Perspectives in Law, Business and Innovation

Markus Heckel
Franz Waldenberger *Editors*

The Future of Financial Systems in the Digital Age

Perspectives from Europe and Japan

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Perspectives in Law, Business and Innovation

Over the last three decades, interconnected processes of globalization and rapid technological change—particularly, the emergence of networked technologies—have profoundly disrupted traditional models of business organization. This economic transformation has created multiple new opportunities for the emergence of alternate business forms, and disruptive innovation has become one of the major driving forces in the contemporary economy. Moreover, in the context of globalization, the innovation space increasingly takes on a global character. The main stakeholders—innovators, entrepreneurs and investors—now have an unprecedented degree of mobility in pursuing economic opportunities wherever they arise. As such, frictionless movement of goods, workers, services, and capital is becoming the "new normal".

This new economic and social reality has created multiple regulatory challenges for policymakers as they struggle to come to terms with the rapid pace of these social and economic changes. Moreover, these challenges impact across multiple fields of both public and private law. Nevertheless, existing approaches within legal science often struggle to deal with innovation and its effects.

Paralleling this shift in the economy, we can, therefore, see a similar process of disruption occurring within contemporary academia, as traditional approaches and disciplinary boundaries—both within and between disciplines—are being re-configured. Conventional notions of legal science are becoming increasingly obsolete or, at least, there is a need to develop alternative perspectives on the various regulatory challenges that are currently being created by the new innovation-driven global economy.

The aim of this series is to provide a forum for the publication of cutting-edge research in the fields of innovation and the law from a Japanese and Asian perspective. The series will cut across the traditional sub-disciplines of legal studies but will be tied together by a focus on contemporary developments in an innovation-driven economy and will deepen our understanding of the various regulatory responses to these economic and social changes.

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Editors

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Editors
Markus Heckel
German Institute for Japanese Studies
Tokyo, Japan

Franz Waldenberger
German Institute for Japanese Studies
Tokyo, Japan

ISSN 2520-1875 ISSN 2520-1883 (electronic)
Perspectives in Law, Business and Innovation
ISBN 978-981-16-7829-5 ISBN 978-981-16-7830-1 (eBook)
https://doi.org/10.1007/978-981-16-7830-1

This Springer imprint is published by the registered company Springer Nature Singapore Pte Ltd.
The registered company address is: 152 Beach Road, #21-01/04 Gateway East, Singapore 189721, Singapore

Preface

This book, as all publications, has a history. It began in 2019, when we set up a study group on the future of the financial system in the digital age. The group met regularly to discuss topics related to digital finance such as big data, AI, algorithm-based trading, blockchain, and digital currencies. It was organized by the German Institute for Japanese Studies (DIJ) in Tokyo in collaboration with the Regional Financial Laboratory, a think tank working closely with Japan's regional banks. The project was supported by the Innovative Nurture Community ("inc."), a privately organized international advisory network.

It soon became clear that we wanted to move beyond the discussions in our study group and engage with international experts. We had planned a joint workshop with the German Bundesbank in Frankfurt, Germany, in May 2020, to discuss similarities and differences in how we understand and assess digital finance. However, due to the COVID-19 pandemic, we had to give up the idea. Instead, we decided to present European and Japanese perspectives on and approaches to the digital transformation of the financial system in a joint book publication.

This publication would not have been possible without the generous support of the Shared Opportunities Society Foundation. We thank Cai Changli and Dylan Scudder for their excellent copy editing and proofreading. We are also grateful to Springer Nature and the editors of the Perspectives in Law, Business and Innovation book series for allowing us to publish with them.

Tokyo, Japan
September 2021

Markus Heckel
Franz Waldenberger

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Editors and Contributors

About the Editors

Markus Heckel is a Principal Researcher at the German Institute for Japanese Studies (DIJ) since November 2018 and holder of a Ph.D. in economics from the University of Duisburg-Essen. From 2012 to 2018, he worked in the Faculty of Economics and Business Administration at Goethe University, Frankfurt. His main research interests include macroeconomics, monetary policy, and the political economy of central banks. His recent publications include "Unconventional Monetary Policy Through Open Market Operations: A Principal Component Analysis" (co-authored with Kiyohiko G. Nishimura, Asian Economic Papers, 2022, forthcoming) and "Employees Who Do Not Know Their Labour Contract Term and the Implications for Working Conditions: Evidence from Japanese and Spanish Microdata" (co-authored with Yuji Genda and Ryo Kambayashi, Japan and the World Economy, 2019).

Franz Waldenberger is Director, German Institute for Japanese Studies. He is on leave from Munich University, where he holds a professorship for Japanese Economy. His research focuses on the Japanese economy, corporate governance, and international management. He is Editor-in-Chief of the international peer-reviewed journal *Contemporary Japan.* His recent publications include "The Digital Transformation. Implications for the Social Sciences and Humanities", (co-edited with Harald Kümmerle, DIJ, 2020) and "Governance, Risk, and Financial Impact of Mega Disasters: Lessons from Japan", (co-edited with Akiko Kamesaka, Springer, 2019).

Contributors

Alexander Bechtel is Head of digital asset and currency strategy, Corporate Bank of Deutsche Bank. He completed his Ph.D. at the University of St. Gallen, where he still holds a position as external lecturer on blockchain and money. His research focuses

on monetary policy and digital currencies. He has worked as an external consultant at the European Central Bank and spent a research stay at Stanford University in the USA. Since June 2019, he has hosted a podcast about blockchain and digital currencies, called "Bitcoin, Fiat & Rock 'n' Roll."

Ulrich Bindseil obtained a Ph.D. in economics at the University of Saarbrücken (1994) and has been the director general of the European Central Bank's Directorate General for Market Infrastructures and Payment Systems (DG-MIP) since November 2019. He has served the European Central Bank for over twenty years in positions including the director general for market operations, head of Risk Management Division, and head of the Liquidity Management Section. His numerous publications include "Monetary Policy Operations and the Financial System" (OUP, 2014) and "Central Banking before 1800: A Rehabilitation" (OUP, 2019).

Agata Ferreira is Assistant Professor, Warsaw University of Technology. With a doctoral degree in law, she has a legal education and experience from several European jurisdictions and legal systems, including common and civil law legal systems. She is a member of the EU Blockchain Observatory and Forum and serves on the advisory council of Blockchain for Europe. She practiced law for a number of years in the City of London in the finance and banking sector, specializing in structured finance cross-border transactions. Currently, she focuses on legal issues brought by emerging technologies, digitalization, and fintech innovation. Her expertise includes legal and regulatory frameworks governing blockchain technology, incorporating tokenization and smart contracts.

Jonas Gross is Project Manager, Frankfurt School Blockchain Center (FSBC). He is also a Ph.D. candidate at the University of Bayreuth, Germany. His main research focus includes central bank digital currencies (CBDCs), stablecoins, and cryptocurrencies. He is co-host of the podcast "Bitcoin, Fiat, & Rock 'n' Roll" and a member of the expert panel of the European Blockchain Observatory and Forum. Further, he is Chairman of the Digital Euro Association, a think tank around digital money.

Nobuyuki Kinoshita is President and CEO, Tokyo Financial Exchange Inc. since 2018. He holds a bachelor's degree in Law from The University of Tokyo and a master's degree in economics from the University of Tsukuba. He joined Japan's Ministry of Finance in 1977 and then spent 12 years at Japan's Financial Services Agency (FSA) from the time of its establishment. He also acted as an executive director of the Bank of Japan from 2010 to 2014, before he was appointed as a senior advisor to Aflac (American Family Life Assurance Company) Japan from 2014 to 2018. His publications include "Legal Background to the Low Profitability of Japanese Enterprises" (Columbia University, Academic Common) and *Dejitaru inobēshon to kinyū shisutemu* ("Digital Innovation and the Financial System," Kinyū Zaisei Jijō, 2018, in Japanese).

Takahide Kiuchi is Executive Economist, Nomura Research Institute. After joining Nomura Research Institute in 1987, he served as an economist, providing insights into a wide range of economic topics including the global economy, monetary policy, and

fiscal policy. In 1990, he began working at Nomura Research Institute Deutschland (Frankfurt), before his transfer in 1996 to Nomura Research Institute America (New York), where he was in charge of analyzing the European and American economies. In 2004, he moved on to Nomura Securities, later assuming the position of head of the Economic Research Department and chief economist in 2007, making forecasts for the Japanese economy as head of the Global Research Team. He went on to serve as a member of the Policy Board of the Bank of Japan from 2012 to 2017. His publications include *Ijigen kanwa no shinjitsu* ("The Truth About Unprecedented Easing," Nikkei Publishing Inc., 2017).

Yuri Okina is Chairperson of The Japan Research Institute, Ltd. She obtained her doctorate in Economics from Kyoto University in 2011. She served at the Bank of Japan from 1984 to 1992. She has been invited by Keio University and Waseda University as a visiting professor. She is Member of the Financial System Council (Financial Services Agency), the Industrial Policy Council (Ministry of Economy, Trade and Industry) and Member of the Planning Meeting on a Social Security System Oriented to All Generations. Her publications include "Financial Crisis and Prudential Policy" (Nihon Keizai Shinbun Shuppansha, 2010).

Anna Omarini is Researcher with tenure in Financial Markets and Institutions at the Department of Finance, Bocconi University (Milan), where she conducts research and teaching. She is Director for the courses "Bank and Fintech" and "Fintech for Digital Transformation." She is also a SDA senior professor, group of experts on banking and insurance at SDA Bocconi School of Management. She completed the International Teachers Program at the Stern School of Business, New York University, in 1999. She has authored books and articles on the related areas of interest (Fintech for banking and digital transformation, bank strategy, and management, retail banking, bank marketing, private banking/wealth management, and electronic payments). She is a member of editorial boards and a reviewer of international journals. She also serves as an independent member of the board of directors at banks and as a member of the Board of Directors at ABILab (Italian Banking Association Lab on Innovation in Banking).

Philipp Sandner has a Ph.D. in business administration from Ludwig-Maximilian-University of Munich. He is now Professor at the Frankfurt School of Finance and Management and founder of the Frankfurt School Blockchain Center (FSBC). From 2018 to 2020, he was ranked as one of the top 30 economists by the *Frankfurter Allgemeine Zeitung* (FAZ), a major newspaper in Germany, and as an economist among the "Top 40 under 40" by the German business magazine *Capital*. Since 2017, he has been a member of the Fintech Council of the Federal Ministry of Finance in Germany. His expertise includes blockchain technology in general, crypto-assets such as Bitcoin and Ethereum, the digital programmable Euro, tokenization of assets, and rights and digital identity.

Kiyotaka Sasaki is Visiting Professor, Hitotsubashi University, School of Business Administration. He joined the Ministry of Finance, Japan, in 1983 and then spent more than 20 years at the Financial Services Agency (FSA) Japan. He has a broad

range of experience in financial sector supervision and capital market oversight both at the levels of policy development and execution. His professional experience and expertise cover prudential risk management, compliance/conduct risk management, oversight of misconduct in financial markets, internal and external audit functions, corporate governance, IT governance including digitalization, and cyber-security threats. He also has extensive international experience and has made significant contributions to policy discussions at international forums including the Financial Stability Board (FSB). Since leaving FSA in July 2019, he has been working as a visiting professor at Hitotsubashi University's School of Business Administration, where he is in charge of programs for global financial regulation and oversight, and serves as chair of its Global Financial Regulation Study Forum.

Hiromi Yamaoka is Member of the Board, Future Corporation, and Head, Future Institute of Research. He is the attorney at law in New York. Having obtained an LL.B. from the University of Tokyo and an LL.M. from the University of California at Berkeley, he has more than 30 years of work experience at institutions including the Bank of Japan and the International Monetary Fund. Before taking up his current position, he was the director general of the Markets Department and Payment and of the Settlement Systems Department at the Bank of Japan. He was also a member of the Markets Committee and the Committee on Payments and Market Infrastructures at the Bank of International Settlements. He is now serving as the chairperson of the Digital Currency Forum. His publications include "Managing the Exit: Lessons from Japan's Reversal of Unconventional Monetary Policy" (co-authored with Murtaza H. Syed, IMF working paper, 2010) and "Digital Innovation, Data Revolution and Central Bank Digital Currency" (co-authored with Noriyuki Yanagawa, BOJ working paper, 2019).

Abbreviations

AI	Artificial intelligence
AISPs	Account Information Service Providers
AML	Anti-money laundering
APIs	Application programming interfaces
ATS	Alternative trading systems
BaFin	Bundesanstalt für Finanzdienstleistungsaufsicht
BAT	Baidu, Alibaba, and Tencent
BCG	Boston Consulting Group
BIS	Bank for International Settlements
BoJ	Bank of Japan
BTC	Bitcoin
CBDC	Central Bank Digital Currency
CCP	Central Counter Party
CDS	Credit Default Swaps
CFT	Combating the Financing of Terrorism
CFTC	Commodity Futures Trading Commission
CISPs	Card Issuer Service Providers
CLO	Collateralized Loan Obligation
CMA	Competition and Markets Authority
CSV	Creation of shared value
DFR	Deposit facility rate
DLTs	Distributed ledger technologies
DvP	Delivery versus payment
DX	Digital transformation
ECB	European Central Bank
ECC	European Commodity Clearing
EEX	European Energy Exchange
EFMA	European Financial Marketing Association
EMD	E-Money Directive
EMTs	E-Money Tokens
EONIA	Euro OverNight Index Average

ERMS	Eurosystem Reserve Management Services
ETFs	Exchange Traded Funds
ETH	Ethereum
EU	European Union
EUR	Euro
Fed	Federal Reserve
FIEA	Financial Instruments and Exchange Act
FSA	Financial Services Agency
GAFA	Google, Amazon, Facebook, and Apple
GDPR	General Data Protection Regulation
HFT	High-Frequency Trading
ICPF	Insurance Companies and Pension Funds
ICT	Information and Communication Technology
IOSCO	International Organization of Securities Commissions
IoT	Internet of Things
JFSA	Financial Services Agency of Japan
JPY	Japanese Yen
JVCEA	Japan Virtual and Crypto Assets Exchange Association
KYC	Know-Your-Customer
MiCA	Markets in Crypto-Assets
MiFID II	Markets in Financial Instruments Directive II
MLF	Marginal lending facility
MRO	Main refinancing operations
NFTs	Non-Fungible Tokens
NIRA	Nippon Institute for Research Advancement
NIRP	Negative Interest Rate Policy
NPP	New Payments Platform
NRI	Nomura Research Institute
NYSE	New York Stock Exchange
OECD	Organisation for Economic Co-operation and Development
OFI	Other Financial Institutions
OTC	Over-the-counter
P2P	Peer-to-peer
PFOF	Payment for Order Flow
PISPs	Payment Initiation Service Providers
PSD2	The Second EU Payment Services Directive
PTS	Proprietary Trading System
QE	Quantitative easing
RPA	Robotics process automation
RTGS	Real-time gross settlement
RTS	Regulatory technical standards
sCBDCs	Synthetic Central Bank Digital Currencies
SEC	Securities and Exchange Commission
SEPA	Single Euro Payments Area
SNS	Social Networking Service

SOR	Smart Order Routing
SPV	Special purpose vehicle
SSM	Single Supervisory Mechanism
TARGET2	Trans-European Automated Real-time Gross Settlement Express Transfer System
TIPS	TARGET Instant Payment Settlement
UK	United Kingdom
US	United States of America
USD	United States Dollar
XaaS	Anything as a Service

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Financial Systems in the Digital Age: Perspectives from Europe and Japan

Markus Heckel and Franz Waldenberger

1 Motivation and Background

Despite the global nature of finance, the institutions and business of finance have until today retained national features that are clearly discernible. These are so distinct and important that financial systems are in fact often considered a key element in the characterization of national systems of capitalism (Dore, 2000; Hall & Soskice, 2001). We should therefore expect that the digital transformation (DX) of finance, its speed, scope and outcome should also be strongly influenced by national contexts. This proposition provided the main motivation for publishing this edited volume. There are numerous publications about how digitalization is transforming, if not disrupting, the financial industry. However, many publications either imply a world void of institutions or presuppose that DX is naturally a global and therefore uniform phenomenon (see for example Hines, 2021; Tapscott & Tapscott, 2016; McMillan, 2014). We think this leaves out at least half of the story. To fully understand the actual implications of DX, one must look at national cases.

We started our project on the future of finance in the digital age in 2019 by setting up a study group of experts from Japanese academia, research institutions, and industry. It was planned that the group would produce position papers on issues related to DX and finance, and that these papers would be presented and discussed at a joint workshop with experts from the Deutsche Bundesbank and the European Central Bank in Frankfurt in 2020. The idea was to identify similarities and differences in the discourses about DX with regard to finance and the transformation apparent in Japan and the euro zone. The choice of countries was for the most part due to the fact, that the editors do research on Japan at an institute in Tokyo funded by the German government. That said, it perfectly served our motivation sketched above because

M. Heckel (✉) · F. Waldenberger
German Institute for Japanese Studies, Tokyo, Japan
e-mail: heckel@dijtokyo.org

M. Heckel and F. Waldenberger (eds.), *The Future of Financial Systems in the Digital Age*, Perspectives in Law, Business and Innovation,
https://doi.org/10.1007/978-981-16-7830-1_1

Japan and the euro zone, while constituting two of the four largest economies in the world, are not considered frontrunners when it comes to DX and related financial innovations. Their national discourses and experiences tend to be underrepresented in the international literature on DX and finance, which is dominated by accounts from the US and China.

Unfortunately, due to the COVID-19 pandemic, our idea of a joint workshop had to be given up. Instead, we decided to disseminate the findings of our study group in an edited volume and to include the euro zone perspective by inviting contributions from European experts, both scholars and practitioners. Altogether, we solicited eight chapters, five from Japan and three from Europe. The topics cover digital currencies, payment systems, banking, and trading in financial markets. Rather than developing abstract scenarios, they discuss specific cases within their respective contexts. The special feature and value the contributions derive from the fact that all authors have a profound and long professional background in the field of finance as academics, policymakers, or regulators.[1] Nobuyuki Kinoshita acted as executive director of the Bank of Japan from 2010 to 2014. He now serves as president and CEO of the Tokyo Financial Exchange. Kiyotaka Sasaki spent a long career at the Ministry of Finance and the Financial Services Agency (FSA) Japan and is now visiting professor at Hitotsubashi University. Hiromi Yamaoka acts as the chairperson of the Digital Currency Forum. He previously worked for the Bank of Japan, the Bank for International Settlements, and the International Monetary Fund. Ulrich Bindseil served 7 years as the director, General Market Operations of the European Central Bank before he took up his current position as the director general of Market Infrastructure and Payment Systems. Alexander Bechtel is head of Digital Asset and Currency Strategy at the Corporate Bank of Deutsche Bank and worked as an external consultant to the European Central Bank. Agata Ferreira is a member of the EU Blockchain Observatory and Forum as well as the Advisory Council of Blockchain for Europe. She is also an assistant professor at Warsaw University of Technology. Jonas Gross is a project manager at the Frankfurt School Blockchain Center, chairperson of the Digital Euro Association, and member of the expert panel of the European Blockchain Observatory and Forum. Philipp Sandner is head of the Frankfurt School Blockchain Center and a member of the Fintech Council (FinTechRat) of the German Federal Ministry of Finance. Yuri Okina is chairperson of The Japan Research Institute. She advises the Japanese government as a member of the Financial System Council (Financial Services Agency) and the Industrial Policy Council (Ministry of Economy, Trade and Industry). Anna Omarini is professor of Banking and Fintech at the Department of Finance of Bocconi University and serves as an independent board member at Italian banks and other financial institutions. Takahide Kiuchi is executive economist at Nomura Research Institute. From 2012 to 2017, he was a member of the Policy Board of the Bank of Japan.

[1] More information about the authors can be found in the list of contributors.

2 Financial Systems: Functions, Resources, and Design

In terms of value creation, financial systems fulfill subordinate or indirect functions. Money and payment infrastructures support the complex system of economic exchange on which the division of labor depends. Financial intermediation and capital markets provide for the financing of investment and liquidity and the diversification of risks associated with entrepreneurial activity. Consumer finance reduces the budgetary constraints of private households, granting them more purchasing options. Similarly, governments rely on public finance when balancing revenues and expenditures related to the provision of public services. Last but not least, financial instruments help to insure against various kinds of income risks faced by individuals and organizations.

In addition, financial systems perform important pricing and governance functions derived from and complementing the primary functions mentioned above. Fundamental prices of the economy, like exchange rates, interest rates, and risk premiums, are determined within the financial system. They guide the allocation of resources within and across organizations, industries, and national economies as well as across time. The final outcome of most financial transactions and the value of financial assets are exposed to risks, which need to be assessed and managed. This is necessarily the responsibility of those involved in financial transactions and in the creation of financial assets. Neglecting such responsibilities, can have severe consequences. The global financial crisis of 2008 originated from US housing market loans. Their default risk had been wrongly assessed by banks and rating agencies (Kirkpatrick, 2009). This negligence was caused by fundamental governance problems, namely, wrong incentives and lack of effective oversight.

All financial systems require four sets of resources. First, physical infrastructures are needed to support the circulation of money and information. Besides the secure transportation of cash and the network of branches and ATMs, modern financial systems rely heavily on telecommunication networks. Second, for the system to work, it is necessary that service providers, legislators, and regulators, and to some extent, corporate and individual users, all have sufficient financial knowledge. Third, given the informational nature of finance (see below), the functioning of a financial system requires trust. Trust is necessary because the value of information does not depend only on its content, but also on its reliability. Trust exists when participants mutually share consistent beliefs. These beliefs are genuinely linked to the knowledge base, the second resource mentioned above. Fourth, financial systems depend on a legal framework and regulatory oversight, i.e., rules as well as the institutions and procedures to implement them. This is not limited to the regulation of financial instruments, institutions, and markets, but also includes corporate law and bankruptcy legislation (see Kinoshita in this volume). By defining rights and duties, the legal framework supports not only the governance of the system, it also contributes to its overall stability and at least partially codifies its knowledge base. Taken together, the legal framework and regulatory oversight constitute an important source of trust.

Design refers to the markets, organizations, financial instruments, business models, and products and services, which perform the actual functions of the financial system. The history of finance and the study of present-day financial systems clearly shows that there are various ways in which the respective functions can be performed (Neal et al. 2016; Kuroda, 2020). For example, the nature of money has changed in the course of history as have exchange rate regimes. Although modern economies now rely on fiat money created by central banks and commercial banks, the design of central and commercial banking has retained distinct national characteristics. The same applies to the role and importance of financial intermediation, financial regulation, public finance, corporate finance or the allocation of financial assets owned by private households.

On the surface, it may seem that national differences are the outcome of discrete and explicit design choices made by legislators, regulators, expert commissions, or business leaders in the financial industry. Respective choices are of course made, and they are especially needed when systems fail as in a crisis, or when, as in the case of DX, new technologies offer new resource and design options. However, the decisions are path-dependent. The choices are embedded in and constrained by the particular conditions of national contexts and by constellations of political and economic interests derived from the status quo.

3 Japan and the Euro Zone

As the contributions in this volume refer to Japan and the euro zone, it is necessary to provide some background information about Japan and the member states of the European Monetary Union. However, whereas Japan is a single nation-state, the euro zone is a very heterogeneous subgroup of 19 countries within the European Union (EU). This heterogeneity, which manifests itself in the data presented below, is actually a first and quite important feature of the monetary union. The unification under one currency system, the euro, established in 1999 with one central monetary authority—the European Central Bank (ECB). Various common regulations, oversight schemes, and stability mechanisms have been introduced over time. For instance, with the implementation of the Single Supervisory Mechanism (SSM) in 2014, a legislative and institutional framework for bank supervision, the ECB greatly expanded its responsibilities. Nevertheless, member states continue to differ widely not only in terms of size, economic activity, and economic structure, but also with regard to national regulations and policies. It is in fact one of the greatest challenges of the euro zone's central authorities and decision-making bodies to come up with common policies that are not only effective, but also do justice to the conditions of the different national contexts.

Table 1 Basic economy characteristics of the eurozone and Japan (2020)

	Population in millions	GDP in trillions US$	Share of world GDP*	GDP per capita**	Share of population aged ≥65
Eurozone	342.9	12.93	15.3%	38,774	20%
Max	83.2	3.81	4.5%	115,874	23%
Median	5.5	0.23	0.3%	27,885	21%
Min	0.5	0.01	<0.01%	17,620	14%
Japan***	125.7	5.06	6.0%	40,113	28%

Notes * Based on purchasing power parity, ** in current US$, *** GDP data from 2019
Source OECD, Statistical Bureau of Japan, World Bank

3.1 Basic Economic Data

Table 1 shows basic economic data for the euro zone and Japan. The 19 economies comprising the euro zone produce more than 15% of world GDP, which corresponds to three times the volume of Japan's. It is noteworthy that the different countries of the euro zone are very diverse in terms of economic size, GDP per capita, and demographics. The euro zone economies' GDP per capita is on average not much different from Japan's. Japan and the euro zone are both facing demographic challenges due to their ageing populations. It is essential for these economies that they exploit the productivity potential inherent in DX in order to maintain their level of income.

3.2 Financial Systems

Given the many functions and design options, comparisons of financial systems confront various challenges. Although only superficial, a first impression can be gained by looking at national accounts statistics of the Organisation for Economic Co-operation and Development (OECD).[2] Ignoring the outliers Mexico and Luxembourg, the financial sector accounts for between 1.5 and 5.3% of employment. With the exception of the UK, labor productivity is significantly higher in finance than in the rest of the economy. Again, excluding Luxembourg, which as a small economy operates an international financial hub, the data show a clear negative relationship between the employment share and the labor productivity of the sector relative to the rest of the economy. A simple conjecture would be that financial sectors expand because non-financial companies tend to outsource labor-intensive financial services.

The OECD financial dashboard, also based on national accounts statistics, provides additional information about structural characteristics (Table 2). It again

[2] Annual national accounts, detailed tables (stats.oecd.org.).

Table 2 Characteristics of national financial systems (2018)

	Japan	Euro zone			UK	US
		Max	Median	Min		
Household financial assets in % of national disposable income	596	712	319	159	481	548
of which (%): Cash and deposits	*54*	*64*	*39*	*17*	*26*	*13*
Life insurance and pensions	*25*	*65*	*17*	*4*	*54*	*33*
Equity and investment funds	*14*	*71*	*31*	*10*	*16*	*45*
Gross debt of general government in % of GDP	235	199	74	13	116	105
Debt-to-equity ratio of non-financial corporations	0.9	1.5	1.0	0.6	0.8	0.7
Financial intermediation ratio	0.5	0.7	0.5	0.4	0.7	0.5

Source OECD, national accounts, financial dashboard, financial indicators (stock), stats.oecd.org

shows the wide variety across the euro zone with regard to the relative size of households' financial assets, their allocation across different asset classes, the structure of corporate finance, and the importance of financial intermediation. As for Japan, the most distinct features are the relative size of households' financial assets, almost double the euro zone average, the highly conservative allocation of these assets, and a record high level of government debt, which at least indirectly represents a liability for private households.

