responded by forming the Real-Time Payments Committee, which over the second half of 2012 managed to coalesce around a proposal that would address the PSB's strategic objectives, namely, the plan for the NPP (Real-Time Payments Committee 2013).

Figure 7.1: NPP Infrastructure and Payment Processing



FSS = Fast Settlements System, NPP = New Payments Platform, RBA = Reserve Bank of Australia.

Note: For a more detailed version of this diagram, including transaction flows, see Rush and Louw (2018).

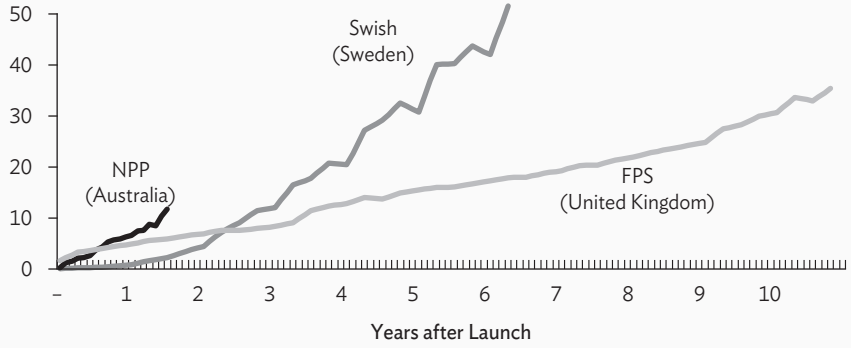
Source: Reserve Bank of Australia.

The NPP, launched in February 2018, is a fast payments system developed by a consortium of 13 financial institutions, including the RBA. The NPP operates on a 24/7 basis and allows financial institutions to provide immediate funds availability to payment recipients, even when the payer and payee have accounts with different financial institutions. NPP payment messages use the ISO20022 format and can carry much richer remittance information than the 18 characters currently available for Direct Entry payments. In addition, the NPP provides a "PayID" service, which allows for a payment to be made to a registered phone number, Australian Business Number, or e-mail address, instead of addressing a payment to a Bank State Branch and account number. To support the NPP, the RBA built the Fast Settlement Service, which provides fast, line-by-line settlement of NPP transactions on a 24/7 basis.

In addition, the NPP is designed to support "overlay" services. These are value-added services that make use of the payment and settlement functionality of the NPP. This could be anything from a set of rules establishing service levels, to advanced integration with other processes, e.g., the transfer of ownership of secondhand motor vehicles on the weekend.

The NPP has gradually built volume following its launch in February 2018. Its growth in the early stage of operations is comparable to that in Sweden's Swish system, and similar to that of the United Kingdom's Faster Payment System (Figure 7.2).

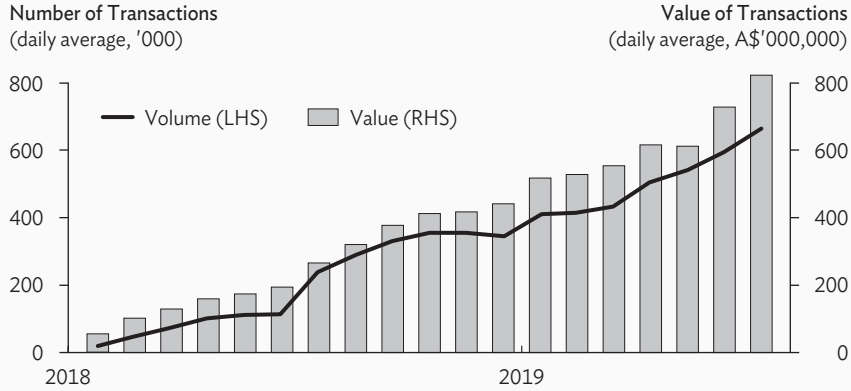
Figure 7.2: Use of Fast Payments Systems
(annualized number of transactions per capita)



FPS = Faster Payments System, NPP = New Payments Platform.
Sources: FSPL, Getswish, national statistics agencies, NPP Australia.

As of April 2019, there were about 500,000 NPP payments per day, with an average value of around A$900 (Figure 7.3). The number of payments is expected to grow as Australia's banks roll out additional functionality and services.

Figure 7.3: New Payments Platform: Daily Average Number and Value of Transactions

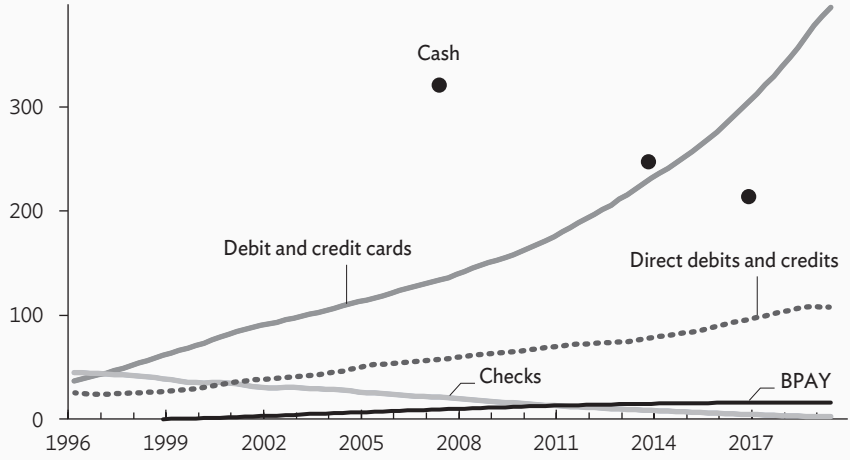


LHS = left-hand scale, RHS = right-hand scale.
Source: Reserve Bank of Australia.

7.3 Central Bank Digital Currency in Australia

The key reason for addressing a CBDC is the decline in the use of cash for transactions purposes and the rise of electronic payments (Figure 7.4).

Figure 7.4: Transactions per Capita (number, rolling annual sum)

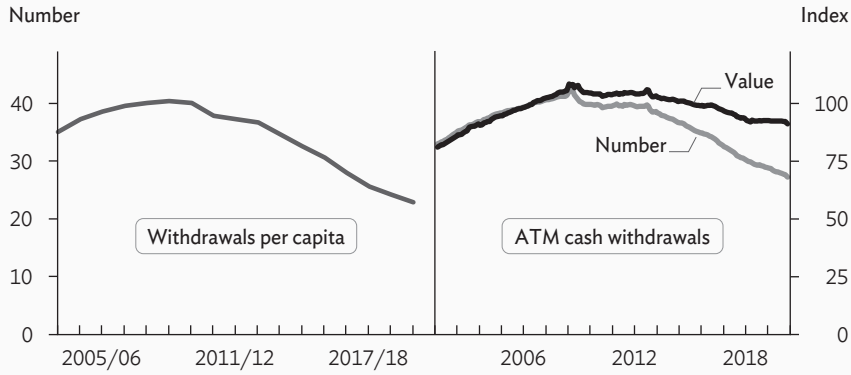


Sources: Australian Bureau of Statistics, AusPayNet, Colmar Brunton, Ipsos, Reserve Bank of Australia, Roy Morgan Research.

Australia is moving toward a near-cashless payments system (see Lowe 2018). The decreasing importance of cash for transaction purposes can be seen readily in monthly data on ATM withdrawals (Figure 7.5). Australians used to visit an ATM on average about once every 9 days. Now it is slightly more than 2 weeks between visits and seems likely to continue to fall.

The decline in the use of cash can also be seen from the RBA's periodic consumer payments surveys. Every 3 years, the RBA surveys over 1,000 Australians about their payment patterns and preferences. The survey asks them to record all their payments over the course of a week. The first survey was in 2007 and was a paper diary that people carried around. Now, of course, the diary is principally online, although the survey tries to capture the preferences of the small percentage of the Australian population without an online presence.

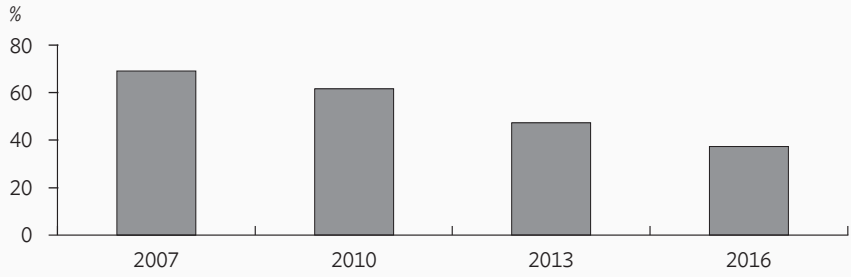
Figure 7.5: ATM Cash Withdrawals



Note: For the index, January 2007 = 100. Statistics are seasonally adjusted.
Sources: Australian Bureau of Statistics; Reserve Bank of Australia.

When the RBA first did such a survey, cash accounted for around 70% of the number of household payments. In the most recent study in 2016, this had fallen to 37% (Figure 7.6). The fifth study is due to be conducted toward the end of 2019. It is likely to show a further fall in the number of cash payments, consistent with the decline in ATM transactions and the growth of electronic payments.

Figure 7.6: Consumer Payments Surveys: Number of Cash Transactions (% of consumer payments)



Source: Reserve Bank of Australia calculations, based on data from Colmar Brunton, Ipsos, and Roy Morgan Research.

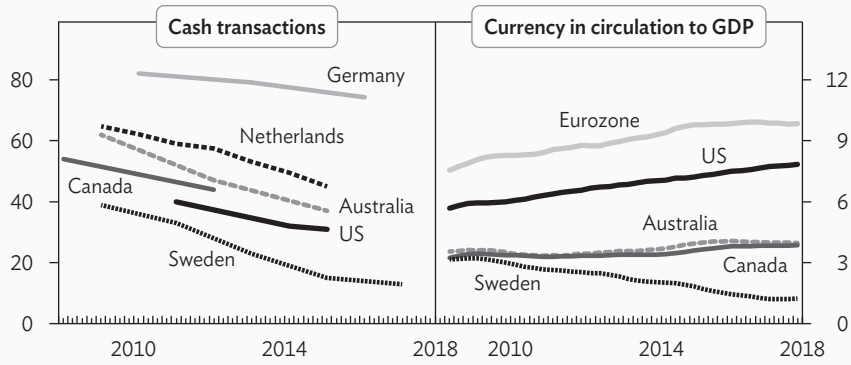
Despite what is effectively a halving of its share of transactions over a decade, cash is still widely used and available for transactions. In some situations, paying with banknotes is quicker and more convenient than paying electronically, although this advantage is less than it once was. Some people also simply prefer paying in cash, perhaps because they find it easier to budget. Our 2016 consumer payments survey indicated that around 14% of Australians preferred using cash as a budgeting tool, and 12% of our sample reported paying in cash for all of their in-person transactions during the survey.

In addition, despite the decline in the use of cash for transactions, the value of banknotes on issue in Australia is close to the highest it has been in 50 years. There is still a demand to hold cash as a store of value, both from Australian residents as well as offshore (see Flannigan and Staib 2017). The low-interest rate environment means that the opportunity cost of doing so is less than it has been in the past. The RBA consumer payments surveys also indicate that some holding of cash is done for contingency and emergency purposes; when people were asked in 2016 why they held cash outside their wallet, the most common response, from nearly half of respondents, was that it was for emergency transaction needs. And, indeed, with natural disasters like floods and bushfires, where electronic and telecommunications networks are affected, there is often a reliance by affected communities on cash being available. This also applies where there are operational outages in the retail payments system, and there have been several serious recent incidents in Australia that have affected networks and participants.

These broad trends are consistent with trends internationally. There are several other countries that undertake payments surveys that resemble the RBA's triennial study. The methodologies are often somewhat different, so direct comparisons should be done cautiously, but there is a fair amount of consistency across different jurisdictions (Figure 7.7). In most countries, the fall in the share of cash payments has occurred while its value in circulation has risen. There are a few exceptions, the most notable being Sweden. Interestingly for Australia, our most recent observation is close to where cash use was measured in Sweden ahead of its decline commencing.

It is in this context that quite a bit of consideration has been given to CBDC as an electronic equivalent of banknotes. Many central banks, as well as the Bank for International Settlements and the International Monetary Fund, have done some work in this area. Rather than define CBDC and all its potential features, a very high-level approach characterizes it as a liability of the central bank, as well as near-universal in its accessibility, and with the ability to be transferred electronically with immediacy to the recipient.

Figure 7.7: Trends in Cash Use and Currency to GDP



GDP = gross domestic product, US = United States.

Sources: Bank of Canada, Colmar Brunton, De Nederlandsche Bank, Deutsche Bundesbank, Federal Reserve Bank of San Francisco, Ipsos, Reserve Bank of Australia, Roy Morgan Research, Sveriges Riksbank.

If, from a policy perspective, an economy wanted an electronic equivalent of cash, the likely issuer would be the central bank. Some of the earlier forms of paper money were issued by private banks. For example, during the Free Banking Era (1837–1866) in the United States, banks could freely issue paper money. However, these private currencies proved to be highly volatile and subject to panics. Many of the banks issuing these currencies primarily lent to farmers and downturns in the agricultural sector were often sufficient to generate a run on them. To overcome these recurrent crises, central banks were granted the exclusive right to issue banknotes, something that is now mostly taken for granted as one of the responsibilities of a central bank.

A less advantageous pathway would be via something that looked like Bitcoin. Setting aside the huge energy costs involved in proof-of-work consensus mechanisms, what is needed for money is being a means of payment (and it turns out that doing this at scale is hard); a unit of account (almost never, outside of other cryptoasset markets); and a store of value (highly volatile).

The provision of currency by a central bank, if well-managed, has aspects of a public good. It is non-excludable since all users of the currency can rely on the central bank's backing of the settlement asset, and it is benign since the reliance on the central bank's reputation by any individual does not diminish the ability of others to do likewise.

Skingsley of the Riksbank, Sweden's central bank, has noted that while it may not be desirable for the general public's access to central bank money to be determined by the market and to steadily decline over time, there is currently a need among the general public and companies to have access to central bank money and that this is likely to persist. If it does, central banks should be able to meet it in some electronic form (see Skingsley 2016).

With the right technology, a CBDC could be a backup when other retail payment networks are down, in a similar manner that physical cash provides some resilience for operational failures and other contingency scenarios in the retail payments system.

Another reason that would support the issue of a CBDC, as has been seen in the Riksbank's views, is if there were segments of the population whose needs were not met by private sector services.

However, our current thinking is that it is not evident that there is a strong case for the RBA to issue an electronic version of the Australian dollar:[2]

- If people want to hold or use something that is a liability of the central bank, banknotes remain available. The RBA provides cash consistent with demand by users and supports its distribution. Additionally, the RBA has over recent years invested in a Next Generation Banknote series, with stronger anti-counterfeiting measures, as a commitment to ensuring that cash has public confidence and meets community needs.
- The NPP means that account-to-account payments are now feasible 24/7, and with immediacy of funds to the recipient, in contrast to other electronic payment methods where there is either a lag in funds being made available or a credit decision by the payee's bank to advance funds ahead of settlement.
- This system is still in a roll-out phase, but as more financial institutions join the NPP and as the existing ones expand their reach and functionality, it should get very close to ubiquity (Australia is a highly-banked population). As noted above, if this universality were not met, we would need to consider the potential policy issues arising.

[2] See Lowe (2017) for more discussion of this topic.

- Although commercial bank deposits are not a central bank liability, depositors in Australia are protected by the Financial Sector Claims Scheme (FSCS), up to a value of A$250,000 per holding at a financial institution. In effect, the account-to-account transfers enabled by the NPP provide for something that is almost universally accessible, electronic, and up to a certain value something that is arguably a contingent liability of the central bank. It is also immediately available to the recipient.

Given this, something that is functionally equivalent to a CBDC (or at least a very close substitute) is already available.

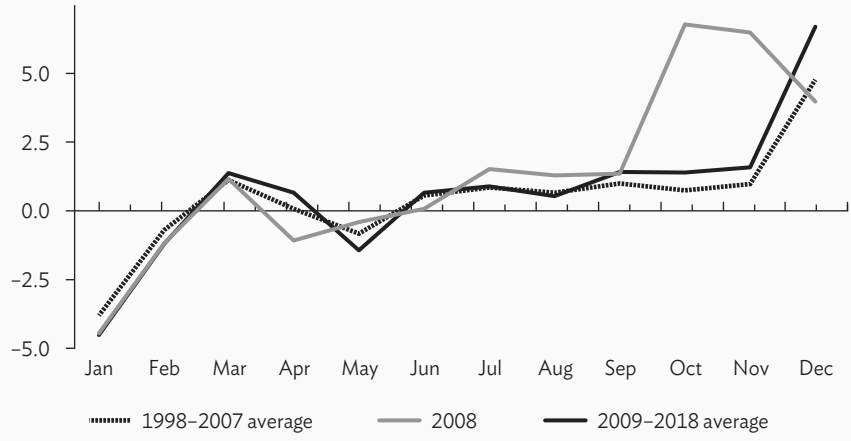
It might be possible to design a CBDC that also provides some of the anonymity features of banknotes, i.e., compared with account-to-account transfers, an alternate model might have less of an electronic fingerprint and be capable of transfer without identity or traceability. As the RBA's governor has noted, it is hard to see a strong public policy case here for issuing an electronic form of the currency that replicates the capacity of cash for anonymity (Lowe 2017).

7.3.1 | Financial Stability

If the RBA was to issue electronic banknotes, it is possible that in times of banking system stress, people might seek to exchange their deposits in commercial banks for these instruments. This might be because they apply some discount to or are uncertain about the FSCS protections described above, or because they hold commercial bank assets higher than the value of the guarantee (this could also reflect expectations that FSCS claims may take some time to be paid). Given their electronic nature, switching from commercial bank deposits to digital banknotes would involve less friction than moving from commercial bank accounts to physical cash. As the RBA's governor has noted, "it might be easier to run on the banking system. This could have adverse implications for financial stability" (Lowe 2017).

In fact, there is some evidence on the willingness of the public to switch from commercial bank to central bank instruments from the 2008 global financial crisis. As many recall, the turbulence that had been building in the financial sector over 2008 reached its peak with the bankruptcy of Lehman Brothers in September. As the crisis hit, one reaction from Australian households was to withdraw cash.

Figure 7.8: Value of Banknotes in Circulation
(higher denominations, monthly % growth)



Source: Reserve Bank of Australia.

Figure 7.8 shows the regular seasonal pattern of cash demand: there is a mini-spike around Easter, but the main time of year for cash demand is just prior to Christmas (which gets unwound in January). In 2008, we saw this Christmas-style spike in September up to November, basically up until the announcement of the government guarantee of deposits. While the values are not large compared to the size of the banking system, we think this is an instructive example of a flight to safety during a scenario of financial uncertainty.[3]

7.4 Concluding Comments

Fintech typically brings connotations of small, nimble, fast-growing start-up firms exploring the opportunities that technology presents for the financial sector. But in Australia one of the significant pieces of fintech in recent years has involved both big and small institutions as well as the RBA building some key new infrastructure, i.e., the NPP.

[3] For much more detail on this topic, see Cusbert and Rohling (2013).

In the absence of the NPP, there would likely be some major gaps in the functionality offered to end-users in the Australian payments system. Alongside the decline of cash, if these gaps persisted then there would be a much stronger case to consider a CBDC in the near term in Australia.

With the NPP, however, we think that we have a bit more time to wait and see. The ubiquitous, electronic, account-to-account transfer with real-time receipt of funds by the payee, backed with a capped government guarantee that the NPP offers, is not exactly a CBDC, but it is a very close substitute. It appears that it might be close enough that the gap that a CBDC would fill is currently quite small.

REFERENCES

Cusbert, T. and T. Rohling. 2013. Currency Demand during the Global Financial Crisis: Evidence from Australia. Reserve Bank of Australia Research Discussion Paper No. 2013–01.

Flannigan, G. and A. Staib. 2017. The Growing Demand for Cash. *Reserve Bank of Australia Bulletin*. September: 63–74.

Lowe, P. 2017. An eAUD? Address to the 2017 Australian Payment Summit, Sydney, 13 December.

———. 2018. A Journey towards a Near-Cashless Payment System. Address to the 2018 Australian Payment Summit, Sydney, 26 November.

Real-Time Payments Committee. 2013. Strategic Review of Innovation in the Payments System: Real-Time Payments Committee Proposed Way Forward. Australian Payments Clearing Association, February.

Reserve Bank of Australia (RBA). 2012. Strategic Review of Innovation in the Payments System: Conclusions. Sydney, June.

Rush, A. and R. Louw. 2018. The New Payments Platform and Fast Settlement Service. *Reserve Bank of Australia Bulletin.* September: 1–15.

Skingsley, C. 2016. Should the Riksbank Issue e-krona? Speech at FinTech Stockholm 2016, 16 November.

CHAPTER 8

Regulating Fintech for Sustainable Development in the People's Republic of China

Zhong Xu and Ruihui Xu

8.1 Introduction

The People's Republic of China's (PRC) financial technology (fintech) market is expanding at an astonishing rate. By the end of 2015, the PRC had become the biggest online financing market in the world, with total transactions exceeding $150 billion (Li 2015). In the PRC, the primary fintech areas include payments, online lending, digital wealth management, insurance, and digital banking. In payments, the PRC's big tech mobile payment services reached CNY14.5 trillion in 2017, the largest in the world, with a ratio of 16% to gross domestic product (Frost et al. 2019). According to the consulting agency iResearch, the market size of the PRC's third-party payments reached CNY312.4 trillion in 2018, of which mobile payments accounted for 61.9%, almost triple that of the United States.

Financial risks also arise alongside rapid fintech development, and provoke calls for regulatory guidance to mitigate fraud. The risks of fintech pertain to financial stability, consumer protection, competition in and efficiency of the financial sector, and illegal activities (PBC 2014). Fintech does not change the essence of financial risk, but instead makes financial risks more hidden, unexpected, contagious, and systemic. Ezubao, a peer-to-peer (P2P) lending platform, is a notorious example, whose failure exposed the default risks of the P2P lending industry. Ezubao, which was set up in July 2014, ceased operation in December 2015, and eventually shut down in February 2016, had posted fake advertisements about its projects, and operated as a Ponzi scheme, with an estimated CNY50 billion and 900,000 investors involved.

A comprehensive regulatory framework for fintech has been developed. Since 2014, the annual government report has stressed internet finance, improved coordination of financial regulators, and high vigilance against accumulated risks. Before 2015, the policy environment is generally supportive of fintech innovations.

Regulations have been markedly tightened after 10 major regulators jointly issued "Guiding Opinions on Promotion of Healthy Development of Internet Finance[1] (关于促进互联网金融健康发展的指导意见)" (Guiding Opinions 2015) on 18 July 2015. Guiding Opinions 2015 clarified the main financial regulators' responsibilities in supervising internet finance. The core principles of fintech regulation are defined as "legitimate supervision, appropriate supervision, category-based supervision, collaborative supervision, and innovative supervision (依法监管、适度监管、分类监管、协同监管、创新监管)". To further mitigate accumulated risks and facilitate healthy and sustainable development of internet finance, in October 2016, the State Council issued the Implementation Plan of Rectification Work of Internet Financial Risks (互联网金融风险专项整治工作实施方案). It specifies the targets, division of regulatory duty, and procession schedule of the rectification work. Currently, regulators are striking a balance between encouraging innovation and preventing financial risks.

8.2 Fintech Landscape in the PRC

8.2.1 | The Driving Factors of Rising Fintech in the PRC

The rise of fintech in the PRC is mainly driven by an underserved demand for financial services, technological advances, and a supportive regulatory environment. Firstly, financial demand of the real sector is the most fundamental driver of fintech in the PRC. While the PRC has deepened reforms in the last 4 decades, an underserved demand for financial services still exists due to financial repression in some fields. Small and medium-sized enterprises (SMEs) have limited access to bank loans due to severe information asymmetry, and residents' financing and investment needs are largely unmet due to backward development of the capital market. In addition, residents have higher requirements for the convenience of financial services. All these leave room for nonbank financial service providers. As indicated in a survey, the PRC SMEs' fintech adoption rate reaches 61%, much higher than the United States (23%), the United Kingdom (18%), South Africa (16%), and the global average (25%).

[1] Internet finance could be viewed as an early version of fintech in the PRC. Both fintech and internet finance are based on synergy between finance and technology.

Secondly, technological advances have significantly boosted financial supply. The digitization of financial information reduces information asymmetry, disintermediation lowers costs and improves efficiency of financial services, and networks have extended coverage of financial services. The PRC's fintech success is largely leveraged via existing social media platforms and the large e-commerce ecosystem, through which tech companies collect huge volumes of customers and transactions. Other technology applications also boost fintech development, including smartphones and e-commerce, and emerging technologies such as big data, artificial intelligence, and blockchain.

Thirdly, the PRC established a fintech innovation-friendly regulatory system and a sound policy environment. Many countries have tightened financial regulation since the global financial crisis in 2008, and fintech has risen to provide services to high-risk customers whose financing needs are not met by traditional banking. The PRC has provided a supportive environment, including investment in digital infrastructure and light regulation at the early stage of fintech development (Zhang and Chen 2019). The measures are effective for enhancing market efficiency and promoting financial inclusion. Vast quantities of capital have been attracted to the PRC's fintech market, creating economies of scale.

8.2.2 | Fintech Institutions in the PRC

While traditional institutions and many startups are rising, the PRC's fintech market is nonetheless dominated by internet giants such as Baidu, Ant Financial, Tencent (known as "BAT"), and JD Finance, which use their large customer bases and datasets to build an integrated ecosystem of financial services, including payments, financing, wealth management, insurance, etc. (Mahoney 2019). Table 8.1 lists the primary fintech areas of both traditional financial institutions and leading fintech companies in the PRC.

Traditional Financial Institutions Expand to Fintech

Traditional financial institutions embrace technology advancement to improve services, explore business model innovation, and strengthen risk management. They either partner with technology companies, or spin off their own fintech, or both.

Firstly, traditional financial institutions adapt to meet the increasing needs of customers. Traditional banks improve the accessibility and convenience of financial services via online banking, mobile banking, reconceiving bank branches, and collaborating with third parties. For example, the Bank of China spun off a separate

company named BOC Consumer Finance, while it also partnered with Tencent to launch a fintech laboratory. In addition, the Industrial and Commercial Bank of China partnered with JD Finance to digitize their services, while the Agricultural Bank of China collaborated with Baidu, and China Construction Bank with Ant Financial.

Secondly, traditional banks explore business model innovation. A typical example is direct banking, which has no branch network and does not issue bank cards, but offers products and services through online banking. It could be organized as an independent bank, a division, or a separate subsidiary of a bank (such as AIBank).

Table 8.1: Leading Fintech Companies and Primary Fintech Areas in the PRC

		Traditional Banks and Insurance Companies		Large Fintech Companies			
Business Lines	Market Description	Commercial Banks	Ping An	Baidu	Ant Financial	Tencent	JD.com
Payments	Highly concentrated between Ant Financial and Tencent	UnionPay Quick Pass	E-wallet	Baifubao (Sep 2008) / Baidu Wallet (Apr 2014)	Alipay (Dec 2004) / Alipay Wallet (Nov 2013)	Tenpay (Apr 2005) / Wechat Wallet, QQ Wallet (Jul 2014)	JD Pay (Jul 2014)
Wealth management (Money market fund)	Market developing	Robo-Advisor / Electronic	LU.com (Lufax, Sep 2011) / Finance One Account	Bai Fa (Dec 2013) / Baidu Finance (Oct 2013)	Yu'e Bao (Jun 2013) / Ant Fortune (Aug 2015)	Li Cai Tong (Jan 2014)	JD Finance (Oct 2013)
Credit/ Lending	Significant startup activity	Online bank / Mobile bank / Intellectualized reconstruction of bank branches	Orange Bank (Jul 2014)	Baidu Finance (Oct 2013)	Ant Credit (Jan 2015) / Zhao Cai Bao (Apr 2014)	Weilidai (May 2015)	JD Finance (Oct 2013)
Banking (Digital only)				Baixin Bank (Nov 2015)	Mybank (Sep 2014)	WeBank (Jul 2015)	NA
Insurance	Traditional institutions well-positioned		Ping An Insurance (1988) / Zhong An Insurance (Nov 2013)	Bai An (Dec 2015)	Zhong An Insurance (Nov 2013) / Yu'e Bao Universal Life (Feb 2014)	Zhong An Insurance (Nov 2013) / WeSure (Nov 2017)	JD Allianz Property Insurance Company (Oct 2018)
Social credit scoring	Highly concentrated		LU.com (Lufax, Sep 2011)	NA	Zhima Credit (or translated as Sesame Credit, Oct 2015)	Tencent Credit (Jan 2015)	JD Credit (Feb 2014)

NA = not available.

Sources: Galvin et al. (2018), PwC (2016), and authors.

Since the launch of the first direct bank by the Bank of Beijing in 2013, there have been more than 50 direct banks in the PRC, most of which adopt a divisional structure.

Thirdly, technology is widely applied to improve risk management. Big data technology is used to develop an early warning model of credit risk, as is the practice at the China Merchants Bank. To supplement existing customer verification techniques, banks such as WeBank adopt biometrics technology to use with mobile banking, bank counters, ATMs, and other online and offline situations. In addition, artificial intelligence technology is used to identify and prevent fraud. For example, the Industrial and Commercial Bank of China applies security certification measures to each transaction.

Insurance companies invest in technology, emphasize online distribution, and work with technology companies. For example, insurance giant Ping An has developed many digital platforms and expanded into primary fintech areas including banking, wealth management, and payments (Table 8.1).

Fintech Companies

Fintech companies have broadly engaged in business lines, such as payments, wealth management, lending, digital banking, insurance, and credit scoring (Table 8.1). Among all business lines, payments, which are highly concentrated among fintech companies, are the foundation upon which many other financial applications are built. The "BAT" companies control more than 80% of the PRC's mobile payments market, of which Ant Financial's Alipay takes about 50% market share, and Tencent's Tenpay takes nearly one fifth. Social credit scoring is also highly concentrated among fintech companies, while traditional institutions are well-positioned in internet insurance, especially life insurance. In addition, the PRC's fintech giants have been rapidly expanding globally and have invested in next-generation technologies. Top technology priorities by Alibaba and Tencent include cloud computing, blockchain, artificial intelligence, etc. Fintech startups fill gaps in underserved markets, mainly in credit/lending (P2P) and wealth management. Typical examples of credit/lending startups include Qudian.com, ppdai.com, Dianrong.com, and Yirendai. Wealth management (money market fund) startups including CreditEase, Golden Axe, Wacai, and Suishouji. In addition, startups such as YeePay and Ping++ provide payment services, and eBaoTech and Cheche Tech specialize in online insurance.

Market Service Providers

E-aggregation platforms integrate the same type of services provided by different agents for a single entry point that improves customer experiences and reduces costs. For example, by turning financial institutions' product information into standardized information, Rong360 builds a vertical search mode to help users to obtain appropriate financial services, and connects individual consumers, privately-owned small business, small and micro enterprises with banks, small loan companies, and other financial institutions.

Banks' and payment institutions' digital identity authentication is mainly supported by market service providers, which currently use big data, digital certificates, and biometrics and other technology for this. iFLYTEK and Fosafer are forerunners in biometrics identification, covering facial, voiceprint, and fingerprint identification.

Distributed account technology applications are also explored in the PRC, especially in fields such as payment and clearing, securities registration, and settlement. Some technology companies such as LinkTime, Bubi, and Bumeng have also started to provide enterprises with the underlying technology support and industry solutions of blockchain.

8.3 Fintech Regulation Framework in the PRC

The regulation framework of internet finance (an earlier version of fintech in the PRC) was set up in July 2015, when the People's Bank of China (PBC) and nine other ministries[2] jointly issued the "Guiding Opinions on Promotion of Healthy Development of Internet Finance" (Guiding Opinions 2015). It clarified the responsibilities of the main financial regulators in supervising internet finance, encouraged financial innovation, promoted the healthy development of internet finance, and clarified the regulatory responsibilities. Table 8.2 displays the PRC's fintech regulation framework, which is embedded in the existing financial regulatory framework.

[2] The regulators include the PBC, Ministry of Industry and Information Technology (MIIT), Ministry of Public Security (MPS), the Ministry of Finance, State Administration for Market Regulation (SAIC), the Legislative Affairs Office of the State Council, China Banking Regulatory Commission (CBRC), China Securities Regulatory Commission (CSRC), China Insurance Regulatory Commission(CIRC), and Cyberspace Administration of China.

Table 8.2: PRC Fintech Regulators

Regulator	Responsibility	Reference
PBC (established in 1948)	Internet payments	Guiding Opinions 2015
CSRC (established in 1992)	Crowdfunding	
	Internet funds	
CBIRC (merged from CBRC and CIRC in 2018)	Internet lending (include P2P)	
	Internet trust	
	Internet consumer finance	
	Internet insurance	
Local finance bureau (initiated by Shanghai in 2002)	Locally registered microfinance companies, crowdfunding entities, etc.	National Financial Work Conference 2017
Committee	**Responsibility**	**Note**
Financial Stability and Development Committee	Oversees financial stability and related reform and development, including coordinating financial regulation	Established in November 2017 by the State Council
Fintech Committee	Strengthen fintech research and coordinate fintech regulation	Founded in May 2017 by the PBC
Self-regulation Associations	**Note**	
National Internet Finance Association	Initiated by the PBC with the relevant authorities (including the CBRC, CSRC, and CIRC) in December 2015	
Fintech Association (at city level)	Vary across cities	

CBIRC = China Bank Insurance Regulatory Commission, CBRC = China Bank Regulatory Commission, CIRC = China Insurance Regulatory Commission, CSRC = China Securities Regulatory Commission, P2P = peer-to-peer, PBC = People's Bank of China, PRC = People's Republic of China.

Note: The CBIRC was founded in March 2018, when the PRC's central government implemented an institutional reform. The CBIRC is based on the former China Banking Regulatory Commission (established in 2003) and the China Securities Regulatory Commission (established in 1998).

Sources: Guiding Opinions 2015 and authors.

According to the regulatory framework set in Guiding Opinions 2015, the PBC leads fintech supervision generally and is primarily responsible for regulating internet payments, including third-party payment. The China Securities Regulatory Commission (CSRC) is responsible for regulating crowdfunding and internet fund sales. The China Banking Regulatory Commission (CBRC), with its local offices and supervisory agencies, is mainly responsible for internet lending (including P2P and micro lending), internet trust, and internet consumer finance. The China Insurance Regulatory Commission oversees internet insurance regulation. In addition, the National Internet Finance Association (NIFA), which commenced operation in March 2016, is responsible for promoting industry self-regulation. During an institutional reform implemented in March 2018, CBRC and the China Insurance Regulatory Commission merged to become the China Bank Insurance Regulatory Commission (CBIRC), and their regulation responsibility are also combined.

The National Financial Work Conference[3] in 2017 further clarified the regulatory boundary of local financial bureaus, which differ from the local offices of the PBC or CBIRC or CSRC. Local financial bureaus are responsible for approval and risk management of "7+4" financial institutions types.[4] Since internet-based sales channels enable fintech platforms to operate widely, their risks become externalized, rather than restrained by local markets. It is critical to improve coordination among the PBC, CBIRC, CSRC, and local financial bureaus.

Coordination mechanisms among financial regulators are markedly strengthened by setting up a committee under the State Council of the PRC. The Financial Stability and Development Committee was announced in July 2017 at the National Financial Work Conference, and had its first formal meeting in November 2017. The committee is headed by a vice premier, and aims to coordinate authorities' overall financial reform strategies, including maintaining financial stability.

[3] It is held twice a decade by the central government, deciding pivotal issues of economic development.

[4] The "7" types of financial institutions refer to microfinance companies, financing guarantors, regional equity markets, pawn shops, financial leasing companies, commercial factoring companies, and local asset management companies; the "4" types of institutions refer to investment companies, specialized farmers' cooperative societies, social crowdfunding institutions, and local exchanges.

Among authorities, the PBC is a forerunner in regulating fintech and setting development plans. To augment regulations and policies surrounding fintech, and facilitate further international cooperation, the PBC announced a new committee on 15 May 2017 that seeks to investigate impacts of fintech development on monetary policy, financial markets, financial stability, payments, and clearing mechanisms. A meeting on 8 March 2019 described the principles of fintech supervision as "integrity, security, inclusion, and openness", and set a development plan.

8.4 The PRC's Fintech Regulatory Measures

8.4.1 | Regulatory Measures on Online Lending

P2P Lending

P2P lending in the PRC started in 2006 when the first platform CreditEase was founded, and its development has accelerated since 2011. Due to different levels of regional economic development and policy support, P2P lending platforms tend to be highly concentrated in a few provinces, such as Beijing, Guangdong, Shanghai, and Zhejiang. The total monthly P2P transaction volume reached a peak of CNY253.7 billion in June 2017, but subsequently fell to about CNY78.0 billion in August 2019, according to industry monitor wdzj.com. While P2P lending platforms had grown rapidly before 2017, the overheated market generated financial risks, including pooled investments and fraudulent practices by some platforms, as well as investors' perception of the implicit guarantee of their fund.

The PRC government has been studying regulations of P2P lending since 2013. The Guiding Opinions 2015 and subsequent documents emphasize that online credit platforms are essentially an information intermediary rather than credit intermediaries, and define the business boundaries. P2P licenses are required to be registered with local financial authority. Online lending platforms are required to deposit client funds in a custodian bank, and P2P platforms must offer no guarantees to customers. Business boundaries are also set for the platforms, and prohibited behaviors include fundraising for self-use, principal or interest guaranteed, splitting the duration of the financing projects, asset securitization of debt, etc. With the Guiding Opinions 2015, the PRC has implemented detailed measures on P2P lending, with the main ones listed in Table 8.3.

Table 8.3: P2P Regulations

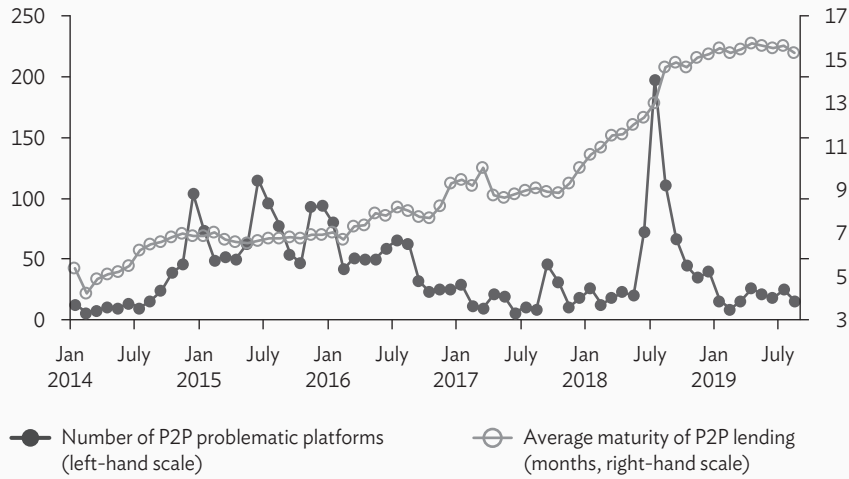
Date	Regulators	Regulation Name	Regulation Name in Chinese
Aug 2016	CBRC, MIIT, MPS, CAC	Interim Measures on Management of the Business Activities of Online Lending Information Intermediary	网络借贷信息中介机构业务活动管理暂行办法
Nov 2016	CBRC, MIIT, SAIC	Guidance on the Documentation and Registration Management of Online Lending Information Intermediary	网络借贷信息中介备案登记管理指引
Feb 2017	CBRC	Guidance on the Custody Business of Online Lending Fund	网络借贷资金存管业务指引
Aug 2017	CBRC	Guidance on the Information Disclosure of the Business Activities of Online Lending Information Intermediary	网络借贷信息中介机构业务活动信息披露指引
Aug 2018	P2P rectification office	Notice on Compliance Inspection of P2P Online Lending Intermediary	关于开展 P2P 网络借贷机构合规检查工作的通知
Dec 2018	Internet rectification office, P2P rectification office	Opinions on Classified Disposal and Risk Prevention of Online Lending Intermediary	关于做好网贷机构分类处置和风险防范工作的意见 (175号文)
Jan 2019		Notice on Further Implementing the Compliance Inspection and Follow-Up Work of P2P Online Lending	关于进一步做实 P2P 网络借贷合规检查及后续工作的通知 (1号文)

CAC = Cyberspace Administration of China, CBRC = China Banking Regulatory Commission, MIIT = Ministry of Industry and Information Technology, MPS = Ministry of Public Security, P2P = peer-to-peer, SAIC = State Administration for Market Regulation.

Sources: Authors and the relevant official websites.

The P2P regulations were mainly set by the former CBRC, with a "1+3" regulation system, which refers to one regulatory document on business activities and three guidance documents, respectively: the Interim Measures on Management of the Business Activities of Online Lending Information Intermediary (issued in August 2016), Guidance on the Documentation and Registration Management of Online Lending Information Intermediary (November 2016), Guidance on the Custody Business of Online Lending Fund (February 2017), and Guidance on the Information Disclosure of the Business Activities of Online Lending Information Intermediary (August 2017). Besides, the local financial bureau is responsible for institutional supervision of online lending information intermediaries in its jurisdiction.

Figure 8.1: P2P Risk in the PRC (January 2014–August 2019)



P2P = peer-to-peer, PRC = People's Republic of China.

Source: wdzj.com.

However, some issues of the P2P lending industry have not been rectified, and caused financial risk across the industry in the summer of 2018. One such issue is the implicit guarantee. P2P platforms circumvent the rule of no guarantee by relying on third-party guarantees for investor funds. During June to September 2018, the number of closed and problematic platforms exceeded 100 per month, reaching 289 in July, with the number of problematic platforms reaching a historical peak of 194 (Figure 8.1).

Subsequent regulatory policies and compliance inspections, mainly by the State Council-established leading group office for special rectification of P2P online lending risks (P2P rectification office, P2P 网贷风险专项整治工作领导小组) and the leading group office for special rectification of internet financial risks (Internet rectification office, 互联网金融风险专项整治工作领导小组办公室) resolved P2P risks significantly.

Online Microlending

Online microlending companies in the PRC are an "internet plus" result of traditional microlending companies, and should comply with the existing regulations for small loan companies. Microlending was encouraged by the PRC

to alleviate the financing difficulties of farmers and small and micro enterprises. Online microlending companies need an additional license. A representative online microlending platform is Ant Credit. By the end of April 2019, 264 companies had obtained online microlending licenses (data from wangdai.com), accounting for less than 4% of the total number of microlending companies (quarterly data from the PBC).

The CBRC and local finance bureaus are the main regulatory authorities of online microlending companies. In May 2008, the PBC and CBRC issued "Guidance on the Pilot Program for Microfinance Companies (关于小额贷款公司试点的指导意见)", which empowered local finance bureaus (or related local authorities) to grant permission for setting microlending companies. A microlending company is not allowed to absorb public deposits, but instead should be funded by shareholders, donated funds, and no more than two banks. Moreover, the balance of funds from banks shall not exceed 50% of the net capital. The Guiding Opinion 2015 assigned microlending regulatory responsibility to CBRC. The National Financial Work Conference 2017 decided that the permission of setting and risk resolution of micro lending companies is a responsibility of the local finance bureaus.

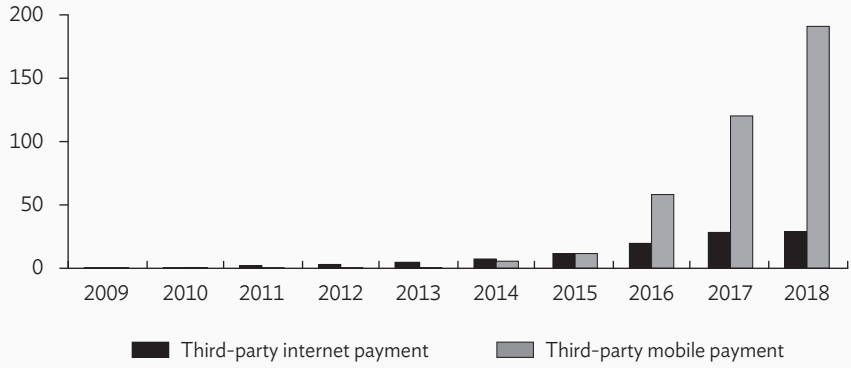
Risks accumulated as the online microlending market grew quickly from 2015 to 2017. Financial risks and social risks were hidden behind issues such as excessive borrowing, repeated credit granting, improper collection, abnormally high interest rates, and invasion of personal privacy. This is especially relevant to payday loans. In addition, online microlending companies are increasingly securitizing their online loans, which may generate contagious financial risks. For example, Ant Credit issues consumer finance asset-backed securities to circumvent regulatory restrictions on the maximum leverage ratio.

To resolve the risks, regulations were significantly tightened in 2017. In April 2017, the CBRC successively issued two documents, namely "Notice on The Clean-Up and Rectification of Payday Loan Business (关于开展"现金贷"业务活动清理整顿工作的通知)" and "Supplementary Notes on the Clean-Up and Rectification of Payday Loan Business (关于开展"现金贷"业务活动清理整顿工作的补充说明)". In November 2017, the Internet rectification office issued the "Notice on Immediate Suspension of Approval for Establishment of Online Microlending Companies (关于立即暂停批设网络小贷公司的通知)", and urged provincial governments to suspend regulatory approval for the setting up of new online microlending companies, and to restrict lending across regions.

8.4.2 | Regulatory Measures on Third-party Payments

The fast growth of third-party payments in the PRC is largely driven by e-commerce and users' habits of conducting daily payments via mobile devices. By the end of 2017, the scale of third-party payments had increased from CNY540 billion in 2009 to CNY154.9 trillion in 2017. As consumers' internet habits shifted, the scale of third-party mobile payments jumped from CNY38.98 million in 2009 to CNY190.5 trillion in 2018, much higher than third-party internet payments (Figure 8.2). Third-party payments are highly concentrated between Ant Financial and Tencent.

Figure 8.2: Scale of Third-party Internet Payments and Third-party Mobile Payments in the PRC (CNY trillion)



Source: Wind Economic Database. https://www.wind.com.cn/en/Defult.htm (accessed 10 September 2019).

The third-party payment market is well regulated, including issuing licenses and setting restrictions on customer provisions, information disclosure, etc. Key regulations on online payment are listed in Table 8.4. The industry has experienced rapid growth since 2010, without major problems or risks. The PRC introduced licensing regulations for third-party payments in 2010, and the PBC issued about 270 licenses in May, August, and December of 2011, June 2012, July 2014, and March 2015. The PBC undertakes on-site inspection and off-site supervision, and has the authority to suspend or revoke a license.

Table 8.4: Regulations on Online Payments

Date	Regulator	Regulation Name	Regulation Name in Chinese
Sep 2010	PBC	Measures on Management of Payment Services of Nonfinancial Institutions	非金融机构支付服务管理办法
Jun 2013	PBC	Measures on Management of Customer Provisions on Payment Platforms	支付机构客户备付金存管办法
Dec 2015	PBC	Measures on Management of Network Payment Business of Nonbank Payment Institutions	非银行支付机构网络支付业务管理办法
Apr 2016	PBC	Measures on Management of Classification and Rating of Nonbank Payment Institutions	非银行支付机构分类评级管理办法
Aug 2017	PBC	Notice on Nonbank Payment Organization Network Payment Operations Shifting from the Direct Model to China NetsUnion Platform Handling	关于将非银行支付机构网络支付业务由直连模式迁移至网联平台处理的通知
Jul 2018	PBC	Notice of Requirements for Nonbank Payment Institutions to Report Large Transactions	关于非银行支付机构开展大额交易报告工作有关要求的通知

PBC = People's Bank of China.

Sources: Authors and the relevant official websites.

In June 2013, the PBC implemented the Measures on Management of Customer Provisions on Payment Platforms, which requires the proportion of paid-in capital and daily balance of customer provisions to be no less than 10%. In 2015 and 2016, the PBC further clarified issues about management of network payment business of non-bank payment institutions, including their classification and rating. Moreover, third-party payment firms must disclose their fee items and standards to the public, and submit certain documents to the PBC, covering documents of business model, service, provisions deposit, internal control measures, and regular financial and statistical reports.

An issue in the third-party model before 2017 was that regulators were not able to keep track of all capital flows, and risked partially losing oversight of the rapidly expanding payment market. In addition, big tech companies' massive payment data was potentially monopolistic, resulting in an information gap and investor protection issues.

To enhance transparency and obtain information, the PBC established a centralized clearing platform in 2017, and issued the "Notice on Nonbank Payment Organization Network Payment Operations Shifting from the Direct Model to China NetsUnion Platform Handling" that August. The notice mandated that any payment operations undertaken by third-party providers involving bank accounts must be processed by the NetsUnion Clearing Corporation's (NUCC) network after 30 June 2018, and that providers must connect to the platform by 15 October 2017. NUCC was officially launched in 2018 as the designated platform for online settlement of non-bank payments. NUCC is subject to the supervision and regulation of the PBC.

NUCC improves market efficiency by lowering the barrier of the online payment market. It standardizes mobile transactions, and enables banks to get access to online payment businesses without signing bilateral agreements with different third-party payment companies. Some foreign banks have joined the NUCC network to meet the e-commerce payment needs of their clients. For example, Deutsche Bank joined with NUCC in March 2019, to expand its service offering in the PRC.

8.4.3 | Regulatory Measures on Crowdfunding

In the PRC, equity crowdfunding emerged as an investment vehicle in 2012, but its development has been relatively slow due to institutional barriers. According to Article 10 Clause 2 of the PRC Securities Law, it is illegal to offer shares to non-specific individuals or to more than 200 specific individuals in public without regulatory approval. The 2014 government work report proposed to carry out pilot projects of equity crowdfunding, aiming to alleviate the financing difficulty and lower real economy costs. Alibaba, JD.com, and Ping An obtained the pilot qualification.

Equity crowdfunding is mainly supervised by CSRC. The private equity crowdfunding is self-regulated by the Securities Association of China, as implied by its document issued in December 2014, namely "Measures for The Management of Private Equity Crowdfunding (Trial) (Draft for Comments) (私募股权众筹融资管理办法(试行)(征求意见稿)". The Guiding Opinion 2015 assigned the CSRC as the regulator of

equity crowdfunding; regulations were tightened in 2015 and 2016. In August 2015, the CSRC issued the "Notice on Special Inspection of Institutions that Conduct Equity Financing Activities through the Internet (关于对通过互联网开展股权融资活动的机构进行专项检查的通知)", and excludes non-public equity financing and private equity fund raising through the internet from the scope of equity crowdfunding stipulated in the notice. In October 2016, CSRC and 15 other authorities issued the "Implementation Plan for The Special Rectification of Equity Crowdfunding Risks (股权众筹风险专项整治工作实施方案)", which identified the rectification priorities and prohibited items of equity crowdfunding.

The PRC has made continuous efforts in guiding the healthy development of equity crowdfunding. In July 2017, the State Council promulgated "Opinions on Strengthening Innovation-driven Development Strategies and Further Advancing Mass Entrepreneurship and Innovation (强化实施创新驱动发展战略进一步推进大众创业万众创新深入发展的意见)", to encourage the standardized development of crowdfunding platforms.

8.4.4 | Regulatory Measures on Internet Fund Sales

The scale of the PRC's internet funds has been constantly expanding since 2013. Yu'e Bao, a money market fund investment product that was launched jointly by Alipay and Tianhong fund, became the largest money market fund in the world in 2017 in terms of total assets (Frost 2019). Data from the Wind Economic database show that the asset volume of Yu'e Bao peaked at CNY1.69 trillion in March 2018, and dropped to CNY1.03 trillion in June 2019 as other online money market funds grew significantly. Currently, internet fund sales institutions in the PRC consist of commercial banks, securities companies, securities investment advisory bodies, and independent sales' institutions.

The fast growth of internet fund sales is driven by easy access, convenient payment services, and higher yield of internet money market funds (FSB 2019). An internet fund sales platform collects idle funds and invests in a related money market fund, which, in turn, invests in bank-negotiated deposits, earning a higher rate of return than deposits alone. Besides, it generally set the minimum investment as low as CNY0.01, provides "T+0" liquidity with its own capital cushion, and allows free transfers between bank accounts. By integrating fund sale platforms with payment systems, customers can get access to fund account openings, subscriptions, and redemption via mobile phones. However, internet money market funds engage in maturity transformation, credit, and liquidity transformation without a banking

license, and have prompted disintermediation of bank deposits and increased social financing costs (Yao 2018). This is partially due to inadequate functional or integrated regulatory policy about internet fund sales.

The regulatory framework of internet fund sales is based on that of traditional fund sales. The CSRC is the main regulator, and the Securities Association of China implements self-discipline management. According to a revised version of the PRC Securities Investment Fund Law, the CSRC revised and issued the "Administrative Measures for the Sale of Securities Investment Funds and the Rules (证券投资基金销售管理办法)" in March 2013, aiming to relax control and strengthen supervision. Other related regulatory measures include "Regulations on Information Management Platform of Securities Investment Fund Sales (证券投资基金销售业务信息管理平台管理规定)" (issued in March 2007) and "Interim Provisions on the Management of Securities Investment Fund Sales Settlement Funds (证券投资基金销售结算资金管理暂行规定)" (issued in September 2011).

Regulations have also been introduced to promote standardized and orderly operation of internet fund sales. In November 2009, the Securities Association of China released "Technical Guidance on Online Fund Sales Information System (网上基金销售信息系统技术指引)" for better standardization of the sales business. In March 2013, the CSRC also released the "Interim Administrative Rules for Securities Investment Fund Sales Institutions' Business Operations via Third-Party E-commerce Platforms (证券投资基金销售机构通过第三方电子商务平台开展业务管理暂行规定)", which specified the regulatory requirements on fund sales institutions and set out provisions regarding the qualification and business scope of third-party e-commerce platforms. As the market keeps developing, regulatory authorities constantly improve regulatory measures to ensure the sustainable development of the market and protect investors' interests. For example, in March 2018, the CSRC issued "Guidelines on Further Standardizing Internet Sales and Redemption Services of Money Market Funds (关于进一步规范货币市场基金互联网销售、赎回相关服务的指导意见)".

8.4.5 | Regulatory Measures on Internet Insurance

The PRC is the second-largest insurance market in the world, while the insurance density is below world average. Data from the Insurance Association of China show that insurance premium incomes amounted to CNY3.8 trillion by the end of 2018. Internet insurance experienced explosive growth from 2012 to 2015, with the premium income increasing from CNY11.1 billion to CNY223.4 billion, and the

penetration rate of internet insurance reached 9.2% in 2015. However, with the tightened policy environment, growth began to slow after 2016, with premium incomes declining to CNY188.9 billion, and the penetration rate drop to 5% in 2018.

CIRC supervision principles are established in "Interim Measures for the Supervising Internet Insurance (互联网保险监管暂行办法)", released in 2015. In addition to promoting healthy development and consumer protection, internet insurance regulations place great emphasis on maintaining consistent regulatory standards for both online and traditional insurance, and strengthening market exit management. Only registered companies and professional intermediaries are permitted to carry out internet insurance business. If these supervised companies do internet insurance business through a third-party online platform, it must obtain related qualifications and meet certain requirements. The companies can determine suitable insurance products to sell online, but must not make any misleading advertisements. Internet insurance companies are also required to ensure platform safety and information security. Updates to these interim measures remain pending.

8.4.6 | Regulatory Measures on Other Fintech Areas

Largely due to regulatory restrictions, the internet trusts market is less developed compared with traditional trusts and other internet finance types. In 2007, the CBRC issued the "Rules Governing Trust Companies (信托公司管理办法)" and "Rules on Trust Schemes of Collective Funds by Trust Companies (信托公司集合资金信托计划管理办法)", which forbade trust companies from allowing non-financial institutions to recommend their schemes. In April 2014, the CBRC issued the "Guidance on Supervision of Risks of Trust Companies (关于信托公司风险监管的指导意见)", which reiterated that third-party financial institutions are not allowed to sell trust products directly or indirectly. Against this backdrop, many trust companies set up their own direct marketing platforms, including CITIC Trust, Ping An Trust, and Zhongrong International Trust. The Guiding Opinion 2015 emphasized the requirements of qualified investors, matching customer risk tolerance with the risk level of trust products.

Internet consumer finance in the PRC is provided by commercial banks, consumer finance companies and e-commerce platforms. Representative institutions include China Merchants Bank, Mashang Consumer Finance, and Ant Financial. The supervision of consumer finance started in 2009 when the CBRC promulgated the "Administrative Measures on Pilot Consumer Finance Companies (消费金融公司试点管理办法)", which specified requirements on consumer finance companies

such as establishment, business scope, and operating norms. These measures were updated in 2013, with some requirements being loosened, including business scope and sources of funds, and they also expanded the pilot cities. In 2015, the consumer finance pilots were fully liberalized and applied to the whole country. In August 2016, "Interim Measures on Management of the Business Activities of Online Lending Information Intermediary (网络借贷信息中介机构业务活动管理暂行办法)" issued by the CBRC set the basic regulatory rules of internet consumer finance. The market is regulated by both the CBRC and local government financial authorities. The regulations of internet consumer finance have been further tightened after the rectification of internet lending risks.

8.4.7 | Features of the PRC's Fintech Supervision

The PRC's fintech supervision is based on a clear division of responsibility among major financial regulators, related government ministries, and local financial authorities, and emphasizes coordination. For example, the MIIT supervises internet financial portals, and the MPS monitors service security and investigates suspected violations and other financial crimes related to fintech lending. In addition, local financial authorities conduct prudential supervision over locally registered platforms, although fintech businesses are not subject to geographical restrictions. By clarifying the supervision responsibility of local financial offices and unifying regulatory practice across regions, arbitrage space could be eliminated.

The financial pilot mechanism is combined with the negative list approach to foster fintech and prevent financial risk. Regional financial pilot reform in the PRC indicates the government's inclusive attitude toward emerging issues. Although different from the fintech sandbox, applying financial pilot mechanisms to fintech helps in judging its influences, and it aggregates valuable experience for reform at the national level. In the spirit of bottom-line supervision, the fintech's negative list is introduced because of regulatory lag, and it aims to prohibit activities that jeopardize sustainability. Taking the supervision of P2P lending as an example, fintech is defined as an information intermediary instead of a credit intermediary. The "Interim Measures on Management of the Business Activities of Online Lending Information Intermediary", issued in 2015, set a negative list for online lending platforms, and the following activities are prohibited: directly engaging in a lending transaction, facilitating and/or promoting lending transactions, and engaging in high-risk financial business. The detailed rules released in 2016 enumerate 13 banned activities.

The government emphasizes collaboration and self-regulation in the fintech industry. NIFA[5] issues reminders and guidance about market risks in accordance with regulations, and sets up platforms for registration, information disclosure, and risk monitoring. The PBC also promotes deep integration of industry resources; for example, NIFA and eight market entities (including Zhima Credit and Tencent Credit) jointly initiated and established Baihang Credit in March 2018 as a PBC-approved, market-oriented personal credit institution that integrates personal and enterprise credit data from different institutions, and aims to improve financial inclusion and facilitate credit scoring of SMEs in the PRC.

8.5 Ensuring Healthy and Sustainable Development of Fintech in the PRC

Fintech plays an important role in the PRC, but its development has been unbalanced and inadequate, and has posed challenges to monetary policy and financial supervision. The PRC has made and will make constant efforts in improving regulation efficiency, encouraging innovation, enhancing infrastructure, setting fintech standards, and fostering the use of fintech in supervision.

8.5.1 | Set Fintech Development Plans

The PRC State Council has announced guidances and plans on promoting technology development since 2015, for example, opinions on promoting cloud computing development (国务院关于促进云计算创新发展培育信息产业新业态的意见) in January 2015, an action plan to advance big data development (促进大数据发展行动纲要) in August 2015, and a development plan for artificial intelligence (新一代人工智能发展规划) in July 2017. These plans help to consolidate fintech in the PRC.

[5] NIFA currently has more than 500 member organizations, covering internet finance institutions in payments, investment, money management, and lending, as well as in banking, securities, insurance, funds, futures, trusts, asset management, consumer finance, and credit reporting.

National fintech development plans will boost synergy between regulatory bodies, and improve the alignment of interpretation across national and local regulators. The Fintech Committee aims to clearly define development goals, primary directions, and main tasks. The PBC partnered with the National Development and Reform Commission at the end of 2018 to launch a trial fintech program in 10 cities and provinces including Beijing, Shanghai, and Guangdong.

On 22 August 2019, the PBC published its Fintech Development Plan (2019–2021). The plan stresses the role of fintech as a "new engine" for high-quality development, highlights key tasks, and strengthens the need to build a fundamental and unified regulatory system, as well as applications for risks identification, prevention, and mitigation. In addition, the Fintech Committee aims to collaborate with industry and university researchers to sort out development status, application prospects, influences and challenges, and policy implications.

8.5.2 | Establish a System of Fintech Supervision Rules

The prudent regulation of fintech must be strengthened systematically. The PBC plans to review current regulatory policies, evaluate fintech situations and trends, and form a complete and rigorous supervision system consisting of three mutually supportive parts, including supervision rules about basic general application, technology application, and security risks control. The PBC, as a leading regulatory authority for fintech, will continue monitoring developments of fintech and the financial stability implications.

8.5.3 | Financial Standardization

Promoting fintech standardization is critical to form industrial synergy, enhance competitiveness, and optimize resource allocation. Standardization unifies various enterprises in coding rules, data format, report structure, and other aspects, which can effectively improve the efficiency of financial markets and curtail transaction costs. The China Financial Standardization Technical Committee was founded in 1991. The PRC became a member of the International Organization for Standardization (ISO/TC68) in 2004, and the PBC began releasing the China Financial Standardization Report in 2009. As of November 2018, there were 67 effective recommended national financial standards, and 242 financial industry standards, which were divided into six categories: general, product and service, infrastructure (information technology), statistical, regulatory and risk prevention, and control.

Fintech constantly raises new requirements for standardization. Challenges include integrating fintech standards into those of the financial services industry. In 2017, the PBC and the China Financial Standardization Technical Committee and other regulators jointly issued the Financial Industry Standardization System Development Plan (2016–2020). The PBC also moved toward the standardization of new fintech, such as the new standards about cloud computing and QR code payment.

8.5.4 | Fintech Infrastructure

Well-built fintech infrastructure is important to maintain financial stability, enhance efficiency, and promote competitive neutrality. The PRC has made progress in building networks, payments, information, credit scoring, and other forms of infrastructure. For example, NUCC and its Nonbank Payment Organization Internet Payments and Clearing Platform have become critical components of the PRC's financial infrastructure. All online payment services will route their transactions via the new platform, and NUCC will submit a clearing order to the PBC. Despite the complexity, the process does not impact the customer side.

Great emphasis has been put on information infrastructure. Many government authorities and institutions collect information about fintech products, firms and activities for their own use, which are not unified. For example, NIFA collects information covering the following:

(1) The Internet Finance Registration and Disclosure Services Platform that launched in March 2017 connects over 100 P2P platforms and facilitates disclosure of their institutional, operational, and financial information.

(2) The Internet Finance Credit Information Sharing Platform integrates information to address problems such as "a single borrower borrowing from multiple platforms" and fraudulent borrowing.

(3) The Internet Finance Statistics Monitoring and Risk Alert System collects a wide range of data and sets 23 rules to identify abnormal platforms and thresholds to caution against risks.

(4) The Internet Finance Complaint Information Platform for financial regulators cracks down on activities in violation of laws and regulations.