The most comprehensive framework for the analysis of financial systems has been developed by the World Bank and the International Monetary Fund (IMF) in response to the Asian Financial Crisis (World Bank and IMF, 2005). This framework aims at assessing the stability of national financial systems and policies. The various country reports, however, apply different statistical frameworks, which again reflects the fact that a standard framework cannot accommodate the wide diversity among national systems. The last euro zone report points to "the fragmented national legal frameworks for bank supervision" as a major area of reform (IMF, 2018, 8). It asserts that banks continue to play a dominant role within the system while financial markets have grown in importance (IMF, 2018, 9). The Japan country report emphasizes demographic change in combination with a low interest rate environment and low profitability as "posing chronic challenges for the financial system" (IMF, 2017, 6). Japan is, however, still seen to have "one of the largest and most sophisticated financial systems in the world," where banks continue to play a dominant role in financial intermediation (IMF, 2017, 9).

The report does not mention the profound changes the Japanese financial system underwent over the last 30 years. The balance sheet recession created by the burst

of the stock price and real estate bubble at the beginning of the 1990s culminated in a domestic financial crisis at the end of the decade, which resulted in the failure of financial institutions and caused a wave of mergers among the largest commercial banks.[3] Since the early 1990s, government debt has continuously risen. In 2020, the gross debt-to-GDP ratio surpassed 250% (Ministry of Finance, 2020), by far the highest among all OECD countries. Already in 1999, the Bank of Japan hit the zero lower bound and started putting the following unconventional monetary policies into action.[4] Especially after the current Governor Haruhiko Kuroda assumed his position, the Bank of Japan (BOJ) embarked on a heavy monetary expansion in order to fight deflationary pressures.[5] Parallel to the outstanding public debt, the monetary base has today reached a historically high level of 650 trillion yen at the end of June 2021, well surpassing Japan's annual GDP.[6] Since the mid-1990s, Japan's non-financial corporate sector has become the country's largest provider of savings, thereby depressing the demand for loans. This gave commercial banks little choice, but to deposit the extra liquidity granted to them through monetary expansion in accounts held with the central bank (Waldenberger, 2017).

3.3 Digitalization

Japan and the euro zone are not in the driver's seat when it comes to DX. The International Institute for Management Development (IMD) World Digital Competitiveness Index 2020 assigns Japan rank 27 among 63 countries (IMD, 2020). Euro zone economies are positioned between rank 7 (the Netherlands) and 50 (Slovak Republic). The larger economies of Germany, France, Spain, and Italy are ranked at 18, 24, 33, and 42 respectively, with an average rank for all 19 euro zone countries of 29. It is also interesting to note that Japan and many euro zone countries lost ground over the last five years. Their rankings declined, which means that they were unable to keep up with the worldwide development of digital services and technologies.

Statistics from the OECD Digital Economy Outlook 2020 draw a more diverse picture (OECD, 2020). Here, Japan scores relatively high with regard to business R&D dedicated to the information industry, ICT patents, enterprise broadband connections, and mobile broadband connections. Germany, the largest euro zone economy, appears in the top ten ranks only with regard to fixed broadband subscriptions. The performance of the euro zone economies is again very diverse, ranging from the upper to the lower ranks.

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[3] For instance, Yamaichi Securities, at the time Japan's fourth-largest securities company, and Hokkaido Takushoku Bank.

[4] The zero lower bound means that the implementation of negative nominal interest rates on deposits are constrained by the fact that economic agents can always hold cash. To cope with this constraint, the BOJ introduced the Quantitative Easing Policy (QEP) in 2001.

[5] For a detailed discussion of the BOJ's monetary policy, see Heckel and Nishimura (2022).

[6] https://www.boj.or.jp/en/statistics/boj/other/mb/base2106.pdf.

The above statistics are not in line with the ambitions that Japan, Germany, and the European Union pursue in the area of digitalization. In 2016, the Japanese government came up with a comprehensive and highly ambitious vision, Society 5.0, explaining how the country would embrace the digital revolution (Waldenberger, 2018). Even earlier, Germany had started promoting the concept of the fourth industrial revolution, Industry 4.0, as the countries plan to take a lead in exploiting the productivity potential of DX for industry (Platform Industrie 4.0, 2019). In 2020, the European Union published "A European strategy for data", stating that "The EU can *become a leading role model for a society empowered by data to make better decisions—in business and the public sector*" (European Commission, 2020, p. 1, italics in the original). While many EU member states lag behind in digitalization, the EU certainly has taken a lead in the regulation of data protection and privacy by, for example, introducing the General Data Protection Regulation (GDPR). The EU competition authorities have also been most active in trying to prevent the leading, mainly US-based international platform companies, from abusing their dominant market positions and in pushing them to implement stricter transparency and data protection policies.

4 DX and Finance: An Extended Overview

4.1 The Informational Nature of Finance

Digital transformation represents a technological revolution, which permeates all aspects of our lives. It has been driven by tremendous increases in connectivity made possible by the internet, mobile networks, sensor technology, social networks, and platform business models, as well as by equally impressive advances in computing power as recently exemplified by neural networks and deep learning algorithms. However, the fundamental and seemingly unbound impact of DX is not just the outcome of technological progress. It is above all related to two other main factors. First, DX exploits two key characteristics of digitalized information, namely, that it can be limitlessly shared, i.e., copied, at almost zero marginal cost, and that it can be ubiquitous, i.e., its accessibility and use are not bound to a specific location. Second, receiving, analyzing, and sending information forms the basis of biological, social, and cultural life. DX is not making information an essential part of our existence. This has in fact always been the case. DX is making us aware of the existential nature of information and it offers us new tools to collect, analyze, and exchange vast amounts of information in previously unimaginable ways. How we use these new powers is a fundamentally important question. It will be addressed in this volume with a focus on a vital part of our economies, the financial system.

DX is radically transforming the financial industry. This is not surprising because finance is after all about collecting and processing information, an activity directly affected by DX. Money, the core element on which finance is built, is an ingenious

information device. As a denominator of the price system and unit of accounting, it informs about the value of goods and services as well as assets and liabilities in balance sheets. As a storage of value and a means of exchange, it keeps a record of who has claims on the economy in terms of purchasing power and how these claims are reallocated when money changes hands in the process of trading, lending, and borrowing as well as saving and investing. Of course, the financial industry not only handles money. It also provides various services related to risk management and governance. But these again are activities that mainly consist of collecting and processing information.

It is not the first time that its informational nature made finance a front runner during fundamental economic transformations. The financial industry was among the first to be impacted by information and communication technologies (ICTs) (Bátiz-Lazo, 2015). Cashless transfers between banking accounts, the deployment of ATMs, and the use of credit and debit cards took early advantage of mainframe computers and telecommunication networks. Globalization, too, was a trend where the financial industry outpaced other sectors of the economy, when capital liberalization undid restrictions on cross-border financial transactions. Information, the basic input of financial activity, is not confined to a special location as in the case of a physical product. As a consequence, finance became a driver of globalization.

The impact of DX on the financial system is profound and broad, but it is also complex because the speed, extent, and details of the actual outcomes depend on national contexts. The following sections summarize the individual contributions and put them in context. As the chapters are not explicitly written in a comparative perspective, and as not all topics are covered with regard to both economies, we provide additional information. In doing so, we use the framework outlined above which describes the financial system in terms of functions, resources, and design. Applying this framework, it is important to note that DX does not change the primary and secondary functions of finance, as these do not depend on a specific technological regime. DX, however, impacts the resources and designs used to perform the functions. Many discussions of DX directly jump to the design level and pay little attention to the resource implications. We first look at the latter. As pointed out above, resources comprise physical infrastructures, knowledge, trust, and regulation.

4.2 Infrastructures

Central banks worldwide are today experimenting with digital currencies based on distributed ledger technologies (DLTs). DLTs exploit the immense increases in connectivity, computing power, and storage capacity. A recent survey by the Bank for International Settlements (BIS) shows that about 60% of central banks worldwide report that they are running experiments with central bank digital currencies (CBDCs)

(Boar & Wehrli, 2021: 7).[7] For instance, the European Central Bank decided in July 2021 to start the investigation phase for a digital euro.[8] If such new currency systems are to be introduced, they will make the existing infrastructures used for the circulation of cash and the transfer of money from bank accounts at least partly obsolete. Three contributions in this volume elaborate on design options for CBDCs. They are discussed below.

Crypto assets also make use of a DLT-based infrastructure. They were introduced in the private sector outside the public payment system (see the contribution by Bechtel et al.). Crypto assets and their infrastructures can be used for transactions and as a store of value. However, despite their impressive diffusion and valuation, they are not recognized as legal tender. Their use is limited to economic entities who explicitly agreed to participate by investing money or real assets in the respective schemes. The infrastructural implications of crypto assets depend on how far they are able to take over or support core functions of the financial system. The answer to this question remains unclear as there are still fundamental problems stemming not only from the high price volatility, but also from regulatory and security issues (see below).

Cashless mobile or online payments were made possible by the internet, mobile networks, smartphones, and the development and diffusion of application programming interfaces (APIs) (see contributions by Okina and Omarini). In contrast to DLTs, they rely on the existing banking infrastructure. Although they have important implications for the design level of business models, from an infrastructural perspective, they simply add what is essentially an additional digital layer.

4.3 Knowledge Base

DX affects the knowledge base of the financial system in myriad ways. The technology underlying DX itself represents new knowledge. Omarini highlights in her chapter how the European banking industry is struggling to adapt to DX. As value chains and business models are being transformed and consumers expect new service propositions, commercial banks have to basically reinvent themselves in order to stay competitive. Her analysis exemplifies the disruptive impact of DX on the knowledge base of commercial banking. The scarcity of adequately skilled human resources is often the decisive bottleneck in the adaptation and diffusion of new technology. DX is no exception. IT, computer, and system engineers are in high demand in the financial sector (PwC, 2019). Customers, both corporate and private, will also have to acquire new skills in order to benefit from new products and services, and to avoid

[7] Central banks and the Bank for International Settlements define CBDC as "a digital payment instrument, denominated in the national unit of account, that is a direct liability of the central bank" (Bank of Canada et al. 2020: 3).

[8] https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210714~d99198ea23.en.html.

and control related risks (see next Subsection). Sasaki emphasizes in his chapter that customer education is also needed from a regulatory perspective.

Legislators and regulators, too, have to learn about the opportunities and risks of DX, lest they become unable to provide the frameworks needed for an efficient, stable, and safe transformation of the financial system. Around the world, universities, public and private research institutes, and think tanks have set up digital finance as a field of expertise. Governments, central banks, and regulatory agencies have installed internal research units together with study groups and external advisory bodies to gain expertise. They commission reports, experiment with regulatory sandboxes, and establish fintech-hubs to collect and exchange information and to showcase innovations (Financial Services Agency, 2021; Parenti, 2020). Typical for EU policymaking processes, the EU's digital finance strategy (European Commission, 2020) was based on broad public consultations. In addition, knowledge has been acquired through a series of public events under the Digital Finance Outreach.[9] The Japanese government has a long tradition of using commissions of experts from academia and industry in its policymaking process (Neary, 2019). There are also numerous international forms of collaboration among policymakers and regulators within and outside established international organizations such as the IMF, the OECD, or BIS. One example is the joint distributed ledger technology project between the Bank of Japan and the European Central Bank referred to as Stella.[10]

Sasaki states in the very beginning of his chapter how regulators not only in Japan are having a hard time keeping up with new technological developments. He especially mentions the lack of human resources and emphasizes that regulators must collaborate closely with the private sector in order to cope with the speed of innovation. As Kinoshita points out, the Japanese financial system requires rules to be specified in great detail, because violations may be linked to criminal charges. This puts especially high demands on the expertise of Japanese legislators to adjust the legal framework in order to accommodate financial innovations because the more detailed rules afford more knowledge in the rule-making process.

Yamaoka's argument of a "private-led and two-layered" digital currency for Japan and Bechtel et al. roadmap show how private sector expertise and initiative can help to promote a digital payment infrastructure. The Study Group on Digital Settlement Infrastructure, which Yamaoka chaired, consisted of members from Japan's three mega-banking groups and leading non-financial companies. Representatives from respective ministries, the Bank of Japan, and the Financial Services Agency participated as observers. The Study Group soon reorganized as the Digital Currency Forum with more private corporations joining the initiative. Promoting system transformation through cross-industry consortia might be seen as a typical approach for a consensus-oriented society such as Japan. The process of knowledge sharing aims to ensure that the introduction of new payment infrastructures can benefit from a broad base of support.

[9] https://ec.europa.eu/info/publications/digital-finance-outreach_en.

[10] https://www.ecb.europa.eu/paym/intro/publications/pdf/ecb.miptopical200212.en.pdf.

Not all knowledge underlying and affected by DX is publicly accessible. A typical field where knowledge is strictly proprietary is algorithmic trading, which high-frequency trading (HFT) depends on. Algorithmic trading is a black box to market participants who use its respective services, but also to regulators who are supposed to monitor its impact. The big question is, how can we trust it if we do not know how it works. One way is to look at performance. Kiuchi, who analyzes the role and relevance of algorithmic trading in Japan in this volume, concedes that recent research has shown HFT to enhance efficiency. What is less clear is how algorithms affect market stability in times of crises, which be definition are uncommon or outlier events for which computer programs are less likely to provide routines. Another aspect is fairness. Efficiency does not assure that everybody gets a fair share of the efficiency gains. Kiuchi stresses that Japanese regulators will need more knowledge and resources to detect unfair trading practices. He concludes that more research is needed to learn how HFT affects the income position of different market participants.

4.4 Trust

Trust is another essential resource impacted by DX. In fact, trust is already needed in the transition process to obtain the support of essential stakeholders. Bindseil's policy proposal for a "two-tier remuneration approach to CBDC" explicitly addresses concerns raised by private households and commercial banks who fear that CBDC could harm their interests. The same applies to other forms of new payment systems (see Okina).

In general, all the financial innovations made possible by DX are bound to affect trust as they come with new risks. Such risks concern the technical stability of new solutions, mistakes made by using new and therefore unfamiliar services, privacy, and security concerns related to the data requirements of digital financial services, and the protection against criminal or otherwise intentionally harmful actions by those trying to take advantage of the inexperience of users and legal loopholes. Not coping with these risks in an adequate way will undermine trust in and acceptance of digital financial innovations.

Promoters of DLTs argue that the underlying infrastructure inherently provides trust. Transaction-relevant information is documented in a transparent way, and manipulations are precluded because to try to attempt them would incur unreasonably high costs (Tapscott & Tapscott, 2016). However, DLTs do bear severe security risks as incidents have shown.

Japan became one of the central turntables for blockchain in Asia and acted quite fast in introducing Crypto Assets. But Japan was also the country to experience the first large-scale security scandal. In 2014, Mt Gox, a Tokyo-based cryptocurrency exchange which once handled 80% of global bitcoin transactions, reported that 850,000 bitcoins worth $450 million had been stolen. Mt Gox became insolvent (Leising, 2021). Four years later, a similar incident happened at yet another Japanese exchange, Coincheck, where hackers were able to steal digital tokens worth

circa $500 million (Bloomberg, 2018). The incidents show that crypto assets face severe security issues. To regain trust, Japan established the Japan Virtual Currency Exchange Association (JVCEA) in 2018, a self-regulatory organization, which has the authority to pass and implement rules and regulations for crypto assets.

Even if security issues are dealt with, the trust produced by decentralized consensus-building mechanisms used to certify transactions in DLT can be very expensive. As the blockchains within DLT applications grow, operating costs in terms of electricity consumption and time will increase. At some stage, it will be cheaper to establish a central authority entrusted with governance functions, but then the system would no longer be able to produce trust on its own.

4.5 Legislation and Regulatory Oversight

Legislation and regulatory oversight support trust by codifying knowledge relevant for market participants and by regulating and sanctioning actions in order to assure that the system is stable and performs in an efficient, secure, and fair manner. In doing so, legislators and regulators have to not only avoid unnecessary administrative burdens, but to also make sure that innovative activity is not unduly restricted. Sasaki discusses how the Japanese Financial Services Agency (FSA) has been trying to balance the protection of users and the promotion of innovation in its regulatory approaches to digital finance.

In adjusting to new technological regimes, legislators are constrained by existing legal and judicative systems. As already mentioned above, Japan's Financial Instruments and Exchange Act (FIEA), which forms the core of Japan's financial legislation, allows for the prosecution of violations under criminal law. According to Kinoshita, this retards legislative responses to financial innovation because lawmakers must specify rules, that provide the detail and clarity required by criminal law. He fears that Japan's financial industry will be left behind, if Japan does not fundamentally reform its approach to financial regulation.

The EU has played a central role in the promotion of DX in financial services. Omarini argues that regulation has been one of the major driving forces in the digital transformation of the European banking industry. The European Payment Service Directive 2 provided essential momentum for the industry in moving towards an open finance framework. The directive stimulated the entry by new companies and promoted cooperation between fintech companies and banks.

4.6 Impact on Design

For the general public, the most visible impact of DX is at the design level. This encompasses new forms of money, new ways of making payments, obtaining credit, saving, investing, and insuring as well as the new advisory services helping us to

choose between different offers. Design aspects dominate the non-regulation chapters in the volume. Three of the contributions look at designs for central bank digital currencies.

Yamaoka provides an overview of currently used and discussed digital payment systems ranging from crypto assets, mobile payment services by banks, and non-financial companies based on the existing payment infrastructure, private digital currency initiatives such as Libra by Facebook and CBDCs. Based on his engagement with the Digital Currency Forum, he proposes a two-layered digital currency system for Japan. It would be issued by private-sector entities. Its upper layer would be equipped with customized programs including smart contracts to enhance the efficiency of payments and facilitate value-added transactions such as delivery-versus-payment (DvP), while its lower layer with common structure would enhance interoperability among various digital currency platforms.

Bindseil analyzes the design of CBDC under the aspect of remuneration, i.e., the rate of interest on CBDC deposits. Given recent interest rate policies by the ECB, he specifically considers the introduction of CBDCs in an environment with negative interest rates. He proposes a two-tier remuneration system in which interest rates on CBDC deposits up to a certain threshold held by private households would be non-negative as in the case of cash, whereas CBDC holdings of corporates and larger holdings of households (beyond the threshold) could be charged a negative rate of interest if required for monetary policy or financial stability reasons. His design proposal explicitly aims to preserve the intermediary function of banks. Moreover, he clarifies that as central banks commit to continue supplying banknotes, introducing CBDC is not an instrument to "tax" households' money holdings through more negative interest rates.

Bechtel et al. provide a detailed discussion of the design options for DLT-based currency and payment infrastructures by comparing account- and token-based payment solutions, including, e-money tokens, synthetic central bank digital currencies, and CBDCs. They then outline a roadmap towards the introduction of central bank digital currencies for the euro zone. Bechtel et al. emphasize that the introduction of digital payment solutions based on DLTs is essential for achieving the EU's strategic goals of digital autonomy and competitiveness. The authors specifically present a three-pillar framework of a digital payments value chain consisting of (1) a contract execution system, (2) a digital payment infrastructure, and (3) a monetary unit. Similar to Yamaoka, they consider both the public and the private sector as potential issuers of a digital euro. However, they conclude that a single payment solution will not be able to meet the diverse demands by the private sector. Instead, a range of complementary account- and token-based payment systems are likely to emerge and co-exist in the foreseeable future.

Many innovations in the field of digital finance originate from fintech startups which, as their name indicates, apply the new technology to create new financial products and services. Fintech solutions allow cost savings and improved customer convenience through virtualization, automation, and seamless integration of processes, the personalization of products and services and the improved analytics made possible by big data and the use of "intelligent" algorithms. The 2nd Global Fintech Ranking

Report (Findexable, 2021) documents the astonishing growth of the fintech industry. The report counted 108 fintech unicorns, i.e., non-listed startups with a market valuation of at least one billion US dollars in April 2021, up 61 cases from one year earlier. In terms of market valuation, fintech unicorns now account for 20% of all technology unicorns. Although fintech is a global phenomenon, the speed and scope of financial innovations differ markedly across countries. The report, which covers 11,000 companies in 264 cities and 83 countries, reflects these differences in its country and city rankings. The rankings are based on the number of privately owned fintech companies headquartered in a specific city or country, including supporting institutions, their performance, and the local or national business and regulatory environment. The country rankings see Japan at position 21, far behind the two Asian top runners, Singapore (4) and China (6). Seven euro zone countries are among the top 20, including the two larger economies of Germany (9) and Spain (16), ten are found among the next 30, whereas Greece and Slovakia occupy ranks 58 and 60 respectively, again showing the wide disparity among euro zone economies.

As Omarini explains in her chapter on commercial banking, whereas some, mainly highly internationalized fintechs, are able to operate independently, others cooperate with incumbent players because they are too small to make a full-fledged entry into finance. Incumbents in return profit from the innovative capacity of such partners. The cooperation between banks and fintechs is again supported by digital innovations such as APIs and promoted by new financial legislation. Large technology companies, Big Techs, have also entered the financial industry. By adding financial services to their platform business, they are able to further expand their capacity of collecting data. They are large enough to found their own financial group companies. As such, they pursue competitive rather than collaborative strategies.

Okina's empirical investigation reminds us that social traditions and customer preferences impact the design and diffusion of new technologies. Whereas Japan seems to be lacking behind with regard to cashless payments, the country has a highly developed loyalty points system, which has partly taken over functions of a cashless payment system. Not only the government and the FSA, but also Japanese e-commerce platforms such as Rakuten and the SoftBank (Yahoo!) Group have promoted payments using loyalty points. Loyalty points can today also be used to invest in exchange traded funds (ETFs) and real estate investment trusts (REIT) (*Yomiuri* Shinbun, 2021). The role that the loyalty points system will play in Japan's future payment system remains to be seen.

Kiuchi's account of algorithmic trading shows that HFT in equity markets is not yet as dominant in Japan as it is in the US. However, with US companies entering the Japanese market, HFT is already impacting the business models of Japan's security industry.

5 Concluding Remarks

Looking at the momentum digital innovations in finance have been gaining worldwide over the last ten years, the amount of venture capital that new entrants into the industry have been able to raise and the support by national legislators and regulators, the DX of the financial system seems unstoppable. Nevertheless, at the level of individual economies, the DX of financial systems is diverse in terms of speed, scope, and outcome. National context matters.

Proponents of DX claim that a digitalized financial system can ameliorate the shortcomings of our present financial systems. Besides general efficiency gains, including improvements in convenience, they point to the possibility of eliminating surcharges on cross-border money transfers and to better social inclusion by providing financial products and services to people who have so far been denied bank accounts. But there are also numerous risks with regard to financial stability, privacy, and cyber security as well as fairness, which can hardly be overestimated. The key question then becomes how the transformation of the financial system can be governed to ensure that the opportunities outweigh the risks. This is closely related to the provision of one of the key resources discussed above, namely, knowledge. To benefit from financial innovation and to not fall victim to scams, the general public needs a sufficient level of financial literacy. But effective governance requires above all, that legislators and regulators have the knowledge necessary to safeguard the public interest. This is not a trivial problem because it will not suffice only to listen to advice provided by industry experts.

Effective governance needs an independent knowledge base, which is able to not only use expert knowledge provided by private industry, but to also assess to what extent advice from industry experts is useful in the pursuit of public policy goals (Waldenberger, 2019). Our publication is the outcome of such an endeavor. We hope it can contribute to the public discourse and further a critical understanding of the impact of DX on financial systems.

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The Future of Japan's Financial Market

Nobuyuki Kinoshita

1 Introduction

In this chapter I investigate the relationship between developments in Information and Communication Technology (ICT) and financial services and legislation, with a focus on the financial market. I then identify the problems with Japan's financial legislation.

The basic approach I employ is as follows: the services for financial transactions are built on the latest ICT, while the legal implications caused by the use of ICT are stipulated by the existing financial legislation. As the rapid development of ICT has made cross-industry and cross-border competition surrounding financial services extremely fierce, this has put enormous pressure on the financial industry to innovate their services. On the other hand, a nation's financial legislation might show remarkable delay because of the path-dependency of lawmaking and enforcement systems. The discrepancy between the rapid progress of ICT and delayed legislation varies by country, depending on the country's institutional structures. These national differences in turn reflect the relative competitiveness of financial industries and markets as a result of the varying speed and smoothness of financial service innovation.

Following this approach, first I explain the basic conditions regarding the relationship between ICT development and financial transactions. Put simply, the economic value produced by financial transactions basically consists of saving transaction costs. Transaction costs are basically information-processing costs, which are determined by the level of ICT. Second, I explain the grand design of financial legislation and the peculiarities of Japan's system. Generally speaking, the financial legislation of a country is composed of two categories. The first is financial legislation in a broad sense including basic legal systems such as bankruptcy laws. The second

N. Kinoshita (✉)
Tokyo Financial Exchange Inc, Tokyo, Japan
e-mail: kinoshita@tfx.co.jp

M. Heckel and F. Waldenberger (eds.), *The Future of Financial Systems in the Digital Age*, Perspectives in Law, Business and Innovation,
https://doi.org/10.1007/978-981-16-7830-1_2

is the financial legislation in a narrow sense including regulatory systems such as security exchange laws. Third, I examine examples of the changes of financial transactions caused by ICT advancement in various countries and compare them with the development in Japan. Here I also survey previous delays in Japan's financial legislation.

Fourth, I focus on the current changes in financial markets by introducing examples of changes in financial markets around the world caused by advances in ICT. Former financial exchanges have transformed themselves into providers of financial market infrastructures. Global regulations have also changed in accordance with this transformation. In the fifth section I identify the challenges for Japan's financial legislation. I provide an example of the collective clearing system of over-the-counter (OTC) derivatives transactions, then I show the challenges of adapting to digital innovation. There are two main challenges: the first is how to design the overall financial legislation, and the second is how to enforce individual legislation. In the conclusion, I address the principle of "Legislative Facts," which is frequently invoked by the Japanese central government.

2 Influence of ICT Development on Financial Transactions

2.1 Transaction Costs and Financial Transactions

Transaction Costs

In this section I explain the relationship between ICT and financial transactions based on the theory of "Law and Economics".

First, let us consider the functions of "currency", which is the core concept of financial transactions. Economics points out that currency has three basic roles: unit of account, means of payment and means of storing value. On the other hand, the theory of Law and Economics stipulates that the basic function of institutions such as legislation and firms is the reduction of transaction costs, namely, search costs, negotiation costs, and enforcement costs. Currency can be understood as an institution. It provides a common infrastructure for transaction parties. Its three functions contribute to the reduction of transaction costs in the economic sphere.

The level of transaction costs depends on the information-processing costs, which are composed of the amount and the unit cost of information processing. The latter can be further decomposed into communication costs and analysis costs.

In this context, the role of currency and institutions is the reduction of the number of information-processing steps for the given economic activity of a country. Namely, currency and institutions work as the hub of an information processing network whose nodes are transaction parties. Information regarding individual economic transactions between the nodes are intensively collected at the hub and processed on the spokes between the hub and nodes. For example, a firm that purchases a good from a transaction partner pays the price via deposit transfer through the nation's bank system.

By doing so, transaction partners can save the search cost, because they can trust the prudence of licensed banks. In addition, partners can save the negotiation and enforcement costs by employing reliable payment means. In this sense, currency and institutions are a kind of hub-and-spoke network.

A form of network contrasting to this hub-and-spoke network is a mesh network, where each transaction party communicates mutually and analyzes the counterparties of an economic transaction one by one. For example, a consumer might pay the price by handing cash directly to the retailer. By doing so, transaction partners can save the banking fee. As the transaction is face-to-face and the amount is relatively small, transaction costs of searching, negotiation, and enforcement are negligible in this case. For this kind of retail transaction, a mesh network using cash payment is preferable in terms of transaction costs.