The information infrastructure building is still in progress under the guidance of "Opinions on Promoting the Comprehensive Statistical Work of the Financial Industry in an All Round Way (关于全面推进金融业综合统计工作的意见)" that was issued by the State Council in April 2018.

8.5.5 | Investor Protection and Education

Investor protection is the goal of financial supervision, and it is a critical part of the financial regulations. Specific guidance for investor protection was issued by the State Council in November 2015, namely the "Guidance on Strengthening the Protection of Financial Consumers (关于加强金融消费者权益保护工作的指导意见)".

The PRC's regulators have engaged in multiple investor protection and education endeavors. First, a third-party depository and custodian scheme was introduced to ensure the security of consumers' assets. Funds lent via a platform must be used legally and only for the purpose listed on the contract. Qualified banks act as third-party depository financial institutions, and are responsible for holding, managing, and transferring investors' funds in fintech institutions.

Second, information disclosure was reinforced. Fintech institutions are required to disclose operational and financial information in a timely manner, and are obliged to perform due diligence and assess information provided by lenders. Platform lenders are required to clearly inform investors of associated risks and prohibited activities.

Third, regulators strengthen management of investor suitability. Fintech institutions must assess investors' risk tolerance, and ensure consumers invest in proper products that suit their levels of risk tolerance. Advertisements for fintech and wealth management products should not mislead investors.

Fourth, financial consumer education is enhanced. Various forms of training help financial consumers learn about fintech, and improve financial literacy and risk management ability.

8.5.6 | Strengthening the Application of RegTech

The government is exploring the application framework of RegTech, detecting financial risks more intelligently. Detailed tasks include: establish a database of digital regulatory rules in some selected regions and fields, develop a regulatory application program interface with extensibility, promote automatic data collection and intelligent risk analysis, and accelerate the construction of a financial risk monitoring platform for mobile financial business. The government hopes to improve the security and integrity of financial transactions, and supervise cross-sector and cross-market financial activities.

8.6 Digital Currency in the PRC

8.6.1 | Regulatory Measures on Cryptocurrency

According to 2018 PBC statistics, there were 65 initial coin offerings (ICOs) completed in the PRC up to 18 July 2017, of which only five were launched prior to 2017. The cumulative funding of CNY2.6 billion accounted for 20% of ICO financing globally. Speculation in the cryptocurrency market can lead to an asset bubble and large volatility; cryptocurrency can also be used for illegal purposes without leaving a trace.

Early-stage Risk Prevention

For investor protection and financial risk prevention, the PBC and five other ministries issued the "Notice on Preventing Risks of Bitcoins (关于防范比特币风险的通知)" in December 2013, which clearly forbids financial and payment institutions from running Bitcoin-related businesses. The notice defines Bitcoin as a virtual commodity and warns citizens about their risks, but does not ban online trading of cryptocurrencies.

The PBC led on-site inspections of Bitcoin and litecoin trading platforms in January 2017, focusing on problems such as operation beyond business scope, suspected market manipulation, money laundering, and fund security risks. The PBC also urges self-inspection and rectification of trading platforms in accordance with laws and regulations. On 30 August 2017, NIFA issued "Reminder about Preventing Risks from Investment in the Name of the ICO (关于防范各类以 ICO 名义吸收投资相关风险的提示)".

ICO Ban and Cryptotrading Platform Regulation

The PRC has officially banned ICOs, restricted the primary business of cryptocurrency trading platforms, and cut their connection with traditional institutions. ICOs were outlawed in the "Notice on Preventing the Risks of Issuing and Financing Tokens (关于防范代币发行融资风险的公告)", issued jointly by seven regulators[6] on 4 September 2017. ICO financing is referred to as a kind of non-approved illegal fundraising behavior under domestic law, suspected of financial fraud, pyramid schemes, and other illegal activities.

[6] Authorities backing the statement include the PBC, CAC, MIIT, SAIC, CBRC, CSRC, and CIRC.

Since the date of the announcement, all types of currency issuance financing activities have ceased. For completed ICOs, the notice allows investors to request a refund from the issuer.

The notice made it clear that so-called virtual currencies are essentially illegal actions of public financing without approval. There are multiple risks in the issuance, financing and trading of tokens, including fake assets, business failure, and investment speculation. Investors bear their own investment risks.

The PBC takes a stringent stance against cryptotrading. Trading platforms are no longer allowed to exchange fiat money and tokens, or provide information and prices for token trading. Financial institutions and nonbank payment institutions are strictly prohibited from providing ICO and cryptocurrency services, including opening bank accounts or providing registration, trading, clearing, or liquidation services.

The PBC monitors the ICO market, and identified several new forms of disguised ICOs as noted in a 2018 financial stability report (PBC 2018). For example, platforms do not directly issue virtual currency to raise funds, but instead initially offer free "gift currency" and keep part of it for speculation. To this end, the PBC will prevent risks via early detection and disposal, rectify misconduct in the cryptocurrency market, and take a variety of measures to crack down on emerging legal issues.

8.6.2 | Central Bank Digital Currency

The PBC has worked to introduce central bank digital currency (CBDC) alongside the yuan (the fiat currency). In November 2016, the PBC set up a Digital Currency Research Institute, which is responsible for developing CBDC infrastructure and research on potential influences and challenges. Many experts in developing blockchain technology, big data, cryptography, and system design have been recruited into the Digital Currency Research Institute.

The PRC's CBDC may adopt a two-layer design. Its supply system will be integrated into the existing banking system, while adopting a centralized management mode rather than being based on distributed ledgers (Fan 2018). According to Yifei Fan, a deputy governor of the PBC, there are several advantages to adopting a two-layer design: (1) make full use of the existing resources of commercial institutions; (2) avoid financial disintermediation and crowding out effect on the deposits of commercial banks; and (3) avoid excessive concentration of risks if the central bank directly serves the public, and risks of regime shift in monetary policy transmission mechanism.

As suggested by Qian Yao, the former director general of the Digital Currency Research Institute, the PRC's CBDC system should maintain centralized management for stabilizing value, and use distributed technology architecture to enhance system safety and access (Yao and Tang 2017). CBDC will adopt multiple mature technologies, including blockchain. The related technologies have been broadly investigated; for example, Xu and Zhou (2019) explored the economic functions of blockchain.

Although there is currently no announced timetable for deploying the PRC's CBDC, the PBC has completed trial runs on the algorithms needed for a digital currency supply, and a trial run of digital currency based on blockchain technology. In the future, CBDC may lay a solid foundation for RegTech (Yao 2017).

REFERENCES

Fan, Y. 2018. Central Bank's Digital Currency: A Few Considerations (in Chinese). 25 January. https://www.yicai.com/news/5395409.html (accessed 26 March 2019).

Frost, J., L. Gambacorta, Y. Huang, H. S. Shin, and P. Zbinden. 2019. BigTech and the Changing Structure of Financial Intermediation. BIS Working Papers No. 779. https://www.bis.org/publ/work779.pdf (accessed 9 October 2019).

Galvin, J., F. Han, S. Hynes, J. Qu, K. Rajgopal, and A. Shek. 2018. *Synergy and Disruption: Ten Trends Shaping FinTech.* McKinsey & Company report. https://www.mckinsey.com/industries/financial-services/our-insights/synergy-and-disruption-ten-trends-shaping-fintech (accessed 26 March 2019).

Li, D. 2015. *Annual Report on China's Internet Finance Development.* Beijing: Social Sciences Academic Press. ssapchina.com/ssapzx/c_00000090002000100007/d_1300.htm (accessed 9 October 2019).

Mahoney, J. 2019. The Rise of Chinese FinTech: Lessons for the United States. New York: Columbia University Press. https://www8.gsb.columbia.edu/leadership/newsn/6881/the-rise-of-chinese-fintech-lessons-for-the-united-states (accessed 26 March 2019).

People's Bank of China (PBC). 2014. *The People's Bank of China Report 2014.* Beijing: People's Bank of China.

———. 2018. *China Financial Stability Report 2017.* Beijing: People's Bank of China.

PwC. 2016. *The Rise of China's Silicon Dragon.* https://www.pwc.com/sg/en/publications/assets/rise-of-china-silicon-dragon.pdf (accessed 26 March 2019).

Yao, Q. 2017. Understanding Central Bank Digital Currency: A Systemic Framework. *Science China Press* 47(11): 1592–1600.

———. 2018. The Economic Significance of Yu'e Bao and Supervision Suggestions (in Chinese). *Wuhan Finance* 5: 4–10.

Yao, Q. and Y. Tang. 2017. Some Thoughts on Central Bank-Issued Digital Currency (in Chinese). *Journal of Financial Research* 7: 1–16.

Zhang, L. and S. Chen. 2019. China's Digital Economy: Opportunities and Risks. IMF Working Paper WP/19/16. Paris: International Monetary Fund.

CHAPTER 9

Fintech Development in Hong Kong, China

Yvonne Tsui, Hongyi Chen, Chris Ip, and Bernia Lee*

9.1 Introduction

Financial technology's (fintech) contribution to financial services is continuing to grow rapidly as it moves the industry into an exciting new era. Keen interest from investors saw global venture investment in fintech companies reach $27.4 billion in 2017, an 18% growth from 2016 (Alun 2018).

As a principal financial center in the region, Hong Kong, China, is experiencing significant fintech growth. In particular, venture capital investment in fintech companies based in Hong Kong, China, jumped from $215.5 million in 2016 to $545.7 million in 2017 (Alun 2018), representing a 150% increase year-on-year. In terms of collaboration, 82% of banks and other financial institutions in Hong Kong, China, are aiming to enter into or strengthen a partnership with a fintech business in the next 3 to 5 years (PwC 2017). Furthermore, a growing number of payment service companies are operating in Hong Kong, China, with 18 stored value facility (SVF) licences issued (HKMA 2019b). Electronic payment platforms are also becoming increasingly popular.

9.2 Fintech Facilitation Office

The Hong Kong Monetary Authority's (HKMA) Fintech Facilitation Office (FFO), set up in March 2016, facilitates the healthy development of the fintech ecosystem in Hong Kong, China, and promotes the city as a fintech hub in Asia. The FFO serves as an initiator of industry research in potential applications and the risks of potential

* The views expressed in this chapter are those of the authors, and do not necessarily reflect those of the Hong Kong Monetary Authority, Hong Kong Institute for Monetary and Financial Research, its Council of Advisers, or the Board of Directors.

fintech solutions; a platform for exchanging ideas of innovative fintech initiatives among key stakeholders and conducting outreach activities; an interface between market participants and regulators within HKMA; and a facilitator to nurture talent to meet the growing needs of the fintech industry in Hong Kong, China.

9.3 Seven Smart Banking Initiatives

To expedite Hong Kong, China's move into a new era of smart banking, HKMA announced in September 2017 the seven smart banking initiatives (HKMA 2017c):

(1) full connectivity of digital retail payments through the Faster Payment System (FPS);

(2) upgrading the existing Fintech Supervisory Sandbox (FSS) to version 2.0;

(3) facilitating the introduction of virtual banking in Hong Kong, China;

(4) introducing a new Banking Made Easy initiative to reduce regulatory friction and improve customer experience;

(5) development of an Open Application Programming Interface (API) framework;

(6) stepping up cross-border collaboration in fintech; and

(7) enhancing research and talent development.

Together with the banking departments of HKMA, the FFO plays a pivotal role in driving these initiatives.

Before going into details of the smart banking initiatives and other projects, we would like to summarize some of HKMA's major fintech achievements, which have been well received by the industry and the public.

9.4 Major Achievements

9.4.1 | Open API

To facilitate the development and adoption of Open API by the banking sector, following the completion of a public consultation, HKMA published a framework in July 2018 that adopts a risk-based principle and a four-phase approach.

Under Phase I, 20 retail banks launched over 500 Open APIs in January 2019, covering information on banking products and services such as deposits, loans, insurance, and investments. Banks are also working to open up more functionalities in subsequent phases (HKMA 2018d).

9.4.2 | FPS and Common QR Code

FPS is a payment infrastructure introduced in September 2018 by HKMA and operated by Hong Kong Interbank Clearing Limited. It supports multi-currency (Hong Kong dollar and yuan) instant payments on a round-the-clock basis, with full connectivity between banks and SVFs. The public can easily transfer funds across different banks and SVFs using a mobile phone number or e-mail address as an account proxy. By the end of May 2019, a total of 22 banks (including most retail banks) and 10 SVFs in Hong Kong, China, have participated in the system to provide FPS services for their customers.

In September 2018, HKMA also announced a common QR code standard for retail payments in Hong Kong, China, together with the launch of a free mobile application tool. The app can convert multiple QR codes from different payment service providers into a single, combined QR code, providing greater convenience to both merchants and customers and in turn facilitating a wider adoption of mobile retail payments in Hong Kong, China (HKMA 2018c).

9.4.3 | Trade Finance

With a view to improving trade efficiency and reducing errors and fraud risks, a blockchain-based trade finance platform named eTradeConnect was launched in October 2018 to share digitized trade documents and automate processes. The platform was fully funded by a consortium of major banks in Hong Kong, China, and facilitated by HKMA.

To promote cross-border trade, HKMA has been exploring opportunities to connect eTradeConnect with trade platforms in different regions. In October 2018, a memorandum of understanding was signed between the operators of eTradeConnect and we.trade, a blockchain-based platform available across 14 European countries, to conduct a proof-of-concept (PoC) on connecting the two platforms (HKMA 2018b).

In addition, HKMA signed a memorandum of understanding with the Monetary Authority of Singapore in November 2017 to jointly build the Global Trade Connectivity Network, which will connect relevant platforms in both jurisdictions to form a cross-border distributed ledger technology (DLT)-based open trade finance network, making trade finance processes safer, more efficient, and cost-effective (HKMA 2017b).

9.4.4 | Virtual Banking

The banking sector in Hong Kong, China is now working on developing its virtual banking arm, an area closely linked to the interests of the general public. Apart from promoting fintech and innovation in Hong Kong, China, virtual banks could offer a new kind of customer experience. They could also encourage financial inclusion as they normally target the retail segment, including small and medium-sized enterprises.

After a public consultation, in May 2018, HKMA issued the revised Guideline on Authorization of Virtual Banks, which sets out the principles that HKMA will take into account in deciding whether to authorize virtual banks applying to conduct banking business in Hong Kong, China (HKMA 2018a). HKMA granted eight virtual banking licences from March to May 2019, with the banks intending to launch their services around 6 to 9 months after authorization (HKMA 2019c).

9.5 Other Fintech Initiatives

9.5.1 | Research and Application

As technological innovation is one of the key elements of fintech development, HKMA has devoted substantial resources to various research projects. Some of the research output has already been adopted by the industry.

HKMA conducted comprehensive research on DLT and published white papers in November 2016 and October 2017. The first white paper explained the technology, as well as the three PoCs that HKMA carried out with banks on trade finance, digital identity management, and mortgage applications, along with their implementation issues (ASTRI, HKMA 2016). The second white paper continued to share the lessons learned from the three PoCs, and, with the help of professionals

and experts, offered advice on the implementation issues of governance, legal and compliance, and general control principles for deploying DLT in the banking and payment industries (HKMA 2017d). Riding on the success of the trade finance PoC, the blockchain-based trade finance platform eTradeConnect was developed and subsequently launched in October 2018.

In collaboration with the three note-issuing banks, Hong Kong Interbank Clearing Limited, and the R3 consortium, HKMA conducted a study on central bank digital currency (CBDC) in March 2017 to better understand its feasibility, implications, and possible benefits through exploring its use in domestic interbank payments, corporate payments at wholesale level, and delivery-versus-payment debt securities settlement. HKMA is exploring and studying the development and impact of CBDC with other central banks in international organizations and meetings.

Against the backdrop of growing cyber-threats, cyber-risks remain a supervisory focus of HKMA. The Cybersecurity Fortification Initiative was implemented in December 2016 to raise the cyber-resilience of Hong Kong, China's banking system. The initiative is founded on three pillars: (i) Cyber Resilience Assessment Framework; (ii) Professional Development Programme; and (iii) Cyber Intelligence Sharing Platform.

9.5.2 | Industry Liaison

HKMA has launched different projects in order to promote communication with and within the industry both locally and globally. In March 2017, HKMA, in collaboration with Cyberport, launched the Haccelerator program, which offers banks and SVF operators a platform to run fintech-related competitions such as hackathons and accelerators to explore innovative solutions, identify talent, and seek cooperation opportunities with start-ups and innovators. As of the end of May 2019, four banks and one SVF operator have organized competitions using the platform.

By the end of May 2019, the FFO had organized 43 events since its inception, attracting more than 15,000 participants locally and from around the world. During the same period, HKMA representatives had attended, as keynote speakers and panelists, 171 fintech-related events and held 615 meetings with other regulators, the private sector, and industry organizations.

9.5.3 | Regulatory Interface

HKMA has launched several initiatives to help improve the industry's understanding of the regulatory landscape. Listed below are some examples of the initiatives.

Launched by HKMA in September 2016, the FSS (HKMA 2019e) allows banks and their partnering technology firms to conduct pilot trials of fintech initiatives in a controlled environment without the need to achieve full compliance with HKMA's supervisory requirements. As of the end of May 2019, 53 fintech or technology products had been allowed in the FSS. Of these cases, 34 pilot trials were completed, and the products were subsequently rolled out.

As a result of the experience gained through the FSS, in 2017 HKMA upgraded it to enhance coverage and linkages with other relevant parties. The enhanced FSS has three new features: (i) a fintech supervisory chatroom (Chatroom) to provide supervisory feedback to banks and technology firms at an early stage of their fintech projects; (ii) tech firms' direct access to the FSS by seeking feedback from the Chatroom without going through a bank; and (iii) the sandboxes of HKMA, the Securities and Futures Commission, and the Insurance Authority are linked to provide a single point of entry for pilot trials of cross-sector fintech products. As of the end of May 2019, HKMA had received a total of 304 requests to access the Chatroom.

To develop the regulatory technology (regtech) ecosystem, the FSS has been open to projects or ideas raised by banks and technology firms starting from September 2018.

HKMA also launched a Banking Made Easy initiative in September 2017 to streamline regulatory requirements and enhance customer experience, namely remote on-boarding, online finance, and online wealth management. The scope of the initiative was expanded in September 2018 to facilitate regtech development in Hong Kong, China, focusing on anti-money laundering/counter-terrorism financing surveillance technologies; regtech for prudential risk management and compliance; and a study on machine-readable regulations.

In November 2016, HKMA established in collaboration with the Hong Kong Applied Science and Technology Research Institute (ASTRI) the HKMA-ASTRI Fintech Innovation Hub (Hub) to provide a neutral ground for evaluating new fintech solutions. As of the end of May 2019, seven projects had used the Hub for development and demonstration of fintech solutions such as optical character

recognition, DLT, soft-token authentication, and trade finance. Three tech firms had also made use of the Hub to provide technical workshops on artificial intelligence and other technologies to banks.

9.5.4 | Talent Development

Talent development is an essential element of the fintech industry. Launched in partnership with ASTRI, the Fintech Career Accelerator Scheme (FCAS) (ASTRI, HKMA 2019) aims to nurture talent to meet the growing needs of the fintech industry in Hong Kong, China. Students can work full-time on fintech-related projects for either 6 months or 1 year at banks and HKMA. For the first intake in 2017–2018, more than 3,000 applications from 421 applicants were received, and 74 students accepted offers to work in 12 banks and HKMA.

As part of the Smart Banking initiatives, FCAS was upgraded in January 2018 to expand the talent pool and nurture young individuals at different stages of their career development. With more partners, more participating employers, and coverage beyond Hong Kong, China, FCAS 2.0 was expanded into four programs: (i) Cyberport University Partnership Programme; (ii) Shenzhen Summer Internship Programme; (iii) Gap Year Placement Programme; and (iv) Fresh Graduate Programme.

9.5.5 | Cross-border Collaboration

In terms of collaboration with Shenzhen in the People's Republic of China, in June 2017 HKMA and the Shenzhen Municipal Financial Regulatory Bureau (formerly called the Office of Financial Development Service, the People's Government of Shenzhen Municipality) agreed to strengthen collaboration on reciprocal soft-landing support, internship opportunities, and fintech events (HKMA 2017a). As a start, the two authorities jointly organized the first Shenzhen–Hong Kong Fintech Award in 2017 to recognize and reward outstanding fintech products and solutions in the two cities. The award was co-organized for the second time in 2018 (HKMA 2018e). In addition, in collaboration with the Shenzhen Municipal Financial Regulatory Bureau, the Shenzhen Summer Internship Program enabled 50 students from Hong Kong, China to experience the fintech ecosystem in Shenzhen by working with eight renowned firms for 6 weeks in 2018 and 2019 (HKMA 2018f).

In international collaboration, as of the end of May 2019, HKMA had entered into fintech cooperation agreements with regulators or governments in the United Kingdom, Singapore, the Dubai International Financial Centre, Switzerland, Poland, the Abu Dhabi Global Market, Brazil, and Thailand. Together with other members of the Global Financial Innovation Network, which is an initiative that seeks to create a framework for cooperation between financial services regulators on innovation-related topics, in January 2019 HKMA launched a pilot scheme for firms that wish to test innovative products and services across international markets (HKMA 2019a). HKMA also held high-level international events from time to time to foster fintech collaboration between jurisdictions. For example, in January 2019 HKMA organized a well-attended fintech roundtable titled *From Mutual Understanding to Global Collaboration* (HKMA 2019d).

9.6 Conclusion

Major advancements in fintech in recent years have attracted the attention of financial regulators around the world, including HKMA. HKMA stands ready to embrace technology and innovations that emerge in the course of fintech development. It also puts great effort into striking a right balance between retaining appropriate flexibility for innovations, while making sure that customer interests are properly safeguarded.

In particular, HKMA adopts a risk-based and technology-neutral approach in its supervision. This means that the intrinsic characteristics of the financial activities or transactions and the risks arising from them will be HKMA's main considerations when developing and implementing the regulatory framework and requirements. To achieve that, HKMA emphasizes a willingness to learn about and understand fintech, an ability to maintain close contact with the industry and other stakeholders, and an ability to achieve a good balance between market development and customer protection. HKMA will also maintain close contact with the industry and regulators in other jurisdictions to ensure the existing regulations are up to date.

REFERENCES

Alun, J. 2018. Investment in Hong Kong Fintechs More than Doubled Last Year, Well Ahead of Singapore and Australia. *The South China Morning Post*, 1 March. https://www.scmp.com/business/companies/article/2135144/hong-kong-fintech-outlay-doubles-5-year-tally-well-ahead (accessed 19 July 2019).

ASTRI, HKMA. 2016. Whitepaper on Distributed Ledger Technology. https://www.hkma.gov.hk/media/eng/doc/key-functions/finanical-infrastructure/Whitepaper_On_Distributed_Ledger_Technology.pdf (accessed 19 July 2019).

———. 2019. Fintech Career Accelerator Scheme. http://fcas.hk/ (accessed 19 July 2019).

Hong Kong Monetary Authority (HKMA). 2017a. HKMA Visits Fintech Firms in Shenzhen. Press release. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-information/press-releases/2017/20170602-3.shtml (accessed 19 July 2019).

———. 2017b. Hong Kong and Singapore Launch a Joint Project on Cross-Border Trade and Trade Finance Platform. Press release. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-information/press-releases/2017/20171115-6.shtml (accessed 19 July 2019).

———. 2017c. A New Era of Smart Banking. Press release. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-information/press-releases/2017/20170929-3.shtml (accessed 19 July 2019).

———. 2017d. Whitepaper 2.0 on Distributed Ledger Technology. Hong Kong, China: HKMA. https://www.hkma.gov.hk/media/eng/doc/key-functions/finanical-infrastructure/infrastructure/20171025e1.pdf (accessed 19 July 2019).

———. 2018a. Guideline on Authorization of Virtual Banks. Press release. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-information/press-releases/2018/20180530-3.shtml (accessed 19 July 2019).

———. 2018b. The Launch of eTradeConnect and the Collaboration with we.trade. Press release. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-information/press-releases/2018/20181031-4.shtml (accessed 19 July 2019).

———. 2018c. The Launch of Faster Payment System (FPS). Press release. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-information/press-releases/2018/20180917-3.shtml (accessed 19 July 2019).

———. 2018d. Open Application Programming Interface (API) for the Banking Sector. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-functions/international-financial-centre/open-api-for-banking-sector.shtml (accessed 19 July 2019).

———. 2018e. Shenzhen-Hong Kong Fintech Award 2018. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-functions/international-financial-centre/fintech/closer-cross-border-collaboration/collaboration-with-mainland-china/joint-events/ (accessed 19 July 2019).

———. 2018f. FCAS 2.0: Shenzhen Summer Internship. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-functions/international-financial-centre/fintech/closer-cross-border-collaboration/collaboration-with-mainland-china/shenzhen-summer-internship-programme/ (accessed 19 July 2019).

———. 2019a. GFIN Invites Applications for Testing Innovative Products. Press release. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-information/press-releases/2019/20190201-3.shtml (accessed 19 July 2019).

———. 2019b. Granting of Stored Value Facility Licences. Press release. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-information/press-releases/2019/20190510-5.shtml (accessed 19 July 2019).

———. 2019c. Granting of Virtual Banking Licences. Press release. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-information/press-releases/2019/20190509-3.shtml (accessed 19 July 2019).

———. 2019d. HKMA Holds High-level Fintech Roundtable. Press release. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-information/press-releases/2019/20190109-3.shtml (accessed 19 July 2019).

———. 2019e. The Fintech Supervisory Sandbox. Hong Kong, China: HKMA. https://www.hkma.gov.hk/eng/key-functions/international-financial-centre/fintech-supervisory-sandbox.shtml (accessed 19 July 2019).

Pricewaterhouse Coopers (PwC). 2017. Global FinTech Report 2017. New York: PwC. https://www.pwc.com/gx/en/industries/financial-services/assets/pwc-global-fintech-report-2017.pdf (accessed 19 July 2019).

CHAPTER 10

Fintech Development and Regulatory Frameworks in Indonesia

Sukarela Batunanggar

10.1 Background

Financial services in Indonesia have evolved in line with innovation and technology, and have also experienced boom and bust cycles as a result of financial crises, including the Asian financial crisis of 1997–1998 and the global financial crisis of 2008 (Batunanggar 2001).

Financial technology (fintech) emerged with the development of information technology, including the internet, smartphones, and big data analytics, which enabled the faster and cheaper distribution of financial services. Fintech presents a challenge to incumbent financial institutions as it offers alternative services to the post-global financial crisis society.

Fintech also reaches parties that have been neglected by banks while providing better services to already-banked customers. Fintech has changed the financial services landscape, and, based on cross-sector services, it will expand its market share in the coming years.

The changing environment has facilitated the emergence of new players in financial services, especially non-financial companies such as smartphone manufacturers and internet providers. The preferences of the millennial generation also opens opportunities for fintech entrepreneurship.

For Indonesia, fintech provides an opportunity to close the current gaps in financial inclusion and financing.

This chapter outlines the fintech landscape and discusses the regulatory framework adopted by the Indonesia Financial Services Authority (Otoritas Jasa Keuangan/"OJK"). Fintech in this chapter refers to non-financial companies or start-ups that provide financial services through digital platforms.

10.2 Indonesia: Key Opportunities and Challenges

10.2.1 | Key Opportunities

Indonesia has many opportunities in the digital economy, with regard to the size of its economy, population, and the number of internet and mobile phone users, as summarized in Box 10.1.

Internet penetration in Indonesia is expected to soar in the next few years. According to the 2018 Daily Social Fintech report, state-owned banks (63%) are implementing digital initiatives to escalate revenue growth compared to private-owned (21%) and *syariah* (14%) banks. Thus, the majority of financial institutions in Indonesia are already aware of the importance of technology in their business processes.

Box 10.1: Indonesian Digital Economy and Finance: Then and Now

- Today, Indonesia is the world's 16th-biggest economy (8th-biggest according to gross domestic product purchasing power parity). It will be the world's 7th-largest economy (5th-largest by gross domestic product purchasing power parity) in 2030.
- As the world's 4th-largest country after the People's Republic of China (PRC), the United States, and India, Indonesia, with a population of 261,890,900 in 2017, will enjoy the peak of demographic bonuses by 2030, enough to generate economic growth.
- Currently, there are 45 million Indonesians categorized as middle (consuming) class; by 2030, the number will be 135 million.
- Currently, there are 55 million Indonesians categorized as skilled workers; by 2030, there will be 113 million.
- Currently, the number of internet users in Indonesia is 132.7 million or about 51.5% of the total population. Together with the PRC and India, Indonesia expects to become a top information technology innovator.
- Currently, there are more than 50 million micro, small, and medium-sized enterprises (MSMEs) in Indonesia. Because 70% of all MSME sectors do not yet have access to bank financing, the government is encouraging 6 million MSMEs to go digital to gain access to finance.

Sources: Biro Pusat Statistik; World Economic Forum (2018); McKinsey (2012).

10.2.2 | Key Challenges

Indonesia's financial sector has grown steadily and become resilient as part of its post-banking crisis restructuring program and continuous regulatory framework initiatives. However, there are two fundamental problems in Indonesia's financial sector. First is the persistent low level of financial inclusion. Based on the World Bank's 2017 Financial Inclusion Index, 48.9% of Indonesian adults have bank accounts; the government plans to increase this to 75% in 2019. The second issue is the large MSME financing gap. The World Bank and International Finance Corporation estimated that the credit gap for MSMEs in Indonesia reached $165 billion (or 19% of gross domestic product), while the current availability is only $57 billion.

Despite the high number of internet users in Indonesia, national digital channel knowledge is only at 34% and digital channel usage is only 8.7% (E&Y Census 2018). Digital finance literacy needs to be improved, with OJK and other institutions having launched related programs.

The fintech and start-up talent shortage is also an issue. According to E&Y (2018), 58% of tech and software talent is not suited to meeting their needs. To develop the capacity of Indonesia's younger generation, OJK collaborates with universities, innovation hubs, industry associations, and international agencies.

10.3 Fintech in Indonesia

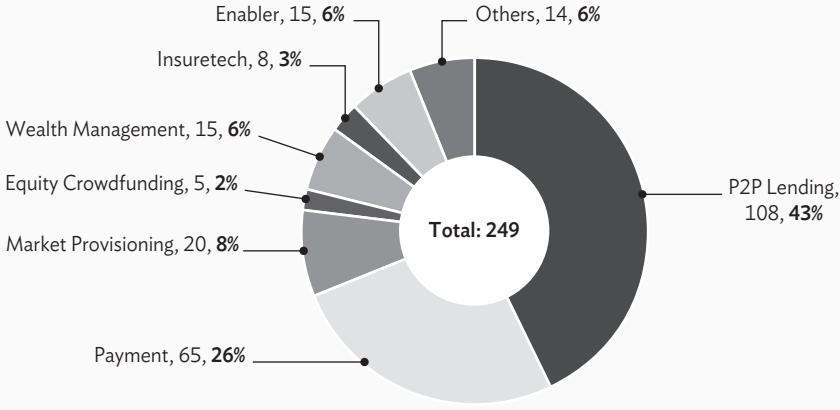
10.3.1 | Fintech Landscape and Development

As of May 2019, there are 249 fintech companies in Indonesia, starting from deposits and lending to payment and capital raising, as illustrated in Figure 10.1.

The top-two fastest-growing fintech areas in Indonesia are peer-to-peer (P2P) lending and e-payments. Based on Bank of Indonesia statistics, the value of e-money transactions grew sixfold between 2012 and 2017 to Rp12.3 trillion ($840 million).