Comparing the hub-and-spoke network with the mesh network, we can say that the former has the advantage saving transaction costs by reducing the number of information-processing tasks, but has the disadvantage of being vulnerable to threats against the hub. Once the hub of a network is damaged, the entire system malfunctions. The relative superiority and inferiority of both systems depend on the unit price of information processing.

Influence of ICT Advances on the Information Network of Economic Spheres

Applying this conceptualization, we can summarize the influence of ICT advances as the reduction of the unit cost of information processing. This cost reduction influences the choice of network by transaction parties. Namely, the transaction parties in the economic sphere always compare the different information processing costs of the hub-and-spoke network and the mesh network, and choose the network with a relatively cheaper cost. If the unit cost of information processing is generally reduced by advances in ICT, the relative advantage of the hub-and-spoke network vis-à-vis the mesh network is mitigated. It has less superiority in terms of reducing the number of information-processing steps because of the cheaper unit price, while its vulnerability at the hub remains unchanged despite ICT advances. This leads transaction parties to prefer the mesh network.

However, this influence varies depending on the kind of transaction cost. Namely, the weight of communication costs is the highest in regards to search cost, the lowest in enforcement cost, and medium in negotiation cost. ICT development so far has had more impact on communication costs than on analysis costs, so the shift of economic transactions toward a mesh network can be realized more remarkably in the area where search cost carries more weight.

2.2 The Unceasing Development of ICT[1]

Performance Improvement of Computer Hardware

ICT development is not a recent phenomenon but has continued accelerating over the recent decades. When we analyze the influence of ICT advances on financial transactions, we should not be captivated by individual novel technologies but should always ascertain the long-term trend.

Advances in ICT are caused by the unceasing improvement of computer hardware performance. Concerning this phenomenon, there is the famous "Moore's Law". This rule of thumb states that the speed and capability of computers can be expected to double every one-and-a-half year as a result of increases in the number of transistors that a microchip can contain. This is an experimental principle but has been valid for several decades. As a result, the performance of computer hardware has improved exponentially. For example, the capacity of a tablet, which we can now purchase for a few hundred dollars, is equivalent to the capacity of a supercomputer that cost billions of dollars 30 years ago.

Innovation of Software

Based on this exponential improvement of hardware performance, various software innovations have been produced. No innovation is a mutation but an extension or combination of existing technologies. For example, the consensus algorithm, which is the core of block chain technology, is a combination of crypto technology and peer-to-peer (P2P) network technology. This is an epoch-making idea, but not novel technology. In block chain technology, transaction data is saved in the form of a cryptograph and disclosed in the P2P network. This cryptograph is checked via crypto technology by any node computer of the network. As this technology requires huge computing capacity, no one could realize this earlier. Indeed, the key challenge for block chain technology is how to overcome the scalability problem.

Another example is Artificial Intelligence (AI). This technology is nowadays in the spotlight, but not a recent development. Applying logical processing to computers has been a major subject of ICT for about 60 years, but there has been severe difficulty because of the insufficient capacity of computers. In the early AI, the logic was programmed in advance so that users had to input the predefined data exactly in order to operate the computer. In the second stage of AI, "expert systems" were employed to instruct the computer to set the logic by itself. However, it did not work satisfactorily at the time, because there was not enough volume of data to instruct the computer effectively. In the current stage, this problem might be solved by "deep learning" technology. The method of deep learning is similar to principal component analysis, which has long been established. However, the capacity of computers was insufficient at that time so that the application of this analysis was limited to the learning of a simple linear function. The performance improvement of hardware

[1] The following passages are based on Kinoshita (2019).

has solved this problem and created the appropriate foundation for deep learning technology.

Influence on the Future of Financial Services

As these examples show, the performance improvement of computer hardware is indispensable for recent software innovations. Following Moore's Law, the improvement of hardware has accelerated software innovations unceasingly, and this has had a strong influence on business. Firms in all industries are aiming for increased customer satisfaction by utilizing ICT progress. As the performance of computer hardware continues to improve, this trend is irreversible.

In this way, the advancement of ICT has been so continuous and irreversible that it has also produced perpetual changes across the economic sphere without interruption. Currency and institutions are no exception. I believe we should recognize this fundamental trend; in the following section of this chapter, I project the future of financial markets based on the extension of this past trend.

3 Financial Transactions and Financial Legislation

3.1 Grand Design of Financial Legislation

Composition of Financial Legislation

As objects of financial transactions are contracts among transaction parties, the change of rights and duties of relevant parties caused by the transactions are prescribed by legislation. In addition, the rules among transaction parties and financial service providers are regulated in accordance with legislation. Therefore, the role of legislation is a matter of critical importance for financial transactions.

Financial legislation can be classified into two categories. The first is financial legislation in a broad sense. The second is financial regulatory laws. Hereafter I explain both categories in detail.

Financial Legislation in a Broad Sense

This category includes laws regarding corporate finance activities. In this context we can consider two kinds of capital providers. The first are human capital providers such as management and employees. The second are financial capital providers such as creditors and equity holders (Shishido, 2000). As for the latter, we can find liabilities to the creditors and capital for the sake of equity holders in the balance sheet. In the profit and loss account we can find the compensation for the management and employees, the payment of interest, and dividends to the financial capital providers. Here, currency works as a unit of measurement for financial statements.

Laws of debt and equity are examples of financial legislation in a broad sense. There are also many supplemental laws to these basic laws, such as securities laws

starting with bills of exchange and promissory note laws, and corporate laws that govern the organizational design of equity-funded incorporated businesses.

Among them, bankruptcy laws have the closest relevance to financial transactions. They substantially govern the conversion process of debt to equity. That is, when a corporation falls into distress and has difficulty paying its debts, a bankruptcy procedure for this corporation would start. In this procedure, first the total value of all assets and businesses of the corporation is assessed. Then, the monetary rights of creditors to this corporation are restricted, subject to the assessed value. At the same time, they acquire managing rights to the corporation in the form of appointing the administrator and voting for the reconstruction plan. In this sense, we can regard bankruptcy procedures as collective debt equity conversions, which is a kind of financial transaction.

Financial Legislation in a Narrow Sense

Financial legislation in the narrow sense comes in two kinds. The first group regulates corporations as designated financial service providers. Banking acts are the typical example. These laws regulate the business scope or financial prudence and so forth of the target corporations, in order to secure public confidence regarding the solvency of corporations. The objects of the second group of regulatory laws are designated financial transactions. Securities exchange acts are a typical example. These laws regulate the methods of transactions, disclosures of information, and so on in order to secure the fairness of the transactions.

Comparing financial legislation in the narrow sense with the broad sense, the first difference is the way of enforcement. Legislation in the narrow sense requires high expertise to monitor the rapidly changing financial transactions and strong resilience to take appropriate measures regarding malpractice. Therefore, most advanced countries establish specialized bodies for financial regulation. The Securities and Exchange Commission of the United States is a typical example.

However, there are many variations of financial regulators among countries, from regulators of payment systems such as central banks to self-regulating bodies within industries such as security dealers' associations. This variation reflects several factors such as the infrastructure-like character of the financial system as well as the structure of financial legislation in the broad and narrow senses.

3.2 Peculiarities of Japan's Financial Legislation

Peculiarity in Legislation

As with other countries, Japan also has financial legislation in the broad sense such as the Law of Obligations, the Companies Act, and the Bankruptcy Act, and in the narrow sense such as the Banking Act and the Financial Instruments and Exchange Act (FIEA).

Among the latter, the structure of the FIEA is characterized by its exhaustive specifications regarding the specific types of financial instruments, that are the object of regulation, except for general debt and equity, which are prescribed by financial legislation in a broad sense. The purpose of this act is fairness and transparency in the transactions of designated financial instruments. The FIEA imposes special regulations on the transaction parties of these designated financial instruments. The act also regulates the related service providers as financial exchanges or business operators of financial instruments. It requires a license for doing such businesses to handle designated instruments, imposes special duties on their business practices, and supervises their management. Specifically, the FIEA regulates every detail of financial exchanges, starting from the scope of business and including financial prudence.

These regulations are backed by criminal punishments. Even in the case of the Banking Act, if a provider violates a particular duty, the regulator would give an administrative order, and if the provider does not follow the order, the regulator would file criminal charges. Furthermore, the FIEA imposes direct criminal punishment for misconduct in the transactions of designated financial instruments. This is a sharp contrast to financial legislation in the broad sense, where the rights and duties of related transaction parties are principally adjusted through civil procedures.

These peculiarities have great impact on Japan's financial institutions and the financial industry. Under the principle of *nullum crimen sine lege,*[2] the specification of the financial instruments must be clearly defined. This hindrance is particularly remarkable for the FIEA. Because of this stringent law-making process, Japan's financial regulations are hardly able to catch up with the rapidly changing financial transactions.

Sometimes we can observe a unique phenomenon in Japan where the behavior of a corporation's management is investigated by the prosecutor for potential violation of financial regulations before the respective issue is taken up by the board of directors as part of the typical corporate governance procedure. In this way, the grand design of Japan's financial legislation distorts the overall function of the country's financial market.

Peculiarities in Enforcement

The financial regulators in Japan are entirely governmental bodies financed by the state budget. As they have policing authority over financial service providers and transaction parties, the everyday practices of Japan's regulating officers are similar to those of police officers. They put emphasis on creating records, requesting reports and issuing orders. They have little monetary incentive to develop the financial market of the country.

The FIEA additionally created a special regulatory body called the 'Securities and Exchange Surveillance Commission'. This commission is, in sharp contrast to the American Securities and Exchange Commission (SEC), an investigating authority. Specifically, it has a special division for criminal investigation which is tasked with

[2] The translation of this maxim is "an act is not a crime if there is no law against it".

collecting sufficient evidence until the prosecutor can strictly prove a violation. Sometimes this might require a considerably long period, potentially meaning that the misconduct being investigated may damage the function of the market significantly.

This character of Japan's regulators is quite different from that of other countries. For example, the main activities of the American SEC are the execution of civil lawsuits. In addition, it takes compensation from misconduct in the capital market on behalf of victim investors, similar to indemnity. Furthermore, a considerable part of their activities is financed by the financial industry. The equivalent market regulator in Germany, Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) has a similar character.

These differences of financial regulations in various countries derive from the legal system as a whole and the history of regulations in the respective countries. However, at the same time, they have great impact on the competitiveness of the financial industry and hence the overall economy. For example, when a new financial service using the latest ICT is introduced, in the United States the service is provided first, then the legal obstacles would be dealt with. In Japan, in contrast, it takes a long period before the FIEA is amended, or the new service is forced into an existing provision of the act. In Japan, the more strictly corporations follow regulations, the less competitive they become in the global financial world where "the early bird catches the worm".

4 Innovation of Financial Services Caused by ICT Developments

4.1 Innovation of Financial Services

As I mentioned earlier, the development of ICT has unceasingly accelerated based on the performance improvement of computer hardware, which has had a continuous and irreversible influence on the innovation of financial services for a long period of time. In the following section I provide two examples of this influence.

The first example is structured finance. In financial legislation in the broad sense, typical instruments of corporate finance are supposed to be debt as specified in the Law of Obligations or equity as regulated by the Companies Act. However, sometimes in actual corporate business, not only such ready-made alternatives but also order-made means of finance might be effective. For example, a corporation might segregate a particular asset for the purpose of effective risk management of various businesses. At the same time, a fund provider might prefer these hybrid products to conventional debt or equity in accordance with the preference of investors. Structured finance is the financial intermediation service used to satisfy the needs of both transaction parties. In the case of asset-backed finance, a service provider puts segregated assets into a special purpose vehicle (SPV) which is insulated from potential bankruptcy procedures of the original fund raiser. Then the service provider

lets the SPV raise funds in the form of securities issuance corresponding to the preference of investors. In structured finance, the service provider utilizes ICT to set up the conditions of securities issued by the SPV, so as to provide more sophisticated services that can bring new revenue opportunities.

The second example of innovation caused by advances in ICT is an expansion of internet-based retail services and the consequent erosion of traditional payment services. Commercial transactions through the internet are exponentially growing, because the communication costs can be dramatically slashed. As the customer has no face-to-face interaction with a retailer, they desire retail and payment services to be provided as a single unit. Therefore, the integration of retail services and payment services through the internet has rapidly grown over the past 30 years and is currently growing exponentially. Particularly in China, this trend of utilizing advancements in ICT is accelerating, so that ICT-based tech giants have entered the market one after another. This development is not due to a plan by the Chinese central government, but it is the result of corporations' hard work in searching for revenue opportunities by utilizing advancements in ICT.

4.2 Development of Financial Services in Japan

Regarding these two examples, Japan has been lagging behind the global developments. In regards to structured finance, this service has been developed in the global market for 40 years. In Japan, however, it was first recognized as a meaningful financial service only in the late 1990s. This was accompanied by interest rate liberalization at first, but thereafter it continued to lag behind global developments. Even now, structured finance is less developed. For example, securitization and credit default swaps (CDS) were remarkably constrained by the poor corporate bond market. The corporate bond market is small in volume and very much biased toward high-rated bonds. There is no "junk bond" issued in Japan (Yoshii, 2009).

As for internet-based financial services, this was initiated as late as the second half of the 1990s in Japan. Moreover, at the beginning, convenience stores introduced banknotes-based services, including serving as receiving agents and providing ATM management services for banks. At that time, the Financial System Research Council considered the possibility of legislation governing new entries to internet-based financial services. However, around this same time, a major financial crisis occurred in Japan and the injection of governmental money into the banks became the main policy measure. It made newcomers prefer to have the status of a bank, as potential investors for newcomers might expect the possibility of receiving governmental assistance. In addition, in the subsequent amendment of the Act on Settlement of Funds, the upper limit was set for payment service operators other than banks. Today, making up for the delay compared with other countries regarding cashless payment has been set as an important policy target.

In the past, the most important reasons for this delay regarding the introduction of financial innovation were the interest rate and service fee regulations. Under the

government's price control, financial service providers had no incentives to innovate. Today, however, I would highlight the problems with the grand design of financial legislation in Japan. The Bankruptcy Act is the first problem related to the delay in structured finance.

Japan's Bankruptcy Act has restrictive requirements for the distressed corporation to petition, in contrast to the United States. Additionally, insolvent corporations in Japan have no obligation to petition bankruptcy procedures, in contrast to Germany. Because of this, the start of most corporate reorganization in Japan is remarkably late so that there is little time to develop proper business and financial reorganization plans for the corporation. In this circumstance, there is little need for junk bonds and hence securitization and CDS.

The more serious hindrance for flexible financial innovation in Japan is the legal structure of financial regulations enforced by criminal punishments. Particularly, the FIEA has the largest influence. As mentioned above, the Act imposes regulations on transactions and service providers of designated financial instruments. As the regulations are backed by criminal punishments, the designation must be completely clear. Lawmakers must perfectly distinguish the designated instruments from common financial instruments. On the other hand, the typical financial innovations that utilize progress in ICT are hybrid financial instruments such as structured finance or integrated services with other industries such as retail or communication. The key for innovations is that they are cross-industry in nature. There is a sharp contradiction between the legal structure of the FIEA and flexible financial innovation in Japan. A clear example is the constraint on financial exchange businesses. Here, the Financial Services Agency based on its wide discretionary power granted by the FIEA and related Cabinet Office Ordinances requires that designation to precede business planning by financial exchanges. This constrains the competitiveness of Japan's financial markets and exchanges in the global market.

The advancement of ICT will accelerate in the future and will have more influence on financial innovation, so that the competition between relevant corporations will become intensified in cross-industry and cross-border contexts. If the Japanese government continues to adhere to the existing legislation in the future, innovation in Japan's financial industry might be left far behind its competitors.

5 Recent Developments of Financial Markets

5.1 Recent Innovations in Financial Markets

Bankruptcy Procedures in China

In this section I focus on the recent developments of financial markets. I begin with two examples of innovation in global financial markets. The first example is bankruptcy procedures in China. China has a bankruptcy law called the Bankruptcy and Reorganization Act, which is equivalent to a combination of Japan's Bankruptcy

Act and Civil Rehabilitation Act. As Chinese courts in many provinces had utilized net-auctions in bankruptcy procedures, the People's Supreme Court of China announced that all notices and acceptances of bankruptcy procedures of all Chinese courts after August 2016 must be disclosed and processed on the internet. Following this announcement, around 30,000 procedures were processed on the internet in 2018.

When we visit the site National Enterprise Bankruptcy Information Disclosure Platform,[3] we can find much information concerning the recruitment of administrators and sponsors, the auction of assets and so forth. Among them, sites for the auction of assets show detailed information about the individual assets of failed corporations, such as descriptions and characteristics of their real property. The auction is implemented on internet platforms by the administrators, based on the process and rules decided by the claimants committee. The only role of courts is the execution of the auction and guidance for the trustee.

The platform where net auctions of bankruptcy procedures take place is Ali Judicial Auction.[4] As we visit this site, we can find detailed information of all kinds of assets. The investors have a strong interest in information on real assets in large cities, as ordinary articles are hardly put on sale in the overheated market. This development could be regarded as a fundamental change of bankruptcy procedure practices, which is the core of financial legislation in the broad sense.

Clearing services of the European Commodity Clearing

The second example is the clearing services of the European Commodity Clearing (ECC) for electricity futures transactions. This corporation belongs to the European Energy Exchange (EEX) group, but provides clearing services not only for transactions made with the EEX group but also to all commodity transactions including OTC transactions around the world. Specifically, the ECC offers a marketplace where 20 clearing members such as banks provide services to 370 non-clearing members.

Here we can see the remarkable difference with Japanese financial exchanges. First, the ECC is a CCP (Central Counter Party) for transaction parties of energy futures, but at the same time, it is a deposit-taking institution. The ECC is a bank supervised by the German regulator BaFin, based on the German Banking Act. In the legal structure of financial regulation in Germany, in contrast to Japan, the law for financial exchanges is separate from the law for security transactions, and the regulation of clearing services is distinguished from matching services (Mitsubishi UFJ Research & Consulting, 2019). In addition, regarding the EEX group including the ECC, more than half of the business of the group consists of OTC transactions. The matching service of transactions is not so important for the exchange any more.

Furthermore, it is not required for the market participants of the EEX to be a registered German corporation. It is enough for them to be regulated by a nation's authority which has mutual recognition with the German regulator. This is the basis for the financial market to develop cross-border business in every part of the world.

[3] In Chinese: 全国企业破产重整案件信息网 (http://pccz.court.gov.cn/pcajxxw/index/xxwsy).

[4] In Chinese: 阿里拍卖・司法 (https://sf.taobao.com/).

In fact, the ECC will provide clearing services for electricity futures transactions in Japan as well.[5]

5.2 Change of the Role of Financial Market Infrastructures

A New Market Infrastructures Industry

Earlier, the main roles of financial exchanges were matching services of offers and bids for standardized instruments and disclosing fair prices generated by the transactions. Nowadays, the role of these corporations is drastically changing from this conventional exchange for two reasons. The first reason is the economic one caused by developments in ICT. The second is the regulatory one as a measure for recurrence prevention in response to the last global financial crisis.

Advancements in ICT push all financial service providers to change their business models in association with the shift of information processing from a hub-and-spoke network to a mesh network. At the same time, ICT advances accelerate cross-industry and cross-border competition among ICT-related service providers so as to inspire innovation across all business areas, including financial services. The above-mentioned developments in bankruptcy procedures in China and clearing services in Europe are examples of this megatrend.

Regarding the function of existing financial exchanges, a significant phenomenon is the unbundling of their functions. Matching, clearing and price discovery were formerly united as sequential core functions of financial exchanges. Earlier these three functions were fulfilled by a single corporation, because information-processing costs can be saved by doing so. However, thanks to advancements in ICT, such information-processing costs have been reduced dramatically. We can enjoy matching services for economic transactions of all kinds of goods and services now, such as electronic commerce, the sharing economy, net auctions and so forth. The marginal economic value of matching services has drastically declined. There is little need for a specialized matching service of standardized financial instruments.

In addition, the implementation of transactions is supported by the various digital trustee businesses and even by the courts themselves, as in China. Therefore, the current emphasis of clearing services is not implementation itself but performance guarantee. This service helps transaction parties to hedge the counterparty risk caused by asymmetric information, which cannot be overcome by ICT advancements. Moreover, the price discovery function of financial exchanges is changing accordingly. The function became diversified, from the price schedule to the indicative price in accordance with various financial instruments.

[5] As for electricity futures in Japan, the Tokyo Commodity Exchange (TOCOM) will provide matching services and clearing services. This corporation has now been purchased by Japan Exchange (JPX), but still provides exchange services for certain commodity futures including electricity. Therefore, EEX and TOCOM will be direct competitors in clearing services of electricity futures in Japan.

In this way, former financial exchanges have grown out of the erstwhile sequential business model from matching to clearing of designated financial instruments, and instead are now playing multiple roles for the transactions of a broad range of financial instruments. The transformation of former financial exchanges is corresponding to the shift of information processing from hub-and-spoke networks to mesh networks. Now they are becoming providers of financial market infrastructures, such as exchanges, clearing houses, and database providers.

Blocking Systemic Risk

Following the global financial crisis, regulatory authorities across the world have made sweeping financial regulation reforms including many recurrence prevention measures against systemic risk. The concentration of OTC derivatives transactions within Central Counter Parties (CCPs) is one of the most important measures. The focal point of this regulation is making use of the clearing function to block default contagion in the case of a market player's failure. The emphasis of this regulation of financial exchanges is not placed on the fair price discovery function, but on the solvency of the exchange system. The Principle for Financial Market Infrastructure was compiled by the Bank for International Settlements (BIS) and the International Organization of Securities Commissions (IOSCO) in 2012 for these reasons.

We can regard this development as a part of the megatrend caused by developments in ICT. First, financial markets have developed derivatives by using financial engineering based on ICT in order to save transaction costs. Derivatives transactions then greatly increased systemic risk as seen in the global financial crisis. On the other hand, the former core functions of financial exchanges were unbundled and reorganized. They are transforming themselves into providers of financial market infrastructures. In this new market infrastructure industry, clearing businesses became central and vital functions. Regulators expect them to act as a barrier against the contagion of market risks.

Regarding the new role of clearing businesses, a recent article has claimed that their role should not be limited only to derivatives, but also should be applied to other broad financial contracts (Schwarcz, 2018). According to this article, there are two reasons why the regulators wanted to concentrate the clearing of derivatives transactions within CCPs. The first was that derivatives tend to inflate transaction volumes as their costs are comparatively small given the expected economic effects. The second was that the contents and conditions of derivatives instruments are highly standardized so as to be suitable for collective clearing at a CCP. Because ICT progress provides similar conditions for financial contracts in general, the barrier function of CCPs should be employed to prevent the systemic risk concerning general financial transactions.

6 Challenges for Japan's Financial Legislation

6.1 Adjustment of Financial Legislation in Response to Advancements in ICT

So far, I have discussed the global trends of financial markets and market infrastructure caused by ICT progress. Under these circumstances, financial legislation must be adjusted to the new reality. In particular, the regulation of the integrated provision of matching, clearing, and price discovery services must be sweepingly revised. The price discovery function that existing laws are designed for is the undifferentiated matching of standardized financial instruments. This is because at the time of its establishment the traditional system was confined by the relatively poor performance of ICT.

Every country has its own financial legislation. All systems have a bias toward the status quo caused by path dependency. The cross-country differences in financial legislation produce diverging effects on the competitiveness of nations' financial markets under the global progress of innovation. We find this problem particularly in Japan.

6.2 Legal Foundation of the Collective Clearing System

In the following section I present an example of the collective clearing system of OTC derivatives transactions. After the global financial crisis, regulatory authorities around the world established a consensus that OTC derivatives transactions should be concentrated within CCPs in order to block the contagion of the default risk of market players. A CCP makes it possible to collectively settle the credits based on the financial derivatives prior to bankruptcy procedures of a failed market participant. As every bankruptcy legislation has an equal treatment rule between creditors, the collective clearing system at CCPs needs an escape clause from the general rule of bankruptcy procedures.

Therefore, every country introduced a legal foundation for advance payment with a CCP. However, the concrete acts of legislation are quite different among concerned countries. In the United States, advanced payment to the financial exchange participants was permitted by the courts as they are not corporate-specific assets in the corporate reorganization procedure (Yamamoto, 2014). In Germany, the Bankruptcy Act was amended to allow advanced payments (Kansaku, 2018).

In Japan, in contrast to these countries, the FIEA was amended to provide a special scheme for financial derivatives transactions. At the same time, it requires business operators to concentrate financial transactions within the CCP in Japan (Article 156–11-2 FIEA). The FIEA is one of the financial legislative acts in a narrow sense. This is quite unique from the point of view of the grand design of financial legislation, as a special law breaks the general conditions in order to maintain the effectiveness of a

specific regulation. The coverage of this special treatment is limited to the financial instruments designated by the regulatory authority. From the point of view of business operators in Japan, the coverage of collective clearing was clearly decided by the authority ex-ante. That means the operators can enjoy high foreseeability, but they do not have enough incentive to modify the specifications of financial instruments spontaneously. Every detail must be clearly specified by the regulators in advance.[6]

However, Japan has a special clause in the Bankruptcy Act as well. This clause allows advance payment for the transactions of instruments that have a market price at exchanges and so forth (Article 58 of Bankruptcy Act) (Act No. 75 of 2004). This clause was established in the case that a bankruptcy administrator might have difficulty to set the timing of disposal for those instruments with volatile market prices. This clause is not backed by criminal punishment, so that the coverage can be decided flexibly in the course of civil procedures. Therefore, if this clause overrides the specific provisions of the FIEA, the constraints on the enlargement of the CCP's function would be more limited.

Regarding this question, legal experts support using this clause in the Bankruptcy Act in a wide range of financial instruments. An authority has written that "The clause can be applied to OTC transactions, as far as the price mechanism works in a fair and transparent manner. The transaction need not be made in the exchange." On the other hand, from an economic point of view, it depends on the balance between foreseeability and flexibility. In the period of less developed ICT, the former was more important as the strict standardization of financial instruments was indispensable for being accurately matched. However, advancements in ICT have made this constraint less important. In addition, it is useful for the barrier function to be applied to as many diverse instruments as possible.

In sum, as far as this example is concerned, financial legislation in the United States or Germany has remarkable superiority to that in Japan in the present situation. In the future, advances in ICT will continue to accelerate, so that the design of financial instruments and the business models of financial exchanges are expected to diversify further. For this reason, I believe Japan should reconsider the structure of its financial legislation. At least, the Japanese financial industry should apply the clause in the Bankruptcy Act to a broader range of financial transactions. In order to satisfy the needs for foreseeability about the coverage of collective clearing prior to bankruptcy procedures, soft-law measures would be desired, just like the treatment of trade creditors in The Guideline for Out-of-Court Workout.[7]

[6] This legislation is designed to be applied in the clearing of CDS. However, as CDS transactions are rare in Japan, this act supported mostly the clearing of OTC interest rates swaps.

[7] The Guideline was established as a consensus of Japan's industrial firms and banks in 2001.