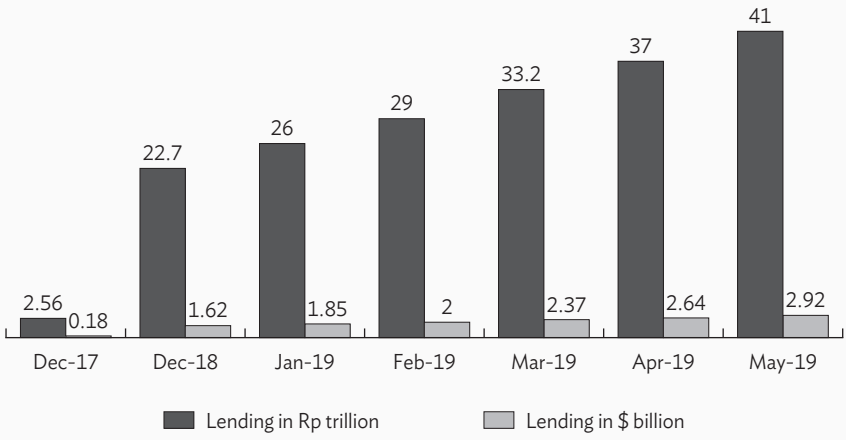
Meanwhile, based on OJK's data as of December 2018, disbursement of credit through P2P reached Rp22.67 trillion ($1.62 million), a 645% year-on-year increase. These funds originated from 101 local P2P platforms that registered with OJK. Figure 10.2 illustrates the development of P2P lending in Indonesia.

Figure 10.1: Indonesia Fintech Landscape—Composition (in numbers and %)



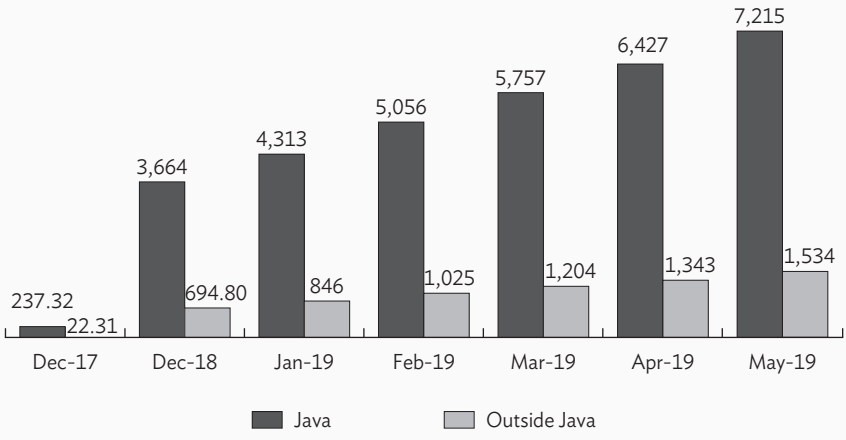
P2P = peer-to-peer.
Source: OJK.

Figure 10.2: Total P2P Lending



P2P = peer-to-peer.
Source: OJK.

Figure 10.3: Total P2P Borrowers ('000)



P2P = peer-to-peer.
Source: OJK.

As seen in Figure 10.3, although the trend is increasing, the number of borrowers and borrowing outside Java is always smaller (16% as of November 2018). The main reasons are that Java has the highest economic growth and the most people, while financial literacy outside Java is lower.

This is the challenge and also the opportunity for the P2P lending industry. Fortunately, some fintech companies, such as the specialized P2P lending company Iternak, tap into this opportunity. Iternak provides loans for animal husbandry businesses, having started in West Sumatra and currently expanding to other areas. With creativity and deep understanding of the market, Iternak proves that a lending business can succeed outside of Java. However, to ensure the sustainability of its business, more advanced technology, especially with digital ID and credit scoring, is needed.

Moreover, there are 55 other fintech firms, excluding e-payment and P2P lending, that have registered with OJK, including aggregators, credit scoring, insure-tech, and financial planning, etc. They, along with e-payments and P2P lending, are expected to make financial services accessible for the unbanked and underserved in society.

10.3.2 | Financial Literacy and Financial Inclusion

Fintech improves financial inclusion by responsibly and sustainably providing individuals and businesses with access to financial products and services, such as transactions, payments, savings, credit, and insurance.[1] Fintech could also deliver much-needed finance to MSMEs.

Financial literacy implies the ability to create informed perceptions and make appropriate choices regarding the utilization of money. Financial literacy can make a change not only in individuals' lives but in the integrity and quality of markets. In Indonesia, the necessity for financial literacy is even more significant bearing in mind the low levels of education and the enormous population, most of which remains outside the official financial set-up, particularly in rural areas.

Fintech becomes one of the radical strategies to attain Indonesia's goal of 75% financial inclusion by 2019. However, the OJK survey found that only about 30% of the population is financially literate, making inclusion rife with potential hazards. Current experiences in online consumer financing have shown that poor individuals take loans that they cannot repay. Therefore, financial inclusion should be integrated with customer education and financial literacy.

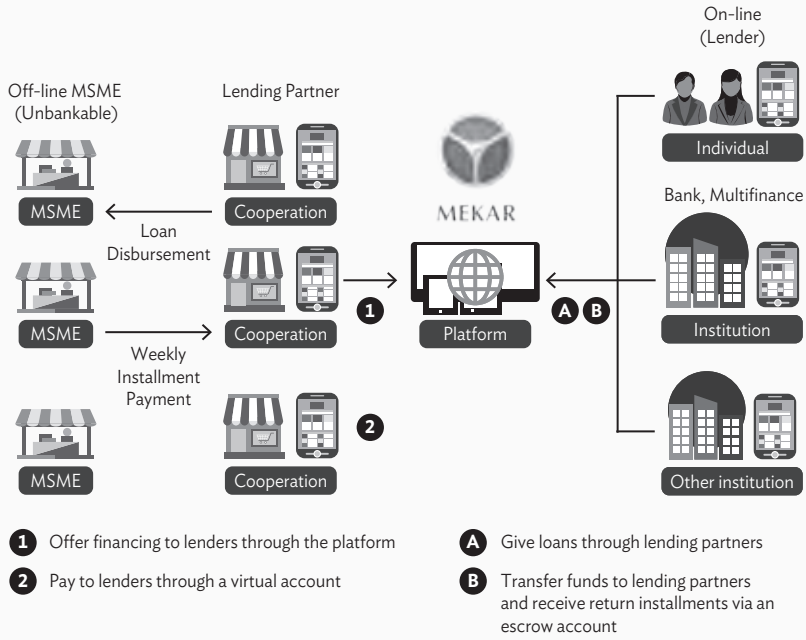
The obligation of fintech in promoting financial literacy has been addressed in Article 4 of OJK Regulation No. 13 of 2018 concerning the Digital Financial Innovation in the Financial Services Sector. One example is Finansialku.com, which is geared to millennials, and condenses financial product articles into an accessible investment e-book, and provides online courses. In this way, Finansialku.com is not only building the next generation of financial planner tools but also facilitating financial education.

Fintech also plays an important role in improving social welfare. An example of social fintech in Indonesia is Mekar, which provides financing to empower MSMEs, especially those benefitting poor women (see Box 10.2).

[1] Financial Inclusion Overview, World Bank, 2018.

Box 10.2: Mekar: Fintech with a Social Mission

Established in 2013, Mekar has a unique value proposition that focuses on creating social impact for micro and small enterprises (MSEs) and empowering women. Its mission is to provide financial access to MSEs, create jobs, and connect investors and borrowers. As a peer-to-peer platform, Mekar receives funds from its investors, both individual and institutional, and gives loans to its online partners, who then disburse them to the MSE borrowers—mostly women (offline).



Mekar reaches out to MSEs in all areas in Indonesia through cooperation with savings and loan cooperatives, rural banks, and other financial institutions through more than 250 branch offices. Total loans disbursed as of September 2018 amounted to Rp92 billion and total borrowers numbered 33,515 people. Non-performing loans constituted only 0.53% of the total.

One of Mekar's lending partners is Komida, Koperasi Mitra Dhuafa or "Partner of the Poor Cooperative", which also focuses its service on women. Komida was established in 2004 as a microfinance company based on the Grameen Bank group lending model. It started its activity to assist tsunami victims in Aceh and opened its first branch in Brunei Darussalam in 2005.

continued next page

Box 10.2: ***Continued***

Since 2009, Komida changed its status to a savings and loans cooperative that helped low-income women to start and grow their business. It provides loans to poor but productive women without collateral, enabling them to work without leaving their houses. The size of loans ranges from Rp2 million–Rp15 million depending on the business capacity of the borrower. Its belief is that poor people can be trusted and constitute a large potential, a philosophy grounded in that of the Grameen Bank's Muhammad Yunus. Starting with only five founders, Komida now has 3,000 employees and serves in 12 provinces, with 235 branches that reach about 574,000 people.

Among the strong features of Komida's business model are the keen identification of potential members, solid group formation, careful review of business prospects, close monitoring of members' businesses, direct collection of loan principal and interest, and empowerment to its members. It is also supported by competent and honest staff developed through intensive trainings. Besides savings and loans, Komida also provides nonfinancial services to its members, including health, education for members' children, and family financial management.

Mekar's innovations on MSE financing to women through collaboration with lending partners such as Komida, combined with social and business empowerment, has been significantly improving the economic and social welfare of the target market.

Sources: OJK and Universitas Trisakti (2018); author's analysis.

10.3.3 | Customer Behavior and Customer Protection

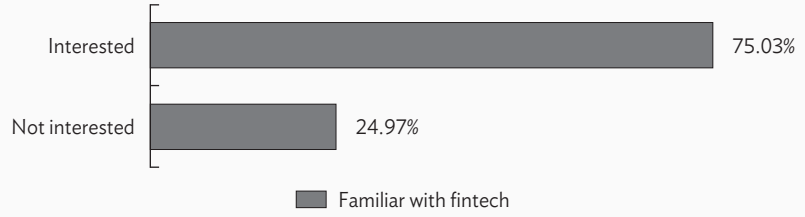
Customer Behavior toward Fintech

The first factor influencing the growth of fintech in Indonesia is how the incumbent financial institutions and customers respond. In general, Indonesian financial services are now more open for collaboration with fintech. Some of Indonesia's large banks have already developed incubation programs, events, and funding programs through which they interact with startups. For instance, Bank Mandiri, the biggest state-owned bank, established Mandiri Capital in early 2016 as a fintech venture fund. It has a $37 million financial plan and funded card-reader startup Cashlez, micro-lender Amartha, and point-of-sales software Moka, among other startups. Bukopin, a mid-size private bank targeting MSMEs and Indonesia's middle segment, launched a startup incubator called BnV Labs in March 2017. Startups in the program can use office space at BnV Lab's partner co-working space, Kibar.

The members get mentorship and access to the bank's network. The collaboration only started in the last 2 years, so the exact result is yet to be determined. However, it inevitably brings the Indonesian fintech ecosystem into clear relief.

The other central stakeholders of fintech are the customers. A survey conducted by the Daily Social (2018) revealed that fintech users are now more familiar with the products and services, though they fear compliance issues and other risks (see Figure 10.4). This can be changed by increasing their financial literacy.

Figure 10.4: Polling of Customers Investing in Fintech



Source: Daily Social (2018), Fintech Report.

Customer Protection

One of the reasons why customers are reluctant to use fintech is the perceived lack of safety. Based on OJK Regulation No. 1 of 2013 concerning Consumer Protection in the Financial Services Sector, consumer protection providers are obliged to incorporate transparency, impartial treatment, trustworthiness, privacy and safety of customer data/information, and simple treatment of complaints and customer disagreement resolution into their operations, along with fast and inexpensive charges.

Because of this, OJK publishes information regularly about registered fintech and encourages customers to deal only with them. OJK Regulation No. 13 of 2018 also obliges that digital financial innovation must be responsible and secure, and prioritize customer protection and governance. This issue is also addressed separately in Bank of Indonesia Regulation No. 18 of 2016 and OJK Regulation No. 77 of 2016. Other sector regulations also addressed the issue.

Regarding customer data protection, the Ministry of Communication and Informatics issued Law No. 11 of 2008 on the Electronic Information and Transactions Law. It is further elaborated in Government Regulation 82/2012 and the Ministry of Communication and Informatics Regulation No. 20 of 2016 on the Protection of Personal Data in Electronic Systems. In principle, an electronic system operator should respect the privacy of personal data and treat it as confidential.

10.4 Fintech Regulatory Framework in Indonesia

Alongside its benefits, fintech also comes with significant risks. Customer protection and data security have been the two main concerns. As fintech provides financial services in a user-friendly platform, this would also mean anyone who has an internet connection could use it and misuse customer data. In a worse scenario, fintech could potentially disrupt financial stability, as users fail to mitigate the risks involved in their businesses. Financial activities carried out may fall outside the rigorous regulatory perimeter and pose a risk to the broader system (KPMG 2017). A significant disturbance in these services, or disintermediation of regulated entities, may potentially have severe negative impacts for the economy (Financial Stability Board 2017).

10.4.1 | Indonesia Fintech Regulatory Strategy

The primary challenge for regulators is to balance innovation with the integrity of the financial markets and customer protection. The regulation on fintech should nurture innovation while also guiding it to be responsible. This implies that a balanced regulatory framework will be required. This strategy aligns with the "light touch and safe harbor" regulatory approach stated by the President of Indonesia, Joko Widodo, in the 2018 Annual Meetings of International Monetary Fund and World Bank Group (IMF-WBG) in Bali.

As Panetta (2017) argued, fintech regulation should ensure four key principles. First, the playing field should be level and tech-neutral in order to avoid supervisory arbitrage. Second, it should be adaptable, given the rapid change that will impact fintech in the future. Third, the collaboration of financial sector authorities with regulators is paramount in other fields such as data protection, cyber-risk, and antitrust. Finally, the regulation should also have a universal dimension to cope with the global development of technology and the market for financial services.

Another crucial issue is the speed of innovation versus the speed of regulation. The survey conducted by Daily Social in 2018 showed that fintech players have the view that government adoption of regulations is somehow slow. In fact, this is a key challenge for all regulators. The question is, how should regulators respond?

Realizing these facts, OJK adopts five strategies to support digital financial innovations in Indonesia:

(1) **Holistic and balance strategy.** OJK ensures resiliency or safety and soundness of fintech and promotes innovation and competition. Fintech must ensure customer protection in its business to create and maintain trust in the industry.

(2) **Agile regulatory framework.** OJK sets the principle-based regulations for digital financial innovation, while acknowledging that the fintech industry is dynamic. It gives the flexibility and also responsibility to the industry to define codes of conduct and operating standards that fit with their business.

(3) **Market conduct supervision.** OJK is accountable for the regulation and supervision of fintech. Meanwhile, fintech is responsible for managing their business by applying sound corporate governance, risk management, and compliance. OJK appointed a Fintech Association to oversee fintech development.

(4) **Regulatory sandbox.** The regulatory sandbox is the OJK's testing mechanism to assess the reliability of the business process, business model, financial instruments, and the governance of the innovator based on specific predefined criteria. The regulatory sandbox allows OJK to gain a deeper understanding of fintech business models and risks, and also allows fintech firms to improve their business models and governance (see Box 10.3).

(5) **Digital innovation.** OJK nurtures innovation and responsible finance through the establishment of OJK Fintech Centre, named "OJK infinity"—"OJK Innovation Centre for Digital Financial Technology" launched on 20 August 2018. OJK Infinity serves three key purposes as a learning and innovation center on fintech, as media for coordination and collaboration among key stakeholders, and as a laboratory for regulatory sandboxing.

Box 10.3: Summary of Regulations on Fintech in Indonesia

a. **OJK Regulation No. 77/POJK.01/2016 on Information Technology-based Lending**

The regulation is directed to support the growth of fintech P2P lending platforms as new financing alternatives for communities that have yet to enjoy optimal services from incumbent financial service institutions. P2P platforms are classified as other financial services institutions. The regulation also mandates customer protection.

b. **OJK Regulation No. 12/POJK.03/2018 on the Implementation of Digital Services by Commercial Banks**

This regulates the use of information technology for digital banking. All banks that wish to issue electronic/digital products must request permission from OJK. Banks must emphasize product innovation, cooperation with partners, and digital processes to ensure better services for customers and effective risk management.

c. **OJK Regulation No. 13/POJK.02/2018 on Digital Financial Innovation in the Financial Services Sector**

This is an umbrella regulation for fintech. Any fintech companies that are not yet regulated by other authorities must apply to OJK to go through the regulatory sandbox process and get registered. The key dimension of this regulation is responsible finance innovation, the adoption of a robust security system, and good governance, and compliance with customer protection and anti-money laundering/combatting the finance of terrorism rules.

d. **OJK Regulation No. 37/POJK.04/2018 on Equity Crowd Funding**

This regulation focuses on regulating equity crowdfunding. It is aimed at boosting economic growth in Indonesia by providing access to start-up companies and SMEs in raising funds electronically for the development of their businesses.

e. **Bank of Indonesia Regulation No. 19/10/PBI/2017 on Fintech Companies**

The regulation is intended to support the fintech ecosystem and the Indonesian economy, in particular companies in payment businesses. Fintech providers are obliged to register at Bank of Indonesia and cannot use digital currency. They are tested in the regulatory sandbox for around a year before they can apply for a license.

f. **Bank of Indonesia Regulation No. 20/6/PBI/2018 on Electronic Money (E-money)**

The regulation is intended to accommodate the development of business models of e-money. The institutional capacity of e-money issuers is enhanced, including capital and ownership composition.

P2P = peer-to-peer, SMEs = small and medium-sized enterprises.

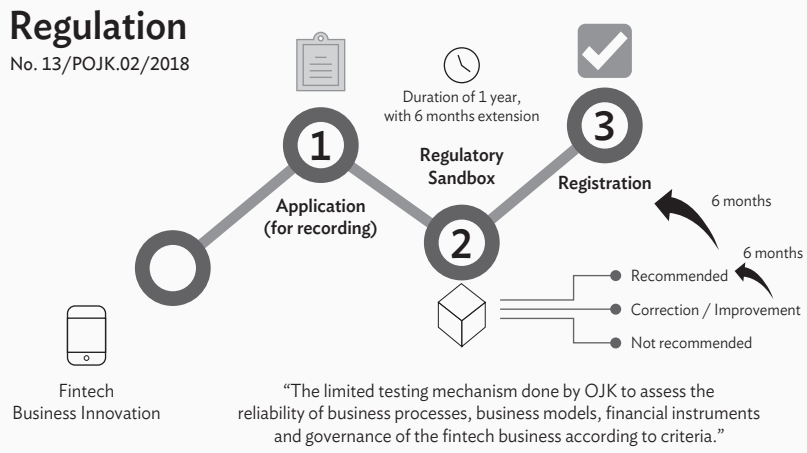
Sources: OJK; Bank Indonesia; author's analysis.

10.4.2 | Existing Regulations on Fintech Industry

Currently, there are two authorities regulating fintech in Indonesia. Bank of Indonesia regulates fintech relating to payments, whereas OJK regulates all fintech that provides financial services, such as digital banking, P2P lending, crowd funding, insure-tech, investment, and market aggregators. The existing regulations are summarized in Box 10.3.

OJK published POJK No. 13/POJK.02/2018 as the legal umbrella for all types of fintech, effective from 16 September 2018. It is designed as a principle-based regulation for the fintech industry and aimed at creating a responsible digital finance innovation. The key content of the regulation is summarized in Box 10.4.

Box 10.4: Umbrella Regulation for Fintech



Recording and Registration Mechanism

All fintech firms not regulated by other authorities must comply with OJK regulation and follow three key steps:

a. **Recording.** Fintech firms must submit all the documents required to OJK for verification and analysis to decide whether they: (i) meet the criteria as innovators and comply with OJK regulation; (ii) are selected to be tested on the regulatory sandbox; and (iii) which cluster they are classified in based on the business model mapping.

continued next page

Box 10.4: ***Continued***

b. **Regulatory sandbox.** The regulatory sandbox is conducted using a sampling and prototyping method, where selected fintech from each business model (cluster) is tested. There are five key steps involved: (i) understanding the business model, business process, and governance; (ii) choosing the review methodology and scenarios; (iii) testing and experimentation; (iv) improvement of the model; and (v) final evaluation. The review process involves a panel forum of supervisors who will provide opinions on whether the fintech model is recommended, needs improvement, or is not recommended for registration or operation. The length of the regulatory sandbox process could vary from a few months to 1 year, with the extension of up to 6 months if they are required to rectify their business.

c. **Registration.** Fintech firms that are recommended by the regulatory sandbox must apply to the registration stage at the latest 6 months after getting the recommendation status.

1. **Governance, risk and compliance**

   Fintech must develop and adopt good governance, effective risk management, and compliance to all rules and regulations to ensure safe and sound practices.

2. **Monitoring and surveillance mechanism**

   Though regulated and supervised by OJK, fintech must also conduct risk self-assessment. During the regulatory sandbox, they must submit quarterly performance reports; once these are registered, the firm must submit a monthly risk self-assessment report. Fintech firms must also continuously report to customers about the performance of their portfolios.

3. **Customer protection**

   Fintech firms must apply basic principles of customer protection, including transparency, fair treatment, reliability, data privacy and security, as well as the effective and efficient handling of customers' complaints.

Sources: OJK, author's analysis.

10.5 Policy Direction

Indonesia is a large nation with abundant potential that could be tapped via digital finance innovation. By preparing the right strategy and taking proactive actions, Indonesia could lead the future of finance and be one of the prominent fintech hubs in Asia.

The adoption of a balanced regulatory strategy will ensure resiliency and foster dynamic growth and innovation. Envisioning and nurturing the spirit of responsible innovations is a noble effort to establish a stable, contributive, inclusive, and sustainable digital financial sector. It is imperative to develop a new regenerative model of finance that focuses not only on profit but also people and the planet.

Indonesia needs to develop a holistic fintech roadmap in line with a national digital economy strategy and roadmap aimed at developing a sound ecosystem, including data protection, customer protection, regulation and supervision, a regulatory sandbox, innovation hub, risk management, and cyber-risk. All these initiatives must be supported by developing the required talents and infrastructure. To realize this, collaboration among OJK and key stakeholders, both domestic and international, is vital. The collaboration of fintech firms with incumbent financial institutions, microfinance, cooperatives, and community agents must be also engaged. Through a vibrant shared vision, the right strategy, and strong co-creation among stakeholders, we look forward to creating a more inclusive and sustainable financial sector in Indonesia.

REFERENCES

Daily Social. 2018. Fintech Report. pp. 16–35. https://dailysocial.id/report/post/fintech-report-2018 (accessed 14 July 2019).

EY. 2017. ASEAN Fintech Census 2018. Jakarta: EY. https://www.ey.com/Publication/vwLUAssets/EY-asean-fintech-census-2018/$FILE/EY-asean-fintech-census-2018.pdf (accessed 14 July 2019).

Financial Stability Board. 2017. Financial Stability Implications from FinTech: Supervisory and Regulatory Issues that Merit Authorities' Attention, pp. 17–21. http://www.fsb.org/2017/06/financial-stability-implications-from-fintech/ (accessed 14 July 2019).

Fintechnews Singapore. 2018. How 4 Indonesian Banks are Collaborating with Fintech Startups. Singapore. http://fintechnews.sg/17582/indonesia/banks-fintech-indonesia/ (accessed 14 July 2019).

KPMG. 2017. *Value of Fintech*, p. 42. https://home.kpmg/uk/en/home/insights/2017/10/value-of-fintech.html (accessed 14 July 2019).

McKinsey. 2012. The Archipelago Economy: Unleashing Indonesia's Potential. https://www.mckinsey.com/featured-insights/asia-pacific/the-archipelago-economy (accessed 14 July 2019).

Otoritas Jasa Keuangan and Centre for Financial Inclusion Universitas Trisaksi. 2018. Kajian Peranan Fintech untuk Pemberdayaan Usaha Mikro Kecil (UMK).

Panetta, F. 2018. Fintech and Banking—Today and Tomorrow. Speech delivered at the Harvard Law School Bicentennial Annual Reunion of the Harvard Law School Association of Europe, Rome, 12 May, pp. 9–10. https://www.bis.org/review/r180515d.htm (accessed 14 July 2019).

PWC. 2017. The World in 2050, The Long View: How Will the Global Economic Order Change by 2050? Jakarta: PWC. https://www.pwc.com/gx/en/issues/economy/the-world-in-2050.html (accessed 14 July 2019).

———. 2018. PwC Survey: Digital Banking in Indonesia 2018. Jakarta: PWC. https://www.pwc.com/id/en/publications/assets/financialservices/digital-banking-survey-2018-pwcid.pdf (accessed 14 July 2019).

Statistical Yearbook of Indonesia. 2018. BPS-Statistics Indonesia. https://www.bps.go.id/publication/2018/07/03/5a963c1ea9b0fed6497d0845/statistik-indonesia-2018.html (accessed 14 July 2019).

Sukarela, B. 2001. Indonesian Banking Crises Resolution: Lessons Learned and the Way Forward, Central for Central Banking Studies, Bank of England. http://www.bi.go.id/NR/rdonlyres/81804644-50F8-411E-847A-AEE92502FAAA/13371/ibcr0212.pdf.

World Bank. 2017. Global Findex Database 2017. https://globalfindex.worldbank.org (accessed 14 July 2019).

World Economic Forum. 2018. The Global Competitiveness Report 2017–2018. https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018 (accessed 14 July 2019).

CHAPTER 11

Project Stella and the Impacts of Fintech on Financial Infrastructures in Japan

Michinobu Kishi*

11.1 Introduction

Information technology (IT) innovation, global developments of various cashless payment means, including mobile payments, the emergence of cryptoassets, and distributed ledger technology (DLT) all have ramifications for central banks (Amamiya 2018).

Central banks are responsible for the stability of payment and settlement systems. They also conduct oversight on major financial market infrastructures (FMIs). From this perspective, they strengthen market infrastructures, financial systems, and IT.

Central banks also provide basic economic infrastructure through large-value and securities settlement systems in their jurisdictions. Furthermore, they catalyze communication and cooperation among various bodies such as financial institutions, IT companies, start-ups, and users. In light of these functions, the Bank of Japan (BOJ) has researched fintech; section 2 explains its promotion of it.

The third section introduces two reports of the European Central Bank's (ECB) and BOJ's joint Project Stella research study, which focuses on the implications of DLT on FMIs, specifically large-scale central bank payment services like BOJ-NET and TARGET2, which are their real-time gross settlement (RTGS) systems.

BOJ does not plan to issue its own digital currency; therefore, this topic is not touched upon in this chapter.[1]

* The views expressed in this chapter belong solely to the author and do not necessarily represent those of the Bank of Japan.

1 BOJ participated in drafting a report on digital currencies and central bank digital currencies published by the Bank of International Settlements Committee on Payments and Market Infrastructures (CPMI) (see CPMI 2015 and CPMI 2018).

11.2 Engagement of the Bank of Japan in the Promotion of Fintech

11.2.1 | Establishment of the Fintech Center

In April 2016, BOJ established the Fintech Center within its Payment and Settlement Systems department, aiming to link financial practices with advanced technologies and research studies, as well as to meet the demands of the digital world.

11.2.2 | Information Dissemination and Participation in International Discussions

BOJ, mainly through the Fintech Center, has held various fintech-related forums and collaborative conferences with the University of Tokyo and other entities.[2] These meetings are characterized by: (i) multifaceted discussions with a wide range of participants including financial institutions, IT companies, fintech ventures, and academic institutions; (ii) important information dissemination platforms by providing presentations and speeches; and (iii) a transparent framework such as the disclosure of meeting documents and minutes on BOJ's website, since open discussion is critical for promoting fintech. Furthermore, BOJ is participating in international forums related to fintech and financial innovations, such as the Bank of International Settlements Committee on Payments and Market Infrastructures (CPMI), as well as various domestic conferences.

11.2.3 | Research and Studies on Fintech

BOJ is also engaged in various research studies related to fintech, beginning with the publication of the annex series of the Payment and Settlement Systems Report, in addition to its regular edition. Furthermore, BOJ has been making efforts for the timely disclosure of the research outcomes on fintech and financial innovations by using various vehicles such as its working papers and review series. Project Stella is part of these efforts.

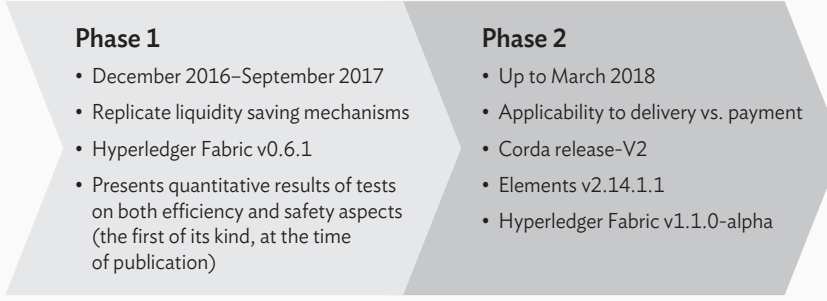
[2] BOJ (2018), pp. 23–24.

11.3 Project Stella

11.3.1 | Overview

DLT is a set of tools for recording data, such as asset holdings or financial transactions, that allows a network of computers to verify and store updates without a single central management system. Project Stella, announced in December 2016, continues to assess DLT solutions in financial market infrastructures. This section introduces the first and second reports of the collaboration, published in September 2017 and March 2018 respectively (hereafter "phase 1 report" and "phase 2 report") (see Figure 11.1)(ECB and BOJ 2017, 2018).

Figure 11.1: Overview of Project Stella



Source: Project Stella phase 1 and 2 reports.

Project Stella contributes to the ongoing debate concerning the feasibility of DLTs for financial markets.[3] This joint research builds on the interest of central banks in ensuring that innovations facilitate safer, faster, and cheaper financial transactions.

This project is exploratory within the described scope. The project's first phase assesses whether specific functionalities of existing payment systems, specifically liquidity-saving mechanisms of BOJ-NET and TARGET2, could be safely

[3] Japanese FMIs are researching DLT. See addendum of BOJ (2018).

and efficiently run in a DLT application, focusing on hands-on testing only.[4,5] The areas of cost efficiency, market integration, and oversight are left for future study. DLT efficiency and safety broadly encompasses the design, functionality, and resource needs of the arrangement (CPMI 2017). Project Stella phase 1 is, however, a first step in the process of assessing DLTs with a limited focus on some facets of both the speed of processing and operational resilience. Furthermore, it should be considered that the analysis contained in the first phase is based on Hyperledger Fabric version 0.6.1, which is a, "developer preview release [...] intended to exercise the release logistics and stabilize a set of capabilities for developers to try out".[6]

While the first phase test series produced promising results, it should be taken into account that no direct conclusions can be drawn from the test set-up with respect to any potential production use. As of the publication of the phase 1 report, given the relative immaturity of the technology at the time, DLT is not a solution for large-scale applications like BOJ-NET and TARGET2.

The objective of the second phase is to explore how the settlement of two linked obligations, such as the delivery of securities against the payment of cash, could conceptually be designed and operated in an environment based on DLT.[7] Settlement mechanisms based on delivery-versus-payment (DVP) link the transfer of two assets in such a way as to ensure that the transfer of one asset occurs if and only if the transfer of the other asset also occurs. The settlement is either that both parties successfully exchange those assets, or no transfer takes place. Such a condition is also often referred to as "atomicity" in computer science.[8] The second phase of the research examines ways in which DVP can be conceptually designed and technically achieved in a DLT environment drawing on existing models, as well as innovative solutions that are being discussed for distributed ledgers. In order to gain practical understanding on DVP functioning

4 Liquidity-saving mechanism smart contracts programmed and run by BOJ and ECB were designed based on queuing and bilateral offsetting mechanisms in BOJ-NET and TARGET2, respectively.

5 For Project Stella phase 1, the ECB conducted its experimental work in a virtualized and restricted in-house test environment, while BOJ used cloud computing services. We programmed and ran smart contracts, and measured the performance of the DLT-based solutions. Each fictitious participant in the system was allocated an account and all related information was stored in the ledger. See Section 4 of the phase 1 report for test set-up.