6.3 Challenges for Japan's Financial Legislation

Integrated Design of Financial Legislation

The above-mentioned case is a typical example of the history of financial legislation in Japan. In Japan, developments in the legal environment regarding particular financial transactions have frequently been made through the amendment of financial legislation in the narrow sense (Takahashi, 2015). This development has constrained flexibility in financial services because these regulations rely on criminal punishment. Moreover, financial legislation tends to follow the inertia from the past because government officials have little incentive to adjust financial legislation to cutting-edge business models. The innovativeness of Japan's financial industry will suffer due to these problems, so that the financial market will be inferior to their overseas rivals.

A typical example of this weakness is the market for Collateralized Loan Obligation CLO) and CDS. Japan's institutional investors are major purchasers in the global CLO market, but the main issuers and main operators of CLO markets are not Japanese. There is no CLO market in Japan. According to my understanding, this is because the Japanese government amended only the FIEA in order to regulate CDS transactions but did not amend the Bankruptcy Act in order to give flexibility to the issuance of CLO. Under this legal structure, the function of the financial market to satisfy the demands of both issuers and investors cannot be fulfilled. The absence of a CLO market leads automatically to the lack of a CDS market, which is basically a measure to manage the credit risk of market instruments.

For these reasons, I believe that an integrated, comprehensive grand design for financial legislation is necessary for Japan's financial market to catch up with global innovations utilizing the rapid advancement of ICT.

Smooth Enforcement of Financial Regulations

The current businesses of the financial industry completely depend on computer systems. As ICT advancement is accelerating exponentially, the decision for system investment is becoming more essential for the management of financial service providers. It is particularly vital that they should take some time for computer system development before initiating new businesses.

From this point of view, the uncertainty of financial regulations would bring risk to earning expectations, while the delay of legislation would have negative effects on the creativity of the financial industry. Japan's method of financial legislation has a certain advantage in terms of the foreseeability of regulation, but a certain disadvantage in the delay in business innovation. As Japan's businesspeople are mostly risk-averse because of the harsh social penalty of business failure, the latter disadvantage has greater influence on management decisions in the financial industry. This baneful influence may be creating a vicious cycle with the industry's excessive dependence on financial regulation.

In this connection, we should pay attention to the concrete method of enforcement of financial regulations. The decisions of financial service providers for computer

system development heavily depend on which type of enforcement is taken, ex-ante prevention or ex-post revision. In the case of ex-ante prevention, the management must incorporate the regulatory requirements into their computer system development in advance. This implies that every detail of the regulatory requirements must be clarified before the start of development, so as to provide longer lead time for new businesses. In contrast, in the case of ex-post revision, the regulator would charge the liability for consumer damages afterwards if the new business is implemented inappropriately. Therefore, the details of requirements and the details of financial regulations can be concurrently clarified.

In addition, we must pay attention to the fact that decisions about investments in new computer systems are made simultaneously with business partners. For example, financial market participants want to make decisions only after the financial exchange has started to develop its computer system. Under this situation, if Japan's regulator chooses the ex-ante prevention-type of enforcement, it would cause significant delays to financial innovation.

The principles of "First come, first served" and "Winner takes all" are dominant not only in the financial industry, but in all ICT-related industries. Every nation's regulator puts forth its best effort to enable the industry to take the lead. From these reasons, I believe that the enforcement of financial regulations in Japan should eliminate the ex-ante prevention-type of enforcement as much as possible and shift to the ex-post revision type. It would also mean that the principle of Japan's financial regulation should be shifted from criminal punishment to civil dispute resolution. The challenges for Japan's financial legislation and enforcement should be examined together in a holistic way.

7 Closing Remarks

In this article I have discussed the relationship between the advancement of ICT and financial services and legislation. However, the path dependency of Japan's institutions is not limited to financial legislation. I found that the response of Japan's institutions has almost always lagged behind industry innovations related to ICT advancement. Among several reasons for this delay, I believe that the principle of Legislative Facts is the most important one. This principle, which states that "legislation is possible only in the case its necessity is proven with substantial facts" is a basic rule for lawmakers.

This principle is surely fundamental under democratic regimes where parliament controls administration through legislative activities. Without this principle, ministries might propose too many bills, thereby preventing efficient discussion in the parliament. However, it is also certain that this principle dampens the creativity of related industries. They may give up on creating new businesses that would require the amendment of existing regulatory legislation, as normally it takes several years before the amendment is made. Meanwhile, overseas competitors might begin the

business and occupy the market. This way, under this principle, the necessary conditions needed to push legislation cannot arise. This results in a strong bias for the nation's legislation to follow the status quo.

Sometimes ministries present the popularization of new kinds of transactions in overseas markets as supporting facts for pursuing legislation. However, Japan's industry will certainly lose to global competition in this competitive environment. Moreover, as the evidence used is mostly from English-speaking countries, it is common to miss out on innovative developments in other regions. For example, although the popularization of QR code payments in China have been common among citizens in Chinese cities for many years, it was not until a few years ago that Japan's mass media began writing reports about the cashless system in China.

It is expected that ICT advancement will continue to accelerate and that the competition in related industries will become even more intense in the future. Under these circumstances, the delay of legislation in Japan would have serious adverse effects on industries' competitiveness. I hope that Japan's lawmakers will acknowledge this situation and take prompt actions that demonstrate a commitment to proactive reform in a way that we have never seen before.

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Financial Digitalization and Regulatory Challenges for Japan

Kiyotaka Sasaki

1 Introduction

This chapter addresses the key features of financial digitalization, challenges, and regulatory responses from the perspective of a former regulator of the Financial Services Agency of Japan (JFSA). The key features of financial digitalization are summarized as the five Ds: Data, Decentralization, Diversification, Democratization, and Disruption. New regulations have been developed to address financial digitalization including oversight of new players, products and services. However, financial regulators around the globe have been facing disruptive challenges for effective and efficient supervision of financial digitalization in relation to domestic and cross-border cooperation, jurisdictions, and resources, especially human resources and IT. The anticipated further progress of digitalization in response to the New Normal with COVID-19 pandemic is posing additional challenges for financial regulators.

2 The Five Ds

Digitalization, recently also referred to as digital transformation (DX), has been advancing rapidly, affecting every aspect of our personal and social lives. The breakout of the COVID-19 pandemic since the beginning of 2020 and what has since been described as the transition to a "new normal" including remote work

K. Sasaki (✉)
Hitotsubashi University, School of Business Administration, Tokyo, Japan
e-mail: kiyotaka.sasaki@hub.hit-u.ac.jp

M. Heckel and F. Waldenberger (eds.), *The Future of Financial Systems in the Digital Age*, Perspectives in Law, Business and Innovation,
https://doi.org/10.1007/978-981-16-7830-1_3

and social distancing to reduce the spread of the virus has been accelerating DX. Although there are a number of definitions of DX,[1] the key features and implications of digitalization in the financial industry can be summarized by the five Ds: (i) Data, (ii) Decentralization, (iii) Diversification, (iv) Democratization, and (v) Disruption. The understanding of the five Ds is essential for the discussion of the responses by financial regulators undertaken in Sect. 3.

(i) **Data** The most distinctive feature of financial digitalization is that it centers around the use of data as opposed to the use of an IT infrastructure, such as hardware and software, which in the past drove IT development in the financial industry, also referred to as digitization.

The innovation in data management, most prominently exemplified by big data analysis, has dramatically increased the value of data as a source of new business opportunities. Collecting, analyzing and leveraging data for multiple purposes promises a competitive advantage for businesses. For example, leveraging data from financial transactions by combining it with data from e-commerce could allow financial service providers to better understand the consumption profiles of their customers and to offer services better fit to the individual needs of their customers (Financial Services Agency, 2019a, b, c). As a result, competition over the acquisition of data has intensified and respective touchpoints with customers have become more crucial for business success.

(ii) **Decentralization** The conventional financial system is characterized by a high degree of centralization, reflected by government regulation, central banks, and other centralized institutions including stock exchanges and clearing houses. However, digital distributed ledger technologies such as blockchain, which are used, for example, with crypto assets or virtual currencies, allow for decentralized systems without the central control functions exercised by, for instance, central banks (Financial Services Agency, 2020d). Instead, control functions are distributed among participants in the blockchain and there is no centralized oversight mechanism. This decentralization in financial transactions might be further promoted by decentralization in lifestyles and workstyles during the COVID-19 pandemic. Working remotely, which has been implemented to avoid infections while working at and commuting to centralized workplaces, also relies on digital tools to support the regional distribution of work teams.

(iii) **Diversification** Financial digitalization has been promoting the diversification of financial players as well as products and services. Increasingly, new players from non-financial industries, including Big Tech companies and platformers, have been entering the financial business space, in particular, payment

[1] Common definitions of these related terms are as follows: "*Digitization* transforms information on written paper or other media into data fit for analysis. *Digitalization* makes processes digital using digital innovation such as robotics process automation (RPA). *Digital Transformation* (DX) provides new services using analyzed data and transforms business models with additional values for clients" (Financial Services Agency, 2019b, p. 2).

services.[2] Conventional players such as banks have been expanding their collaboration with non-financial players under the so-called open banking strategy. Conventional banks have noted advantages of non-financial players including platformers in enhancing touchpoints with individual customers, and have increased their alliances with new players and their reliance upon them in developing customer relations (Basel Committee on Banking Supervision, 2019). This has led to increased diversification in terms of financial products and services such as crypto assets and mobile payments.

(iv) **Democratization** Diversification of financial service providers and enhanced competition among conventional and new players have been leading to a shift in business models from a business to customer (B to C) to a customer to business (C to B) model (Financial Stability Board, 2019). The conventional financial system has been dominated by banks and other traditional financial service providers on the supply side. However, with financial digitalization, improved and ubiquitous access to the internet, increased diversification, and intensified competition, private customers and other users of financial services have acquired more power. Thus, customer satisfaction (CX) and touchpoints with customers have become more critical for financial service providers.

(v) **Disruption** The first four of the five Ds mentioned above have had a disruptive impact on conventional financial firms, regulators, and supervisors. Financial digitalization, diversification of financial players and democratization of financial services in particular, are posing existential threats to the business models of existing conventional players (Financial Stability Board, 2019). Many financial firms have been struggling with a difficult business environment characterized by low interest rates and low profitability after the world financial crisis of 2008 (Financial Services Agency, 2017b). Financial digitalization poses yet another significant challenge.

Financial digitalization also represents a disruption for financial regulators and supervisors. Although financial digitalization can benefit customers and users of financial services, and ultimately can contribute to the positive development of the economy, a number of issues and challenges need to be addressed by regulators and supervisors including the depth and scope of their jurisdiction, an adequate regulatory framework, effective oversight, and enforcement (Basel Committee on Banking Supervision, 2018).

3 Regulatory Responses and Challenges

In my position as Director General for Strategy Development, I was responsible for the reform of the JFSA including its supervisory framework, organization, human resources, and IT from 2017 to 2019. Financial digitalization was an important part of

[2] Since 2017, non-financial service providers such as PayPay, Line Pay, and au-Pay have been allowed to provide payment services in Japan, subject to JFSA's supervision.

the background and a driver of the reform. The regulatory responses to digitalization constitute a top priority in the ongoing reform process.

3.1 Visions Guiding the Regulatory Response to Financial Digitalization

The purpose and mission of the JFSA was revisited as part of the JFSA reform. It was reconfirmed that the JFSA purpose was to contribute to sustainable economic growth and the welfare of society. Based on this purpose, the vision of JFSA was redefined as follows (Financial Services Agency, 2018a):

- A better balance between effective financial intermediation, and the safety and soundness of the financial system
- A better balance between market function and market integrity
- A better balance between convenience for users and protection of users.

The actual balancing in each vision statement can vary depending on economic conditions and priorities stipulated by JFSA's policy, but ensuring a balance by keeping the ultimate purpose and mission of JFSA in mind is important.

Following the three parts of the vision, the policy on a regulatory response to financial digitalization was developed by focusing on the promotion of innovation beneficial to users and society at large. Financial digitalization must not only serve the interests of financial firms, but also of users and society. Furthermore, digitalization is a tool or means to increase customer satisfaction and welfare. It is not an ultimate goal in itself.

Based on this vision, JFSA has developed innovation-friendly initiatives including FinTech Innovation Hub, sandboxes for new services/products, and open laboratories with private firms (Financial Services Agency, 2019c).

Regulation of New Services and Products

Conventional financial regulations are established separately for each financial industry such as banking and insurance. Typically, licensing for entering into business and ongoing supervisory oversight to ensure the safety and soundness of each firm are required. However, when new players from non-financial services are interested in specific services or products, for example payment, to reap the economic benefit from combining respective users' data with non-financial services such as e-commerce, financial services provided by conventional players become un-bundled by these new players, who provide specific mono-line services rather than full-line services. In this case, service- and product-based regulation needs to be applied to new players to ensure a level playing field for the same services among conventional and new players (Financial Stability Board, 2019).

For certain products and services, the existing regulatory framework can no longer be applied and a new regulatory framework will have to be introduced. For example,

new regulation for virtual currencies as a means of payment was introduced in 2017 in Japan and a supervisory oversight for trading platforms was implemented (Financial Services Agency, 2018b). A regulatory requirement for smaller amounts of remittance was reduced for money remittance services, which are attracting new tech players. New regulations for cross-product portal services have also allowed new non-financial players to market various products across the financial industry to benefit customers.[3]

In addition to "hard" law and regulations by the government and regulatory agencies, soft law or self-regulation by private firms often appears to be more efficient and effective in addressing financial digitalization.[4] Due to the speed of innovation and increasing complexity of the technology underlying new products, closer collaboration between regulators and self-regulatory bodies is necessary to properly regulate financial digitalization.

Supervisory Oversight

Besides the regulatory responses to financial digitalization, issues related to supervisory oversight of firms and products also require special consideration.

First, "digital governance" becomes an important element in the oversight of financial digitalization. In the conventional supervisory oversight of financial firms, the effectiveness of IT risk management including IT system development and consolidation used to be major issues in carrying out reviews. Even before DX developed as far as it has today, since IT infrastructure has become critical for the success of financial business, financial firms have been required to develop an IT strategy that enables them to provide sophisticated products and services in line with their business strategy. Thus, IT governance at financial firms that align IT strategy with business strategy and ensure effective internal control of operational processes have become critical for financial supervision (Financial Services Agency, 2020b). Under the conditions of ongoing digitalization or DX that go beyond conventional IT innovation, IT governance needs to be replaced or transformed as digital governance to ensure the alignment of DX with the business model or mission that financial firms pursue.

The digitalization strategies that financial firms develop should be aligned with their business model as well as their purpose and mission, that is, the creation of shared value (CSV) for their users and society. Digitalization is a means to achieve CSV and not an ultimate goal in itself. It needs to be well designed to reflect the purpose and mission of the firm. Digitalization, which will continue to contribute to CSV, needs to be supported by a sustainable innovation cycle, which allows firms to exploit new business opportunities within a sustainable business model (Financial Services Agency, 2020c).

[3] For both amendments, see Financial Services Agency (2020a).

[4] The rules and guidelines developed by JVCEA (Japan Virtual and Crypto Assets Exchange Association) as a self-regulatory organization are good examples. See https://jvcea.or.jp/.

Second, oversight with the conventional "three lines of defense" model needs to be adjusted as financial digitalization progresses.[5] An effective digital governance must ensure that business models for new digitalized products and services are well designed and that the risk appetite of firms is sufficiently contained. The supervisory review of the three lines of defense, i.e., business (first line), risk management (second line), and internal audit (third line), constitutes an essential prerequisite when it comes to ensuring the effective functioning of digital governance. In particular, risk management for operational risks including IT and cybersecurity as well as compliance and conduct risks such as customer protection and AML/CFT, will require enhanced oversight.[6] A deep-dive analysis to identify deficiencies in business models, governance, or corporate culture is also useful in the evaluation of possible root causes.

Third, cooperation with other agencies, both domestic and cross-border, is necessary. Since new players under financial digitalization are mostly from the non-financial sector, financial regulators need to collaborate with relevant non-financial agencies. In addition, as data and their value are crucial for financial digitalization, cooperation is also required not only with the competent agencies responsible for customers' privacy protection, but also with those responsible for anti-monopoly and national security in each jurisdiction. Cross-border cooperation is more critical for oversight under financial digitalization, since digitalized products and services easily cross national borders. For example, an oversight of crypto assets using blockchain technology poses serious challenges in this regard. Differences in the development of legal frameworks for digitalized financial services around the globe including the establishment of effective regulatory bodies remain obstacles for cooperation in information exchange and enforcement.

Cyber Risk Management

In response to the progress of DX, enhanced cyber risk management at private firms as well as supervisory oversight should be in place. Cyber-attacks have been noted as increasing risks for the financial industry even prior to DX due to its highly complex and sophisticated IT infrastructure and the potential systemic impact of cyberattacks on economies and societies. JFSA developed its first strategy on cyber security for the financial industry in 2015 (Financial Services Agency, 2015), and conducted supervisory oversight for cyber risk management through off-site and on-site monitoring. JFSA has also organized a series of industry-wide drills for cyber risk management among financial firms referred to as the Delta Wall (Financial Services Agency, 2020e).

In response to the rapid progress of DX and increasing reliance by financial firms on third-party service providers for DX, JFSA has noted higher risks of cyberattacks

[5] Since the global financial crisis of 2008, the concept of the three lines of defense model for effective internal control among financial firms has been developed and shared among financial regulators around the globe. Business promotion departments at financial firms should be the first line of defense, with risk management/compliance functions as the second, and internal audit as the third. These three should be effectively developed as control functions.

[6] See anti-money laundering (AML) and combating the financing of terrorism (CFT).

and updated its strategy in 2018 including enhanced international cooperation for cyber security (Financial Services Agency, 2018c).

Technology for Supervisory Oversight (SupTech)

In addition to the above changes and adjustments required for supervisory oversight in the process of financial digitalization, IT infrastructures to support such oversight are also necessary. Private financial firms have been engaged in FinTech and DX to establish new businesses. They have also been developing IT for regulatory compliance including risk management and regulatory reporting (RegTech). With the advancement of FinTech and RegTech among private firms, financial regulators need to develop their own IT for supervisory oversight or SupTech (Broeders & Prenio, 2018). However, it takes time for the development of SupTech, since it is normally designed after FinTech and RegTech among private firms. Gaps between the development of SupTech and FinTech/RegTech may become wider. As a result, SupTech risks being left far behind FinTech/RegTech. An idea to develop a kind of ecosystem to fill in the gaps, for example, by embedding the needs for SupTech into the development of FinTech/RegTech has been under discussion between JFSA and the private sector including financial firms and IT companies.

Similar challenges are relevant with regard to human resources for supervisory bodies (Financial Services Agency, 2017a). In addition to the existing experts on IT risk management, professionals with expertise in blockchain, cybersecurity, and DX are required.

Customer Education

In order to maximize the benefits of financial digitalization for users, customer education for financial transactions needs to be reviewed. In addition to conventional financial literacy, literacy of digitalized products and services are also advisable for customers. Such literacy should cover knowledge about cyberattacks and more sophisticated financial crime using digitalized tools.

4 New Issues Under COVID-19

In addition to financial digitalization's rapid development and the regulatory responses for the past couple of years, the outbreak of the COVID-19 pandemic in early 2020 has been posing new issues and challenges for financial firms as well as for regulators (Financial Stability Board, 2020).

4.1 Acceleration of DX

Under the COVID-19 pandemic, we need to adapt to the New Normal, including social distancing and remote work using online tools. Due to a number of measures

taken against the infection including the lockdown of cities, the global economy has been negatively affected and a number of companies have been forced to change their business models or even close their businesses.[7] As an effective means to avoid the infection, DX has been accelerating in aspects of our lives that are not limited to financial services. I call this acceleration of DX under the COVID-19 pandemic "COVIDX." COVIDX is expected to continue advancing even after the pandemic.

4.2 The Three Ss

Financial firms need to review their business models to adapt to the changes brought about by the pandemic. Since COVID-19 represents a threat to human lives, issues such as health, hygiene, safety, employment, education, and the role of communities have taken on much more importance than they did before the pandemic. The aspect of sustainability, but also solidarity to overcome divisions within society, are being recognized as invaluable. In this respect, attention to the three Ss comprising society, sustainability, and solidarity provides a useful framework when reviewing business models during and after COVID-19.

4.3 Role of the Financial Sector and Financial Digitalization

Compared with the global financial crisis of 2008, the financial sector has been safe and sound under the COVID-19 pandemic since the pandemic is caused by a virus and not by reckless financial firms or traders. However, the role of the financial sector to support economies and to overcome the effectives of the pandemic including production of vaccines for COVID-19 is increasingly acknowledged. Financial digitalization can benefit users and society at large by providing new products and services that fit the New Normal under COVID-19 conditions. Also, digital money or other non-face-to-face means of payment have been better received by individuals who want to avoid infection by limiting the use of paper money or face-to-face transactions. In this regard, financial digitalization also benefits people's health and hygiene.

The JFSA has been stressing the more positive role of the financial sector during and beyond the current pandemic with a focus on the three Ss. It also keeps reminding the financial sector that financial digitalization is not a goal in itself, but a means to improve customer satisfaction and welfare, and of the precautions necessary to control the heightened risk of cyberattacks (Financial Services Agency, 2020c).

[7] In Japan, a number of measures have been taken by the government to support industries that have been severely affected by the pandemic and to encourage business model changes. See Cabinet Office (2020).

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Digital Currencies and the Future of Money

Hiromi Yamaoka

1 The Modern Monetary System

1.1 Brief History of the Modern Monetary System

Most countries now share an established model of providing money to the economy through a two-tiered structure, which consists of a central bank and commercial banks. Each country or jurisdiction has one central bank as a single issuer of its sovereign currencies, which are called central bank money. Commercial banks provide deposits that function as both payment instruments, referred to as commercial bank money, and the sources of their financial intermediation.

The modern monetary system was formed in the later stage of modern nation states. Although commercial banks were born in the late Renaissance era, modern central banks were established almost simultaneously in the nineteenth century (Maes, 2018). For example, the Reichsbank was formed in 1876 and the Bank of Japan in 1882. There are some central banks, such as Sveriges Riksbank and the Bank of England, which were founded in the seventeenth century. Nonetheless, these banks were originally akin to commercial banks, and became the single issuers of sovereign currencies in the nineteenth century. Indeed, the Bank of England became the single issuer of its sovereign currency in 1844 owing to the Peel Banking Act, and Sweden placed the power for issuing its sovereign currency in the Sveriges Riksbank in 1897.

The credibility of money is based on people's trust, and it was the establishment of modern nation states that could build sufficient trust in their sovereign currencies and central banks. There were various elements and institutional frameworks, such as legal systems, taxation powers, and banking regulations, that enabled the emergence of the modern monetary system (Yamaoka, 2019).

H. Yamaoka (✉)
Future Institute of Research, Tokyo, Japan
e-mail: h.yamaoka.7w@future.co.jp

M. Heckel and F. Waldenberger (eds.), *The Future of Financial Systems in the Digital Age*, Perspectives in Law, Business and Innovation,
https://doi.org/10.1007/978-981-16-7830-1_4

1.2 Benefits and Advantages of the Modern Monetary System

Although the history of modern central banking is brief, most countries came to have their central banks function as the single issuers of their sovereign currencies during the nineteenth and the twentieth centuries, and to use a two-tiered structure to organize the modern monetary system. This fact suggests that the system has been efficient and beneficial to the economy.

Indeed, the modern monetary system with its two-tiered structure has various advantages and benefits (Study Group on Digital Currency Settlement Infrastructure, 2020). First, both central bank money and private money are denominated by a single currency unit, and there is no additional cost or inefficiency stemming from the exchanges of payment instruments with different units. Cash, central bank deposits, commercial bank deposits and other private payment instruments are exchangeable with one another on a one-to-one basis. In order for this system to work smoothly, the credibility of bank deposits is secured by banking regulations, supervision, and deposit insurance.

If two or more currency units were to be used in a single jurisdiction, individuals and firms would need to verify the credibility of each currency unit and decide whether or not to accept it in each transaction. Moreover, they would have to bear the cost related to the exchange of currencies with different units. In this regard, the invention of the modern monetary system has significantly reduced costs and risks in the economy.

Second, the modern monetary system contributes to efficient resource allocation led by private-sector initiatives. Commercial banks can use deposits as the source of their loans and investments under the partial reserve system. As each bank tries to make loans and investments to projects with higher returns and lower risks, private-sector initiatives can be utilized to improve the allocation of resources.

Third, innovation led by private-sector initiatives can be encouraged. Indeed, private entities have created various instruments within the monetary systems such as checks, wire transfers, ATMs, credit cards, debit cards, and mobile payments were invented by private entities. Central banks have carefully avoided occupying the monetary infrastructure, letting private entities innovate their own payment and settlement services instead.

Fourth, data attached to payments and settlements can be utilized by private entities. Central banks issue two types of central bank money: cash and central bank deposits. Cash, which can be used by anyone for daily transactions, is anonymous and its ownership is unknown to central banks. Central bank deposits are used mainly by banks and for large-scale settlements. From the viewpoint of data utilization, central banks process data from large-scale interbank transactions, which is necessary for maintaining the stability of payment and settlement systems, while avoiding the monopolization of the data attached to daily transactions.

Over the past century, almost all nation states, including developed, emerging, and developing nations, have given their own central banks the exclusive responsibility

of issuing sovereign currencies,[1] which has led to a two-tiered monetary system, consisting of the central bank and commercial banks—a system that has proved effective in enhancing the efficiency of transactions and economic development.[2]

2 Digital Innovation and Challenges to the Modern Monetary System

2.1 Digital Innovation and the Monetary System

After the emergence of commercial banks, which coincided with the introduction of printing technology in the Renaissance era, payment infrastructures had mainly operated on paper-based technologies. Central banks issued paper-based banknotes and people used checks as payment instruments. In the twentieth century, electronics-based technologies fostered the development of new payment infrastructures including wire-transfers, ATMs, credit cards, and debit cards. Then, at the period of the global financial crisis in 2008, new digital technologies emerged almost simultaneously (Yamaoka, 2019).

The iPhone was born in 2007 and smartphones have been spreading worldwide ever since. According to a survey by the World Bank Group (2017), among a population of 1.7 billion adults without bank accounts, over 1.1 billion had mobile phones. The popularization of mobile phones and smartphones has drastically promoted financial inclusion worldwide by enabling people to access mobile payment services.

Bitcoin, the first crypto-asset, as well as blockchain and other distributed ledger technologies (DLTs) were introduced in 2009. Although bitcoin and other first-generation crypto-assets have not been used as payment instruments but as speculative investment targets, blockchain and other DLTs have become technological platforms for new payment infrastructures such as Libra.

Big data has become the core of various economic activities. The volume of data has drastically increased due to web-browsing, social networking service (SNS), e-commerce, and smartphone apps. Billions of smartphone users worldwide are producing gigantic amounts of data through SNS posting, web-browsing, and game playing. It is estimated that over 90% of the data produced in the history of humanity has been created in the last two years alone (SINTEF, 2013). Data are now regarded

[1] On the website of the Bank for International Settlements (BIS), 191 central banks were listed on April 1st, 2019, while there are 189 member countries in the International Monetary Fund.

[2] For example, the Committee on Payment and Settlement Systems of the Bank for International Settlements (2003, 1–2) stated as follows: "(C)entral bank and commercial bank money coexist in a modern economy […] the composite of central and commercial bank money is an essential feature of the monetary system and should be preserved. […] This policy position implies a rejection of the two extreme arrangements of monobanking, where the central bank acts as the sole issuer of money, and free banking, where commercial banks provide all the money required by the economy. Neither of these corner solutions has proven to be sufficiently stable or effective to endure."

as the "new oil of the twenty-first century" (Lowe, 2021) and as useful intangible assets, they can create added value in multiple ways. AI and deep learning, which can be used as tools for analyzing big data, also started developing rapidly since around 2010.