6 See release from Hyperledger Fabric dated 16 September 2016.

7 "The authors of the phase 2 report are grateful to R3, IBM and DG Lab for technical advice." See footnote 2 of the phase 2 report.

8 Atomic operations, as implied by the term's base meaning, cannot be divided; either all operations are fully performed or they are not performed at all.

on DLT, prototypes were developed using three platforms: Corda, Elements, and Hyperledger Fabric (hereafter referred to as Fabric). The analysis is based on a basic, stylized scenario of two counterparties exchanging securities against cash.[9]

Phases 1 and 2 do not attempt to replicate existing payment and securities settlement systems and are not geared toward replacing existing central bank services with DLT-based solutions. Legal aspects have not been the object of the study.

11.3.2 | Main Findings of Phase 1

DLT-Based Solutions Could Meet the Performance Needs of an RTGS System

The analysis found that a DLT application could process payment request volumes comparable to those routed to RTGS systems in the eurozone and Japan. Considering the average traffic of the two centralized payment systems (between approximately 10 and 70 requests per second) (see Figure 11.2), transactions were processed in less than 1 second on average. When increasing requests per second up to 250, however, the analysis confirmed that the trade-off between traffic and performance was significant. More generally, tests proved the feasibility of implementing the processing logic of standard liquidity-saving mechanisms (queuing and bilateral offsetting) in a DLT environment.

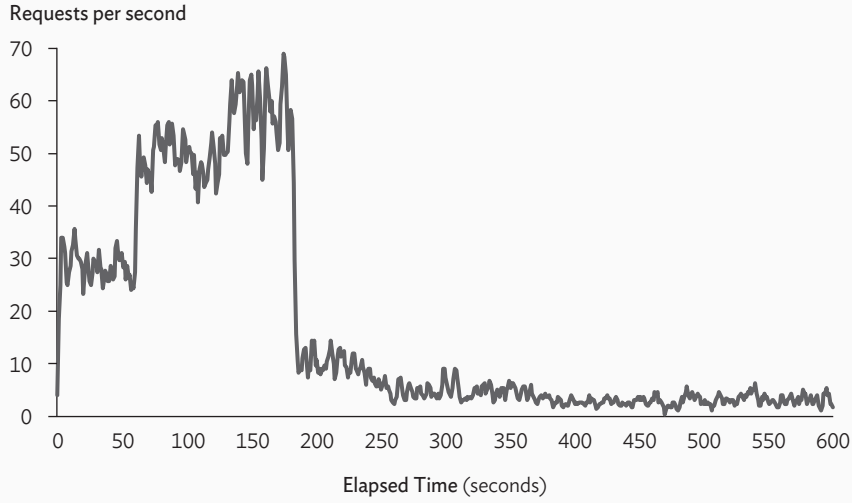
DLT Performance Is Affected by Network Size and the Distance between Nodes

The analysis confirmed the well-known trade-off between network size and performance. Increasing the number of nodes[10] led to an increase in payment execution time. Furthermore, the impact on performance from the distance between nodes was found to depend on the network configuration: provided the minimum number of nodes (quorum) required to achieve consensus was sufficiently close together (see "concentrated" scenario in Figure 11.3), the effect of dispersion in the rest of the network on latency was limited (see Figure 11.4). Nevertheless, the nodes on the periphery of the network may produce inconsistencies with the quorum. If the quorum is sufficiently dispersed, the effect on latency will be greater.

[9] Similar to phase 1, in the phase 2 test set-up, participants (buyers and sellers of securities) are fictitious.

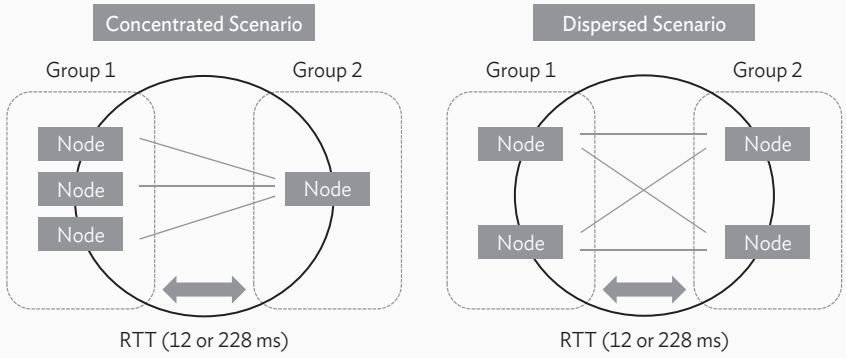
[10] Nodes, or "validating nodes", are responsible for gathering and processing transactions to append to the ledger. See annex 2 of the phase 1 report.

Figure 11.2: Sample Requests per Second during Peak Hours



Source: Project Stella phase 1 report.

Figure 11.3: Scenarios Explored

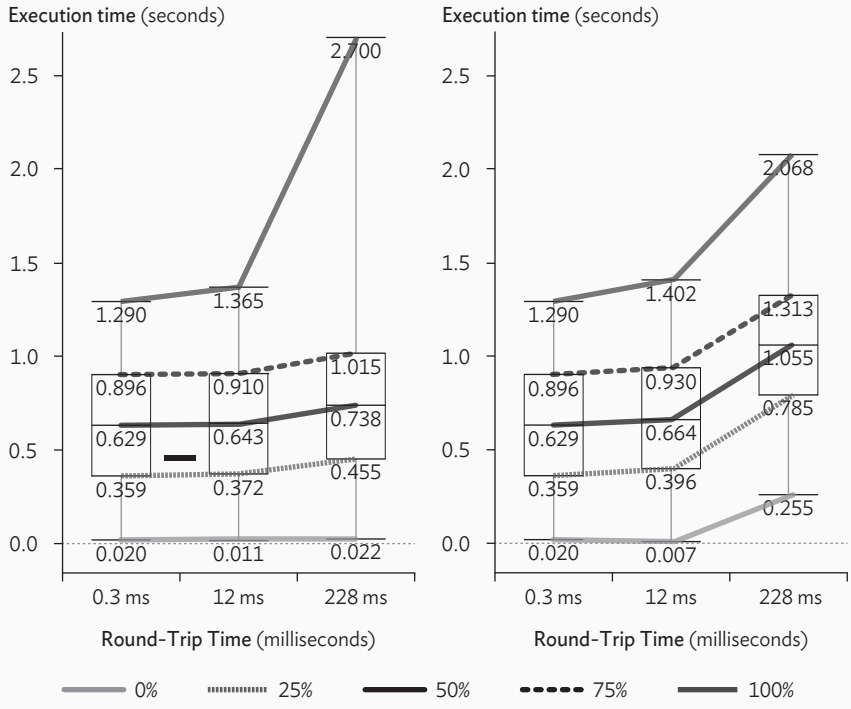


- In the concentrated scenario, three nodes were in the same location and the fourth node was separated from the others.
- In the dispersed scenario, the nodes were evenly distributed between two locations.
- In both scenarios, the distance between the locations was set to have a round-trip time of (i) 12 ms (i.e., the time needed for a message to cover the distance between Tokyo and Osaka), and (ii) 228 ms (i.e., between Frankfurt and Tokyo). Round-trip time for the baseline scenario is 0.3 ms.

ms = milliseconds, RTT = round-trip time.

Source: Project Stella phase 1 report.

Figure 11.4: The Effect of Node Location and Latency



Note: The execution time (y-axis) is the time between (i) a transaction request being sent, and (ii) the transaction being executed and written to a block for each node.

Source: Project Stella phase 1 report.

DLT Solutions Have the Potential to Strengthen Resilience and Reliability

The analysis, while not exhaustive, indicated the potential of a DLT network to withstand issues such as validating node failures and incorrect data formats. Regarding node failures, it was observed that, as long as the number of nodes required by the consensus algorithm was operational, system availability was not affected. Tests also confirmed that a validating node could recover irrespective of downtime. However, it should also be considered that the chosen DLT set-up includes a single certificate authority, which is a single point of failure that could undermine the benefit of distributed validation. Furthermore, tests using incorrect data formats showed the system to be capable of detecting incorrect data formats without affecting overall performance.

11.3.3 | Main Findings of Phase 2

DVP Can Run in a DLT Environment Subject to the Specificities of the Different Platforms

DVP could be conceptually and technically designed in a DLT environment with cash and securities on the same ledger (single-ledger) or on separate ones (cross-ledger). The concrete design of DVP, however, depends on the characteristics of the DLT platforms, e.g., range of information shared among participants, data structure and locking of delivered assets. In addition, depending on the use case, the design of DVP can be influenced by several factors, including the interaction of its arrangement with other post-trade infrastructures.

DLT Offers a New Approach for Achieving DVP between Ledgers, Which Does Not Require Any Connection between Ledgers

Conceptual analysis and conducted experiments have proven that cross-ledger DVP could function even without any connection between individual ledgers, a novelty that does not exist in today's set-up.

Functionalities such as cross-chain atomic swaps have the potential to help ensure interoperability between ledgers (of either the same or different DLT platforms) without necessarily requiring connection and institutional arrangements between them (Figure 11.5).[11]

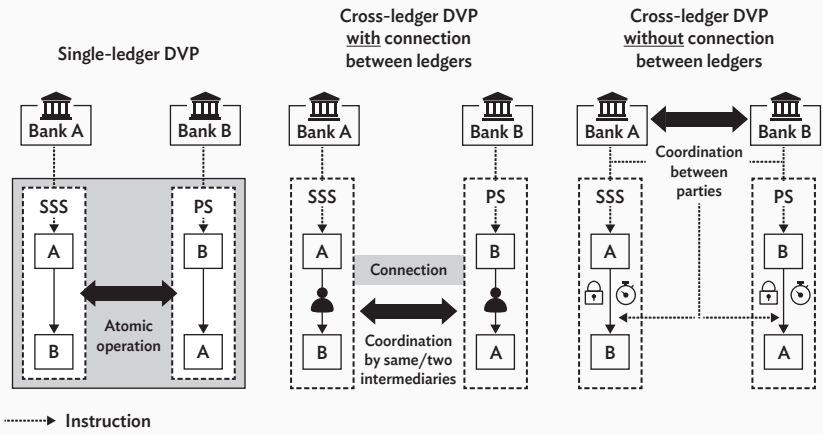
Cross-chain atomic swap mechanisms were originally developed for the purpose of exchanging two cryptoassets on two separate blockchains without relying on a third party.[12] The key elements of cross-chain atomic swaps are the use of digital signatures and so-called hashed timelock contracts (HTLC) to support the atomicity in transferring two assets across two separate ledgers. HTLC is one of the building blocks of Lightning Networks and similar ideas are also being used in Ripple Interledger Protocol, although they assume connections between ledgers and could be categorized as cross-ledger DVP with connection between ledgers.[13]

11 From a technical point of view, functionalities that enable cross-chain atomic swaps could be implemented for non-DLT platforms.

12 The original idea was first described by Tier Nolan in 2013 (https://bitcointalk.org/index.php?topic=193281). In this study, the modified version of the original Tier Nolan approach was used. For further information, see annex 5 of the phase 2 report.

13 For further information about HTLC, refer to Poon and Dryja (2016).

Figure 11.5: Stylized Approaches for DVP on DLT



DLT = distributed ledger technology, DVP = delivery versus payment, PS = payment system, SSS = securities settlement system.

Source: Project Stella phase 2 report.

Table 11.1: Comparison between Single-ledger DVP and Cross-ledger DVP with HTLC

	Single-ledger DVP	Cross-ledger DVP with HTLC
Infrastructure Design	Able to perform DVP across different asset classes	DVP can be achieved without developing institutional arrangements or operational procedures between the two ledgers
Advantages	Liquidity efficiency Settlement speed	Flexibility
Issues	Flexibility Scalability Resiliency	Liquidity efficiency Settlement speed

DLT = distributed ledger technology, DVP = delivery versus payment, HTLC = hashed timelock contracts.

Source: Project Stella phase 2 report.

Cross-ledger DVP Arrangements on DLT May Entail Certain Complexity and Could Give Rise to Additional Challenges

The process of DVP transactions between ledgers that have no connection requires several steps and interactions between the seller and the buyer (see Appendix A11.1). Depending on the concrete design, this could impact transaction speed and require the temporary blockage of liquidity. It should also be borne in mind that independently acting ledgers may inadvertently affect each other operationally. From a risk perspective, the absence of a fully synchronized process could also expose participants to principal risk if one of the two counterparties does not complete the necessary steps. Those additional risk aspects would need to be properly addressed.

11.4 Conclusion

Project Stella studies the possible use of DLT for FMIs, including large-value central bank RTGS systems. Phase 1 implemented the processing logic of the standard liquidity-saving mechanisms in a DLT environment, and the analysis found that an application could meet the performance needs of an RTGS system. There is a trade-off between DLT performance and network size or distance between nodes. DLT solutions have the potential to strengthen resiliency and reliability.

In phase 2, the project team proved that cross-ledger DVP could function even without any connection between individual ledgers. HTLC and digital signatures would be used to achieve interoperability between ledgers, while liquidity efficiency and settlement speed may be negatively affected as a result.

DLT solutions have the potential to improve safety and efficiency of existing systems adopted at FMIs, yet balancing diverse system requirements demands careful analysis and consideration. As evidenced by increasing research and proofs-of-concept on DLT undertaken by many central banks[14] and securities exchanges in major jurisdictions, there are both opportunities and challenges for further exploration.

[14] See Figure 6 of BOJ (2018). Between the projects run by central banks, there is a difference in terms of industry participation and collaboration. Jasper III, for example, was commissioned by Payments Canada, TMX Group and Bank of Canada in collaboration with delivery partners Accenture and R3. See Payments Canada et al. (2018). Project Stella is undertaken by ECB and BOJ, with technical advice from vendors (see footnote 10).

REFERENCES

Amamiya, M. 2018. The Future of Money. Speech at the 2018 Autumn Annual Meeting of the Japan Society of Monetary Economics, 20 October. Tokyo: BOJ.

Bank of Japan (BOJ). 2018. Fintech Special Edition – Financial Innovation and Fintech, Payment and Settlement Systems Report Annex. Tokyo: BOJ.

Committee on Payments and Market Infrastructures (CPMI). 2015. Digital Currencies. November. Basel: CPMI.

———. 2017. Distributed Ledger Technology in Payment, Clearing and Settlement – An Analytical Framework. Basel: CPMI.

———. 2018. Central Bank Digital Currencies. March. Basel: CPMI.

European Central Bank and Bank of Japan. 2017. Project Stella – Payment systems: Liquidity Saving Mechanisms in a Distributed Ledger Environment. 6 September. http://www.boj.or.jp/en/announcements/release_2017/rel170906a.htm/ (accessed 17 August 2019).

———. 2018. Project Stella – Securities Settlement Systems: Delivery-Versus-Payment in a Distributed Ledger Environment. 27 March. http://www.boj.or.jp/en/announcements/release_2018/rel180327a.htm/ (accessed 17 August 2019).

Monetary Authority of Singapore, Singapore Exchange, Anquan Capital, Deloitte, and Nasdaq. 2018. Delivery Versus Payment on Distributed Ledger Technologies – Project Ubin, 11 November. Singapore: Monetary Authority of Singapore.

Payments Canada, Bank of Canada, TMX Group, Accenture, and R3. 2018. Jasper III – Securities Settlement Using Distributed Ledger Technology. October. Ottawa: Bank of Canada.

Poon, J. and T. Dryja. 2016. The Bitcoin Lightning Network: Scalable Off-Chain Instant Payments. 14 January. https://lightning.network/lightning-network-paper.pdf (accessed 17 August 2019).

APPENDIX 11

Process Flow for Cross-ledger DVP with HTLC

The idea behind the cross-ledger DVP is for the two counterparties to agree on transfer instructions based on the committed records on ledgers and to use HTLC for conditional delivery of securities and payment of cash. To be concrete, a cryptographic hash function enables the two counterparties to block the assets to be delivered and a timelock enables them to recover the assets when the process fails. In addition, as the cryptographic hash of the secret links all instructions throughout the process flow, like the single-ledger DVP process flow, there is no need for a specific matching function on the DLT network.

Settlement Success Scenario

In Figure A11.1, the seller of securities (Bank A) and the buyer of securities (Bank B) have agreed to the amount, asset type, locking time, and cryptographic hash function (H) to be exchanged. The agreement comprises two sets of transfers: (i) eight units of securities from Bank A to Bank B within 2 hours, and (ii) six units of cash from Bank B to Bank A within 1 hour.[1] Both Bank A and Bank B have access to the DLT networks where securities and cash are settled respectively and the flow of time of these networks is predictable by both participants.

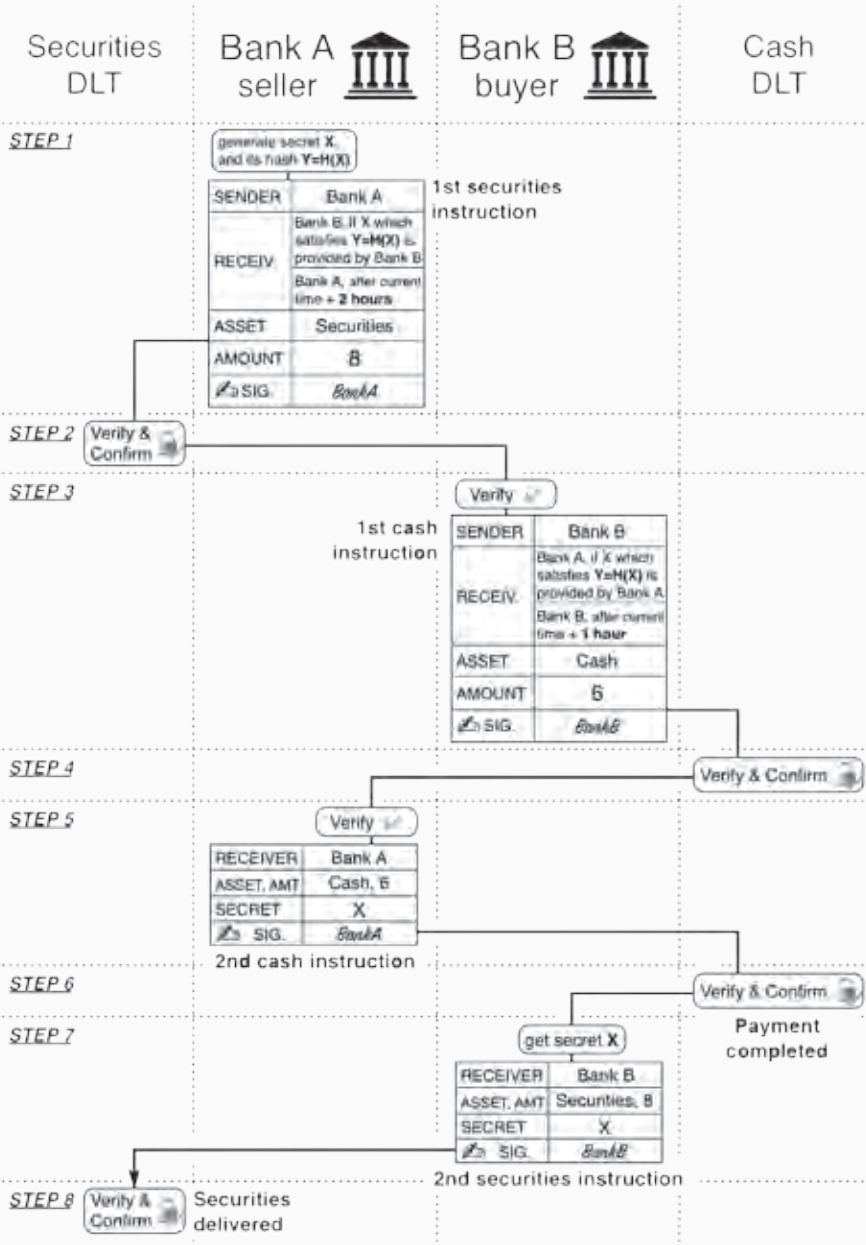
Settlement is successful when participants follow the following steps:

(1) Bank A (original holder of the securities) generates a secret (***X***) and its hash (***Y*** = H[***X***]).[2] Bank A shares ***Y*** with Bank B. As long as a one-way hash function is used, it is impossible within reasonable assumptions for Bank B to find ***X*** from ***Y***. Bank A creates the first securities instruction (spending of the agreed amount of securities). In this instruction, Bank A specifies the following two states: (i) the receiver of the securities will be Bank B if Bank B provides ***X*** which satisfies ***Y*** = H(***X***), or (ii) the receiver of securities will be Bank A if 2 hours pass. Bank A then signs it and submits the signed instruction to the securities consensus mechanism.

1 In most of the DLT platforms used in this study, the locking time can be defined either as an absolute time (e.g., 12:00 a.m, 31 March 2018) or a relative time (e.g., within 1 hour after the instruction is confirmed). The locking time used in the process flow description is for illustrative purposes only and actual implementation would differ based on the configuration of the environment.

2 Either Bank A or Bank B can be the generator of the secret; for this study, Bank A is its generator.

Figure A11.1: Process Flow for Cross-ledger DVP with HTLC



DLT = distributed ledger technology, DVP = delivery versus payment, HTLC = hashed timelock contracts.

Source: Project Stella phase 2 report.

(2) Following the implemented consensus mechanism of the platform, the submitted first securities instruction is verified and confirmed, and results are written on the ledger in the securities DLT network.

(3) Bank B (original holder of the cash) verifies the content of the committed first securities instruction of Bank A. Bank B then creates the first cash instruction (spending of the agreed amount of cash). In this instruction, Bank B specifies the following two states: (i) the receiver of cash will be Bank A if Bank A provides $\boldsymbol{X}$ which satisfies $\boldsymbol{Y} = H(\boldsymbol{X})$, or (ii) the receiver of cash will be Bank B if 1 hour passes. Bank B signs it and submits the signed instruction to the cash consensus mechanism.

(4) Following the implemented consensus mechanism of the platform, the submitted first cash instruction is verified and confirmed, and results are written on the ledger in the cash DLT network.

(5) Bank A verifies the content of the committed first cash instruction of Bank B. Bank A then creates the second cash instruction (obtaining of the agreed amount of cash) providing $\boldsymbol{X}$, signs it, and submits the signed instruction to the cash consensus mechanism.

(6) Following the implemented consensus mechanism of the platform, the submitted second cash instruction is verified and confirmed, and results are written on the ledger in the cash DLT network.

At this point, the agreed amount of cash is transferred from Bank B to Bank A.

(7) Bank B obtains $\boldsymbol{X}$ specified in the committed second cash instruction of Bank A. Bank B then creates the second securities instruction (obtaining of the agreed amount of securities) providing $\boldsymbol{X}$, signs it, and submits the signed instruction to the securities consensus mechanism.

(8) Following the implemented consensus mechanism of the platform, the submitted second securities instruction is verified and confirmed, and results are written on the ledger in the securities DLT network.

At this point, the agreed amount of securities is transferred from Bank A to Bank B.

Potential Settlement Fail Scenarios

Settlement could fail if one of the steps described above is not completed. For cross-ledger DVP with HTLC, this could result in two different risk scenarios. In the first scenario, settlement is not successful and cash and securities are returned to the original holders. In the second scenario, settlement is not successful and one of the counterparties could be exposed to principal risk.

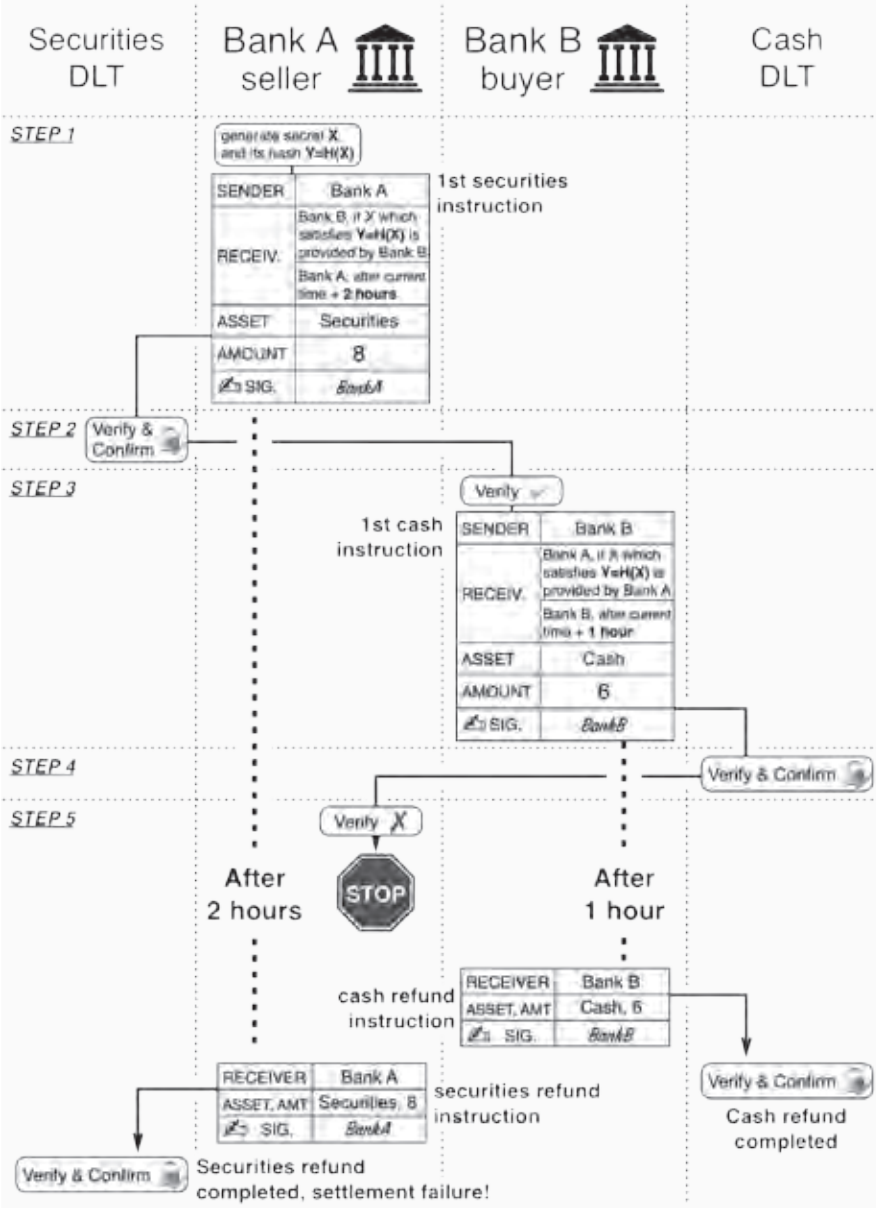
In the first scenario (see Figure A11.2 when the process is suspended at step 5), settlement fails could occur, for example, where the first securities instruction and the first cash instruction are completed, but Bank A (receiver of cash and generator of the secret) does not submit the second cash instruction within the predefined locking time (1 hour). In this case, while the transfer of both cash and securities is not successful, neither counterparties are exposed to principal risk as the assets are returned to the original holders after the locking time expires. The counterparties would, however, be exposed to replacement cost risk and liquidity risk.

In the second scenario (see Figure A11.3 when the process is suspended at step 7), settlement fails could occur during the process flow where one counterparty (here Bank A) already retrieved the agreed amount of cash and the other counterparty (here Bank B) did not complete the second securities instruction within the predefined locking time (2 hours). In this case, the locking time for the latter instruction will expire and the original holder (Bank A) can refund the locked assets (securities). Ultimately, this counterparty (Bank A) will hold both his refunded assets (securities) and the retrieved assets (cash), while the other counterparty (Bank B) will be exposed to principal risk for his settled assets (securities). In this specific fail scenario, only one leg of the transaction is settled and DVP will not be achieved.[3] This scenario illustrates weakness of HTLC and stresses the need for further developments.[4]

[3] Several arrangements may be considered to mitigate such risks. For example, the locking time could be set at a large interval (e.g., 24 hours, 48 hours). A larger difference between the two locking times increases the likelihood of successful settlements, while it also reduces the efficiency in the use of liquidity when a settlement fails. Another approach could be for Bank B to incentivize a third party to send the second securities transaction on its behalf, with the assumption that an instruction with a cryptographic signature can only be changed by Bank B.

[4] The Monetary Authority of Singapore, in collaboration with the industry, is exploring the use of DLT, which is named Project Ubin. The third report of Project Ubin explores how DVP settlement finality, inter-ledger operability, and investor protection may be realized through specific solutions. One of the differences between Project Stella phase 2 and Ubin's DVP-on-DLT project is that the latter introduces a dispute resolution mechanism by an arbitrator. The arbitrator would intervene during a process flow when, for example, a buyer of securities is exposed to principal risk, and pass judgement on possible recourse. See Monetary Authority of Singapore et al. (2018). Project Stella phase 2, the report of which was published about 8 months earlier than that of Ubin's DVP-on-DLT report, does not have such a dispute resolution mechanism, as illustrated in the second settlement fail scenario.

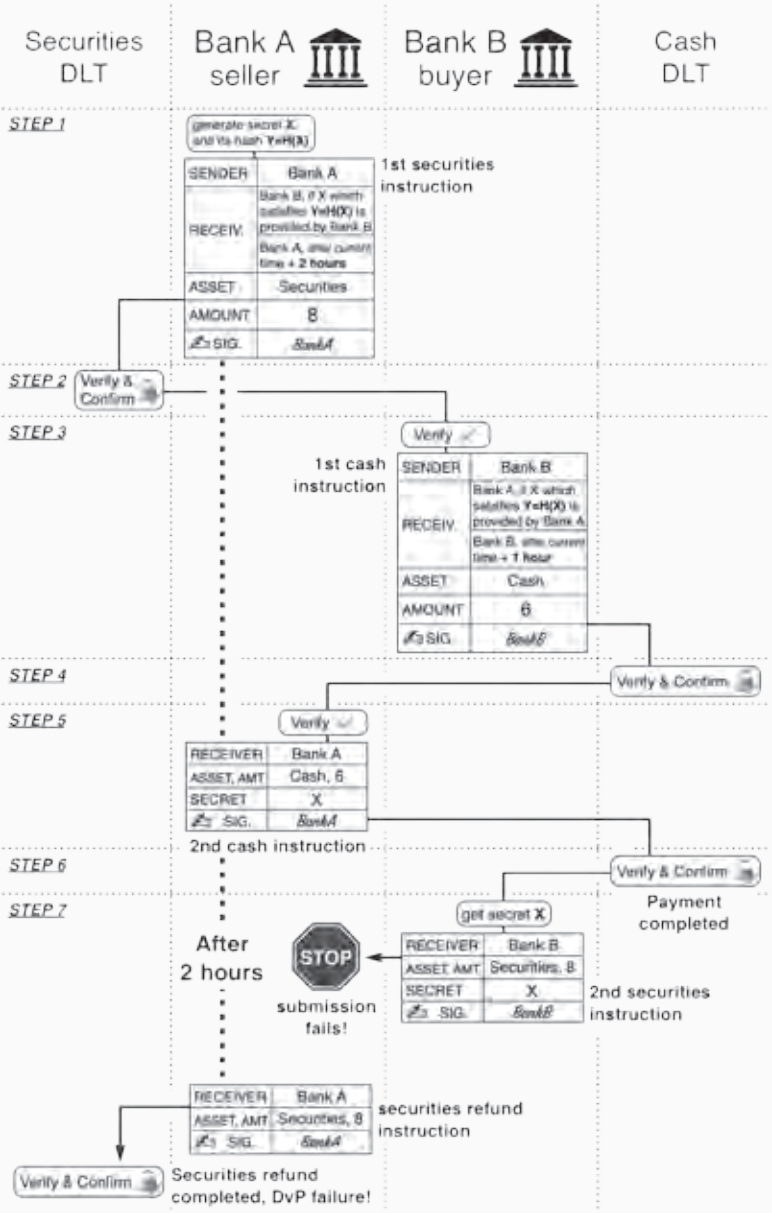
Figure A11.2: Settlement Fail Scenario of Cross-ledger DVP with HTLC (Process is Suspended at Step 5)



DLT = distributed ledger technology, DVP = delivery versus payment, HTLC = hashed timelock contracts.