Backed up by these technological advances, a new industrial movement has emerged: Fintech, that is, the application of new information technologies to financial services such as smartphones, AI, blockchain, and other DLTs (International Monetary Fund and World Bank, 2019). Big data and these technologies have facilitated the growth of Big Tech firms worldwide. Many new entities, including start-ups and Big Tech firms, are now entering into financial businesses. Fintech has promoted financial inclusion, since more and more people in emerging and developing countries now have access to payment services through their smartphones.

2.2 New Challenges to the Modern Monetary System

Digital innovation has brought about various new challenges to the modern monetary system.

Crypto-Assets (Virtual Currencies)

Bitcoin and other first-generation crypto-assets are inherently outside the scope of nation states. They are not denominated by sovereign currency units. Bitcoin tries to build trust and credibility, which are prerequisites for money, through computing power and not through the credibility of nation states. If these first-generation crypto-assets are widely used in domestic transactions, the effectiveness of macro-policies, including monetary policy, will be reduced substantially. Since traditional monetary policy influences only the supply and interest rates of sovereign currencies, it would not affect economic activities undertaken in crypto-assets.

So far, first-generation crypto-assets have rarely been used as payment instruments. Instead, they have remained speculative investment targets. This fact implies that the cost of creating trust and credibility beyond the framework of nation states could be high, as illustrated by, for example, the massive consumption of electricity required for their operation. Thus, the impact of first-generation crypto-assets on the effectiveness of macro-policies has so far been limited. Nonetheless, crypto-assets have paved the way for new payment instruments such as Libra.

Big Tech as Payment Service Providers

Under the recent data revolution, Big Tech firms, such as GAFA (Google, Amazon, Facebook, and Apple) in the United States and BAT (Baidu, Alibaba, and Tencent) in China, have been growing very rapidly. These Big Tech firms have grown to become

the top companies in the world in terms of market capitalization, and their economic power surpasses that of several countries.

Although data is often called the "oil of the twenty-first century," there are several differences between oil and data (Haldane, 2018; Yamaoka, 2019): First, data does not depreciate after being used. Second, data does not need much space for its storage. Third, the marginal utility of data could increase as the volume of data increases. Accordingly, data may have the tendency to be concentrated. Although the origins of Big Tech firms vary, they are similar in terms of accumulating gigantic amounts of data and utilizing it for a variety of businesses.

These Big Tech firms have recently entered into payment services. Among them, Alipay of Alibaba group and WeChat Pay of Tencent group have become the biggest payment networks in terms of the number of users. Tencent launched WeChat Pay in 2013, and it now has around 1 billion users.

The entry of Big Tech firms into payment services challenges modern monetary systems in a couple of aspects (Yamaoka, 2019). First, non-banks are becoming big players in payment infrastructures. Indeed, several central banks have recently allowed non-bank payment service providers to have central bank accounts. In China, Alipay and WeChat Pay have been required to deposit the amount equivalent to their customer balances at central bank accounts. These developments challenge the two-tiered structure consisting of a central bank and commercial banks. Second, payment infrastructures operated by these Big Tech firms tend to be gigantic and challenge the authorities' power to control payment systems.

Libra Led by Facebook

In June 2019, the plan of Libra, a digital currency led by Facebook, was announced and gathered great attention (Diem Association, 2020).

Bitcoin and other first-generation crypto-assets are not used as payment instruments because of their high volatility and insufficient number of users to generate network externalities necessary for payment instruments to be used. In this regard, Libra planned to be fully backed up by safe assets denominated by highly credible sovereign currencies such as the USD and EUR in order to stabilize its value. Moreover, Facebook already has over 2 billion users worldwide, so Libra could have sufficient network externality if issued. In other words, Libra tried to overcome the defects of first-generation crypto-assets in order to be used as money.

In general, the global regulatory community was cautious about the Libra project. In April 2020, Libra modified its plan and in December 2020 changed its name into Diem. Libra has not yet been issued although it was originally planned to be issued in the first half of 2020. Nonetheless, the Libra project seemed to have accelerated studies of central bank digital currencies.

Table 1 Classification of digital money

Unit \ Issuer	Banks	Non-bank private entities	Central banks
Denominated in sovereign currency unit	Bank deposits, Debit cards, Swish, J-Coin Pay, etc.	E-money, M-Pesa, Alipay, WeChat Pay, etc.	Central bank digital currencies (CBDCs)
Not denominated in sovereign currency unit		Crypto-assets (virtual currencies)	

Source by the author.

Table 2 Two types of CBDCs

Central Bank Money (Base Money)	CBDCs
Banknotes	General-purpose CBDCs
Central Bank Deposits	Large-value CBDCs

Source by the author.

2.3 Central Bank Digital Currencies[3]

Basic Concept

Central bank digital currencies (CBDCs) are characterized as digital payment instruments denominated by sovereign currency units and issued as central bank liabilities of central banks (Table 1).

Central banks issue two types of central bank money, which are banknotes and central bank deposits. Banknotes can be used by anyone at any time for daily transactions, and central bank deposits are used for large-value transactions mainly by banks. In parallel with these two categories, central bank digital currencies can also be classified into two types (Table 2). The first category is general-purpose CBDCs, which share characteristics with banknotes and are used by wide-ranging entities including individuals. The second category is large-value CBDCs, which share characteristics with central bank deposits and are used for large-value settlements mainly by banks.

Central banks in developed countries in general started studies on large-value CBDCs. Since central bank deposits have already been digitalized, large-value CBDCs are unlikely to cause issues related to financial stability or monetary policy. In other words, large-value CBDCs could be understood as applying DLTs like blockchain to already-digitalized central bank deposits. The European Central Bank (ECB) and the Bank of Japan started their joint research entitled Project Stella in 2016 (Bank of Japan, 2016). There have been many other projects including Project

[3] See also the chapter by Bindseil in this volume.

Table 3 Several issues with CBDCs

■ Impacts on bank deposits?
· Deposits ⇒ CBDC? (decrease in bank loans?)
■ Digital bank run?
· Deposits ⇒ CBDC as "flight to safety," accelerating liquidity crisis?
■ Zero lower bound?
· CBDC might be used for avoiding negative interest rates on reserves
■ Interest-bearing?
· Positive rate on CBDC might accelerate the decline in bank deposits
· Negative rate on CBDC might deteriorate consumer sentiments
■ Limit on the amount of CBDC (per person)?
· Due to the "scarcity" of CBDC, its exchange rate with cash might fluctuate
■ Monopolization of payment data by the central bank?

Jasper of the Bank of Canada, and Payment Canada and Project Ubin of the Monetary Authority of Singapore (Chapman et al., 2017; Monetary Authority of Singapore, 2020).

Recent Developments

Recent developments, such as the entry of Big Tech firms into payment services and the Libra project, have accelerated studies and experiments on general-purpose CBDCs. As a forerunner, Sveriges Riksbank started studies on its CBDC entitled e-Krona in 2016 (Skingsley, 2016). The central bank of Uruguay experimentally issued the e-Peso from November 2017 to April 2018 (Licandro, 2018). In January 2016, the People's Bank of China also disclosed its plan to issue its CBDC[4] and in April 2020, started experimentally issuing its CBDC entitled e-CNY in four cities in China (Harada, 2020). In October 2020, the ECB and the Bank of Japan announced their intention to accelerate their research on general-purpose CBDCs (European Central Bank, 2020a; Bank of Japan, 2020). The central bank of The Bahamas officially launched its general-purpose CBDC, Sand Dollar, on October 20, 2020 (Project Sand Dollar, 2020).

Issues in Central Bank Digital Currencies

Nonetheless, as shown in Table 3, there remain many issues to be overcome before general purpose CBDCs can be launched (Yanagawa & Yamaoka, 2019). These

[4] The official document of the People's Bank of China is available only in Chinese. For a reference in English, see, for example, Reuters (2016).

issues are more challenging to developed economies with well-established banking systems.

Possible Impacts on Bank Deposits

First, general-purpose CBDCs could cause a shift of funds from bank deposits to CBDCs, since CBDCs are credit-risk-free. Accordingly, bank deposits, which function as the source of bank loans and investments, would decrease and the volume of financial intermediation through banks would decline. On the other hand, the size of the balance sheet of central banks would increase. Since central banks are not in a good position to make loans directly to firms and individuals, the flow of funds from deposits to CBDCs could distort the resource allocation formerly guided by private-sector initiatives, and thereby lead to inefficient resource allocation in the economy.

If banks could offer sufficiently high interest rates on their deposits, they could prevent fund outflows from their deposits to CBDCs. Nonetheless, in countries with extremely low interest rates, it would be difficult to make deposits attractive compared to CBDCs whose interest rate is zero.

Accelerating Digital Bank Runs

If general-purpose CBDCs are issued, they could be used by anyone, even at midnight and weekends through PCs and smartphones. Thus, if financial markets come under stress due to rumors or other incidents, depositors would immediately move their funds from deposits to CBDCs. Such digital bank runs could be much faster than traditional bank runs, since depositors do not have to be physically present at the bank or ATM to withdraw cash. Accordingly, in a stressful situation, digital bank runs could accelerate the spillover of liquidity problems across borders.

A digital bank run could occur even in the absence of CBDCs since depositors could transfer their deposits to other banks through the Internet. Thus, CBDCs should not be regarded as the single cause of digital bank runs. The question is to what extent CBDCs could amplify the flight to safety. In addition, if the central bank could provide the banking sector with liquidity obtained through the shift of deposits to CBDCs, it could at least compensate for the shortage of liquidity at the macro level. Nonetheless, in the real world, it might not be easy for central banks or financial markets to cover up the source of a liquidity crisis within a very limited timeframe.

Possible Ceilings on the Amount of CBDCs

In view of the issues above, some argue that there should be a ceiling on the amount of CBDCs held by each entity, or on the value of transactions through CBDCs. They argue that, due to the quantitative ceiling, CBDCs could work as substitutes for banknotes but would not replace deposits.

Nonetheless, in many countries, there is no legal limit on the use of banknotes as legal tender. Having a quantitative ceiling on CBDCs but not on banknotes could create a scarcity in CBDCs so that an exchange rate of 1 by 1 could not be maintained. Since the efficiency of the modern monetary system is based on the assumption that

cash, central bank deposits, and commercial bank deposits are equitably exchangeable with one another, the possible scarcity premium on CBDCs might reduce the efficiency of the payment infrastructure.

Moreover, risk-free payment instruments are strongly needed in large-value transactions. Indeed, in the present system settling large-value transactions through risk-free central bank money is encouraged, while small value settlements are dealt with mainly by private entities. In Japan, interbank settlements of 100 million JPY or larger are settled through the Bank of Japan Financial Network System (BOJ-NET), which is the central bank real-time gross settlement system, while interbank settlements in amounts lower than 100 million are netted through the Zengin System, which is the private sector based system operated by the Japanese Bankers Association. The Bank of Japan explains that "(t)he changeover to the RTGS [Real-Time Gross Settlement] system was aimed at reducing the systemic risk inherent in designated-time net settlement" (Bank of Japan, 2001). In this regard, the economic rationale of having a quantitative ceiling on CBDCs is unclear.

Possible Impacts on Innovation

In our present payment and settlement systems, we use major innovative products such as checks, credit cards, debit cards, ATMs and wire transfers that were created through private initiatives. In this regard, if the central bank dominates payment and settlement infrastructures by issuing CBDCs, it could hinder innovation by private entities.

Impacts on Data Utilization

If the central bank, by issuing CBDCs, collects and accumulates the data related to daily transactions, it would become difficult for private entities to utilize the data. It might prove challenging for central banks to fully utilize the data accumulated through CBDCs, and the data attached to transactions through CBDCs in the economy.

In addition, the accumulation of gigantic amounts of data by the central bank might raise sensitive issues regarding its independence, especially if these data could potentially be exploited for other purposes such as taxation and crime prevention. Whether or not the central bank could allow tax agencies or the police to make full use of such transaction data is a delicate issue. In many countries, central banks are independent from the administrative power of the government, based on the assumption that the central bank keeps a distance from administrative actions.

CBDCs and Monetary Policy

There are also many CBDC issues regarding monetary policy. These issues are critical especially for countries with independent currencies and monetary policy.

Positive Interest Rate on CBDCs

First, some scholars argue that CBDCs should be interest-bearing (Bordo & Levin, 2017). One of the reasons for this is that interest rates on CBDCs could constitute a

hard floor for a wide range of interest rates so that central banks could use it as an operational tool.

However, if the CBDC interest rate is positive, the shift of funds from deposits to CBDCs could be accelerated. Moreover, if CBDCs are designed to replace cash and not deposits, there is no strong reason to offer positive interest rates on CBDCs.

Negative Interest Rate on CBDCs

Second, there is also an argument that CBDCs could contribute to overcoming the zero-lower bound and facilitate a negative interest rate policy, since simply cutting the nominal value of CBDCs would enable deeply negative interest rates (Bordo & Levin, 2017; Haldane, 2015).

Nonetheless, as long as paper-based banknotes continue to exist, the zero-lower bound will remain. It will be extremely difficult for central banks to completely abolish cash, since cash has its own benefits, such as not relying on the supply of electricity. Indeed, cash proved to be an effective payment tool even in the large-scale blackout caused by the earthquake in Hokkaido, Japan, in 2018. As long as individuals can still use cash for various payments, without having to use a PC, a mobile phone, or a smartphone, cash remains a convenient tool. Under these environments, imposing negative interest rates on CBDCs could trigger the shift of funds from CBDCs to cash. If people prefer cash to CBDCs, then the rationale for issuing CBDCs might be lost.

Moreover, it is not certain whether cutting the nominal value of CBDCs would have positive or negative impacts on expenditures. A negative remuneration of CBDCs would substantially undermine confidence in central banks issuing them (Mersch, 2017).

CBDCs and the Modern "Two-Tiered" Monetary System

Digital innovation fosters new challengers, such as Big Tech firms and Libra, to the modern monetary system based on nation states. CBDCs could be understood as the authorities' efforts to utilize digital technologies independently to maintain the controllability of money. At the same time, general-purpose CBDCs might have the possibility to challenge the "two-tiered" structure, which is another aspect of the modern monetary system. Indeed, general-purpose CBDCs have the potential to transform the two-tiered structure into a single-tiered one, depending on their design.

Central banks studying or experimenting with general-purpose CBDCs argue that they will maintain the two-tiered structure and that CBDCs, if launched, would be issued indirectly (European Central Bank, 2020b; Bank of Japan, 2020).[5] In other words, central banks issue general-purpose CBDCs directly to banks and payment service providers, and these private entities convey CBDCs to firms and individuals.

[5] The European Central Bank (2020b) states that "(a)n intermediated access model is preferable." The Bank of Japan (2020) states that "(e)ven if the Bank were to issue general-purpose CBDC, it would still be appropriate to maintain a two-tiered payment and settlement system of a central bank and the private sector," and that "(t)his means that CBDC would be issued indirectly through intermediaries.".

Under this indirect scheme, banks would offer both deposits as their own liabilities and CBDCs as central bank liabilities. However, there have been many institutional frameworks, such as banking regulations, supervision, and deposit insurance, aimed at securing the safety of deposits and at guaranteeing equitable exchanges of deposits and cash. Thus, CBDC issues will require reviewing the rationale of banking regulation, supervision, and deposit insurance as well as the modern monetary system itself. These issues are also deeply connected to the classical debates on narrow banking (Kobayakawa & Nakamura, 2000).[6] For example, in 1987 Professor James Tobin proposed that the government should offer payment tools "with the convenience of deposits and the safety of currency" to the public. He also proposed two ways in which such tools could be offered: The first way was that the central bank itself could offer such tools, and the second way was that private banks could offer such tools that would be invested entirely in central bank money or short-term treasury securities, so that they would not have to be insured (Tobin, 1987).

3 The Potential of Digital Currencies Issued by Private Entities

3.1 Issues to Be Resolved in Japan's Payment Infrastructure

It is vital for advanced economies with well-developed banking systems to make full use of the benefits of the modern monetary system while applying new digital technologies. In addition, the experience of COVID-19 has reminded us of the importance of digitizing the economy in order to maintain economic activity while social distancing. In this respect, the digital transformation (DX) of the economy and digitalized payments are more needed than ever. Regarding CBDCs, there are many relevant issues related to economic efficiency, financial stability, monetary policy, and data utilization. As any payment instrument, including cash, has strong network externalities, it is difficult to determine how long it will take for digital payment tools to outstrip cash, as this may depend largely on country-specific conditions. For example, in countries where cash is widely used, it would take time for digital payment tools to replace cash due to its strong network externalities. Moreover, especially in countries with low interest rates, the demand for cash would remain strong, mainly for storing value. Nonetheless, the digitization of payments will generally continue, and the use of digital payment instruments is expected to be further popularized over the medium term.

First, as digital innovation fosters the development of various digital-based activities such as e-commerce, firms and individuals are becoming more aware of the costs of handling cash. Although consumers do not directly bear the costs of handling

[6] Kobayakawa and Nakamura (2000) state that "narrow banks are broadly referred to as ones specializing in deposit-taking/payment activities that do not provide lending services.".

cash, handling, storing, and conveying cash are often costly, especially for firms and financial institutions.

In this regard, digital payment instruments are needed since they are expected to reduce the costs, enhance the efficiency and promote the development of new businesses. Utilizing digital technologies in payments is critical in fostering new economic activities, such as e-commerce, sharing economies, and "as a Service" applications ["anything as a service" (XaaS)], through the use of data associated with payments (Financial Stability Board, 2019).

Also, being considered the "oil of the twenty-first century," data are intangible assets whose importance is growing, and digital payment instruments are now attracting great attention as tools for collecting data. In this regard, the ongoing "data revolution" is the driving force of promoting digital money. Cash can only convey data concerning the value by which its owner can purchase goods or services with the equivalent value. On the other hand, digital payment instruments can handle a variety of data, like who buys what, when, and where. Many firms are now providing digitalized payment services in order to collect customer data by giving incentives and discounts to customers.

In order to overcome the issues associated with CBDCs while obtaining these benefits of data revolution, one possible option is to issue private-based and two-layered digital currencies, which are denominated by sovereign currency units and incorporate advanced technologies such as blockchain and smart contracts.

3.2 The Concept of "Private-Led" and "Two-Layered" Digital Currency

Japan's payment infrastructure faces many challenges. Japan remains one of the most cash-oriented countries, where cash is heavily used for transactions and as a form of value storage (Ōtani and Suzuki, 2008).[7] Accordingly, Japan bears substantial costs associated with cash. Moreover, reliance on cash makes it difficult to utilize data attached to payments and settlements. Although there are many digital payment platforms available, they are rarely inter-operable and users need to choose from many payment options, including cash, in each transaction.

In light of these issues, in June 2020 the three mega-banks, leading non-financial companies, and experts in Japan established the Study Group on Digital Currency Settlement Infrastructure, where the author of this chapter acted as the chairperson. Relevant ministries, the Financial Services Agency and the Bank of Japan also participated as observers. The Study Group carried out intensive studies on relevant issues, with a view of innovating payment infrastructures through private-sector initiatives and promoting the DX of Japan's economy. The Study Group also hopes for Japan

[7] In Japan, cash is not hoarded "under mattresses," but put away in dressers (*tansu*). Japanese households hoarding cash, therefore, are said to have "dresser deposits" (*tansu yokin*) (Ōtani and Suzuki, 2008) in place of bank deposits (*ginkō yokin*).

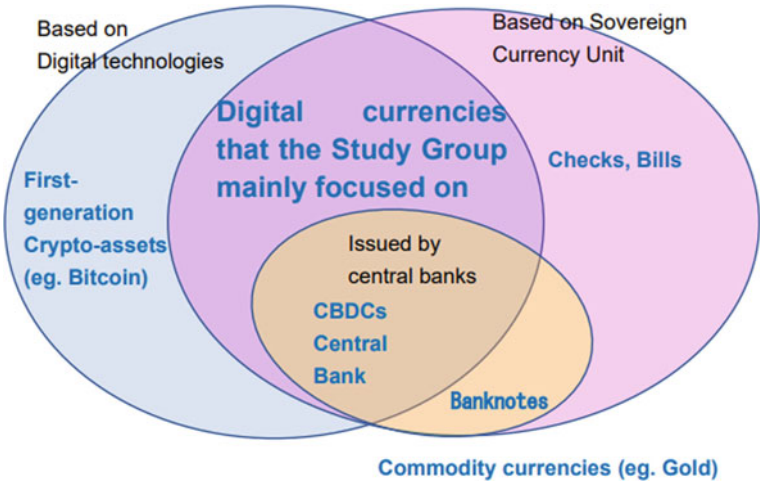

Fig. 1 Research scope of the "Study Group on Digital Currency Settlement Infrastructure". *Source* "Innovation of Payment Infrastructure and Potential of Digital Currencies in Japan" (Study Group on Digital Currency Settlement Infrastructure, 2020)

to become a leading country in terms of innovating financial infrastructures. The Group reviewed possible designs and the feasibility of digital currencies so they could contribute to innovating payment infrastructures.

Among a variety of options, the Group agreed that digital currency issued by private entities and denominated by JPY should be one of the most promising options, and agreed to further examine its potential and applicability to various use cases (Fig. 1).

In order for digital currencies to contribute to the economy, their infrastructure should be stable, highly secure, resilient, and reliable. It should also be available for a wide range of users and for long hours, and be inter-operable with each other. Moreover, it should continuously evolve by flexibly adopting new technologies and innovate themselves. These attributes will be necessary for digital currency to promote innovation and economic development by facilitating fair competition while supporting cooperation among the relevant entities.

In view of these requirements that digital currencies are expected to satisfy, the Study Group agreed that digital currency with a "two-layered" structure is a promising option, and that private entities such as banks can issue it.

This two-layered digital currency consists of its lower layer (the "common" field) and its upper layer (the programmable field for value added) (Fig. 2). The upper layer will be equipped with customized programs to meet various business needs, so that the digital currency can enhance the efficiency of payments and facilitate high-speed and sophisticated transactions. Business needs may vary, including coordination and synchronization of logistics, commercial distribution and finance, supply chain management, delivery versus payment (DvP) of securities and funds, and streamlining of back-office operations. The lower layer contains value-related information

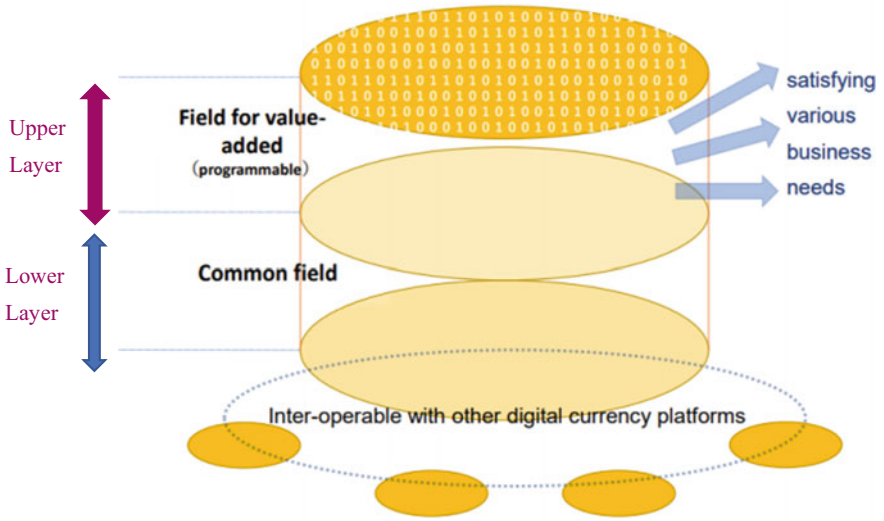

Fig. 2 Two-Layered Digital Currency. *Source* "Innovation of Payment Infrastructure and Potential of Digital Currencies in Japan" (Study Group on Digital Currency Settlement Infrastructure, 2020)

such as how much JPY a digital currency represents. Since all the digital currencies issued in this scheme share the same structure in the lower layer, they will become inter-changeable with each other, regardless of what kind of customiz*f*ed programs are written in the upper layer.

The two-layered digital currency denominated by JPY and issued by private entities such as commercial banks may have several benefits:

- It maintains financial intermediation led by private-sector initiatives.
- It makes use of existing frameworks for maintaining the credibility of money, including banking regulation and supervision. If non-banks become its issuers, they can secure its credibility by backing it up completely with safe assets, as Libra (currently Diem) is trying to do. If the central bank operates its RTGS system on a 24/7 basis and allows the issuers of digital currencies to participate in it, the digital currencies issued by private entities will be almost as safe as CBDCs.
- It applies new DLT technologies such as blockchain and smart contracts in its upper layer in order to enhance the efficiency of various economic activities.
- It promotes inter-operability of various payment platforms by utilizing the lower layer, which is common in all of the digital currencies issued under this scheme (Fig. 3).
- It makes use of private-sector initiatives to innovate payment and settlement infrastructures. In the two-tiered monetary system, private entities compete with each other to provide innovative payment services such as internet banking and mobile payments, while using common currency units such as the dollar and the yen. By maintaining the benefit of the two-tier monetary system, the two-layered digital

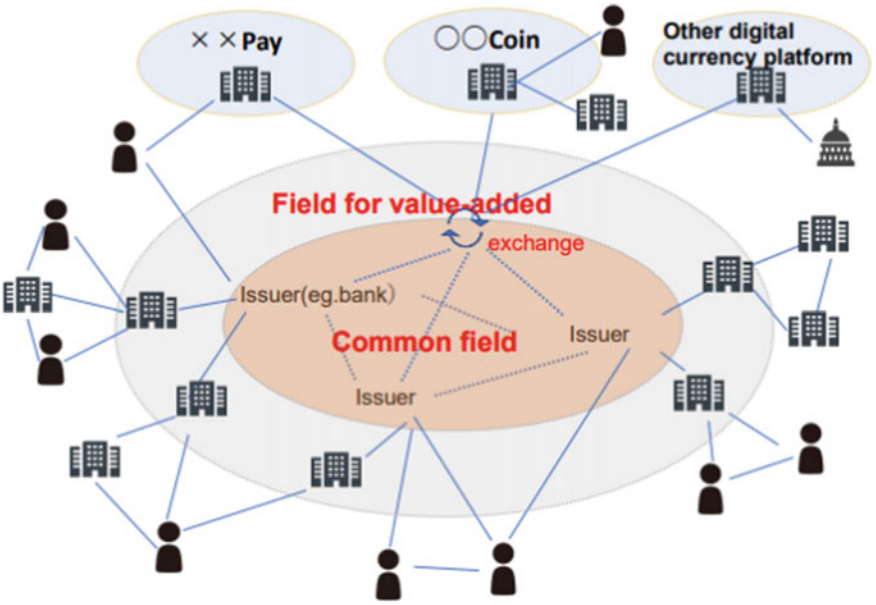

Fig. 3 Two-layered digital currency and its inter-operability. *Source* "Innovation of Payment Infrastructure and Potential of Digital Currencies in Japan" (Study Group on Digital Currency Settlement Infrastructure, 2020)

currency can strike a balance between payment stability and private sector-led innovation.
– It facilitates the use of the data attached to payments and settlements by private entities.

There are plans for this two-layered digital currency to co-exist with current digital payment instruments (such as electronic money and credit and debit cards), centralized payment infrastructures (such as the Zengin system), or CBDCs. The two-layered digital currency will be able to enhance the inter-operability of these payment platforms by bridging them. The Study Group argued that payment innovation adopting new technologies and led by private-sector initiatives enhances the efficiency and convenience of wide-ranging transactions, and contributes to the DX of the economy.

3.3 The Digital Currency Forum

In November 2020, the Study Group developed into the Digital Currency Forum (Fig. 4), where many new member firms joined. The Forum now consists of leading

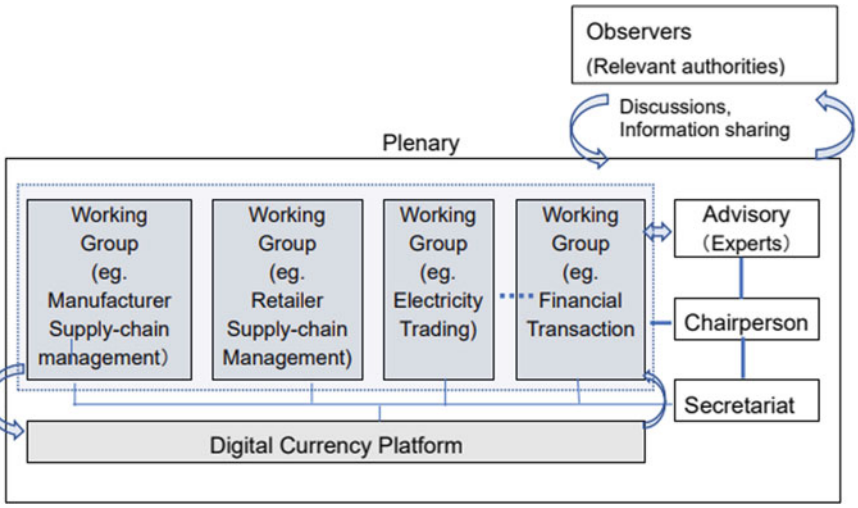

Fig. 4 Structure of the Digital Currency Forum. *Source* "Innovation of Payment Infrastructure and Potential of Digital Currencies in Japan" (Study Group on Digital Currency Settlement Infrastructure, 2020)

banks, non-financial companies and experts, including both the original members of the Study Group and new participants (Table 4).

The Study Group selected various use cases in which two-layered digital currencies can be effective in enhancing efficiency and overcoming business obstacles (Table 5 and Fig. 5). What is needed as the next step is to develop the ideas and concepts into actions and initiatives. In view of these tasks, the Digital Currency Forum, which the author of this chapter chairs, will conduct various actions and initiatives, such as the Proof of Concept (PoC) applying digital currency to possible use cases and a review of related issues such as desirable reforms of business practices.

The Forum also facilitates the sharing of information, lively discussion among stakeholders, and the cooperation of relevant entities across Japan. Through these activities, the Forum promotes the innovation of payment infrastructures and the establishment of an efficient eco-system. The Forum tries to leverage new technologies and private-sector initiatives, and to contribute to enhancing the efficiency and convenience of Japan's financial infrastructure, and the DX of Japan's economy.

Before issuing the two-layered digital currency, it will be necessary to clarify the legal and institutional framework for it, in order to overcome technological hurdles and to analyze its economic impact more deeply. Accordingly, the Forum established an Advisory Board consisting of experts on laws, accounting, technologies, and economics (Fig. 4).

In order to make full use of the innovation of payment infrastructures for the DX of Japan's economy, it will be beneficial to go beyond the application of digital technology to payments and to review comprehensively the way in which economic activities and business practices are carried out. In order to promote the DX of the

Table 4 Members of the Digital Currency Forum (as of November 19, 2020)

Original Members of the Study Group		
(Chairperson) Hiromi Yamaoka (Member of the Board, Future Corp. Former DG of Payment and Settlement Systems Dept., BoJ) MUFG Bank, Ltd. Sumitomo Mitsui Banking Corporation	Mizuho Bank, Ltd. Seven Bank, Ltd. (Seven & I Holdings Co., Ltd.) NTT Group East Japan Railway Company	KDDI Corporation Internet Initiative Japan Inc. Mori Hamada & Matsumoto Accenture Japan Ltd. SIGMAXYZ Inc.
New Members Joining with the Establishment of the Forum		
Aeon Co., Ltd. ANA Group The Kansai Electric Power Company Inc. KYOCERA Corporation Kesennuma City JCB Co., Ltd. Sumitomo Life Insurance Company SECOM Co., LTD. SOHGO SECURITY SERVICES Co., LTD (ALSOK)	Sony Bank Incorporated Sompo Holdings, Inc. DAIDO LIFE INSURANCE COMPANY Daiwa Securities Group Inc. Chubu Electric Power Co., Inc. TIS Inc. DENTSU Inc. Tokyo Marine & Nichido Fire Insurance Co. Tokyo Financial Exchange Inc.	Toppan Printing Co., Ltd. Nomura Holdings, Inc. Hitachi, Ltd. FamilyMart Co., Ltd. Mitsui Sumitomo Insurance Co., Ltd. Sumitomo Mitsui Trust Bank, Limited Mitsubishi UFJ Research and Consulting Co., Ltd. JAPAN POST BANK Co., Ltd. Lawson, Inc.
Advisors		
Masakazu Masujima, Partner, Mori Hamada & Matsumoto Tetsuya Inoue, Chief Researcher, Nomura Research Institute, Ltd. Shuji Kobayakawa, Professor, School of Political Science and Economics, Meiji University Kenji Saito, Professor, Graduate School of Business and Finance, Waseda University Chikako Suzuki, Certified public accountant		
Observers		
Financial Services Agency Ministry of Internal Affairs and Communication Ministry of Finance Ministry of Economy, Trade and Industry Bank of Japan		

Source "Innovation of Payment Infrastructure and Potential of Digital Currencies in Japan" (Study Group on Digital Currency Settlement Infrastructure, 2020).

economy it will be vital to build an ecosystem that can make full use of integrated digital payment infrastructures.

Table 5 Possible use cases of digital currency

a. Supply chain of manufacturers (Fig. 5)	k. Royalty rewards and local economies
b. Supply chain of retailers	l. Financing, fundraising
c. Logistics	m. Credit card operations
d. Transactions of financial assets	n. Insurance
e. Trade finance	o. Transactions of non-fungible tokens (NFTs)
f. Electricity trading	p. Mobility as a Service (MaaS)
g. Linkages of e-money and digital currency	q. Cross-border remittances
h. Inter-bank settlements	r. Off-line payments between smartphones
i. Regional currency, community money	s. Cash management of business groups
j. Administrative operations	

Source "Innovation of Payment Infrastructure and Potential of Digital Currencies in Japan" (Study Group on Digital Currency Settlement Infrastructure, 2020)

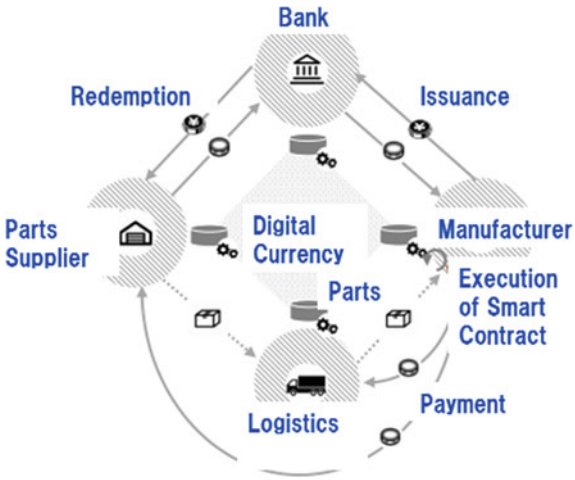

Fig. 5 Possible Use Cases of Digital Currency–Supply Chain. *Source* "Innovation of Payment Infrastructure and Potential of Digital Currencies in Japan" (Study Group on Digital Currency Settlement Infrastructure, 2020)

4 Digital Currency and the Future of the Monetary System

4.1 Challenges to the Modern Monetary System Triggered by Digital Innovation

To conclude this chapter, the last section tries to provide the prospects of the monetary system in the future, and to explain how the initiatives of the Digital Currency Forum could contribute to enhancing the utility and the credibility of the monetary infrastructure in Japan.

The modern monetary system, which consists of the central bank as a single issuer of sovereign currency and a two-tiered structure, was established at the final stage of modern nation states in the nineteenth century (Yamaoka, 2019). The introduction of digital currencies provides the opportunity to reconsider the rationale of this system.

Recent digital innovation has brought about various new challenges to the system, and these challenges include crypto-assets, the entry of Big Tech into payment services, and ambitious projects like Libra led by Facebook. CBDCs could be regarded as the authorities' efforts to maintain the controllability of the monetary system by utilizing digital technologies independently. Nonetheless, CBDCs in turn might influence two-tiered structures of the modern monetary system.

Digital currency issued by private entities could contribute to enhancing the efficiency of economic transactions by making use of digital technologies while securing inter-operability of various payment platforms. The Digital Currency Forum is trying to utilize the scheme of two-layered digital currency, which could incorporate programmable parts in the upper layer while maintaining the two-tiered structure of the monetary system.

Moreover, this two-layered digital currency issued by private entities will not impair the effectiveness of monetary policy. If crypto-assets not denominated in sovereign currency units become widely used for transactions, the effectiveness of monetary policy could be substantially impaired. Theoretically, this situation is similar to dollarization, where foreign currencies are widely used instead of domestic currencies. In this regard the two-layered digital currency proposed by the Forum will enhance the utility of JPY, and thereby contribute to the effectiveness of monetary policy.

4.2 The Monetary System and Nation States

Digital currency gives us the opportunity to review the modern monetary system. The trust and credibility of the modern monetary system has been secured by various institutional frameworks based on nation states, laws, taxation, banking regulation and supervision and deposit insurance. Central banks are also inventions of the post-seventeenth-century era of nation states. Indeed, the framework of nation states has worked as a trust machine backing up the modern monetary system (Yamaoka, 2019).

Within a relatively short period, the modern monetary system has become a globally shared design, in which the central bank of each state is the sole issuing authority of the sovereign currency, and commercial banks provide deposits as convenient private money.

In this regard, bitcoin, which belongs to the first-generation crypto-assets, tries to create trust and credibility from scratch without relying on nation states, and may entail substantial costs in terms of electricity consumption in relation to mining (Criddle, 2021).[8] The fact that the first-generation crypto-assets have not been used widely as payment instruments implies that a framework for creating trust and credibility that works better than nation states has not yet been found.

In this regard, Libra has interesting characteristics as a stable coin: All indications are that it will be backed up fully by safe assets denominated by credible sovereign currencies (Diem Association, 2020). This scheme means that Libra tries to make use of the trust of key currencies in order to stabilize its value. In this regard, Libra could be regarded as a combination of crypto-assets and sovereign currencies and could be understood as a scheme to borrow the framework of nation states to create trust and credibility.

In view of these developments, it is unlikely that the monetary system in the near future will operate outside of nation states. As long as nation states maintain trust and credibility, it will be difficult for crypto-assets to replace sovereign currencies.

At the same time, the DLT behind crypto-assets such as blockchain may have great potential. If these technologies are successfully combined with the trust and credibility of existing currencies, they could contribute to enhancing the efficiency of payments, settlements, and the economy. The two-layered digital currency, which the Digital Currency Forum is trying to realize, will be one of the options to achieve these goals.

4.3 The Monetary System and the Two-Tiered Structure

The two-tiered structure in the monetary system will be maintained at least for the foreseeable future. The case in which CBDCs transform the current two-tiered structure into a single-tiered structure is similar to the idea of narrow banking. Nonetheless, many issues need to be further examined in this respect. If CBDCs substantially replace not only banknotes but also bank deposits, it would squeeze credit intermediation through banks and inflate the central bank's balance sheet instead. Central banks are neither destined to make loans directly to firms or individuals, nor suitable for evaluating the risks and returns of various projects. Accordingly, a CBDC replacement of deposits could distort the allocation of resources. Although banks could pay interests on their deposits to maintain their attractiveness over CBDCs, it may not be easy for them to offer sufficiently high interest rates on demand deposits, especially in low interest rate environments. Moreover, it is unlikely that the central bank would

[8] According to Criddle (2021), the mining for bitcoin "consumes more electricity than Argentina".

continuously innovate the payment infrastructure, utilize smart contracts to facilitate each business need, or manage anti-money laundering (AML) in combating the financing of terrorism (CFT). Nonetheless, the participants in this two-tiered structure will become more diversified, and not only banks but also non-bank payment service providers and Big Tech firms are expected to play important roles in the payment infrastructure.

In this regard, if the central bank allows a larger range of direct participants to participate in their settlement systems and extend their operating hours, they might reap some of the potential benefits of CBDCs. Indeed, several systems such as the TARGET Instant Payment Settlement (TIPS) launched by the ECB, and the New Payments Platform (NPP) by the Reserve Bank of Australia, started to operate on a 24/7 basis in order to support private-sector-based digital payments in 2018 (Bullock, 2018; Mersch, 2018). Since 2018, the Bank of England has also allowed non-bank payment service providers to directly join its RTGS system, and since 2019, Swiss National Bank started allowing Fintech companies access to Swiss Interbank Clearing (Bank of England, 2018, and Swiss National Bank, 2019). These options could continue to be sought, in parallel with studies on CBDCs.

4.4 Competition Among Currencies

Digital innovation could intensify the competition among currencies by reducing the cost of using multiple types of payment instruments. Currencies without sufficient credibility and utility might lose their presence more easily than before.

As most countries came to have their own central banks in the last century, the number of central banks gradually increased and became almost equal to the number of nations. Following that, however, there has been a growing trend towards currency union, and by the end of the last century the ECB was established. The ECB, as well as several other initiatives in Africa and the Caribbean states, could be regarded as part of a wider effort to reduce the cost of cross-border transactions through the sharing of a central bank and of a common currency unit. Although central banks are still needed, having one's own central bank may no longer be a necessary condition to remain a nation state. Nations are increasingly capable of sharing a central bank, provided they join forces to create a robust and effective framework that guarantees its trustworthiness and credibility through the harmonization of diverse economic policies and infrastructures. Accordingly, the future monetary system would consist of several key currencies and satellite currencies that try to maintain their credibility and utility by linking them to one of those key currencies or basket of currencies. Under these environments, each jurisdiction is required to make more efforts towards enhancing the efficiency and utility of their payment and settlement infrastructures, if they want to maintain their own currency.

4.5 Public and Private Initiatives to Shape the Future of the Monetary System

If we think about the future of the monetary system, we cannot avoid thinking about the relationship between currencies and data. The monetary system in the future should facilitate the utilization of data by society in a safe and reliable manner.

From the origin of its history, money has translated the value of various goods and services into prices with common units, and enabled price mechanisms to function effectively. Thanks to money, we can measure general price levels and inflation. As such, money works as a critical tool for processing information and data in the economy.

In the current two-tiered monetary system, central banks obtain the information and data they need for maintaining the overall stability of payment and settlement systems. On the other hand, insofar as banknotes are anonymous instruments, central banks do not have access to the information and data attached to daily transactions carried out by ordinary people. These data have long been exploited mainly by private hands.

Traditionally, financial institutions used to gather financial data while non-financial companies mainly collected non-financial data. But with the kind of digital-based transactions entailed by e-commerce, financial and non-financial data are increasingly interlinked with each other. As digitized payment instruments develop, they are playing a greater role in collecting and processing a variety of data attached to payments and settlements. The accelerating accumulation and utilization of customer data with financial and non-financial data are bound to become more closely interlinked with each other. That is the major reason why many Big Tech firms are entering into digital payment services.

In such an environment, the new monetary system is expected to facilitate the utilization of not only financial but also non-financial data in a safe and reliable manner. As digital innovation enables payment instruments to function as tools for conveying and processing a variety of data, ensuring data security, privacy and anonymity are becoming crucial issues in the financial services industry. It may not be feasible for the central bank to bear all the responsibility in this respect, and effective cooperation between private entities, regulatory agencies, and the central bank will be essential.

In such an environment, whether the monetary system can facilitate the utilization of data in a safe and effective manner will substantially influence the efficiency of the economy. In this regard, one of the critical issues regarding CBDCs is also its impact on the use of data. In thinking about the future monetary system, it is important to design the optimal style and distribution of roles regarding the use of the data attached to economic transactions.

5 Outlook

In 2008, when we were in the midst of a global financial crisis, crypto-assets, blockchains, and DLTs were nowhere to be seen. The iPhone, Kindle, Uber, and Airbnb were still in their infancy. Nobody had yet pressed Facebook or Instagram's Like button. Since then, the number of smartphones has increased dramatically, and Big Tech firms have grown very rapidly and have become top global firms. These instruments and firms are now playing important roles also in digital payments. As such, the ongoing digital innovations are influencing also the style of currencies in various ways.

Given the complexity of the challenges and the different fields of expertise involved, the future of the monetary system will necessarily be shaped by both public and private initiatives. As for Japan, the Digital Currency Forum will continue to mobilize private resources while closely cooperating with public entities to maintain the credibility of Japan's currency system and to enhance the utility of payments and settlement infrastructures.

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Central Bank Digital Currencies in a World with Negative Nominal Interest Rates

Ulrich Bindseil

1 Introduction

Both academics and central banks have recently started to analyze merits and dangers of introducing central bank digital currencies (CBDC), i.e., some form of central bank money handled through electronic means and accessible to the broad public. CBDC could be considered a third form of base money, next to (i) overnight deposits with the central bank, currently available only to banks, specific non-bank financial firms, and some official sector depositors; (ii) banknotes, being universally accessible but arguably of limited efficiency and relying on old[1] technology. This chapter discusses issues relating to the remuneration of generally accessible CBDC, in particular in a negative interest rate environment such as prevailing in the euro area and Japan. A number of quite diverse benefits of CBDC have been put forward in the literature (see e.g., Bindseil, 2020 for an overview). This chapter focuses on one specific dimension of CBDC, namely its remuneration. Some authors have noted that CBDC could be designed to have cash-like properties, including a zero remuneration. However, a zero remuneration of CBDC means very different things depending on the interest rate environment, i.e. depending on whether short-term nominal interest rates are at 10%, 3%, 0%, or −0.5%. Central bankers and holders of central bank money got used to the fact that banknotes represent a risk-free short-term financial asset offering a zero nominal yield regardless of the structural and cyclical level of nominal interest rate in an economy. While some consider this feature of banknotes an anomaly which could precisely be solved with CBDC (and the discontinuation of banknotes), others have argued the opposite, namely that it is important to preserve this feature of banknotes

[1] Of course, modern banknotes are at the same time based on modern technology in terms of material and security features.

U. Bindseil (✉)
European Central Bank, Frankfurt, Germany
e-mail: ulrich.bindseil@ecb.europa.eu

M. Heckel and F. Waldenberger (eds.), *The Future of Financial Systems in the Digital Age*, Perspectives in Law, Business and Innovation,
https://doi.org/10.1007/978-981-16-7830-1_5

in the design of CBDC such as to provide an as much as possible banknote-like electronic means of payments.

In this chapter, it is argued that for currency areas with presently negative risk-free nominal interest rates, or with this possibility being somewhat likely for the future, the ability to remunerate CBDC, and also to remunerate it negatively, will be necessary. More specifically, it is proposed to solve the tension between the desire to offer CBDC to citizens (at a reasonable quantity needed for its use as a means of payment) at interest rates never worse than the ones on banknotes (i.e., never below zero), with the need to preserve financial stability and the effectiveness of monetary policy, by having a two-tier remuneration approach to CBDC. This approach allows offering CBDC in an elastic and unconstrained way to other potential holders, such as corporates or foreigners. It would thereby also overcome the perceived dichotomy between "retail" and "wholesale" CBDC.

Section 2 will review the potential risk of a structural and cyclical (i.e., crisis-related) bank disintermediation. Section 3 will look at the problem of preserving, with CBDC, a very accommodating stance of monetary policy, i.e., one with even negative remuneration. Section 4 proposes tiered remuneration of CBDC as solution to both problems, while keeping CBDC attractive for citizens in comparison to banknotes, and being able to offer it without constraints to other holders. Section 5 concludes the chapter.

2 The Risk of Structural and Cyclical Bank Disintermediation Through CBDC

CBDC has both found support, and caused strong concerns, with regard to its impact on the structure and scale of bank intermediation. Advocates of "sovereign money" see bank disintermediation as precisely the goal of CBDC. Others have strongly rejected the idea of CBDC inflating the central bank balance sheet at the expense of deposit funding of banks. For example, Alex J. Pollock, in testimony to the Subcommittee on Monetary Policy and Trade of the Committee on Financial Services United States House of Representatives,[2] argues that CBDC would lead to various distortions precisely because of bank disintermediation: on one side the central bank would benefit from an unfair competitive advantage in deposit collection and amass undue power and market share (also likely misusing its regulatory powers to further strengthen its unfair advantages), on the other hand it would have competitive disadvantages in credit provision, which it would however ignore, leading to inefficiency, conflicts of interest and financial losses that eventually the taxpayer would have to bear. Carstens (2019) reiterates such worries (see also Mancini-Griffoli et al., 2018). Finally, the Committee on Payments and Market Infrastructures and Markets Committee (CPMI-MC) of the Bank for International Settlements (2018) emphasizes the cross-border issues that CBDC may create. Indeed, also for banknotes, foreign

[2] https://www.govinfo.gov/content/pkg/CHRG-115hhrg31510/pdf/CHRG-115hhrg31510.pdf.

demand has been a major factor in recent decades (e.g., Jobst & Stix, 2017). CBDC, if offered in the same perfectly elastic way as banknotes, could facilitate further the cross-border access to central bank money.

Below the creation of CBDC is captured in a financial account system, which very broadly replicates the euro area financial accounts as of Q2 2018 provided in the ECB Statistics Warehouse or the ECB Economic Bulletin (see Table 1). The accounts are simplified in particular with regard to netting and that the non-bank financial sectors (OFIs and ICPFs, i.e., "other financial institutions" and "insurance companies and

Table 1 Financial accounts representation of CBDC, compensating securities purchases by the central bank, and possible bank deleveraging (numbers in trillions of Euro broadly illustrating euro area accounts)

Households, Pension and Investment Funds, Insurance Companies					
Real assets	20		Household equity	44	
Sight deposits	5	**−CBDC2**			
Savings deposits	4		Bank loans	5	
CBDC		**+CBDC1+CBDC2**			
Banknotes	1	**−CBDC1**			
Bank bonds	4	**+S1**			
Bonds	7	**−S1**			
Equity	8				
Corporates					
Real assets	13		Bonds issued	3	
Sight deposits	2		Loans	8	
Savings deposits	1		Shares/equity	5	
Government					
Real assets	11		Bonds issued	9	
			Loans	2	
Commercial Banks					
Loans to corporates	8		Sight deposits	7	**−CBDC2**
Loans to govt	2		Savings deposits	5	
Loans to HH	5	**−S2**	Bonds issued	4	**+S1**
Bonds	5		Equity	3	
Deposits with CB	0		Central bank credit	1	**+CBDC2 −S1−S2**
Central Bank					
Credit to banks	1	**+CBDC2 −S1−S2**	Banknotes	1	**−CBDC1**
Bonds	0	**+S1+S2**	Bank deposits	0	
			CBDC		**+CBDC1+CBDC2**

Source by the author

pension funds") have been omitted or been broadly integrated into the household sector. Also, the ECB's asset purchase program is not reflected.

If households substitute banknotes with CBDC, then central bank and commercial bank balance sheets do not really change. However, if households substitute commercial bank deposits with CBDC, then this would imply a funding loss for commercial banks and could lead to "disintermediation" of the banking sector. In particular sight deposits with low remuneration could be expected to shift at least to some extent into riskless CBDC, leading to a loss of commercial banks' funding of equal size. Banks would have to try to offer better conditions on their deposits in order to protect their deposit base as much as possible—but this would imply higher funding costs for banks and a loss of commercial bank "seignorage". Below, the creation of CBDC has thus been split into two parts: **CBDC1** which substitute banknotes and **CBDC2** which substitute deposits with banks. It seems most likely that indeed CBDC would do both of those, but it is unclear with what weights. The effect of CBDC1 on the rest of the financial accounts is neutral, but the effects of CBDC2 are not: CBDC2 lengthens the central bank balance sheet as central bank credit will have to fill the funding gaps of the banks. The central bank may want to avoid this effect by purchasing government and corporate bonds, whereby the source of the bonds could be either households or banks, being captured in the financial accounts by **S1** and **S2**, respectively. In the former case, it has been assumed here that the households will not keep the money obtained in the form of bank deposits, but would purchase bank bonds that the banks would in addition issue (however, from a financial account perspective, it makes no difference if the purchases of bonds by the central bank from households imply additional deposits with banks or additional capital market investments of households into bank bonds).

While CBDC1 appears uncontroversial as it merely substitutes one form of central bank money into another without changing the rest of the financial system, CBDC2 increases the dependence of banks on central bank credit and decreases sight deposits with the banking system. Both S1 and S2 have positive effects in the sense that they reduce again the dependence of banks on central bank credit. CBDC2 will obviously have effects on funding costs of the banking system, as typically central bank credit and bond issuance are more expensive than the remuneration rate of sight deposits (except in unusual circumstances, as the ones prevailing, e.g., in the euro area since 2014, in which obtaining credit from the central bank was partially possible for banks at negative rates, while sight deposits of households with banks remained non-negative). Moreover, a larger recourse to central bank credit could lead to collateral scarcity issues and the question whether the central bank collateral framework becomes so crucial from a credit allocation perspective that one would observe an effective centralization of the credit provision process. Both effects will be analyzed further in the next two subsections.

2.1 Effects on Bank Funding Costs of CBDC2

Following Juks (2018), one needs to understand what impact CBDC will have on average funding costs of banks, and therefore on bank lending rates (see also, e.g., Engert & Fung, 2017). In addition, it should be understood how this may impact monetary policy interest rate setting of the central bank and the seignorage income of the central bank. Bank funding costs will obviously increase because a cheap funding source (sight deposits) decreases, and more expensive funding sources (central bank credit or bank bond issuance) have to take over. The central bank would have to compensate the implied tightening of financial conditions caused by a decrease of cheap sight deposit financing of banks by *lowering* the monetary policy rate. The extent of the required lowering of short-term interest rates would depend on the size of CBDC2, on the relative share of bank funding in the economy, and on the spread between the other bank funding rates and the monetary policy operations rate. Moreover, substitution effects from bank-based to capital market-based financing of the economy would impact on the overall needed adjustment of central bank rates. The fact that bank funding is only one part of overall funding of the economy implies that the central bank will not reduce the short-term interest rates in a way that bank funding costs are stabilized, but only partially so. Therefore, in the new equilibrium, banks will have lost competitiveness and will lose some market share relative to other forms of funding (through capital markets and non-bank intermediaries).

Tables 2 and 3 provide the average levels of the relevant shares and interest rates for the period 2003–2008, and 2009–2018, respectively.

The largest share in bank funding came from deposits with residual maturity of less than two years and redeemable at three- or less-month notice, i.e. the types of deposits contained in the monetary aggregate M3. This is also the cheapest funding source in the first period, while in the second period, central bank funding becomes even cheaper. Actually, overnight deposits contribute 50–65% of these deposits, and have a significantly lower interest rate. For example, in December 2005, new overnight deposits were remunerated on average at 0.71% with up to one-year term deposits at 2.15%.