Source: Project Stella phase 2 report.

Figure A11.3: Settlement Fail Scenario of Cross-ledger DVP with HLTC (Process is Suspended at Step 7)



DLT = distributed ledger technology, DVP = delivery versus payment, HTLC = hashed timelock contracts.

Source: Project Stella phase 2 report.

CHAPTER 12

Fintech, Cryptoassets, and Central Bank Digital Currency in the Republic of Korea

Ohik Kwon, Jongik Park, and Byoung-Ki Kim*

12.1 Introduction

In recent years, financial innovation has been one of the most discussed economic issues in the Republic of Korea. In particular, financial technology (fintech), cryptoassets, and central bank digital currency (CBDC) are drawing much attention from the public, as well as policy makers. Because these topics are closely related to the fundamental role of a central bank, the Bank of Korea has been watching the progress of financial innovation with great interest, and preparing for changes in the economic environment.

In this chapter, we briefly introduce key features and progress around financial innovation by focusing on fintech, cryptoassets, and CBDC. We also review measures and assessments of the government, as well as the Bank of Korea, concerning these topics.

* The views expressed herein are those of authors and do not necessarily reflect the official views of the Bank of Korea. When reporting or citing this chapter, the authors' names should always be explicitly stated.

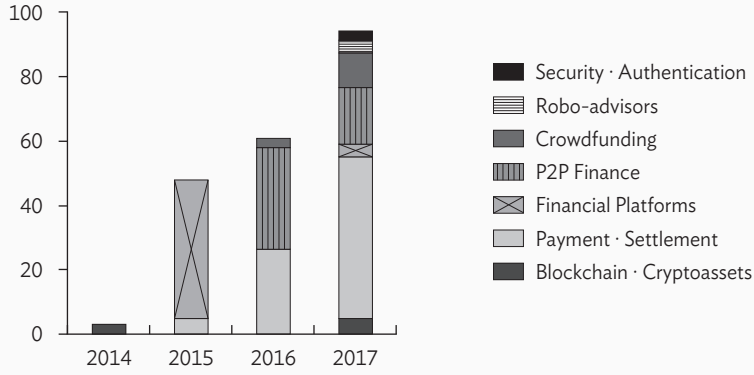
This chapter is based on the reports published by the Bank of Korea including Financial Stability Report June 2018 (BOK 2018b), Financial Stability Report December 2018 (BOK 2018c), Cryptoassets and Central Bank (in Korean) (BOK 2018a), Central Bank Digital Currency (in Korean) (BOK 2019a), and Payment and Settlement System Report 2018 (BOK 2019b).

12.2 Fintech

12.2.1 | Ongoing Progress

The fintech industry in the Republic of Korea has been growing steadily since the mid-2010s. Now, fintech is gradually spreading into payment and settlement services, and further into peer-to-peer (P2P) lending, crowd funding, robo-advisors, etc. The total amount of investment in the fintech industry has increased as well, from W3 billion in 2014 to W100 billion in 2017 (see Figure 12.1). More than half of the investment in 2017 centered on payment and settlement services (Bank of Korea 2018b).

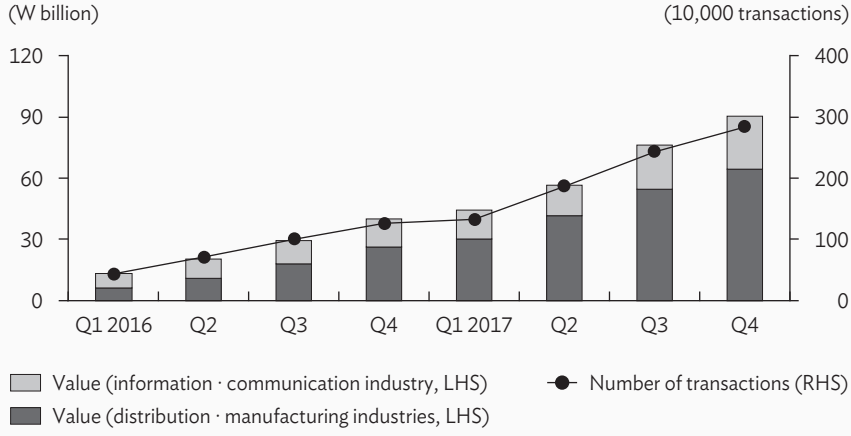
Figure 12.1: Amount of Investment in Fintech (W billion)



P2P = peer-to-peer.
Note: Based on startups attracting investments of W3 billion or more.
Source: Platum (2018).

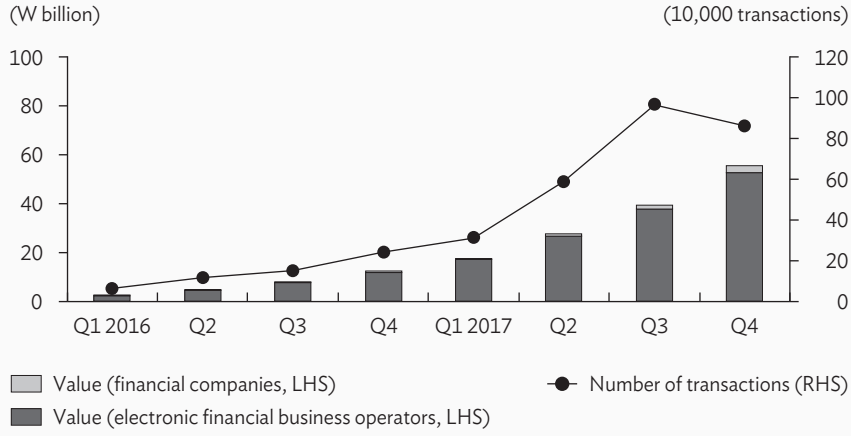
In 2017, the average daily usage of easy payment services was W67.2 billion, an increase of more than 150% compared to the previous year (see Figure 12.2). In the case of easy transfer services, the average daily usage jumped to W35.1 billion, an increase of more than 400% from 2016 (see Figure 12.3). The use of P2P lending and crowd funding has also been on an upward trend (Bank of Korea 2018b).

Figure 12.2: Daily Average Values and Transactions Using Easy Payment Services



LHS = left-hand scale, RHS = right-hand scale.
Source: Bank of Korea.

Figure 12.3: Daily Average Values and Transactions Using Easy Transfer Services



LHS = left-hand scale, RHS = right-hand scale.
Source: Bank of Korea.

12.2.2 | Utilization of Fintech in Mobile Payment and its Background

Although its usage has markedly increased, fintech accounts for only a small share of each market and services and the utilization of fintech for payment and settlement services is not enough. Despite the recent entry of startups and multiple fintech companies into mobile point-of-sale (POS) payment services, in particular, credit cards[1] accounted for approximately 70% of mobile POS payments in the first half of 2018.[2]

This is attributed to the following reasons. First, the development of the POS payment market has centered on credit cards because of the government's policies to secure tax revenues. For example, the obligation to accept credit cards, the no-surcharge rule, and tax benefits have led to credit card-focused development. Second, the financial market infrastructure has been set up mainly for banking services. The real-time payment and settlement system was set up relatively early. Besides, the bank account ownership rate is very high. Finally, the regulatory framework has not been fintech-friendly. For instance, the obligation to use accredited certificates[3] was abolished in 2015. As a result, fintech firms have been entering the POS market in earnest since 2015.

12.2.3 | Government Measures

The government has been trying to foster the fintech industry by, for example, loosening related regulations. In addition to abolishing the obligation to use accredited certificates, the government revised the Capital Market Act to embrace fintech and implemented regulatory sandboxes at the beginning of 2019. In addition, a further loosening of regulations, such as increasing the upper limits on money transfers, will be implemented soon.

1 Credit card information is stored in mobile applications.

2 Although fintech firms provide remittance services that are more convenient for users, mobile money transfers processed by commercial banks accounted for 98% of the market over the same period.

3 The accredited certificate is a kind of digital signature, which is required to use internet banking services and e-commerce.

12.3 Cryptoassets

12.3.1 | Recent Developments in Cryptoasset Markets

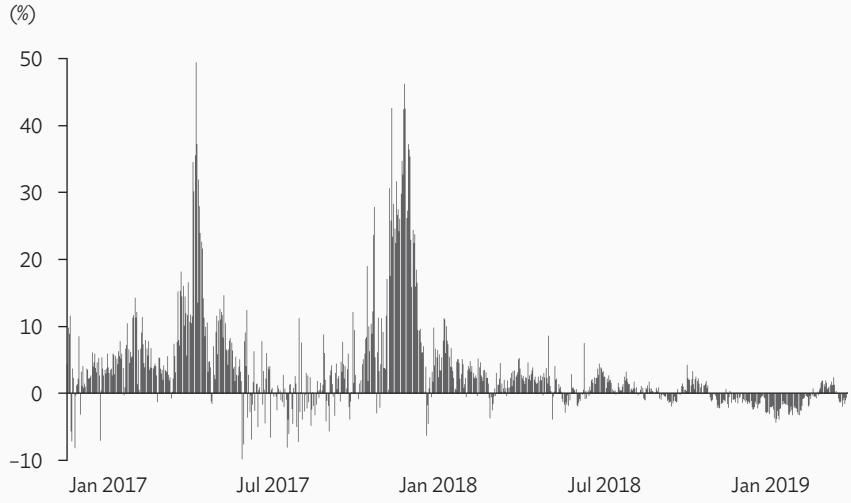
The cryptoasset markets in the Republic of Korea have shown high volatility mainly reflecting regulatory changes at home and abroad (see Figure 12.4). In particular, they exhibited overheating between the first half of 2017 and early 2018. The gap between domestic and overseas cryptoasset prices, a phenomenon known as the "Kimchi Premium", indicated the degree of domestic cryptoasset market overheating. The "Kimchi Premium" for Bitcoin rose more than 40% for specific moments (see Figure 12.5). With the market cooling down since the beginning of 2018, however, this premium has disappeared. Since mid-November 2018, the price of Bitcoin is hovering around W4 million–W5 million, with a sharply lowered trading volume.

Figure 12.4: Bitcoin Price and Trading Value

LHS = left-hand scale, RHS = right-hand scale.

Sources: Bithumb.com, Cryptocompare.com.

Figure 12.5: Kimchi Premium



Sources: Coinmarketcap.com, Bithumb.com.

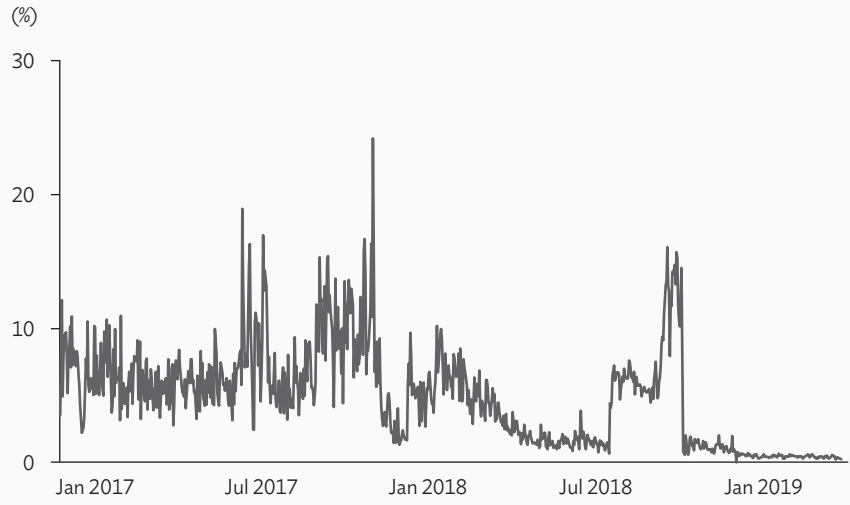
With the price of Bitcoin cooling, the won's share in its trade with hard currencies has notably dropped (see Figure 12.6). The won's share temporarily surged in Bitcoin trading in the second half of 2018 due to promotions at some cryptoasset exchanges, but soon dropped again and has remained at around 0.5% from January to April 2019, a low level considering the scale of the economy.[4]

12.3.2 | Government's Policy Response to Cryptoassets

The government has responded to the overheated market for cryptoassets, emphasizing consumer protection and prevention of illegal transactions. This includes banning initial coin offerings (ICOs) (September 2017), implementing a real-name cryptoasset transaction system (January 2018), and establishing anti-money laundering guidelines (January 2018).

[4] As of 2017, the Republic of Korea economy accounted for around 2% of the global nominal gross domestic product.

Figure 12.6: Share of Won-denominated Bitcoin Settlements



Sources: Coinmarketcap.com, Cryptocompare.com.

Prohibiting ICOs

In September 2017, the government announced the ban on ICOs, citing their side effects: the overheating of markets due to heightened speculative demand, a growing risk of fraud, and consumer victimization. After the ICO prohibition, some local businesses moved their headquarters overseas, for example to Switzerland or Singapore, where ICOs are allowed. A government survey[5] in the second half of 2018 to see how those ICOs were conducted overseas concluded that the risk of investing in one remained high. As a result, the government announced in January 2019 that it would maintain its ban, and it provided several reasons for standing its ground: overseas ICOs did not offer the information people needed to make clear investment decisions, nor details about how or where the raised funds were going to be used, and none of the businesses provided any practical service.

While the government has maintained a cautious stance toward ICOs, it plans to fully support the advancement of blockchain technology and relevant industries.

[5] Between September and November 2018, the government carried out a survey of 22 businesses that had conducted their ICOs overseas and examined their white books and PR materials.

Anti-money Laundering

On the international front, at the request of the Group of Twenty (G20),[6] the Financial Action Task Force revised its recommendations, and is seeking to revise its guidelines, in an effort to prevent money laundering or terrorist financing through cryptoassets, with the government also seeking to revise acts and laws accordingly. The government's existing guidelines adopted indirect regulations on financial firms that trade with the cryptoasset exchanges; however, recently proposed bills[7] include the imposition of direct money-laundering prevention obligations on cryptoasset dealers. In addition, before dealing with cryptoassets, dealers are required to report to the supervisory authorities. The bill also includes an article related to the cancellation of qualifications and penalties if the requirement is breached. Also, the supervisory authorities are unwilling to accept the report if the dealers use virtual accounts whose holders' real names are not verified. These are all seen to be steps that strengthen the real name system from past administrative guidance.

12.3.3 | Assessment of Cryptoassets

Qualification as Currency

Whether cryptoassets are qualified to be currency can be assessed depending upon whether they carry out the functions of money, including being a medium of exchange, a unit of account, and a store of value.

A medium of exchange should be portable and widely accepted, as a currency is. Cryptoassets are portable, but their values are very volatile, making it unlikely they will be widely accepted within a short period of time. In addition, contrary to the existing means of payment, such as cash or debit or credit cards, cryptoassets have a low competitiveness in terms of transaction costs and stability. Therefore, for now, they can be used as a medium of exchange within a very limited scope.

---

6 At the G20 Financial Ministers and Central Bank Governors Meeting in March 2018, it was assessed that cryptoasset-related technologies can make the financial system more efficient and inclusive, but such technologies can also cause issues in terms of investor protection, tax evasion, money laundering and the use of funds for terrorism. Accordingly, the G20 asked the Financial Stability Board and the Financial Action Task Force to report progress related to the establishment of international standards related to cryptoassets.

7 The Act on Reporting and Use of Certain Financial Transaction Information was brought before the National Assembly in March of this year and is pending as of May.

In addition, it is difficult for cryptoassets to play a role as a unit of account or a measure of value, due to their highly volatile market values. While the currency supply can be adjusted by the central bank, the supply of cryptoassets is determined in advance based on an algorithm. Therefore, it is difficult to maintain their prices or values.

Finally, since currencies, unlike cryptoassets, are highly liquid and stable, they can be used as means of storing value. In light of these three aspects, there is a low possibility at this point that cryptoassets would replace regular currencies.

Impact on Central Banking

The impact of cryptoassets on the macroeconomy and the financial system has been meagre so far, as government measures,[8] including a ban on cryptoasset purchases, have limited financial institutions' exposure. Major central banks also perceived that the likelihood of cryptoassets replacing existing legal tender or means of payment is very low, given their current status. However, it is necessary to note that central bank mandates, including financial stability and monetary policy, could be affected if cryptoassets were to gain more ground as investment assets and/or as a means of payment. The emergence of new payment services using cryptoassets would result in lower credit card fees, enhanced convenience of mobile payment services, and a cost reduction. Non-P2P payments of cryptoassets made through third parties, i.e., exchanges, could undermine the stability of existing payment and settlement systems by causing delays or the suspension of receipts due to intermediaries' credit and liquidity problems, or via cyberattacks.

Price volatility, price manipulation, and the possibility of a sharp contraction in transactions are regarded as inherent risks[9] to stability. In cases of an increase in the number of financial institutions directly investing in cryptoassets or holding related financial products, and with a growing interconnectedness between the cryptoasset market and existing financial institutions as a result of leverage in cryptoassets, the possibility of the inherent risks spreading to the overall financial system cannot be ruled out. However, given that the volume of cryptoasset investment is not large compared to other asset classes, and that the exposure of financial institutions is small, cryptoassets are at present deemed to have a limited impact on financial stability in the Republic of Korea.

[8] The government prohibited financial institutions from purchasing cryptoassets and from acquiring collateral and equity investments via cryptoassets through measures announced on 13 December 2017.

[9] As cryptoassets are hard to appropriately price due to the controversy over their intrinsic value, and as ownership is concentrated on a limited number of market participants, price manipulation and a sharp contraction in trading can occur, depending on market conditions.

The impact on monetary policy is also likely to be marginal, given the low share of cryptoassets in the economy, and the lack of any institutional foundation for their use as means of payment. Assuming that the demand for cryptoassets as an investment asset and as a means of payment would grow in the future, the effects of the reserve requirement adjustment would likely weaken, and the usefulness of monetary indicators would decline. However, considering that the share of bank lending replaced by cryptoassets would be small, and that the reserve requirement adjustment is less useful under the current interest rate-oriented monetary policy framework, such negative impacts would not be significant.

Currently, it seems unlikely that cryptoassets will become widely used in the economy and compete with legal tender anytime soon. However, it is necessary to monitor and study their development and economic impacts.

12.4 Central Bank Digital Currency

From the beginning of 2018, the Bank of Korea has been studying the possibility of issuing a CBDC by organizing a joint research taskforce. In early 2019, the Bank of Korea published a report and presented its views concerning a CBDC. Considering broad impacts on the economy, as well as the financial sector, the bank takes a cautious stance concerning the issuance of a CBDC. The bank also announced that there would be no possibility of issuing a CBDC in the near future, though it will nonetheless continue to conduct in-depth research not only into a CBDC, but also into distributed ledger technology (DLT) more broadly in preparation for any changes that might occur in the economic environment (Bank of Korea 2019a).

The following two subsections summarize the key messages of the report, and the last subsection introduces mock tests and research conducted by the Bank of Korea.

12.4.1 | Policy Implications

First, a CBDC would bring down the credit risk arising from the interbank market and would significantly reduce the cost associated with payment and settlement. However, as settlement would be concentrated on the central bank, the operational risk could increase accordingly. Competition for payment services between commercial banks and the central bank would be inevitable.

Second, a CBDC can also cause fundamental changes in how a central bank conducts monetary policy. Once a positive interest is paid on a CBDC, the interest rate is likely to work as a lower limit for commercial banks' loans and deposits. It could also be a benchmark for market interest rates. Meanwhile, it seems that the demand for reserves would become more volatile and harder to accurately predict because funds are more likely to move between the CBDC and demand deposits.

Third, the issuance of a CBDC could undermine financial stability and distort the role played by commercial banks. If people deposit some money into a CBDC account rather than into a commercial bank, the latter's funding costs would rise. This could lead to a decline in the supply of credit, which would challenge the role of commercial banks as a financial intermediary, and, in turn, undermine financial stability.

Finally, the issuance of a CBDC expands the central bank's balance sheet, which increases the central bank's portion in the credit allocation in the economy, thus impairing its efficiency.

12.4.2 | Legal Issues

The issuance of a CBDC would require a legal basis. Since the current central banking system is based on currency and reserves, the issuance of a CBDC as an electronic version of legal tender might not be consistent with the current Bank of Korea Act. In addition, it is unclear whether paying a positive (or negative) interest rate on a CBDC would be viable. Other legal issues, such as privacy and abuse of power, may arise since the central bank can collect personal information from daily transaction data.

12.4.3 | Mock Tests and Research

The Bank of Korea has been conducting mock tests of DLT-based interbank payment and settlement systems. Between September and December 2018, the bank tested DLT on retail payment systems in an actual transaction environment between real buyers and sellers and with money transfers between participants in a permissioned network. The test generated some positive results regarding transaction processing efficiency, system resilience, and scalability. The test also confirmed that DLT can ensure settlement finality and anonymity.

Such results imply that the permissioned DLT-based system would not fall behind the current retail payment systems in terms of dealing with the actual transaction volume. However, more evidence would be needed before applying DLT to actual payment and settlement systems. The Bank of Korea will continue to investigate the possibility of application of DLT to its payment and settlement systems (Bank of Korea 2019b).

The Bank of Korea also published research on the impact of a CBDC. Kim and Kwon (2019), in particular, developed a monetary general equilibrium model to investigate how the introduction of a CBDC affects financial stability. Without central bank intervention in the provision of credit to commercial banks, the introduction of a CBDC can undermine financial stability. An increase in the quantity of a CBDC raises the likelihood of bank panic via a reduction in credit, which, in turn, raises the equilibrium interest rate. However, it is shown in the paper that this problem could be fully addressed by lending the exact amount of money in CBDC accounts to the commercial banks, thereby recovering the decrease of credit provision.

12.5 Concluding Remarks

Fintech in the Republic of Korea still accounts for only a small share of payment and settlement services. That said, recent investment in the fintech industry shows a marked increase in, and paves the way for, changes in the financial industry.

It is unlikely that cryptoassets will become widely used and accepted in the near future, considering their limited competitiveness as means of payment and store of value.

A CBDC has both a bright and dark side. It could reduce costs related to payment and settlement processes, while generating non-negligible financial stability issues. The Bank of Korea takes a cautious stance and it announced that it would not issue a CBDC in the foreseeable future.

The bottom line is that we cannot swim against the tide of financial innovation. We should maintain a balanced view of the opportunities and risks brought by financial innovation by monitoring and studying related issues.

REFERENCES

Bank of Korea (BOK). 2018a. Cryptoassets and Central Bank (in Korean). Seoul: BOK.

———. 2018b. Financial Stability Report June 2018. Seoul: BOK.

———. 2018c. Financial Stability Report December 2018. Seoul: BOK.

———. 2019a. Central Bank Digital Currency (in Korean). Seoul: BOK.

———. 2019b. Payment and Settlement System Report 2018. Seoul: BOK.

Kim, Y. S. and O. Kwon. 2019. Central Bank Digital Currency and Financial Stability. Bank of Korea (BOK) Working Paper 2019-6. Seoul: BOK.

Platum. 2018. 2017 Startup Investment Trends in Korea (in Korean).

CHAPTER 13

Project Inthanon and the Project DLT Scripless Bond

Chananun Supadulya, Kasidit Tansanguan, Vijak Sethaput, Wipat Wattanasiriwiroj, and Kantitat Areechitranusorn

13.1 Introduction

Technological advancement is accelerating, impacting our lives, experiences, industries, and economies. This transformative force is also reshaping the financial services industry and challenging traditional business models. To support Thailand's long-term competitiveness, the Bank of Thailand (BOT) fosters technologies that will prepare Thailand's financial sector for a new digital era.

Among disruptive technologies, distributed ledger technology (DLT) demonstrates promise for enhancing the financial infrastructure. DLT enables direct transfers of digital value among parties, with immutable record keeping, smart contracts, and enhanced security. The BOT launched two DLT initiatives in 2018, namely Project Inthanon and Project DLT Scripless Bond, aiming to catalyze an industry-wide exploration and assessment of the potentials and applications of DLT. In addition, these initiatives also focus on redesigning work processes to anticipate a widely decentralized system.

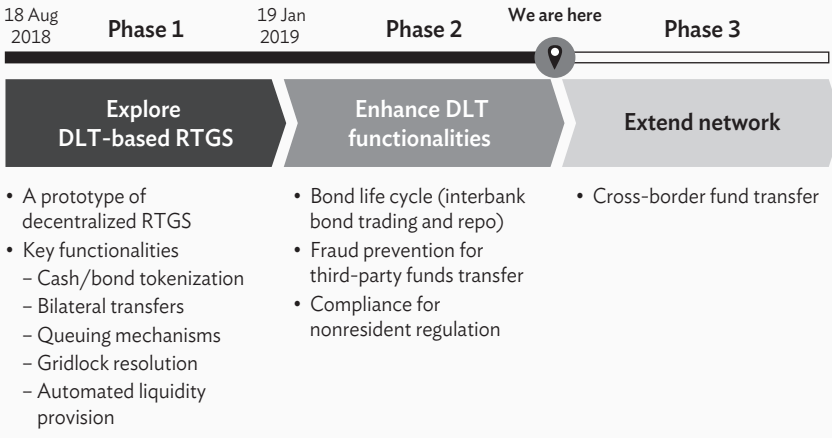
Project Inthanon is a proof-of-concept (POC) for wholesale central bank digital currency for interbank and cross-border settlements. More details on the project's design, key findings, and future considerations are discussed in Section 13.2. Project DLT Scripless Bond aims to improve the registration and sales process. Further details are in Section 13.3.

13.2 Project Inthanon

13.2.1 | Overview

Project Inthanon is a collaborative effort initiated by the BOT, together with eight commercial banks. The prime focus is to develop and test a DLT-based, real-time gross settlement system (RTGS) by issuing wholesale central bank digital currency. Project Inthanon is divided into three phases as shown in Figure 13.1. Each phase builds upon the findings and learning of the previous phase.

Figure 13.1: Overview of Project Inthanon



DLT = distributed ledger technology, RTGS = real-time gross settlement system.

Source: Bank of Thailand.

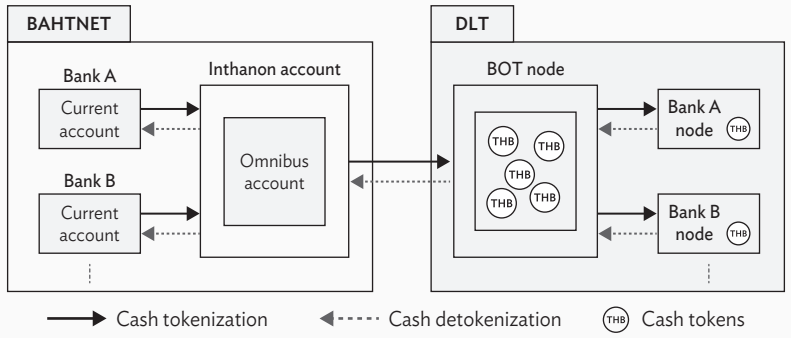
13.2.2 | The Design

Project Inthanon Phase 1

The focus of phase 1 is to build a prototype of a decentralized RTGS with key payment functionalities, that is, the tokenization of cash and bonds, bilateral transfer, queueing mechanisms, gridlock resolution, and automated liquidity provision (ALP). The last functionality, along with the tokenization of bonds, is considered an innovative addition to other central bank studies.

A decentralized payment network is set up on the Corda[1] platform with the BOT node and participating bank nodes. The BOT node has the sole capability to create and destroy Thai baht cash tokens on the network. Other participating bank nodes are entitled to convert their RTGS balance into cash tokens, as shown in Figure 13.2. Once cash tokens are on hand, bank nodes can use them to make payments to other nodes on a peer-to-peer basis.

Figure 13.2: Tokenization of Cash



BOT = Bank of Thailand, DLT = distributed ledger technology, THB = Thai baht.

Source: Bank of Thailand (2019a). Project Inthanon phase 1 report.

When bank nodes encounter temporarily insufficient liquidity for settlement, they can set priorities to their outgoing payment queues to meet business and operational needs. The system also provides gridlock resolution[2] in order to save cash liquidity by netting the queued payments. The design of gridlock resolution in phase 1 is enhanced from models explored in previous central bank studies (Figure 13.3).

[1] Corda is an open-source distributed ledger platform built to record and manage contracts between mutually distrusting parties. Corda was built by R3 in collaboration with the world's largest financial institutions. It was designed to meet the rigorous requirements imposed by financial service regulators, conform to industry standards, and deliver on the promise of DLT. Corda is unique among blockchain platforms in that multiple networks can join to create a wider network with assets that can be transferred between them.

[2] Gridlock is a group of transactions that cannot settle individually in gross due to insufficient liquidity, but two or more transactions are resolvable with one or more net payments. Gridlock resolution is an optimization process to help resolve a gridlock situation. The system searches for a combination of transactions that can be netted, in which these transactions are executed simultaneously.

Figure 13.3: Gridlock Resolution Comparison

Project	GR Steps	
	Initiation, detection, and planning	Execution (net payments)
Jasper	Centralized (Oracle node)	Centralized (Oracle node)
Inthanon	Centralized (Oracle node)	Decentralized (Involved node)
Ubin	Decentralized (Any node)	Decentralized (Involved node)

GR = gridlock resolution.

Source: Bank of Thailand (2019a). Project Inthanon phase 1 report.

In the new gridlock resolution mechanism, a node performs centralized calculation of the possible solution to preserve transaction privacy, while participating bank nodes execute the settlement in a decentralized manner to avoid a single point settlement risk. This resolves the inherent privacy issues of a decentralized gridlock resolution process and provides participating nodes with full anonymity.

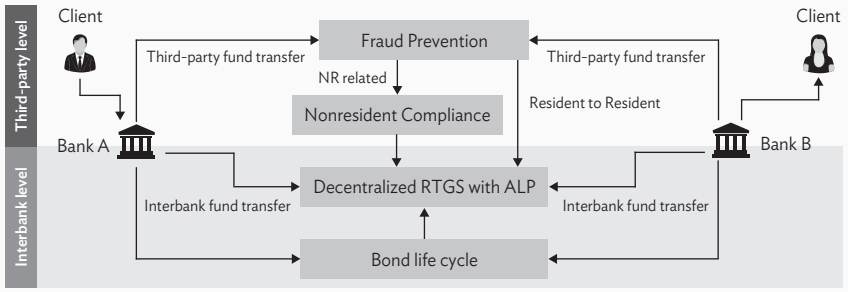
As noted, the innovative functionalities explored in phase 1 are bond and ALP tokenization. The bond token is introduced in the RTGS system through a process similar to cash tokenization. Having a bond token in the system enables the central bank liquidity provision to be seamlessly automated. The ALP mechanism allows banks to enter into a repurchase agreement with the BOT where they can exchange their bond tokens for cash tokens when they are temporarily short of liquidity. The exchange of bonds and cash tokens occurs in a real-time and atomic[3] manner. The introduction of the ALP, therefore, allows banks to increase efficiency of bond usage and reduce the opportunity cost of holding eligible bonds.

[3] Atomicity is a transaction property which either succeeds or fails as a whole, that is, all or nothing. An exchange of two assets with atomic transaction will never leave a transaction partially completed.

Project Inthanon Phase 2

Phase 2 aims to explore the applicability of DLT to more complex use cases, leveraging on the smart contracts. The functional objectives of phase 2 include (i) the addition of a securities settlement system to phase 1 by enabling bond life cycle activities in a secondary market such as trading, repurchase, and coupon and margin management; and (ii) the integration of a fraud prevention mechanism and a regulatory compliance module into the DLT workflow for third-party funds transfer. An overview of these functionalities is shown in Figure 13.4.