Table 2 Euro area bank funding costs across different instruments, 2003–2008

	Share in bank funding (%)	Average interest rate (%)
Deposits (in M3)	44	1.83
Other deposits	13	3.25
Bonds issued	30	4.10
Equity issued	10	8.47
Central bank credit (MRO rate)	3	2.79

Source author's calculation. Bond yields data (Merrill Lynch); all other data ECB

Table 3 Euro area bank funding costs across different instruments, 2009–2018

	Share in bank funding (%)	Average interest rate (%)
Deposits (in M3)	47	0.78
Other deposits	14	2.39
Bonds issued	23	2.15
Equity issued	12	10.54
Central bank credit (MRO rate)	4	0.50

Source author's calculation. Bond yields data (Merrill Lynch); all other data ECB

For example, assume that the 2003–2008 data apply, and that 10 percentage points of M3-deposits of banks are substituted with CBDC2, and that CBDC is not remunerated. If everything else remains unchanged, then the funding costs of banks increase by 0.1 × (2.79%–1.83%), i.e., around 10 basis points. If the central bank wants to keep financial conditions unchanged, it needs now to lower the general interest rate level. If bank funding is 50% of total funding of the economy, the rest being capital market based, then the central bank will have to lower the interest rate level by 5 basis points if it wants to achieve that the average funding costs of the real economy stay unchanged (and if one ignores secondary effects). Average funding costs of banks will have increased by 5 basis points, and costs of capital market financing will have decreased by the same amount, implying some loss of competitiveness of banking.

2.2 *Increase of Banks' Reliance on Central Bank Credit, Collateral Constraints, and Credit Centralization?*

To what extent could CBDC undermine the decentralized, market-based financing of the real economy by increasing massively the central bank balance sheet, and thereby making it, either via increased central bank securities holdings, or via an increased funding of banks through central bank credit, an important (but potentially inefficient) element of the credit allocation process? State liabilities can be stores of value for households, in particular if they are matched, in the state balance sheet, by *real* assets that the state owns. However, probably the state would not want to become a *financial* intermediary for household savings, which would happen if the state re-invested proceeds from issuing debt to households in the form of financial assets, or in the form of real assets not linked to state tasks, just for the sake of re-investment. This logic may also be applied to central banks in a somewhat different way as central banking starts from the liability side: to the extent they issue means of payment, they need to re-invest the proceeds from doing so. However, the central bank probably does not want central bank money to become a large-scale store of value, i.e., investment vehicle, as this would mean that the central bank would become a

financial intermediary. Turning to the asset side of the central bank balance sheet, one may note different views of central banks on what is the best match with its monetary liabilities: The Fed and the Bank of England systematically invested the proceeds from the issuance of banknotes into government paper. The Deutsche Bundesbank in contrast traditionally considered exposures of the central bank to the government as problematic and therefore preferred assets in the form of loans to banks collateralized with high-quality securities or bills of exchange.

In view of the outstanding levels of government debt in developed economies, and the much lower level of cash in circulation so far [around 10% of GDP for advanced economies,[3] and 8% for emerging economies (Sveriges Riksbank, 2018)] it would appear that there would be some scope for CBDC2 to be matched on the central bank asset side with higher holdings of government bonds, such that neither (i) the reliance of banks on central bank credit would need to increase, nor (ii) would the central bank have to hold a credit-risk-intense portfolio of securities. In any case, currently at least the central banks of the UK, Japan and the euro area hold large quantitative easing (QE) related portfolios that created large amounts of excess reserves of banks, that would provide scope for CBDC2 of at least the size of banknotes in circulation before reserve scarcity would emerge (without any further purchases of government bonds). Moreover, once the potential for matching CBDC with government exposures had been exhausted, the central bank could still try to minimize the impact of the lengthening of the central bank balance sheet on the credit allocation process by aiming at diversified exposures to the private sector (e.g., outright holdings of various securities types and issuers proportional to market capitalization; credit operations with banks against a broad collateral set). In so far, it could be argued that there is some scope for CBDC2 before the central banks would have to accept really credit-intense exposures to the private sector, and thereby play a potentially larger role in the credit allocation of the economy, which may eventually be negative for the overall efficiency of the economy.

2.3 Bank Runs and Cyclical Bank Disintermediation Through CBDC

Mersch (2018) and Panetta (2018), amongst others, have emphasized the potentially destabilizing effects of CBDC in a financial crisis, namely its facilitation of a run on the banking system. CPMI–MC (2018) also supports the view that CBDC could worsen bank run dynamics in a crisis. Mancini–Griffoli et al. (2018) also discuss this aspect of CBDC, but conclude that overall, these effects are likely to be muted. While a run into banknotes has limitations resulting from the risks and costs of storing larger amounts of banknotes at home or at some safe places, no such limitations would arise if everyone would have an unlimited ability to hold CBDC. Also, a crisis-related

[3] Japan is an interesting outlier and has a much higher share of cash in circulation (see, Ministry of Internal Affairs and Communications, 2020).

run into safe financial assets (gold-related assets, highly rated government debt) is different: although being possible in "electronic" form and therefore not creating security issues (except for physical gold), it is (i) dis-incentivized through the price mechanism, i.e., the secure assets will become very expensive in a crisis; (ii) on aggregate such a run does not reduce per se deposits with banks. Therefore, it is plausible that CBDC could worsen bank runs, as it would neither create physical security issues, nor be subject to scarcity-related price dis-incentives, as it would be supplied in a fully elastic way (like banknotes). The financial flow representation of a bank run into CBDC is identical to the one of CBDC2 in Table 1.

3 NIRP and CBDC[4]

A number of central banks have implemented negative interest rate policies (NIRP), notably in Denmark, Switzerland, the euro area, Sweden, and last but not least, Japan. Moreover, long-term nominal interest rates suggest that NIRP could have a significant probability of re-occurring in future decades, and maybe even in monetary areas not applying it currently.

Issuing unremunerated CBDC without access and quantity constraints would however imply the end of NIRP. As it would also imply that NIRP would no longer be considered possible in the future, long-term nominal yields—even those currently in positive territory —would tend to increase as NIRP scenarios would no longer be factored into expectations.

Indeed, if the most liquid and risk-free asset—central bank overnight liabilities in domestic currency—offers a return rate of zero, no other financial instrument should yield a negative rate any longer as its holders would otherwise substitute it with CBDC. Therefore, effective access- and/or quantitative constraints on CBDC holdings would be necessary to preserve the ability to conduct NIRP under a future issuance of *zero-remunerated* CBDC. However, such constraints reduce the scale and scope of usage of CBDC and therefore its effectiveness and usefulness as means of payment.

4 A Two-Tier Remuneration System for CBDC

Some authors (e.g., Kumhof & Noone, 2018) note the possibility of addressing CBDC's potential structural and cyclical bank disintermediation through applying unattractive and/or negative interest rates on CBDC. However, they are skeptical that the tool of negative interest rates will always be sufficiently effective in crisis times, also because of political acceptance problems. Indeed, central banks will prefer to be able to promise to citizens that CBDC will be at least as attractive as banknotes on

[4] See also the chapter by Yamaoka in this volume.

all relevant aspects, i.e., excluding that a household's holdings of CBDC of the size of normal holdings of banknotes could be subject to negative remuneration, even during a crisis. In this section, a solution, namely tiered remuneration of CBDC, is proposed to solve the potential problems explained in the preceding two sections, while allowing central banks to achieve this objective. Panetta (2018) was first to hint at the idea of a tiering system for CBDC to address the bank run problem (italics added), whereby he does not go as far as to envisage negative remuneration for the second tier:

> in bad times, depositors could switch rapidly and at no cost from their bank account to the CBDC. The central bank could limit such risks—for example by setting a ceiling on the amount of CBDC that each individual investor can hold, or by bringing the remuneration to zero for holdings of CBDCs *above a certain threshold*. (p. 29)

Actually, reserve tiering systems have often been applied by central banks for the remuneration of deposits, and exactly for the purpose to control the total amount of deposits while being forthcoming toward moderate levels of deposits. Under such a system, a relatively attractive remuneration rate is applied up to some quantitative ceiling, while a lower interest rate is applied for amounts beyond the threshold. The Eurosystem has applied such tiering systems for deposit accounts of public sector institutions, notably of domestic government and foreign central banks or sovereign wealth funds. Regarding the remuneration of *government deposits*, for example, Article 5 of the Eurosystem's DALM guideline[5] specifies that a two-tier remuneration system applies. Similarly, the Eurosystem reserve management services (ERMS[6]), granting accounts to foreign central banks and public sector funds, also typically foresee the differentiation between a more attractive rate applying up to some limit, and a less attractive one without limits. If the remuneration rate for tier two deposits is sufficiently unattractive, then the amount of such deposits should be low, or even zero. The central bank should also be able to counter, through an as aggressive as needed lowering of tier two remuneration rates, the inflow of additional deposits in a financial crisis context.

One may also note that some central banks (DK, SE, CH, JP) have collected experience over the last years with a differentiated remuneration of bank deposits with the central bank. For example, the Bank of Japan introduced on 29 January 2016 a three-tier system (Press release of the Bank of Japan dated 29 January 2016) following the existence of two-tier approaches in other central banks. The size of the better remunerated tiers is calculated by the Bank of Japan for each bank essentially in proportion to the bank's required reserves, which itself are calculated proportionally to the short-term liabilities of the bank to non-banks.

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[5] GUIDELINE OF THE EUROPEAN CENTRAL BANK of 20 February 2014 on domestic asset and liability management operations by the national central banks (ECB/2014/9), as amended by GUIDELINE OF THE EUROPEAN CENTRAL BANK of 5 June 2014 amending Guideline ECB/2014/9 on domestic asset and liability management operations by the national central banks (ECB/2014/22).

[6] https://www.ecb.europa.eu/paym/erms/html/index.en.html.

In sum: central banks have ample experience with tiered remuneration systems. These could be readily applied to deposit-based CBDC and could address the structural and the financial crises-related bank disintermediation issues without exposing households using CBDC for payment purposes to (perceived) financial repression. Of course, an undue structural or transitionary increase in CBDC at the expense of banks could also be addressed by a single tier system in which the interest rate applied to the entire CBDC deposits would be sufficiently low (or temporarily lowered). However, a two-tier system seems to have important advantages:

- It allows assigning the **payment function of money to tier one CBDC**, while the **store of value function would be assigned to tier two**, and would essentially be dis-incentivized through a less attractive remuneration rate. Indeed, central bank money should probably not become a large-scale store of value (or investment vehicle), i.e., a major form of investment of households, as this eventually implies that the central bank would become an investment intermediary of the economy (for which it has no particular qualification).
- It ensures that **CBDC is attractive** to have in principle for all households, **as reliance on tier one CBDC never needs to be dis-incentivized by a particularly low remuneration rate**.
- A two-tier system allows **better steering of the amount of CBDC**, which provides additional confidence into the manageability of the introduction of CBDC.
- As mentioned above, it avoids that in a crisis situation, one would need to push into negative territory the remuneration of *all* CBDC. Thereby **tiering decisively reduces the scope for popular criticism of the central bank (e.g., of financial repression, expropriation of money holders, etc.)**. The central bank would need to communicate clearly at an early stage that the remuneration of tier two CBDC is not meant to be attractive, and may be made particularly unattractive in a crisis, as needed. For tier one CBDC, the central bank can commit to never charging negative rates.
- In case it is wished to be combined with abolishing bank notes, it allows overcoming the zero lower bound (ZLB) for monetary policy reasons when needed, without implying that tier one remuneration needs ever to fall below zero, which appears fair for low-wealth individuals and toward the payment function of central bank money more generally.

The central bank can also provide a **commitment with regard to the quantity of tier one CBDC**. For example, it could promise to always provide per capita a tier one quota of e.g. EUR 3000, implying an amount of total tier one CBDC for households of around EUR 1 trillion (assuming an eligible euro area population of 340 million; the allowances of minors could be either set to zero or they could be allocated to a parent's CBDC account). To recall: banknotes in circulation in the euro area are somewhat above EUR 3000 per capita (summing up currently to around EUR 1.2 trillion); securities holdings of the Eurosystem (including both investment and policy portfolios) are currently around EUR 3 trillion; and the banking system has excess reserves close to EUR 2 trillion. Everything else unchanged, there would thus still be no need for large scale credit operations with banks if CBDC of a total amount of EUR

1 trillion would be issued now. The central bank could moreover commit to increase the tier one CBDC quota when the amount of banknote in circulation decreases. An amount of EUR 3000 for tier one CBDC could be interpreted as covering the average monthly net income of euro area households, such that the normal payment function of money would be covered. CBDC tier one allowances for companies would not necessarily have to be high, as it could be argued that the main objective of CBDC is to serve citizens. When estimating how tier one CBDC allowances would be translated into total CBDC volumes, it should on one side be taken into account that not all CBDC accounts will be opened rapidly, and maybe some households will never open an account, or will not hold the full tier one allowance on the account. On the other side, some households will be willing to hold tier two allowances.

For corporates (financial non-banks and non-financials), the tier one allowance could be set to zero, or alternatively it could be calculated to be proportional to some measure of their size and thereby presumed payment needs. Simplicity and controllability of the assignments would be essential. Foreigners, if allowed to open accounts, should have a tier one ceiling of zero. Finally, a deposit based CBDC framework could in principle be complemented by an anonymous token-based CBDC. If so, then the anonymous token-based part would be remunerated at the same level as account-based tier two CBDC. Simple solutions (such as a stored-value card like the London Oyster card) could be sufficient for instance to allow tourists to use CBDC without having an account. Again, those cards should be subject to the tier two remuneration rate.

The tier one remuneration rate r_1 could be set in principle at a relatively attractive level, up to the rate of remuneration of banks' excess reserves, and it would in addition be specified that it could never fall below zero. The tier two remuneration rate would be set such that tier two deposits are rather unattractive as store of value, i.e., less attractive than bank deposits or other short-term financial assets, even when taking into account risk premia. The two rates would co-move in parallel with policy interest rates, with in addition some special provision when the zero lower bound territory is approached. The rates would themselves not be regarded as policy rates. Moving the rates would simply serve keeping a similar spread over time to other central bank rates, and thus in principle to other market rates. The objective would be to sufficiently stabilize and control over time the incentives to hold CBDC. Of course, the existence of banknotes, which are invariably remunerated at zero, creates a variable spread between the remuneration of banknotes and CBDC, which may also have quantitative effects on both.

Initially, for example the following remuneration could be considered by the ECB for tier one CBDC (DFR is the rate of the ECB's deposit facility):

$$r_1 = max(0, DFR - 1\%) \tag{1}$$

For tier two CBDC, the remuneration formula could be:

$$r_2 = min(0, DFR - 1\%) \tag{2}$$

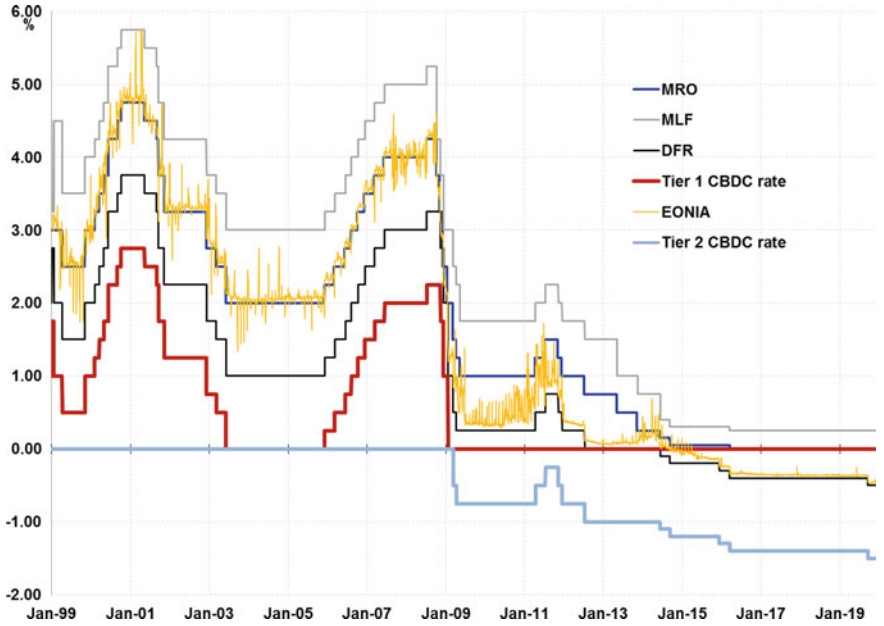

Fig. 1 An example of CBDC remuneration rates relative to historical ECB official interest rates *Note* tier one CBDC rate $r_1 = max(0, DFR - 1\%)$ and tier two CBDC rate $r_2 = min(0, DFR - 1\%)$. DFR: Deposit facility rate; MLF: Marginal lending facility; MRO: Main refinancing operations; EONIA: Euro overnight index average

In words: r_1 would equal the rate of ECB deposit facility minus 1%, with however a zero lower bound applying, while r_2 would be the rate of the ECB deposit facility minus 1%, however with zero as a ceiling. Figure 1 shows the relationship of remuneration rate r_1 and r_2 with the ECB's official interest rates.

Of course, alternative formulas for remuneration of the two tiers could be imagined and applied.

5 Conclusion

This chapter proposes a way to achieve simultaneously four key objectives related to the introduction of CBDC:

1. Offering CBDC as means of payments to households at conditions at least as attractive as banknotes, implying a non-negative remuneration of some relatively significant amount of CBDC per household.
2. Offering CBDC in a quantitatively unconstrained manner to *any* holder, also beyond citizens, i.e., including corporates, foreigners, institutional investors, etc., such as to ensure that CBDC can achieve maximum scale, scope, and

effectiveness as means of payment, including internationally, and serve both as "retail" and "wholesale" CBDC.
3. Being able to control the risks of structural or cyclical bank disintermediation through CBDC, in particular in a low-interest-rate environment (including NIRP).
4. Preserving the ability to conduct NIRP and thereby preserve the current accommodative stance of monetary policy, such as it currently prevails in a number of advanced economies (including Japan and the euro area).

The solution relies on a tiered remuneration of CBDC, in line with long-tested central bank logic and practice. Tiered remuneration is probably not needed when nominal short-term risk-free interest rates are far above zero, as they have been e.g. in G7 countries in the early 1980s. In such circumstances, where nominal interest rates would be, e.g., close to 10%, a zero-remuneration of CBDC would be effective to prevent an extensive use of CBDC as a store of value (i.e. as a large-scale investment), probably even in financial crisis situations. For economies with moderately positive nominal interest rates, the technical ability to introduce a tiered remuneration may also be desirable, in particular for the risk of crisis-related bank dis-intermediation. Moreover, CBDC issuance which would technically exclude future NIRP would not only, by definition, constrain future policy options, but it would also tend to increase long-term interest rates today, i.e., tighten the stance of monetary policy, because of expectations effects.

Offering unremunerated CBDC to households can achieve either objectives 1 and 2 but not 3 and 4, or, in case of quantity and access constraints, 1, 3, and 4, but obviously not 2. Offering CBDC with a single remuneration rate can achieve in addition 2, 3, and 4, if it sacrifices 1. Therefore, tiering appears as the only solution to achieve all four objectives.

Acknowledgements Ulrich Bindseil would like to thank Andrea Pinna, Andrej Bachmann, and Markus Heckel for helpful comments. Opinions expressed in this chapter are those of the author and not necessarily those of the European Central Bank.

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The Future of Payments in a DLT-Based European Economy: A Roadmap

Alexander Bechtel, Agata Ferreira, Jonas Gross, and Philipp Sandner

1 Introduction

Distributed ledger technology (DLT) has the potential to address long-standing industrial challenges, remove frictions, build trust, and unlock new value across businesses and industries. It enables decentralization, the immutability of data, transparency, and the automation of business processes. Thereby, it creates a multitude of use cases ranging from energy and manufacturing to mobility and logistics. However, a digitized economy based on DLT can flourish only if it does not merely enable the exchange of assets, goods, and services but also the exchange of money. In other words, there is a need for a payment solution that is compatible with DLT-based decentralized networks and enables transactions denominated in euro. This is particulary relevant in the currently evolving geopolitical environment. Digital payment solutions constitute an important strategic building block in Europe's quest for digital competitiveness and strategic autonomy (Anghel et al., 2020). Various European institutions have increased their efforts to modernize the payment infrastructures in Europe, including the Digital Finance Package from the European Commission (European Commission, 2020) and the inquiry into a digital euro by the European Central Bank (European Central Bank, 2020). Against the background of these developments, we aim to answer the following research questions: What will the future

A. Bechtel
University of St. Gallen, St. Gallen, Switzerland

A. Ferreira
Warsaw University of Technology, Warszawa, Poland

J. Gross · P. Sandner (✉)
Frankfurt School Blockchain Center, Frankfurt, Germany
e-mail: email@philippsandner.de

M. Heckel and F. Waldenberger (eds.), *The Future of Financial Systems in the Digital Age*, Perspectives in Law, Business and Innovation,
https://doi.org/10.1007/978-981-16-7830-1_6

of payments in a DLT-based European economy look like? What are the most suitable euro-based payment systems to facilitate the execution of and integration with DLT-based smart contracts? When will these payment systems be operational?

We answer these questions by comparing account- and token-based solutions for the (digital) euro. In our analysis, we consider both the public sector and the private sector as potential issuers of the digital euro. In particular, we analyze possible designs of a digital payment system that enables the transfer of money triggered by DLT-based decentralized business logics, such as smart contracts. These payment systems include solutions based on existing infrastructures, such as bank accounts, as well as novel DLT-based payment rails, such as e-money tokens, synthetic central bank digital currencies (sCBDCs) or a central bank digital currency (CBDC). Our analysis indicates that there will be no single payment solution for a DLT-based European economy. Rather, we expect a broad array of payment systems for multiple use cases to be launched at different points in time. It is unfeasible to expect that there will be a single suitable solution for a wide range of emerging use cases. It is also unlikely that one solution applicable to many use cases will be launched in the short term. Therefore, we propose a roadmap toward a digital euro and the future of payments in a DLT-based European economy that entails a step-by-step timeline of incremental infrastructure solutions.

Several economic and technological trends foster the need for an upgrade of the existing payment system. The ultimate goal is to integrate DLT-based, decentralized business logics with payment systems to enable the seamless exchange of assets, goods, and services and the programmability of payments. Programmable payments already exist today, for example, in the form of standing orders and direct debits. However, it is burdensome to implement complex logic into these payments, and hence their flexibility is limited. Smart contracts offer flexibility and facilitate the integration of complex business processes with payments. A payment system that enables programmable money flows is an important building block for Industry 4.0, including the Internet of Things (IoT), the machine economy, and tokenized assets.

In the Internet of Things, data and value can be transferred based on machine-to-machine interactions. These interactions create an ecosystem known as the "Economy of Things" in which machines, devices, sensors and other physical assets become economic agents that autonomously enter into binding agreements and conduct payments. The Economy of Things increases the efficiency of existing business models and creates new business opportunities. For instance, machine manufacturers can offer their capital-intense machines on a pay-per-use basis instead of selling them to their customers. Another use case would be electric cars that negotiate the price for recharging with a charging station and automatically execute a payment. The Economy of Things already exists on a small scale today. Industry experts expect the number of connected devices to grow strongly over the coming years (e.g., Lueth, 2018).

Another trend that fosters the use of DLT-based smart contracts is the tokenization of tangible and intangible assets. Tokenization refers to the creation of digital representations of assets and rights on a DLT. It brings about several advantages. First, tokenization increases liquidity and facilitates the fractionalization of assets.

Illiquid assets, such as real estate or art, can be represented by tokens and traded on a secondary market. Additionally, investors can own and trade a small fraction of these assets. Second, tokenization can render non-tradable assets tradable. For instance, students could tokenize their future earnings and sell these tokens to investors in order to finance their studies. Third, tokenization increases efficiency by enabling faster and cheaper transactions and settlements because certain steps of the exchange process are automated, and intermediaries become redundant. The key advantage is that decentralized business logics, such as smart contracts, enable mathematically guaranteed settlement and exchange. Consequently, the speed of execution increases and transaction costs decrease because counterparty risk is substantially reduced.

To analyze and compare potential digital payment solutions for the euro that can be integrated within a DLT-based Industry 4.0, we propose a framework in which we decompose the digital payments value chain into the following three pillars: (1) the contract execution system, (2) the digital payment infrastructure and (3) the monetary unit. The contract execution system is the starting point of the digital payments value chain, where a smart contract triggers a payment. The digital payment infrastructure refers to the payment rails. These payment channels can be both DLT-based and based on conventional payment systems, such as the Single Euro Payments Area (SEPA) or TARGET Instant Payment Settlement (TIPS). The monetary unit refers to the unit of account. It can be fiat- or non-fiat-denominated. In this chapter, we analyze and discuss how a digital payment system has to be designed in order to enable the exchange of money that has been triggered by DLT-based decentralized business logics, such as smart contracts. In particular, we distinguish between account- and token-based digital payment systems and focus on payments that are denominated in euros. Finally, we lay out a timeline of potential market launches for different payment solutions.

Our key findings are as follows: Both account- and token-based infrastructures have advantages and disadvantages. We find that systems relying on the existing account-based banking infrastructure are sufficient for most of the relevant use cases in the short term. Token-based solutions will require more time to be developed and implemented, but they will be more effective and able to address the use cases that remain incompatible with account-based solutions. Nevertheless, the account-based payment system will not cease to exist after token-based payments are enabled. We consider the two systems to be complementary. For the future, we envision an increasingly complex world with the euro running on multiple infrastructures (including DLT) and serving different classes of use cases. Consequently, we argue that there will be no one-size-fits-all payment solution. Neither a euro CBDC nor e-money tokens nor sCBDCs alone will be able to address the diverse needs that arise in an increasingly interconnected and automated world. It is essential to work on different payment solutions in parallel not only because they address different use cases but also because they will be rolled out at different points in time. Private-sector solutions building upon existing account-based infrastructures will enter the market soon. The first token-based solutions will also be issued by the private sector and include e-money tokens and sCBDCs. Depending on the progress with regard to technological and regulatory hurdles, these solutions could enter the market in

2022/2023. We do not expect a CBDC issued by the ECB to be rolled out on a large scale before 2026.

The remainder of this chapter is structured as follows. In Sect. 2, we present design paradigms for a future payment infrastructure. Section 3 illustrates multiple payment solutions in detail, ranging from the euro in bank accounts to e-money tokens, sCBDCs and a CBDC issued by the ECB. Section 4 summarizes the advantages and disadvantages of the different payment solutions and outlines a timeline of their potential launches. Section 5 provides concluding remarks. In the Appendix, we present specific use cases for the digital euro.

2 Design Paradigms for a Future Payment Infrastructure

2.1 Account-Based Versus Token-Based Solutions

Payments can be performed and recorded either in account-based or token-based systems.[1] In this analysis, "account-based" refers to the legacy banking system with underlying bank accounts.[2] Bank accounts are based on double-entry bookkeeping, where a bank deposit represents a liability of the bank and hence a claim of the customer against the bank. To initiate a bank transfer, the transaction sender instructs the bank to update the account balances. For the authorization of a transaction within an account-based system, customer authentication procedures are used to verify the identity of the account holder through different types of credentials, such as a password, a PIN, or biometric data.