Figure 13.4: Design of Functionalities in Phase 1 and Phase 2



ALP = automated liquidity provision, NR = nonresident, RTGS = real-time gross settlement system.
Source: Bank of Thailand.

Bond life cycle

The life cycle of debt-securitized BOT bonds was modelled in phase 2's POC. The activities include the tokenization of the bonds as representing fungible assets and then using smart contracts to automate coupon payments and final redemption at maturity. Bond tokens then can be traded and repurchased between bank nodes. The exchange of bond and cash tokens is settled on an atomic delivery-versus-payment (DvP) basis.

To fully operate repurchase activities, the smart contract generates daily scheduled events as part of decentralized margin management process initiated by each bank node. A net margining mechanism collates calculation inputs, which are ongoing repo contracts, margin thresholds, and prices of bond tokens posted as collateral. A margin call is then issued by a payee to a payer to review and confirm for subsequent settlement.

The gridlock resolution for bond tokens is also explored in the POC. Leveraging on phase 1 gridlock resolution, the new model is further developed to handle both cash and bond tokens. The redesigned gridlock resolution, which is known as a multi-asset liquidity-saving mechanism, supports DvP gross settlement and optimizes liquidity saving across cash and bond tokens.

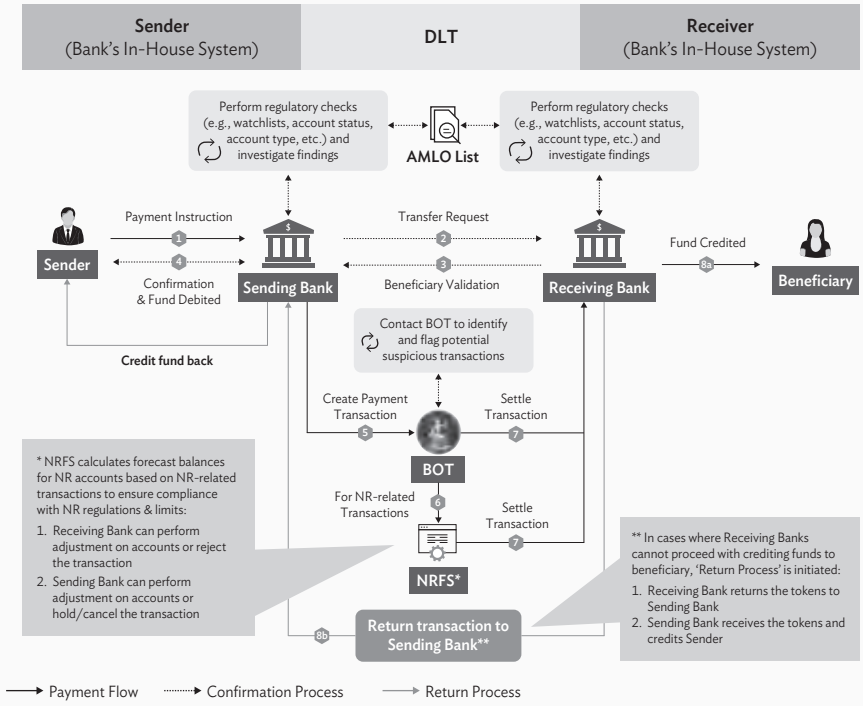
Fraud prevention and regulatory compliance
In phase 2, the third-party funds transfer's end-to-end process is extended on top of phase 1's interbank funds transfer workflow. This allows the pre-settlement operational steps, which include creation, checking, validation, and confirmation to be integrated with the settlement mechanism.

To prevent fraudulent transactions, a sending bank and a receiving bank need to reconcile and validate beneficiary information. Currently, there are no automated functions available for this. Sending banks create a transaction with the information given by the sender, regardless of the validity of its correctness. Once a receiving bank receives the funds, it is obliged to investigate and perform necessary compliance checks before crediting the funds to the beneficiary accounts, thus reducing the efficiency of payment operations. In Inthanon phase 2, a peer-to-peer reconciliation process has been developed that allows sending banks to directly reconcile the information with receiving banks on a need-to-know basis. The system also provides anti-money laundering and suspicious pattern checks, as well as allowing senders to confirm the transaction before settlement. In addition, banks receive a channel where they can track the status of their transactions in real time, from initiation to final settlement and funds crediting to end beneficiaries. The step-by-step workflow is demonstrated in Figure 13.5.

Under foreign exchange regulations, nonresidents can open two types of Thai baht accounts, that is, nonresident baht accounts (NRBAs) and nonresident baht accounts for securities (NRBSs). Transfer between NRBAs and NRBSs is prohibited. The NRBA/NRBS balances are not allowed to exceed a limit at the end of the day. The limit is imposed on per account type and per nonresident entity, so if a nonresident opens an NRBS with three banks, at the end of the day, the aggregated balances of the accounts are required to stay within the limit.

In current practice, banks perform a manual reconciliation to ensure compliance, resulting in operational burdens. Phase 2 has incorporated the nonresident forecasting system, which draws on all balances and transactions to calculate the forecasted balance of each account. All nonresident-related transactions are processed in this module before settlement takes place. The transactions are settled only when the regulation is compiled through the nonresident forecasting system. The system also notifies banks when forecasted balances exceed limits and require banks to mitigate potential noncompliance. This automated mechanism allows banks to manage their nonresident flows and accounts more efficiently. It also helps the BOT to better monitor compliance in near real-time fashion.

Figure 13.5: End-to-End Funds Transfer Workflow



AMLO = anti-money-laundering organization, BOT = Bank of Thailand, DLT = distributed ledger technology, NR = nonresident, NRFS = nonresident forecasting system.

Source: Bank of Thailand (2019b). Project Inthanon phase 2 report.

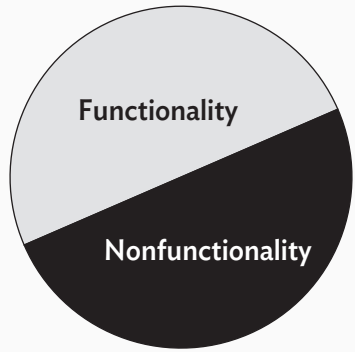
13.2.3 | Main Findings and Future Consideration

The findings of Project Inthanon phases 1 and 2 are as follows (Figure 13.6).

Figure 13.6: Summary of Key Findings and Next Challenges

Payment
DLT can perform key features of existing RTGS and enables complex functions in payment

Asset Life Cycle
Smart contract can handle bond life cycle with complicated business activities



Transaction Privacy
Bank and customer data are protected by privacy design

Settlement Finality
Notary provides technically deterministic finality

Network Resiliency
Notary is a single point of failure

Operation
- Potential to operate 24/7
- DLT can provide atomic DvP settlement

Next Challenges
- Nonfunctionality (performance and system security)
- Operational consideration
- Legal and regulatory consideration

DLT = distributed ledger technology, DvP = delivery-versus-payment, RTGS = real-time gross settlement system.

Source: Bank of Thailand.

Functional Finding

DLT can implement key functionalities of RTGS. Smart contracts can handle complex use cases that include bond life cycle events, fraud prevention, and regulatory compliance. The technology also demonstrates the ability to support 24/7 payment operation and provides an atomic DvP settlement without intermediaries.

Nonfunctional Finding

Settlement finality describes the way a system reaches consensus when a change of ownership occurs. The system can provide a technical settlement finality for the funds transfer and the exchange between cash and bond tokens. In Corda, the point of finality is when the notary[4] signs against a transaction. The notary guarantees that every transaction state can be consumed at most once, thus preventing double spending.

Transaction and settlement *privacy* are achieved given the Corda platform design, where the information is shared on a need-to-know basis. Meanwhile, the network *resiliency* is still a key challenge, as the Corda platform requires a notary node to validate the transaction, becoming a single point of failure issue.

After phase 1 and 2, several issues remain that need to be explored as a prerequisite before moving the POC into production, including (i) technology capacity: performance testing and cybersecurity; (ii) governance arrangement: role and responsibility among parties in a decentralized network; and (iii) legal and regulatory consideration: the review of related laws and regulations needed in advance of going to production.

13.3 Project DLT Scripless Bond

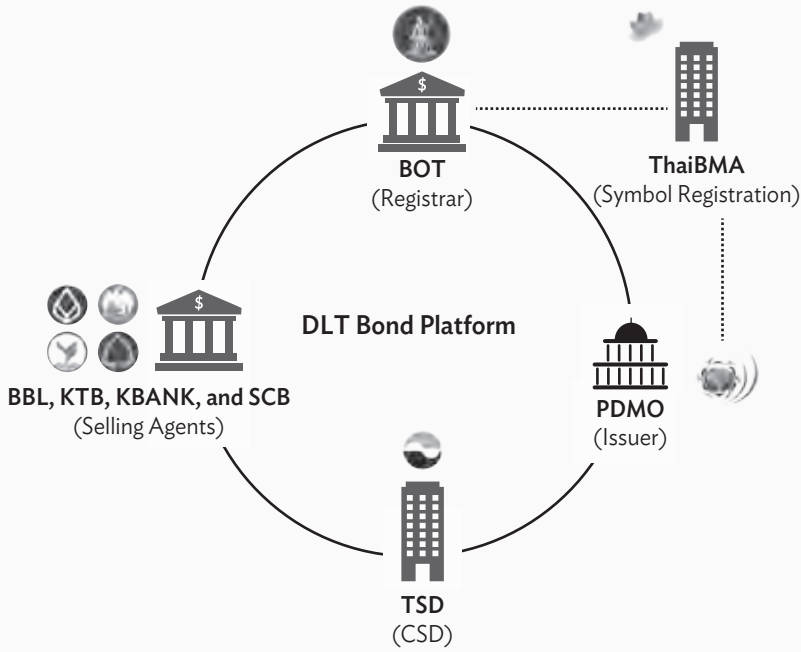
13.3.1 | Overview

The BOT initiated the DLT Scripless Bond Project and conducted a POC around blockchain technology. The project was built with Hyperledger Fabric, an open-source blockchain framework to assess benefits and business values that could potentially improve efficiency.

The BOT spearheaded the project with the collaboration of key industry participants employing their considerable expertise and experience. Key stakeholders with their roles and responsibilities are described in Figure 13.7.

[4] The notary service in Corda serves to prevent double spending within the network. Once the notary service is satisfied that a digital token has not been spent before, it issues a signature to indicate transaction finality.

Figure 13.7: Stakeholders with their Roles and Responsibilities



Notes:

1. Bank of Thailand (BOT): Registrar and Paying Agent
2. Thailand Securities Depository (TSD): Central Securities Depository (CSD) and International Securities Identification Number and Classification of Financial Instruments code registration
3. Public Debt Management Office (PDMO): Bond Issuer
4. Bangkok Bank (BBL), Kasikorn Bank (KBANK), Krungthai Bank (KTB), and Siam Commercial Bank (SCB): Selling Agents
5. Thai Bond Market Association (ThaiBMA): Bond Symbol Registration

Source: DLT Scripless Bond Executive Meeting.

The Thai government savings bond sales process has several points of friction, that is, a non-real-time system and duplicate validation steps with manual reconciliation requirements that are prone to data errors, which blockchain could potentially resolve. Delivery of savings bonds to investors currently takes 15 business days, while other government bonds can be delivered in just 2 business days according to market best practice.

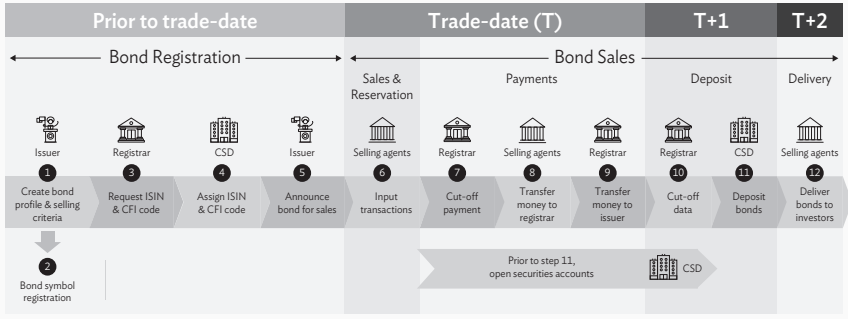
13.3.2 | The Design

The main features improving process efficiency and transparency of the Thai government savings bond sales are as follows:

- **Single validation.** This feature allows participants to validate any transactions by using the same set in the smart contracts before it is committed to a ledger.
- **Single source of information.** All participants can access the same information, such as bond profiles, selling criteria, and the remaining available amount.
- **Common standard within the blockchain network.** One set of standards is adopted for data format, reference data, and transactional data used in business processes to improve data quality and remove duplicated processes.
- **Flexible information management.** Before the bond deposit process, all sales transactions are editable to allow flexibility in timing of processing. Selling agents can update details as required. Any time a modification is made, the sales transaction would be digitally time-stamped and recorded for transaction transparency.

According to these key elements and considerations to reduce the savings bond settlement cycle from trade date plus 15 business days (T+15) to 2 business days (T+2), the processes and all operational improvements relating to bond registration and sales are designed as illustrated in Figure 13.8.

Figure 13.8: T+2 Process of Bond Registration and Sales



CFI = Classification of Financial Instruments, CSD = Central Securities Depository, ISIN = International Securities Identification Number.

Source: Bank of Thailand (2018). Project DLT Scripless Bond White Paper.

Bond Registration (Prior to Trade-date)

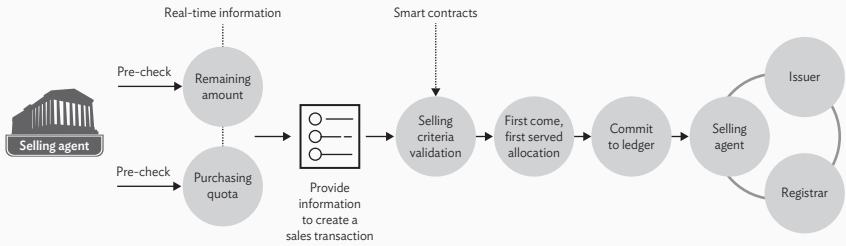
The bond registration process was piloted on the blockchain-based system, where relevant information was digitalized onto the common shared ledger for stakeholders.

With regard to the newly designed process, the issuer is required to enter full bond profile details and their selling criteria into the blockchain. Once the information is entered, the smart contract will send bond information to the Thai Bond Market Association and the Thailand Securities Depository to assign a unique symbol and International Securities Identification Number and Classification of Financial Instruments codes. The issuer will then officially announce the completion of the bond profile and selling criteria.

Bond Sales (T to T+2)

Once a selling agent receives an order from their client investor, the agent will need to validate whether the investor has the right qualifications to purchase, and whether there is still a sufficient amount remaining in the central pool. The pilot system is redesigned to enable selling agents to send their client's order and update the quota from the central pool on a first-come, first-served basis. Such practice helps elevate the efficiency and transparency in bond sales, in comparison with the current practice in which the total amount of bond issuance is divided to each selling agent. Once the order is entered into the common ledger, it is visible to the relevant parties, including the registrar and Central Securities Depository (CSD), to monitor transactions in real time.

Figure 13.9: The Processes of Sales and Reservation



Source: Bank of Thailand (2018). Project DLT Scripless Bond White Paper.

In the case of new investors that require an opening of a new securities account with the CSD, the selling agents will be able to enter their client's information, and the smart contract will automatically send the request in real time. The CSD will then be able to relay back the status of the account opening, and the selling agent and the registrar would then be informed.

In transferring the funds received from bond sales to the issuer, each selling agent will be notified to transfer funds at the end of each business day. The selling agent will then transfer the specified funds to the registrar, who will accumulate them from all selling agents and send to the issuer in a single transaction. The funds transfers are performed externally via the BAHTNET system.

On the next business day (T+1), the CSD is notified to credit bonds to the investor's securities accounts, as well as to notify the selling agents on the status. Once this process is completed, the investors will then be able to update their balances via channels provided by their selling agents on the next business day (T+2).

13.3.3 | Findings and Next Considerations from the POC

Functional Findings

The POC has demonstrated that the DLT Scripless Bond could successfully meet core business demands, while generating business values for all relevant parties. These key benefits are: (i) individual investors are able to receive bonds within 2 business days, from the current setting that takes 15 business days, and they can purchase bonds with their full rights from any selling agent without the current purchasing limit per bank; (ii) selling agents, the Thailand Securities Depository, and the BOT can reduce the complexity of their operational processes; and (iii) bond issuers can monitor and manage sales in real time, increasing competition among selling agents. Overall, the project will lead to greater efficiency, transparency, security, and reduction in operating costs across the entire value chain.

Nonfunctional Findings

Security and data privacy are critical to preserve the sensitive information of all participants in the blockchain network. Several methods can be implemented in Hyperledger Fabric such as Access Control Language and a private channel to ensure that the data are safe, secure, and available to everyone on a need-to-know basis.

In terms of performance, decentralized systems may experience some constraints in handling a high volume of transactions and workloads, as well as scaling up their capacity.

13.3.4 | Current Progress

Following the POC's success, the DLT Scripless Bond project has been developed into production to transform processes related to the sales of government savings bonds. However, more research is required to address certain issues discovered through the POC, for instance, the performance capacity of blockchain-based systems, in particular, the Hyperledger platform. Alternative mechanisms and solutions have been adopted in order to elevate the performance of the overall system to achieve the business requirements.

Furthermore, cybersecurity, data privacy, governance structure, roles and responsibilities, procedures, as well as related business and technical issues have been continually addressed in order to implement the production system.

13.3.5 | Next Steps

The project is expected to be launched by the first half of 2020, which will support the first annual issuance of the government savings bonds. The expected success of this project will pave the way for Thailand's bond market infrastructure in the future.

13.4 Conclusion

The BOT gained invaluable experience and insights from these two initiatives, not only regarding the benefits and capabilities of the technologies, but also the innovative power of collaboration among industry-wide participants. We strongly believe that despite DLT being still a fledgling system, the early preparation and profound understanding of the technology will constitute a foundation for the Thai financial sector to seize the opportunities when it is widely adopted in the future.

REFERENCES

Bank of Thailand. 2018. Project DLT Scripless Bond – Investing in Thailand's Future Transforming the Securities Markets Infrastructure with Blockchain. https://www.bot.or.th/English/DebtSecurities/Documents/DLT%20Scripless%20Bond.pdf (accessed 1 August 2019).

———. 2019a. Project Inthanon Phase 1 – An Application of Distributed Ledger Technology for Decentralised Real Time Gross Settlement System Using Wholesale Central Bank Digital Currency. https://www.bot.or.th/English/FinancialMarkets/ProjectInthanon/Documents/Inthanon_Phase1_Report.pdf (accessed 1 August 2019).

———. 2019b. Project Inthanon Phase 2 – Enhancing Bond Lifecycle Functionalities & Programmable Compliance Using Distributed Ledger Technology. https://www.bot.or.th/English/FinancialMarkets/ProjectInthanon/Documents/Inthanon_Phase2_Report.pdf (accessed 1 August 2019).

ANNEX

Central Bank Digital Currency: A Historical Perspective

Yuksel Gormez*

A.1 Money: A Primitive Introduction

The difference between a closed and open economy may not best be identified as connected to money. In the early forms of money, such as wheat, animals, seashells, skins, seeds, iron and bronze, leather or rare stones, silver, and gold, it was clear that money had a societal function. That was the main reason for the permanent concept of money. The format or shape of money changes often, but money never dies or disappears permanently. In ancient times in Asia Minor or Egypt, as well as in the 20th century under global experiments, there were attempts to eliminate money; socialism with different characteristics tried its best to remove the societal role of money but all attempts failed again. Maybe, it was not surprising for the mainstream economist.

Money is immortal because it is the only real answer to the double coincidence of wants problem. Only with money can we go beyond barter and create a common unit to measure value. Basic arithmetic underpins how money survives all the conditions in our common life because it solves a fundamental problem among humans to interact with each other beyond barter: without a unit of account, trade is limited because of the practical information costs of barter, the only option without money. When we cannot support a single common measure of value as a single numeraire, what we need to memorize is quite straightforward:

"For <n> number of commodities (trade units or goods and services)", we need to memorize a massive number of prices:

$$(n[n-1])/2 \qquad (1)$$

* The views expressed do not reflect the views of the Central Bank of Turkey. All the opinions exhibited here should be interpreted as those of the author's. The usual disclaimers apply. I would like to thank the Asian Development Bank Institute and Shenzhen Finance Institute for encouraging me to produce this note. I also want to thank Naoyuki Yoshino, Sayuri Shirai, Peter Morgan, Ben Shenglin, and Zhang Bohui for their support.

The outcome of this equation is the number of bilateral exchange ratios, which constitutes all the prices needed to be memorized to activate our trade opportunities in a given infrastructure or market. To see what this equation refers to, we can use samples of how prices climb to unbearable figures as the number of goods and services go beyond a certain threshold.

Our calculation capacity is surely enough to handle the mathematics for *small numbers*. Most of us can easily calculate the relative prices of 10 goods and services in terms of each other since the total number of prices to memorize will only be 45. According to the same formula, the number will only be 10 if we are trading with each other for only five different goods and services.

On the other hand, when we have 100 commodities in our exchange basket in a given time, the total number of prices under barter in practice will reach 4,950. As the number of goods and services in our trading basket increases to 500, for example, then the number of relative prices we need to calculate goes even further to 124,750.

In a modern way of life, the total number of goods and services we keep exchanging with each other is probably not fewer than 1,000 in a given economic area under a single currency. We may also cross-check this number from the inflation basket of a typical country. When we calculate monthly inflation figures for a country, we check the prices of a sample basket and most of the time the number of goods and services is close to 1,000 if not much higher. In such a case, we have 499,500 prices under barter in practice to memorize. It is the argument of this paper that people on average will not be able to handle such a heavy burden of calculation.

Surely, we have geniuses who can handle such extremely complicated calculations, but they are inherently exceptional. We cannot construct a societal order by relying on exceptional people's brain power. We emphasize this simple argument to explain the immortality of money as it derives from pure mathematics. It is a numeric reality as money solves the problem of double coincidence of wants through the following mechanism.

When money is declared as a common numeraire for measuring value by creating a common denominator, the number of prices is not (n[n–1])/2, but only "n". It is this property that makes the concept of money immortal under any circumstances. We have good money or we have bad money, but we always have "a money" because of this simple arithmetic. Anything with some sort of immortality must have a mathematical backing and this formula is the real mathematical backing

of money. This means that when we have 10 goods and services in our trading basket, we just need to memorize 10 prices. We can even make the number of goods and services in our trading basket 100 and in this case the number of prices reaches to 100, that is, still on a manageable scale for a typical human being.

Once we can agree on a common denominator, cognitive forces come into full force as well, and we automatically compare relative prices. We can easily activate this mechanism when we travel to other countries with different monies or common denominators for value. We will figure out soon as we keep engaging through trade in the new market that some of the prices are cheaper, while others more expensive compared to those relative to our home currency area. This is important because a common denominator for value also creates a cognitive recognition of value and our brain automatically figures out what is relatively cheap or expensive when we are out of familiar situations and have a well-informed relative price institutionalization.

It may not seem logical to emphasize the definition of money in a high-level academic publication because we always take it as a given. It is the argument of this paper that this assumption is not as common as it often appears. Actually, we can argue the opposite, that some of the problems surrounding the extreme exploitation of the so-called cryptocurrency proposals that have attracted so much investment in the last decade may be taken as the best proof of the real misunderstanding of money, even at a very basic level. Otherwise, how can we explain the investor behavior of putting so much money into so many different "money" proposals just because of an emerging technology around distributed ledger concepts, or blockchain?

Actually, because of the simple arithmetic emphasized here, it is almost impossible to issue hundreds if not thousands of cryptocurrencies at the same time circulating in digital networks. The physical, chemical, or biological capacity of our brain is nowhere close to being able to trade with more than a dozen forms of money if not just a few for a given monetary structure to support division of labor through specialization. With exactly the same cognitive mechanism addressing why we cannot have more than five definitions of "what one meter is" or "how a kilogram is measured as permanently the same", there is no technical capacity to support so many different monies. Recognizing the reality of more than 1,000 different cryptocurrencies[1] in the market, it is clear that we need to explain what money is from the beginning using as easy a terminology as possible.

[1] The current number of cryptocurrencies in the so-called crypto money markets is much higher than that, with more than 2,000 alternative cryptos currently (CoinMarketCap 2019).

From this perspective, we can argue that money is one of the most important inventions, similar to kilograms as the common measure of weight, meters as the measure of length, wheels to ease the burden of transportation to create mobility, and fire to support nutrition for resilience. It basically empowers the division of labor and specialization for optimal productivity. As far as there was an opportunity to interact with other living groups, there was a chance of trade in one way or another. The invention of uniform metal money as a coin in Asia Minor by Alyattes, king of Lydia, who minted the first official currency, should make sense given that Ephesus at that time was one of the main trading hubs on the Mediterranean peninsula. The coins were from electrum, a mixture of silver and gold that occurs naturally.

In the same context, the invention of paper money in the People's Republic of China (PRC) can also not be taken as a pure coincidence as it was a global trade center at that time with the impact of the Silk Roads. This may even be taken as a form of process innovation to ease the cost of trade within the Greater PRC and around the Silk Roads ecosystem. From this perspective, we can use the famous sentence that money turns the wheels. Yes, money supports the creation of a sustainable welfare society when fully appreciated by an ecosystem respecting its fundamental ability to address the double coincidence of wants.

A.2 What Backs Fiat Money (Spectrum of Money)

The real understanding of money is harder than it seems, even for central bankers. It is the argument of this paper that some of the misunderstanding may be eliminated by respecting the basics before exaggerating complexities.

Before getting into what *fiat money* is as the current form or global standard, maybe we can use etymology to understand what "fiat" refers to. Like many other complicated terms, the term is also a Latin word whose meaning approximates "it shall be".

With this meaning, we may place the definition of fiat money as "the shall be money" or "(be money) if not (money be)". The mechanism is based upon a central authority declaring something or anything to be money within a given sovereign zone. In this argument, we once again emphasize that money is a legal concept that can be enforced.

Because declaration is a must, we can argue even further that without the rule of law, anything and everything that may circulate physically or digitally in any given area to fulfil the functions of money may not be accepted as such, even if it finds a critical mass of acceptance. To make the point clearer, partial success in creating a demand for "money" does not make that unit legal. It is accepted that money may only survive in the short run under illegal terms and long-term sustainability will not be guaranteed unless that unit is brought back into the full coverage of a legal backing with an enforcement capacity.

We should remember this part again when so many so-called monies are available. Without any legal backing, nothing can be real money. Anyone who wants to experiment with the concept of money should keep this in mind that there will never be a real legal money to play all three functions of money without an authority to declare it as such. After that declaration will come the defense of money in the court when there is any disagreement among economic units. Anyone arguing money without legal backing argues that social life without the backing of law to regulate order or to sustain social cohesion in a society is possible. The philosophy of such suggestions will be beyond the coverage of this paper.

On the other hand, one issue is of clear interest to us: anyone talking about global money had better explain a "global legal system" to back its legal prerequisites. The same holds for private money: no private money may be sustainable in the long run without a "private rule of law" or without a private justice system.

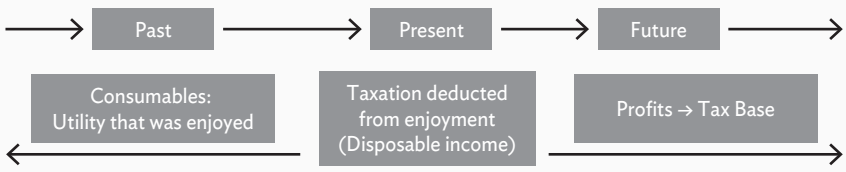
Going back to the basics of money, after 1972, the universally accepted form of money has been fiat, that is, anything and everything that is accepted as money under conditions of universally perfect convertibility. It is any form that everybody voluntarily and systematically accepts as representatives of the value of goods and services in exchange. It allows quick and easy comparison of value through standardized units such as the kilogram and meter. Fiat money converts anything into everything with a common numeraire and makes all prices perceivable and comparable to all.

But, only declaration can make any form of money as good as any others; in other words, all monies are not equal. There are "good monies" and "not so good monies, if not bad monies". The difference comes from the concept of the "backing of money". Backing refers to anything and everything that powers the relative purchasing power of a particular money. Consequently, money is a contestable concept: we can figure out the best among equals. Still, before we detail the concept of the backing of money, we had better underline once again that any declared money has no backing other than that declaration's own power.

Fiat money has objective parameters. One way of measuring and comparing different monies is to use International Monetary Fund (IMF) guidelines[2] on how to calculate basket weights to declare the value of the currency known as Special Drawing Rights (SDR). Once the comparative measurement becomes clearer with this mechanism, we can invoke the concept of the "spectrum of money" to better the identification of backing.

When we have good money and not so good money, we can have the criteria to distinguish between them. Yes, money turns the wheels of economies, but not all economies' wheels perform the same; this is correct in the both the short and long run. Under this complex dynamism, we use the concept of the spectrum of money to differentiate one money from the other. We can also find out the chance of one particular money performing better in the long run. Every form of legal money that is accepted in a well-identified sovereign structure, be it national or under a global consensus with a legal backing, can be categorized using this concept, as shown in Figure A.1.

Figure A.1: Spectrum of Money



Source: Prepared by the author.

In this exhibit, money for the past represents total goods and services consumed. It is the previously attained utility, that is, the intrinsic value of money. The satisfaction that we get by using money is what was derived from the "use of money". In a typical human lifecycle, money plays no role in the past other than every benefit, be it material or non-material, that has already been provided or supported.

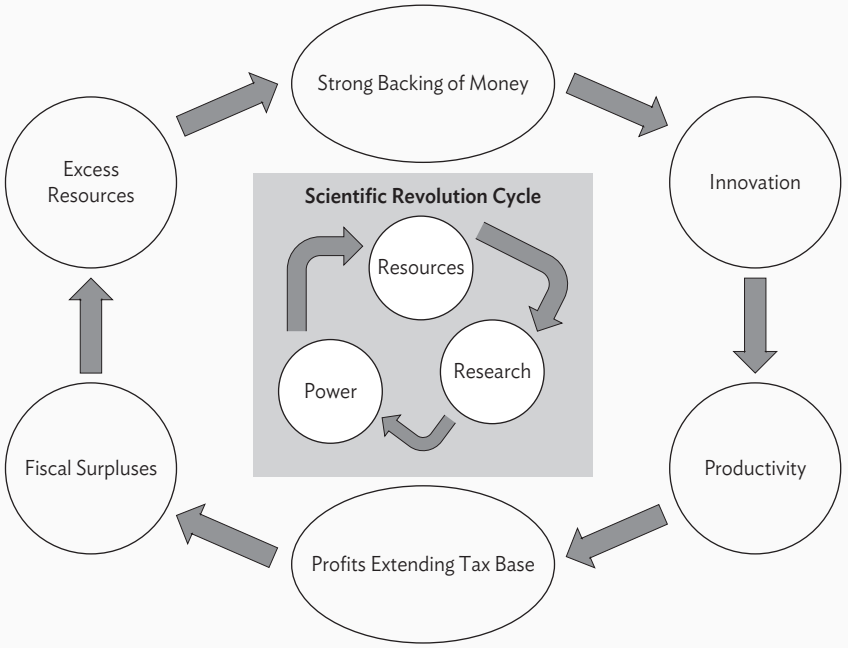
[2] https://www.imf.org/external/np/fin/data/rms_sdrv.aspx. The currency value of the SDR is determined by summing the values in dollars, based on market exchange rates, of a basket of major currencies (the dollar, euro, Japanese yen, pound sterling, and PRC yuan). The SDR currency value is calculated daily (except when the IMF is closed for business) and the valuation basket is reviewed and adjusted every 5 years.

When we shift the analysis from the past to the present, the spendable amount is calculated after taxation and savings, as "only the rest" can be used for total utility from money. Economists mostly use the concept of disposable income for this line of argument. Any satisfaction from the use of money for the present is not completely enjoyed because of a personal decision to save money for future consumption or because of a government's decision to tax the economic entity's capacity to spend all personal earnings or gains. For the present, money lacks full or 100% use or satisfaction of income or wealth because of saving and taxation motives. The enjoyment is not up to full capacity. Still, on average, we can argue that most of the money earned or gained is used for present maximization or optimization of benefit. Under a relatively stable price level away from extreme hyperinflationary pressures, the routine performance of money in the present is quite functional, with relatively satisfactory stability supporting a certain level of monetary transmission.

It may be easier to position money in its role in social life for the past or even for the present; bringing the discussion into the future complicates figuring out the backing or spectrum. We may argue at best that money is backed by profit-generating productivity supported by entrepreneurs who pay taxes without harming their profitability base or operational structure. Backing is relative and the strength of different monies competes. The measure of strong money backing for the future may be placed under the sustainable price stability (and financial stability) concept. With this, we may ensure that the purchasing power of money is maintained. Some of the indicators of strong money backing may be called a country's taxable wealth, income, real estate, profits, services, or scale.

The strength of money comes with the "relative" invention capacity to generate taxable profits. To extend the discussion, the backing of money can be strengthened through corporatization. Corporate taxes may be more sustainable in the long run in terms of seamless innovation, and do not have to come from the same company. Sometimes, innovation can generate an absolutely new sector. One example of this is the information and telecommunications sector that emerged in the last half century. We may suspect the emergence of another new sector such as organ transplants or reproductive biological processes under the same category or simply define it as biogenetic developments. Both venture and risk-sharing capital through crowdfunding or similar processes are already investing in this area. After the research and development cycle, one may suspect that the future tax revenues will most likely be expanded most from these new industries if not from companies investing heavily in the area.

Figure A.2: Innovation Cycle for Sustainable Strong Backing of Money



Source: Prepared by the author; center chart by Harari (2014).

To simplify a complex story, the strong backing of money is best supported by heightened investment in innovation through research and development, as shown in Figure A.2. This investment will generate higher productivity when excess resources are reinvested into further research to create a positive loop fostering power creation. The missing part in this short description is the increase in the tax base arising from the higher productivity. Surely, additional tax earnings will increase fiscal surpluses, which themselves can also be reinvested, with the heightened backing of money.

Why are taxes so important in this discussion? For one reason: government is the biggest economic unit in a given sovereign zone. Without a sustainable balance sheet for the government, the real backing of money fails. Only a well-designed mechanism to support government activities can support the basic balance of sustainable backing of money.

From productivity to tax base extension to fiscal surpluses and excess resources, the main direction may be different. The macroeconomic dynamics of the Japanese economy can be given as a good example of this complex differentiation of the pattern: the cycle of "good" innovation to increase the quality of the backing of the Japanese yen is enacted not by adding to the fiscal surplus, but by using it as additional borrowing capacity. This way, the Japanese economy enjoys a very low domestic borrowing cost; even the debt- to-gross national product ratio is highest compared to any developed nation. Corporate Japan's productivity-enhancing research and development activities are supporting the yen such that the Ministry of Finance is not facing any pressure from the so-called "crowding out" phenomenon. Productivity gains for Japan are characterized not by increasing tax revenues but by decreasing the cost of public finance to levels that have never been experienced by any other Group of Seven (G7) country. Without an innovation-based economic cycle, maintaining this low value-added tax could not have been possible as well.

Before completing the discussion of the spectrum of money, one critical issue should be addressed: once a "good innovation cycle" creates a very strong backing for the national or international money, there is no guarantee that it will keep it in its best form forever. Innovation is not static, but dynamic, and typically replaces a given process with one that costs less and produces more. Such revolutionary moments may be observed often in the corporate arena: iPhones not only redefined the way we use mobile technologies, but also expanded the tax base on a scale not often observed. Though the term "dividend base" could be interchangeable with "tax base" in this argument, that is better addressed elsewhere.

We may review the historical size of the world's biggest companies to figure out a visual base, under the assumption that their size implies a certain amount of innovation capacity. The change is massive in both the short and long run, and the power of innovation in the biggest companies means they change not only every 100 or 50 years (Table A.1), but also in just 10 years as well.

From this perspective, under the fiat money standard with no absolute guarantee to keep the strong backing of a particular money, the ultimate goal needs to be on seamless support for research and development investment. Innovation driven from such a strategy is the best chance to have a relatively strong money to compete with other available alternatives to fulfill three main functions of money, that is, medium of exchange, store of value and unit of account.

Table A.1: Company Size and the Impact of Innovation Capacity

100 Years of the United States' Top 10 Companies		
1917	1967	2018
US Steel	IBM	Apple
ATT	ATT	Alphabet
Standard Oil	Kodak	Microsoft
Bethlehem Steel	GM	Amazon
Armour & Company	Standard Oil	Facebook
Swift & Co	Texaco	Berkshire
International Harvester	Sears	J & J
Du Pont	GM	Exxon
Midvale Steel	Polaroid	JPM
US Rubber	Gulf Oil	Wells Fargo

Largest Global Companies in 2018 versus 2008							
2018				2008			
Rank	Company	Founded	Size ($ billion)	Rank	Company	Founded	Size ($ billion)
1	Apple	1976	890	1	PetroChina	1999	728
2	Google	1998	768	2	Exxon	1870	492
3	Microsoft	1975	680	3	GM	1892	358
4	Amazon	1994	592	4	China Mobile	1997	344
5	Facebook	2004	545	5	ICBC	1984	336
6	Tencent	1998	526	6	Gazprom	1989	332
7	Berkshire	1955	496	7	Microsoft	1975	313
8	Alibaba	1999	488	8	Shell	1907	286
9	J&J	1886	380	9	Sinopec	2000	257
10	JPM	1871	375	10	ATT	1885	238

Sources: https://milfordasset.com/insights/largest-companies-2008-vs-2018-lot-changed (accessed 4 September 2019); https://www.marketwatch.com/story/how-the-list-of-americas-most-valuable-companies-has-changed-over-100-years-2017-11-16 (accessed 4 September 2019).

A.3 The Long Discussion of What Is Electronic Money

The electronification of money is nothing new: my early doctoral thesis on the topic was started before the millennium (Gormez 2000),[3] but even before that, the European Monetary Institute, the institution created to support a European Central Bank, published reports on "prepaid cards" as early applications of electronic money technologies. The European Monetary Institute concluded there was a "need to restrict the issuance of electronic purses to credit institutions" (EMI 1994).

Money can be defined in many different words. On the other hand, it is difficult to argue that technology can change the nature of money by just using new forms of access. Money has a numeric or mathematical reasoning and technology will not change its basic definition. From this end, any technology that supports the basic properties of money should be taken as its own innovation. With electronic technologies, money can become cheaper to access, handle, and exchange. Still, the properties of money such as acceptability, portability, divisibility, durability, recognizability, unforgeability, economy, interoperability, anonymity, applicability, convertibility, ease of use, efficiency, reliability, scalability, security and trust, traceability and conservation can, in one way or another, be supported or enhanced with new technologies. Consequently, it is good news for the business of money, but not a radical change in the way that we earn, own, spend, invest, or give it away.

The anonymity of electronic money has attracted much attention. Sidestepping the details, we may argue that anonymous electronic money is possible with advanced technologies if societies want to support it. This decision surely has moral issues, but the fiscal dimension should also be kept in mind, including the struggle against money laundering.

Before addressing the details of electronic money (e-money), we can recall that electronic payment systems are older than the electronic money discussion: starting with the innovation of credit cards as an additional application of telephone and telegraph technologies into payment industries, electronic payments emerged

[3] The thesis has four purposes. Firstly, define and critically assess e-money, including the expected functions, necessary features, potentials, and major implications. Secondly, present empirical evidence on the current state of e-money technology with case studies. Thirdly, investigate the perception of e-money innovators and operators. Lastly, study the free banking implications of e-money, covering its impact on monetary policy framework and instruments, including whether it should be regulated.

as an industry. Banks copied early success stories and created consortiums to develop critical mass. Retail outlets now offer plenty of alternatives for electronic payments; the European Central Bank report offers a detailed summary of these developments (ECB 1998).

It will not be the aim of this paper to go into all the discussions of e-money after the Bitcoin hype; rather, the argument here is that e-money discussions are much older than Bitcoin and date to the early 1980s as academics started digging into its possibilities (Chaum 1981). None of these discussions has any potential to change the main mathematics of money: its role as the common numeraire to address the double coincidence of wants problem.

Payment systems will evolve without any break. It is almost common practice now for all fintech companies to integrate payment processes not just to reflect an individual interest on money itself; under the evolving digitalization of our daily lives, any new proposal to address a particular issue carries a payment dimension as well.

On the other hand, payment technologies have failed to eliminate the banking industry, even though there has always been pressure on that side. Gormez (2000) addressed some of those arguments when supermarkets were supposed to supplant brick and mortar banks. That was the narrow view of banking services to limit their benefits only to payments and ignoring all the other services, including wealth management.

Electronic money came into our lives with the emergence of information and communication technologies, which will not go away any time soon. Until we reach a perfectly sustainable form of life where all interactions go through digital platforms, the share of conventional payments will progressively decrease until it reaches almost zero through the next millennium. Electronic payments will survive, with other forms disappearing in one way or another. However, the speed of change may be much slower than many anticipate. Conventional payments with central bank paper money will survive for a century and maybe even more due to the different levels of digitalization. It may be very speedy in central Tokyo, while fishers in Hokkaido or Okinawa may still carry banknotes for their daily payments.

As an extreme case, numismatic enthusiasts may prevent the total collapse of the demand for banknotes. Any assumption that a central bank may not need to issue paper money may fall into the same trap as the idea of supermarkets finishing the need for banks or mobile technologies being the end of conventional payments.

The adaptive capacity of human addictions or habits will constitute a great source of demand for banknotes and central banks will still design, develop, and operate banknote systems.

On the other hand, electronic money technologies will surely have an impact on a certain group of central banks. Electronic technologies will ease access to better money, not only for earning, but also spending and savings. The real opportunity for alternative money trials arises when the so-called authority fails to provide a "stable and credible money". With the same mechanism or forces we observe on a typical dollarization process, there will be decreasing demand for a so-called "funny money" and people will speedily exchange all these holdings into "good money" using the opportunities electronic technologies will supply.

From this perspective, it will be easier and cheaper to be a member of a monetary union or to leave one to create a national money. Remembering the massive preparation during the launch of the euro provides a good basis for this argument. Consequently, any central bank that fails to understand the real backing of a money will start losing market share to other central banks. Acceptance of money with inferior backing will decrease while the reach of good money will expend continuously. For unsuccessful monetary policy strategies, the speed of so-called dollarization will be quite sharp, and they will need to optimize to support research and development instead of relying on tools developed to prevent the risk of price instability or inflation. This is also a part of the lessons learned from the easy monetary policy utilized by the Bank of Japan in the last 2 decades where some level of inflation has been expected to emerge—an expectation not realized at the time of writing. The expectation to see any price pressure in Japan may not be realistic with the level of relative productivity gains.

Before discussing central bank digital currencies, there is one area of demand for electronic money that may be a real source of productivity. Central bank money cannot pay any amount less than the smallest unit of the national currency. For the Turkish lira, the smallest unit is one kurus; Turkish Central Bank banknotes or coins cannot execute any payment less than that. This limit will be one penny for many currencies. Nano payments, which are those less than smallest unit, have no reliable infrastructure. Coupons and loyalty cards can be used as replacements. Service trades such as electronic games need more efficient and reliable payment system solutions, especially for nano payments. Central banks should not be against e-money innovation from this perspective. They can even provide incentives to operators as they are not able to execute nano payments, while Alipay, WechatPay, and others can serve retailers and citizens much better in terms of nano payment services if they upgrade their software.

To conclude the discussion, any hype around the concept should be placed aside to figure out any potential gain. E-money is not a new phenomenon. Even the de-nationalization of money is not new, with Hayek (1990) having made the proposal much earlier. Technological progress and Moore's Law, which posits the doubling of computation power with the same cost in less than 2 years, helped to develop many alternative solutions to regional, national, and international payments. Electronic money proposals are available with many ease-of-use possibilities. Every year, another proposal garners more attention than others as its critical mass makes it the dominant choice of payment, i.e., the so-called "killer application". Still, none of those proposals turned out to create any danger for the safe and sound circulation of a national currency in any given systemically important nation, be it a member of the G7 or even the Group of Twenty (G20).

A.4 Central Bank Digital Currency

Central banks' investment in wholesale payment and settlement systems is nothing new; they have been investing in these systems for a long time, through the so-called real-time gross settlement system. Fedwire by the Federal Reserve, Target or Sepa from the European Central Bank, Zengin from the Bank of Japan, Electronic Funds Transfer System from the Central Bank of the Republic of Turkey, and Cnaps from the People's Bank of China are all wholesale payment systems operated by national central banks. Most of these systems were designed to improve effectiveness and efficiency in money market payments in terms of wholesale transactions.

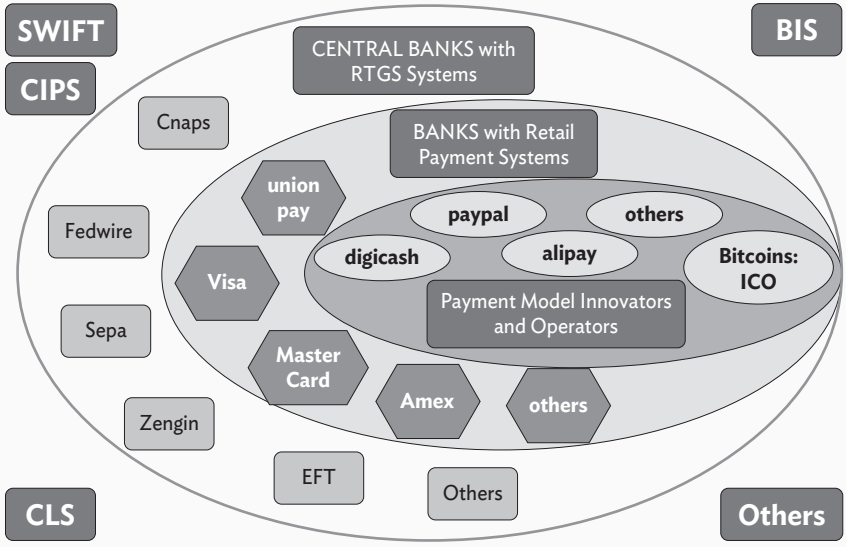
We emphasize this to make sure that the involvement of central banks in payments should not be taken as a new initiative or episode. We need to clarify the situation in order to discuss the matter of central bank digital currency (CBDC) in a more effective way. Actions always speak louder than words, and central banks know the business of payments, especially in the wholesale markets. They are not new to electronic money management protocols, digital security, and emerging technologies as they need to keep themselves up to date in order to operate real-time gross settlement systems.

Central banks are also investing in human resource capacities in payment technologies. There are many electrical and electronic engineers under central bank payrolls and they are expected to keep themselves one step ahead of hackers' capacity to attack their payment systems. Whenever there is a new technology relevant to payments, central bankers hurry to learn more about their potential applications into their current processes. This is one reason why so many central bankers are studying distributed ledger technologies or blockchain.

When we take the initial conditions for the discussion as the simple fact that central banks are already in the business of electronic money in terms of real-time gross settlement systems, the rest of the argument becomes clear. There is a real case for CBDC and any related proposal deserves to be taken seriously. Just looking at the universe of payments underlines these facts.

In this universe, central banks are ultimate players in payment systems (Figure A.3). They are already serving banks and market-maker financial institutions in both the money and, when necessary, capital markets. As long as their scope is limited to serving or helping banks to clear wholesale payments, it is almost common practice that they are actually meant to design, develop, and operate payment systems with their own conventional money turned into electronic money, which is an argument that central banks are already issuing central bank electronic money, if not a digital currency.

Figure A.3: Payments Universe and Involvement of Central Banks on Payments



BIS = Bank for International Settlements, CIPS = cross-border interbank payments system, CLS = continuous linked settlement, EFT = electronic funds transfer, ICO = initial coin offering, RTGS = real-time gross settlement.

Source: Prepared by the author.

The importance of payments does not come from the one-sided supply initiatives from the central banks; on the contrary, payments are the core of any monetary system. Monetary transmission is not possible without an effective and efficient payment system infrastructure. Central banks, especially in developed economies, are responsible for a range of assignments, such as the traditional fight against inflation, but also to realize potential growth, sustain financial stability especially after the latest global financial crises, prevent absolute nationalization of both short-end and also long-end yield curves, etc. It is not generally well documented that central banks are primarily responsible for ensuring that money pays seamlessly. Payments without disruptions are the ultimate prerequisite for a proper transmission mechanism.

Against this background, the reason there is little noise about payment system efficiency is because of its current level of near-perfection in wholesale and retail payments, if not ultimate perfection. Especially in the last half-century, paying has never been so easy and cheap, regionally, nationally, and internationally. This argument does not mean to accept a limit of innovation to further increasing the efficiency and effectiveness of payments; there is surely room for further improvement. However, compared to the fight for lower inflation with higher and more stable growth and the fight for stability with financial institutions serving economic entities with cheaper but better services, payments are much closer to perfection. If we prepare a score card for central banks, probably their best score will be seen on payment systems.

Before we proceed to the pros and cons of CBDC, we try to shed light on one issue where there is some confusion: what is the difference between electronic money and digital currency? For the sake of this paper, central bank money is already electronic, especially in terms of wholesale payment systems. While it is true that anyone or any economic entity can bring conventional banknotes to any central bank branch, central bank money is circulated mostly in the wholesale universe of transactions electronically.

With some of the current initiatives such as the international bank account number, or some well-accepted codes such as TRY for Turkish lira, JPY for Japanese yen, or CNY for the PRC yuan, there are many helpful standardization efforts to ease the burden of creating a global ecosystem for better, faster, and cheaper payments, again locally, regionally, and internationally. In this picture, where is the real demand for central banks to go one step further from their already electronic monies and circulate a digital currency? Why should central banks volunteer to bring their services very close to commercial banking by providing a digital currency?

The last question comes from digitalization of a currency having mostly been taken as a job not in the wholesale payments area, but as a retail payment product. Most of the time, central bank digital currencies are amalgamated by opening a bank account for every economic unit in a given sovereign national monetary system. With the current level of information technology capabilities, it is possible to create that type of payment service by the central banks by hiring more information technology experts instead of only relying on economists or experts to analyze national and international data to bring the economy close to its potential without inflation or financial instability. They will need many information technology experts to operate a retail payment system under CBDC.

CBDC is feasible under certain conditions. If a central bank is operating in an economy with the following conditions, not issuing a CBDC may be questioned by stakeholders:

- There is already a network-based economy where most financial services are digital. Credit and debit card services are well developed, with a great deal of financial literacy.
- There is an absence of structural inflation risk: no twin deficits or unsustainable single deficits. Problems such as lack of inflation may be accepted; however, in an inflationary environment, digital currency must wait to be a priority for a central bank. This also holds for financial stability. If the nonperforming loans ratio is higher than a certain threshold and if the financial service capital adequacy ratios do not meet global standards, then central banks should prioritize these problems before issuing a digital currency.
- Perfect capital market functioning can help as well. Intermediation should be deep enough to replace routine financial services. A banking-based financial structure may not be an ideal environment to issue CBDC. When capital markets are not fulfilling demands for venture capital through new models such as crowdfunding, then banks are desperately needed for optimal allocation of deposits and credits.
- Banks are already wealth managers; if this goes beyond deposits, collectors, or credit distributors, then CBDC may fall into their markets.
- Central banks should already be able to control the long-term yield curve from high and volatile inflation to low and stable inflation. When central banks are targeting inflation, then it may mean that they have enough space for central bank digital currencies.

- Retail financial services should be already diversified with postal office banks, supermarket banks, and digital services. Economic units can get cash or digital tokens not only from brick-and-mortar bank branches, but from all sorts of access points, including digital service centers in any form.
- There should be no prospect of monetary union or disunion, at least in the short run: a monetary union needs a certain amount of money logistics and we do not live in a perfect digital world where we can be a member by just pressing a button. In practical central banking, the situation is much easier compared to the launch years of the euro, but many conventional physical processes still must be fulfilled to be a member of a currency union. Any CBDC initiative should be delayed until the clarification of the prospect of a monetary union.
- There should be no major risk of currency wars or destructive trade wars.
- A manageable demographic structure is necessary where urbanization is the main status quo and where the financial limitations of rural life are manageable. Isolated fishers, forest guards, and farmers can be served by technology for the logistics of money. What we mean can be as broad as delivering, or downloading, or receiving money from or into cards, or however the money is being interacted with by using drones or similar technologies. A central bank cannot fail to deliver or receive or execute a transaction with digital currency and there can be no tolerance for delay or failure to execute a payment once digital currency is in circulation. A commercial bank can surely enjoy some tolerance or excuse for such failures, but not a central bank.

To sum up: a central bank in a welfare society with no major inflation or financial stability issues under perfectly performing capital markets where optimal credit and deposit allocation is supported with well-institutionalized companies or emerging tools such as crowdfunding has no hurdle to a digital currency of its own. Such an initiative will bring certain benefits and side effects as well, but all could be addressed in the short or medium term. Banks will not cede market share to unacceptable levels because, in this economic environment, they are mostly making their profits from wealth management products, including long-term pension fund trading strategies.

When it comes to the business of money, evolution will be a more viable option than revolution, meaning that central banks should follow a gradual approach in terms of upgrading their societal functions to circulate a better money both conventionally and electronically or digitally. The first mission is to sustain price stability as a prerequisite for an overall economic stability.

By contrast, CBDC may not be the optimal strategy or may be taken as unfeasible when:

- There is a low level of digitalization. This prerequisite needs no additional explanation; still, central banks should be hesitant to push digital payments in immature ecosystems. Because of the speed of technological innovation, any preemptive investment may turn out to be an out-of-date proposal and the digital currency may not meet the latest capabilities of emerging technologies.
- Inflation is still a risk with either twin or single deficits. Exchange rate pass-through is still not negligible in many emerging countries. For a stable monetary system, price and financial stability are needed, with a sustainable external and internal balance. It is a simple reality that with convertibility, good money drives out bad money, and with digital currencies, the speed of doing so can be on a scale never before experienced. The volatility that may arise from such a speedy "digital run on a currency" can be costly. Immature launches of digital currencies must be guarded against. The same risk arises for G7 or G20 currencies, but their swap facilities can handle some of the problems that may arise from digital runs. Central banks without such arrangements similar to the Chiang Mai Initiative should think twice before digitalization.
- Lack of financial deepening in both capital and money markets are both signs against launching central bank digital currencies. The main role of markets is not only to optimize allocation of resources, but also to provide liquidity for fully functioning transmission. Intergenerational transfer of wealth with the liquidity facilities of yield curves, be it for treasury or commercial bonds, desperately needs perfect efficiency before relying on the digital circulation of a national currency. In the age of global markets with day traders, a lack of such national liquidity will only lead to an infrastructure where limited national savings will be converted into international liquidity, allowing currencies to be invested in markets where deepening is no problem. Such a drain of capital will be unbearable for any emerging country.
- Banks are still important players in the financial and monetary transmission and retail financial services are bank-based with unreliable capital: any CBDC will be a direct challenge. Before additional policies to support the liquidity and capital needs of commercial banks are in place, a full launch of digital currencies may not be advisable, as it may lead to the erosion of commercial banks' profit base. Proper resolution mechanisms should be better placed to support the transformation of banking services more into wealth management and less into account-based commissions.

- Central banks still make the rules of financial engagement: many countries may be facing a reality that sovereign wealth management companies may have a bigger balance sheet than the central banks. Such an ecosystem provides a perfect environment for central bank digital currencies, since there would be few hurdles in front of a launch.
- The risk of monetary union or disunion may be taken as a risk to the "common denominator" of the nation and any launch of CBDC may not be a good idea as it could lead to a great deal of confusion among households, especially among the most vulnerable segments.
- Major risks for currency wars or destructive trade wars may also delay the launch of digital currencies. Open economies may be facing higher impact from trade wars, but spillovers even to isolated countries from external trade and investment may suffer badly through, for example, tourism.

Against this background, any country with price and financial instability and a level of external and internal balances that shrinks the long-end national yield curves may be seen as a negative CBDC ecosystem. With a small tax base, extreme reliance on domestic borrowing and a heavy dependence on external savings can also be responsible for destructive side effects from any immature launch. Money means trust, which, whether domestic or international, can be hard to earn but easy to lose. In the logistics of money management, be they digital and conventional, one mistake may lead without exaggeration to lost decades in terms of bringing the economy back to its potential. Without solving fundamental problems of the management of money conventionally, any digital currency initiative may only bring confusion on the sustainable balance of the national currency. Any sustainability doubts will surely deteriorate the basic balance of money with serious problems such as dollarization.

A.5 Conclusions and Recommendations

Central banking issues have been attracting too much attention globally in the last 4 decades since the collapse of Bretton Woods. Recently, most national or international central banks are taken for granted as a panacea for many macroeconomic problems from inflation to financial crises to asset price distortions, etc. They are assigned to solve problems without really quantifying whether the problem is solvable or not. A similar attitude or hype seems to reach to a potential launch of central bank digital currencies.

We should counterbalance this hype: innovation capacity, not central banks, is the real backing of a currency. We should always remember that the United States became the biggest world economy without a central bank in the 19th century. Seamless innovation was the real backing of the dollar from this perspective.

The same holds for CBDC. Those central banks operating in innovative countries where there is no risk of inflation or volatile growth and adequate human resources can issue digital tokens immediately. Central banking in those countries are mostly dealing with postmodern problems such as excessive reserve accumulation, yield curve nationalization, excessive innovation capacity, or excessively rapid change.

Issuing CBDC will not be a major hurdle in those countries from an operational perspective, and can almost be considered a *fait accompli*. Banking services will not be affected because of their current adaptive capacity. Banks will have funds necessary to finance their transformation from traditional services to managing wealth in a postmodern way of life for their customers, with almost perfect digitalization capacity. In an advanced digital world, currency, conventional or digital, becomes a minor determinant of a financial business model, including banks. There may be some additional cost for banking transformation, but this will not disrupt financial service provision.

In other countries with limited innovation capacity where public finance still is not sustainable, an immature launch of CBDC may not decrease the cost of borrowing. The expected benefits should not be exaggerated: without a proper transition to a fully-functioning market economy, where some regional characteristics are acceptable, a digital currency will not be a panacea for macroeconomic problems in financial transmission. Worse, there will be no leapfrogging to a financial ecosystem where banks are not needed, since fintechs will fulfill their functions. Banking is an evolutionary business, best based on learning-by-doing. The transition from a nomadic life to a life in space may be taken as a synopsis for such an impossibility: adaptation needs transition and this is best when it comes step by step. Without learning, banking and digital financial service provision may face unprecedented challenges. Without strong financial resources, which are almost permanently scarce in emerging countries, CBDC should not be a priority, at least in the short run. Better banking macro- and micro-structures should be taken as an initial condition for the launch.

There may be some examples where it is possible to fund such a transition at any cost. A discovery of tradeable commodity reserves in an emerging country can be a perfect opportunity and the best way to use additional earnings from gold,

oil, gas, etc. Investment in human resource capacity and a leapfrog digitalization of the daily way of life with extreme investment in financial awareness can support an ecosystem to effect a full functioning launch of CBDC. We do not exclude such miraculous possibilities in our arguments, but we also do not take them as the common policy advice where economic transition comes with certain delays in a typical emerging country.

In our understanding of money, technology in itself cannot change the main mechanism or dynamics of money in our daily lives. Money is beyond technology. The mathematics of money or its dynamics cannot be altered by its form. From this perspective, CBDC is not an issue: it can be done if the cost is taken for granted and if enough resources are assigned to pay for the change. The cost will arise from banks needing additional capital to pivot from conventional activities of collecting deposits and distributing credits to being intergenerational wealth managers. Nothing in this road map seems very difficult to realize with respect to technology. Central banks have been in the payment business for a long time now, especially in the field of real-time gross payments, settlements, and custody services. Bringing macro-technological capabilities in terms of handling payments to micro-payments with CBDC can be done. It is not a paradigm shift anywhere close to the nationalization of the yield curve.

From now on, there is only one probability of a paradigm shift in terms of money: bringing barter back to reality. Can barter capabilities be brought back into practice to make a change in the way we need money? Yes, that is possible if we can imagine "life in space" conditions on mother earth. However, that part will be beyond our discussion of money or CBDC in this paper. We may come back to the topic as a future research agenda that may be placed here as "optimal money for life in space".

REFERENCES

Chaum, D. 1981. Untraceable Electronic Mail, Return Addresses, and Digital Pseudonyms. Communications of the Association for Computer Machinery (ACM) homepage archive 24(2): 84–90. New York: ACM. https://dl.acm.org/citation.cfm?id=358563 (accessed 4 September 2019).

CoinMarketCap. 2019. All Cryptocurrencies. https://coinmarketcap.com/all/views/all/ (accessed 8 January 2019).

European Central Bank (ECB). 1998. *Report on Electronic Money.* Frankfurt: ECB.

European Monetary Institute (EMI). 1994. Report to the Council of the European Monetary Institute, on Prepaid Cards. Working Group on EU Payment Systems. Frankfurt: EMI. https://www.ecb.europa.eu/pub/.../prepaidcards1994en.pdf (accessed 4 September 2019).

Gormez, Y. 2000. Topics in Electronic Money. Unpublished PhD thesis. London: City University Business School.

Harari, Y. N. 2014. *Sapiens—A Brief History of Humankind*. London: Penguin.

Hayek, F. A. 1990. Denationalisation of Money: The Argument Refined. The Institute of Economic Affairs, Hobart Paper Special, No. 70, Third Edition. London: Institute of Economic Affairs.

Central Bank Digital Currency and Fintech in Asia

The development of financial technology has already radically altered the landscape of the financial system in Asia and promises to have an even greater impact in coming years. This book provides a comprehensive introduction to the principles and developments regarding central bank digital currency and fintech. The first part of the book covers the theory of central bank digital currency, regulatory aspects, economic digitalization, and the role of fintech in advancing financial inclusion for small and medium-sized enterprises. In the second part, selected case studies offer an in-depth overview of recent fintech-related developments in major Asian economies, including Australia; the People's Republic of China; Hong Kong, China; Indonesia; Japan; the Republic of Korea; and Thailand.

About the Asian Development Bank Institute

ADB Institute, located in Tokyo, is the think tank of the Asian Development Bank, an international financial institution. ADBI aims to be an innovative center of excellence for the creation of rigorous, evidence-based knowledge that can be implemented as new actionable policies by developing and emerging economies, so as to contribute to achieving a prosperous, inclusive, resilient, and sustainable Asia and the Pacific. It also contributes to ADB's overall mission and operational priorities in line with ADB's Strategy 2030. This vision will lead ADBI to continue to be a globally recognized think tank.

About the Chinese University of Hong Kong, Shenzhen

The Chinese University of Hong Kong, Shenzen, is committed to providing world-class education and research and nurturing high-end talent with a global perspective. Its Center for Financial Technology and Social Finance at the Shenzhen Finance Institute focuses on the innovative application of big data, cloud computing, machine learning, and blockchain in the financial sector.

Marlene Amstad is an economics and finance professor at the Chinese University of Hong Kong, Shenzhen, and co-director of its Center for Financial Technology.

Bihong Huang is a research fellow at the Asian Development Bank Institute.

Peter J. Morgan is a senior consulting economist and vice chair of research at the Asian Development Bank Institute.

Sayuri Shirai is a visiting scholar at the Asian Development Bank Institute.

ADBIPress

ASIAN DEVELOPMENT BANK INSTITUTE
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo, 100-6008 Japan
Tel +81 3 3593 5500
www.adbi.org