Table 1 compares account-based and token-based forms of money across different categories, such as convenience, efficiency, and privacy. For illustrative purposes, bank deposits are used as the most prominent account-based form of money, while cash and crypto assets are used as examples of token-based money.

Token-based forms of money, in contrast, are bearer instruments. The authorization of a transaction involving token-based money does not require the verification of the identity of the transacting party but is instead based solely on verifying the validity of the token itself. The token contains all the information necessary for the recipient of the payment to verify its legitimacy. The most prominent example of a token-based form of money is cash. For transacting cash, the authenticity and

[1] Note that there are also hybrid systems that display features of both account- and token-based systems. We do not consider such hybrid forms in this chapter. We also assume for the purposes of this chapter that digital token-based money is implemented by using DLT. This assumption is in line with current token-based CBDC prototypes, such as the CBDC by the Eastern Caribbean Central Bank (DCash).

[2] We note that the term "account" can also be used as a technical term and can refer to the software architecture of some DLT networks or can be a synonym for a digital "wallet." In such a system, "account-based" software design is used to record ownership of digital instruments on a distributed ledger. In this chapter, we do not consider such a technological perspective.

Table 1 Comparison between account-based and token-based forms of money

Category	Account-based money	Token-based money	
	Bank deposits	Cash	Crypto assets
Convenience of transacting and storing money	High	Moderate	Moderate, increasingly more convenient
Risk of theft or loss	Low	High	Moderate
Interoperability with DLT systems (including tokenized assets)	Moderate	Low	High, if based on same DLT
Peer-to-peer transactions	Not possible	Possible only in person	Possible on a global scale
Payment resilience	Low, only online transactions possible	High, offline transactions possible	Moderate, offline transactions possible to a certain extent
Privacy	Low	High	Moderate, as most crypto assets are pseudonymous
Regulatory embeddedness	High	High	Low, but, increasingly more embedded
Payment efficiency	High for national payments and low for cross-border payments	Low, due to transacting in person	High for large-value payments, low for low-value payments

Source The authors

validity of the banknote itself are the only kinds of identification necessary to conduct a payment. Another example would be crypto assets, such as Bitcoin.

Today, money is mainly transacted via account-based systems, such as in the form of bank transfers, credit cards, or mobile payments, which are linked to an underlying bank account. The popularity of such account-based payments is mainly due to the convenient handling of transactions and the comfortable storage of money. In cases where money is deposited with a regulated entity, such as a bank, the risk of theft and other forms of loss of the deposited money is relatively low as the account provider is responsible for record-keeping and managing the accounts. Therefore, the account provider may be liable if funds are lost, and in such a case the client would get compensated. Furthermore, fungibility and interoperability are typically higher in account-based systems. Fungibility means that assets are interchangeable and indistinguishable from one another. Interoperability refers to the ability of the underlying technologies to communicate with each other in order to enable the seamless exchange of assets. The euro within an account-based system is fungible, and the systems are interoperable because financial intermediaries have agreed on common (technological) standards. This is not automatically the case for token-based versions of the digital euro. Different tokens might be issued by multiple

institutions on different technological platforms, leading to non-fungible forms of the digital euro that are not interoperable. Finally, account-based money also brings about advantages from a regulatory perspective because accounts are deeply embedded in existing regulatory frameworks.

Nevertheless, account-based systems have several drawbacks related to privacy, resilience, and efficiency, which token-based systems might address. Table 1 summarizes the advantages and disadvantages of account- and token-based money. Tokens can be transacted peer-to-peer as the identification of the token holder through an intermediary is not required. Importantly, it needs to be ensured that tokens cannot be counterfeited or duplicated. As a revolutionary concept, DLT digitally solves, for the first time, the double-spending problem and enables decentralized digital token-based forms of money. Furthermore, DLT enables tokenization, that is, all kinds of physical assets, goods and rights can be represented by digital tradable tokens. Peer-to-peer transactions with token-based money increase payment efficiency as transaction processing is no longer dependent on intermediaries and can be directly conducted between the two counterparties of a transaction. Moreover, this peer-to-peer characteristic increases payment resilience since payments can also be conducted when an intermediary is not available or acts in a malicious way. Moreover, payment privacy can be higher in token-based systems. In account-based systems, the account provider has access to the transaction data, and payments are assigned to the identifiable account holder. Tokens, in contrast, are not necessarily linked to the identity of the holder.

2.2 Contract Execution, Digital Payment Infrastructure, and Monetary Unit

To provide a structured analytical framework for the debate about payments in a DLT-based European economy, we decompose the digital payments value chain into three pillars: (1) contract execution system, (2) digital payment infrastructure, and (3) monetary unit (see, Fig. 1). The contract execution system concerns the programmability of payments, i.e., DLT-based smart contracts implemented and integrated with business processes. The digital payment infrastructure is the payment rail, i.e., the system facilitating the transfer of money. Finally, the monetary unit is the unit of account transacted on the digital payment infrastructure. Payments can be denominated in euro, US dollar, and other fiat or non-fiat currencies.

Contract Execution System

The contract execution system is the first pillar of the digital payments value chain. It comprises decentralized business logics that automate business processes and trigger payments in a predefined way. Programmable payments already exist in today's

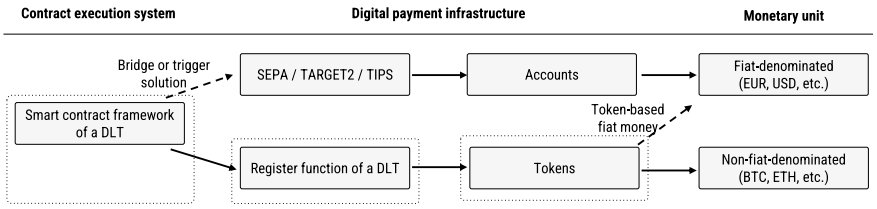

Fig. 1 Digital payments value chain. *Notes* SEPA: Single Euro Payments Area; TARGET2: Trans-European Automated Real-time Gross Settlement Express Transfer System; TIPS: TARGET Instant Payment Settlement; DLT: Distributed Ledger Technology; BTC: Bitcoin; ETH: Ethereum. "Fiat-denominated" is a broad category and includes money issued by the government, which has a status of legal tender and other forms of fiat-denominated money. *Source* The authors

banking system in the form of standing orders and direct debits, but current programming capabilities and system capacity are very limited. DLT networks provide more flexibility and capability, for instance, via smart contracts.[3]

Smart contracts can be applied to execute, control, and document transactions. They can be used to pre-program money flows and automate payments and processes. Payments executed via smart contracts are automatically triggered when predetermined conditions are met. Examples include business processes involved in escrow arrangements, standing orders, interest payments, factoring, leasing, rent deposit accounts, loans, machine-to-machine payments, and exchanging tokenized assets.

In the Economy of Things, machines will become market participants, negotiating prices, and making payments on their own. For instance, an autonomously driving electric car might drive to the next charging station, negotiate a price with the charging station, carry out the charging process, and conduct a payment. The process of negotiating, recharging, and triggering the payment is part of the contract execution system. The payment could be split and transferred directly to all stakeholders as predefined in a smart contract (e.g., 70% to the electricity provider and 10% each to the charging station manufacturer, gas station operator, and car manufacturer).

Digital Payment Infrastructure

The second pillar of the digital payments value chain, the digital payment infrastructure, determines which payment channels are used to process and settle the payments. Within the digital payment infrastructure, we distinguish between the system operator, such as a bank, central bank, or another entity, and the underlying technology, whether DLT or otherwise. The payment infrastructure must be distinguished from the monetary unit, that is, from the unit of account that is ultimately used for the payment. Payments executed in euro are currently supported by existing

[3] We acknowledge the evolving landscape of technological solutions for the deployment of decentralized business logics onto DLT. Business logics can be implemented either directly inside the core DLT layer or as a sandbox smart contract solution. We refer to smart contracts in a broad sense, that is, as computer programs that can implement business logics and automate business processes in a predefined way without reference to any specific technological architecture that may or may not give rise to questions of legal enforceability or risk of undesirable effects of these contracts.

legacy banking systems and traditional bank accounts. In the world of crypto assets, DLT networks such as Bitcoin or Ethereum constitute digital payment infrastructures for payments denominated in non-fiat currencies.

Traditional bank accounts can be used to process payments that have been triggered by DLT-based smart contracts. To this end, they have to rely on a so-called bridge solution, which connects the DLT network (i.e., the DLT-based contract execution system) and the legacy payment system (i.e., bank accounts). Hence, payments are triggered by DLT-based smart contracts, but they are processed via traditional bank accounts. Against this background, the bridge solution is also called a "trigger solution."

In the electric car example, the digital payment infrastructure defines the payment channels used for the settlement of the payment. This infrastructure can be the legacy system, such as SEPA, or DLT-based payment rails. Since bridge solutions are not yet available outside of test environments, payments triggered by a DLT-based contract execution system can be settled only via DLT-based payment channels. However, these channels do not yet allow for transactions denominated in euro. This leads to the third pillar of the digital payments value chain—the monetary unit.

Monetary Unit

The monetary unit refers to the unit of account in which payments are made. It can be denominated in fiat currencies, such as the euro and US dollar, or in non-fiat currencies, such as Bitcoin and Ether. Technically, currencies such as the euro could be processed through multiple different digital payment infrastructures.

3 Euro-Denominated Payment Solutions for DLT-Based Smart Contracts

In this section, we outline how the digital payments value chain could be implemented and linked to DLT-based use cases. First, we consider existing account-based infrastructures and then token-based solutions. All possible solutions are illustrated in Table 2. Use cases are discussed in the Appendix.

3.1 Account-Based Solutions

Euro on Bank Accounts

Definition. The term "bank account" refers to a financial account opened by a customer with a financial institution—usually a bank—that maintains the account on behalf of the customer by recording financial transactions. By depositing money in the account, the customer transfers the money to the bank in exchange for a claim against the bank for the sum deposited. Bank accounts form part of the legacy banking system

Table 2 Four solutions to implement the digital euro

Digital euro	Contract execution system (Pillar 1)	Digital payment infrastructure (Pillar 2)		Monetary unit (Pillar 3)
	Technology	System operator	Technology	
Euro on bank accounts	DLT	Commercial bank	No DLT (account-based)	Euro (commercial bank money)
E-money token (EMT)	DLT	Commercial bank or e-money provider	DLT (token-based)	Euro (e-money)
Synthetic CBDC	DLT	Commercial bank or e-money provider	DLT (token-based)	Euro (tokenized commercial bank money or e-money, but 100% backed by central bank reserves)
CBDC	DLT	ECB	DLT or not DLT (account- or token-based)	Euro (central bank money, legal tender)

Source The authors

governed by well-developed legal and regulatory frameworks. To process payments via the existing banking infrastructure, several systems, processes, and participants are involved, including clearinghouses for settlement and messaging networks for payment instructions.

Application. To process payments triggered by the DLT-based contract execution system, bank accounts need to be connected to a DLT with the help of a bridge solution. Connecting DLT-based contract execution systems with a digital payment infrastructure based on the legacy banking system benefits from the well-established banking infrastructure and legal certainty of existing legal, regulatory, and compliance frameworks. This solution would be the least disruptive as it would be the closest to existing payment solutions. However, the suitability of such a solution for all DLT use cases is less convincing. The DLT-empowered machine economy involves hundreds of millions of machines that would have to be linked to bank accounts and would involve processing a multitude of micropayments across currencies and jurisdictions. This is not feasible via existing banking infrastructures. Furthermore, international payments tend to be slow and costly, particularly in territories outside Europe and without well-established cross-border payment architectures (World Bank, 2018). Despite advancements in modernizing legacy banking infrastructures, there are challenges to providing seamless integration with tokenized assets and rights. Furthermore, when a bridge solution is used, a number of intermediaries would continue to be involved in the payment process. This intermediation causes inefficiencies that can be addressed with token-based solutions.

Regulation. Payments based on existing banking infrastructures are governed by existing legal and regulatory frameworks. Banks and financial institutions are closely regulated, supervised, and bound by regulations designed to mitigate risks. There are policies and regulations in place preventing financial institutions from taking excessive risks and ensuring that adequate protections for customers are in place, such as deposit insurance schemes. Banks have well-developed customer-facing infrastructures with integrated anti-money laundering (AML) and know-your-customer (KYC) compliance procedures and systems adapted to the continuously evolving regulatory landscape.

Technology. Payments triggered by a bridge solution and processed via the legacy banking system are easily scalable within the existing infrastructure. There is no need for costly large-scale investment or disruptive changes to banking operations. Payment processes within the existing banking infrastructures benefit from interoperability within a single country and within the territories with well-developed payment infrastructures (such as in Europe). SWIFT also enables a certain level of worldwide interoperability of payment messaging services. However, the technological disadvantage of this solution is that legacy banking infrastructures do not effectively support micropayments and delivery-versus-payment settlement mechanisms.

The European payment infrastructure has been undergoing major modernization efforts and is well-positioned to cater to the digital economy. A new market infrastructure—TARGET Instant Payment Settlement (TIPS)—was launched by the Eurosystem in November 2018 and is based on a pan-European instant payments scheme called SEPA Instant Credit Transfer. It enables instant round-the-clock pan-European final and irrevocable settlement of payments. TIPS settles euro payments in central bank money and is an extension of the existing TARGET2 system, which is already widely used across Europe. SWIFT has already successfully implemented its messaging service for TIPS and has become one of the network service providers of TIPS.

Time horizon. Connecting a DLT-based contract execution system (or multiple DLT systems) to the existing banking infrastructure could be implemented quickly and efficiently, relying on existing technology. The first bridge solutions entered test mode in 2021 and are expected to enter the market soon.

Costs. DLT-facing interfaces can be implemented relying on the existing IT systems and banking infrastructure, which would remain unaffected. They could also cater to multiple DLT systems and can be implemented in a cost-efficient way.

Dependencies and risks. Using legacy banking infrastructures for payments carries risks. These risks include counterparty risk because commercial banks, financial institutions, and other actors intermediate these payments and process commercial bank money, not central bank money. For cross-border payment transactions, market participants have historically relied on SWIFT's global network for cross-border messaging, which enables financial institutions worldwide to exchange payment instructions in a secure and fully standardized environment. The downside of the SWIFT system is that it does not facilitate the transfer of actual funds and does not

provide clearing and settlement services. Transacting banks must process SWIFT payment instructing messages themselves and settle payments through foreign exchange markets, which delays and increases the costs of cross-border payments. Smaller financial institutions without established business relationships with foreign counterparties may not be able to use the SWIFT network. Furthermore, there are controversies and concerns over the monitoring level and access of third parties (such as governmental agencies) to the SWIFT transactional data. For example, SWIFT has been subject to legally binding requests from government authorities to give access to data and is also subject to various regulations. This sometimes results in disconnecting certain sanctioned countries or companies from the network.

Account-Based CBDC

Definition. A retail CBDC is a novel, digital form of central bank money, which would be made available to the general public.[4] Central bank money constitutes a claim against the central bank and hence is risk-free.[5] There are various design solutions for a CBDC, including direct, indirect, and hybrid CBDC distribution models (Auer & Boehme, 2020). In the case of a direct CBDC model, the central bank distributes CBDC units directly to the end user, while in a hybrid CBDC model, the CBDC is distributed via intermediaries. In this section, we focus on a non-remunerated, hybrid retail CBDC, in other words, a CBDC that provides a direct claim on the central bank is non-interest-bearing and is distributed via intermediaries. We do not analyze a direct account-based CBDC, where the central bank distributes CBDC units directly to the end user, as this design option is not considered in current CBDC projects and prototypes (Auer et al., 2020). In the case of an account-based CBDC, the CBDC holder must be identified in order to authorize a CBDC transaction (see Sect. 2.1).

Application. As the primary use case, an account-based CBDC constitutes a general means of payment (European Central Bank, 2020). Depending on its implementation, a CBDC can also be made available globally and could be used for cross-border payments, which could significantly increase cross-border payment efficiency. As an account-based CBDC would—according to current developments—most likely not be implemented on a DLT, the benefits related to micropayments and tokenization would remain marginal.

Regulation. A CBDC would be compliant with all regulatory requirements. However, legal frameworks would have to be adapted, including, for example, resolving KYC, AML, counter-terrorist financing (CFT) compliance, and data management issues, and making a determination on the legal status of the CBDC.

Technology. An account-based CBDC would most likely be implemented based on a conventional, centralized infrastructure that is not DLT-based. As the ECB would

[4] In this chapter, we do not consider wholesale CBDCs, referring to central bank money only accessible by banks. We solely consider payment solutions available to the general public.

[5] In this context, we abstract from inflation risk as this affects all forms of money.

operate (most of) the payment infrastructure, such a CBDC would be interoperable. However, a centralized implementation would carry IT security risks due to a potential single point of failure (Kiff et al., 2020).

Time horizon. A CBDC would be interoperable and would not expose the holder to counterparty risk. While these features are desirable, it would take time to launch such a CBDC. Before a CBDC can be launched, regulatory adjustments have to be made, and the CBDC infrastructure has to be set up and tested. Furthermore, risks related to financial stability have to be addressed (see next paragraph). We estimate that the launch of a CBDC in the euro area is unlikely to take place before 2026.

Cost and risks. If a CBDC replaces (at least partly) cash and bank money as the means of payment, a large number of payments would be conducted in the CBDC. The substantial use of a CBDC would have the following implications. First, it could cause disintermediation of the banking sector since the end-user would rely less on commercial bank money. As a consequence, refinancing costs for banks could increase, thereby potentially disrupting the financial sector (Bindseil, 2020). Second, bank runs on commercial bank money could become more likely as they are easier to carry out with digital CBDCs as compared to physical cash (Sandner et al., 2020). Both disintermediation and a higher likelihood of bank runs might affect financial stability. The actual impact of a CBDC on the financial sector strongly depends on the design of the CBDC and the policy conducted by the ECB (Gross & Schiller, 2021). In a case where the ECB decides to introduce a cap on CBDC holdings (Panetta, 2018) or a tiered remuneration (Bindseil, 2020), the negative effects on the financial sector might only be marginal. Third, a CBDC might change the existing monetary system's character to a full reserve system, whose implications are currently difficult to assess. Fourth, due to the widespread use of CBDCs, the balance sheet of the ECB would grow substantially, implying financial risks for the central bank and—in the end—for taxpayers.

3.2 Token-Based Solutions

As mentioned previously, we assume that token-based solutions are digital bearer instruments based on DLT. Using DLT for the entire payments value chain provides several benefits. First, the use of DLT would enable real-time settlement with other assets or DLT-based currencies (i.e., delivery-vs-payment). Second, DLT would support the tokenization of all kinds of assets in addition to money. Third, by using DLT, trust would be shifted from institutions, such as commercial banks, central banks, and other financial institutions, to technology as executing a transaction would not necessarily require an intermediary. Counterparty risk is, thereby, significantly reduced or altogether removed. This latter aspect is one of the key points advocating for DLT as it is the key driver for more efficient systems. Fourth, business processes could be operated more seamlessly by removing system breaks, and

automation can be increased. In the following sections, we discuss token-based solutions for the digital euro. For this purpose, we address e-money tokens, sCBDCs, and a token-based CBDC.

E-money Token (EMT)

Definition. Euro-denominated e-money tokens (EMTs) are a token-based form of the digital euro issued by the private sector. EMTs are defined in the European Commission proposal for a Regulation of the European Parliament and of the Council on Markets in Crypto-assets, and amending Directive (EU) 2019/1937. The EMT category will include different existing forms of DLT-based tokens that reference the euro, such as tokenized e-money and euro stablecoins.

Tokenized e-money is a DLT-based form of e-money as defined in Directive 2009/110/EC (e-money directive [EMD]). It is issued at par value to the euro, and the holders are provided with a claim on the issuer as well as the right to redeem the e-money at par at all times. Issuers of tokenized e-money must be authorized and are subject to the full e-money regulatory regime, including capital, safeguarding, and conduct of business requirements. Tokenized e-money is backed by safeguarded funds received from e-money customers, which must be either segregated or insured and guaranteed.

Stablecoins that reference the euro are an alternative, privately issued and token-based form of the digital euro.[6] Since they may currently fall outside of the regulatory regime of the EMD, they may not provide the holders with the right of redemption or a claim against the issuer. Additionally, they may not necessarily be backed by safe and liquid assets but by risky ones, such as crypto assets. Stablecoins can even be completely unbacked. Since stablecoins will fall under the scope of MiCA, they will have to be compliant with these regulatory requirements, as they will otherwise effectively be prohibited in the EU after MiCA becomes applicable.

Application. EMTs can be used for a wide range of use cases. Since they constitute crypto assets, they are transferable on a global scale and can be seamlessly integrated into DLT-based environments to serve as a means of payment, for example, for the machine economy or tokenized assets and rights. However, for an efficient application of privately issued EMTs, it is crucial that issuers agree on a technological standard to ensure interoperability.

Regulation. Under current EU regulations, DLT-based instruments referencing the euro may fall under a number of different regulatory frameworks, including regulations governing banks, e-money issuers, or investment funds. A number of characteristics determine the applicable regulatory regime, including the existence of the claim against the issuer, a guarantee of redeemability, credit provision, or asset

[6] Since this chapter focuses on DLT-based payment solutions for the euro, we exclusively focus on stablecoins referencing a single fiat currency. Hence, we exclude stablecoins that reference a basket of fiat currencies, crypto assets, or a commodity (index), which will fall into different regulatory categories. Furthermore, we do not consider algorithmic stablecoins.

management function. Some of these instruments may even fall outside the existing regulatory frameworks.

MiCA seeks to provide legal certainty and creates a bespoke regulatory regime for all crypto assets that have as their main purpose to serve as a means of exchange and that refer to a single fiat currency. To avoid regulatory arbitrage between e-money and e-money tokens, MiCA proposes that e-money tokens that are indistinguishable from e-money be subject to two regimes—the new MiCA regulation and the EMD. Accordingly, the issuer of such e-money tokens must be authorized as an e-money or credit institution and comply with the relevant governance and redemption rules. All e-money tokens will have to be issued at par value, and the holders will have to be provided with a claim on the issuer and right of redemption at any moment and at par value. E-money tokens that do not fulfill the regulatory requirements set out in MiCA will not be permitted to be offered to the public nor to be admitted to trading on a trading platform for crypto assets in the EU. So-called significant e-money tokens will be subject to stricter rules and requirements. Through MiCA, Europe has the opportunity to be one of the first jurisdictions to provide legal and regulatory certainty for the issuers as well as end users of privately issued and DLT-based forms of fiat currency.

Technology. EMTs can be issued on any appropriate DLT. Since EMTs are crypto assets, they can be subject to scalability issues.

Time horizon. The EMT category has not yet been implemented because MiCA will only be applicable 18 months after the date of entry into force, which is unlikely before the end of 2022. Nevertheless, the predecessors of EMTs—tokenized e-money and stablecoins—already exist today. Since tokenized e-money already complies with some of the requirements specified in MiCA, there should be a smooth transition into the new regulation. Those euro stablecoins that do not fulfill the requirements under MiCA will not be permitted. Consequently, MiCA will most likely affect the operations of some of the existing stablecoin issuers.

Cost and risks. MiCA and the introduction of EMTs provide a regulatory framework aimed at mitigating financial stability risks. In particular, risks related to stablecoins will be mitigated once MiCA has entered into force. So far, stablecoins have depended on the management of a one-to-one peg between the underlying asset(s) and the specific reference currency. The management of the peg requires substantial assets and introduces counterparty and liquidity risk. It might occur that the obligations to manage the peg are not fulfilled, either due to inaction, insufficient resources on the part of the issuer of the stablecoin, or the illiquidity of the underlying assets. Consequently, stablecoins expose their users to the risk that the peg could break. Currently, given the lack of a uniform regulatory framework applicable to stablecoins, stablecoin issuers are not always subject to obligations to redeem the stablecoin, and end users are not always provided with a claim against the assets of the issuer. MiCA aims to mitigate these risks and provide legal certainty and a uniform regulatory framework for all stablecoins and tokenized e-money. However, even when governed

by MiCA, EMTs remain a private form of the digital euro. Consequently, they carry counterparty risk and are not risk-free like a CBDC.

Synthetic CBDC (sCBDC)

Definition. Synthetic CBDCs (sCBDCs) are liabilities issued by private-sector intermediaries and are denominated in the domestic unit of account. They are fully backed by central bank reserves and are redeemable for central bank money at any time (Adrian & Mancini-Griffoli, 2019). sCBDCs are based on a public–private partnership that exploits the comparative advantages of the private and the public sectors. The private sector (i.e., banks or other licensed intermediaries) is responsible for innovating and building intelligent solutions for end users. The responsibilities include technology choice, data management, and regulatory compliance as well as customer onboarding, management, screening, and monitoring (including KYC and AML/CFT). The public sector (i.e., the central bank) focuses on financial stability, regulation and supervision. In other words, the central bank supports innovation within the boundaries of legal and regulatory frameworks.

Application. The use cases of sCBDCs are very similar to those of EMTs. Since sCBDCs are fully backed by central bank reserves, the tokens are fungible. Therefore, different sCBDC tokens issued by different intermediaries are indistinguishable and are always pegged one-to-one to the euro. However, fungibility does not imply that different sCBDC tokens are indistinguishable from a technological perspective. If intermediaries do not agree on a joint technological environment, these tokens would not be interoperable and could not be seamlessly exchanged despite their fungibility.

Regulation. As of today, the regulation of sCBDCs has not been addressed. Issuing sCBDCs through intermediaries, who would be responsible for the entire process—from issuance to distribution to payment system to customer interface—raises regulatory and supervisory issues similar to those of the current banking system. Certain regulatory adjustments will be necessary to deal with appropriate regulatory authorizations, standards, supervision, and liability issues of sCBDCs issuers and other service providers according to their roles and relevant risks. Since sCBDCs are backed by central bank reserves, issuers of sCBDCs require access to the central bank's reserve accounts, which, as of now, requires a banking license. However, so far, even banks have not been allowed to utilize their access to central bank reserves to issue fully backed commercial bank money. It remains to be seen, therefore, whether central banks will allow the issuance of fully backed sCBDC tokens. All participants in a sCBDC ecosystem would need to be subject to the relevant regulatory requirements and standards in order to mitigate risks from their potential operational or financial failure, fraud or cyber risks. Any regulatory framework would need to be innovation-friendly and technology-neutral and would need to ensure resilience, interoperability and minimum standards of consumer protection. Since sCBDCs could effectively be bank-issued stablecoins—albeit backed with central

bank reserves—they might also fall into the EMT category and be subject to the regulatory framework provided by MiCA.[7]

Technology. sCBDCs can be issued on any appropriate DLT. Depending on the underlying DLT framework, sCBDCs might be subject to scalability issues similar to those of EMTs.

Time horizon. sCBDCs could be implemented faster than a direct or hybrid CBDC because the agile and innovative private sector plays a larger role. More precisely, the development of a token standard, customer onboarding, compliance with AML and CFT, etc. will all be conducted by the private sector. Fast implementation could be important in light of serious competition from the public (e.g., Chinese CBDC) and private (e.g., Diem, formerly known as Libra) domains. We expect sCBDCs to be operable in 2023.

Cost and risk. The success of sCBDCs depends on the ability of the private sector to agree on common token standards to ensure interoperability. In recent years, several initiatives have shown that coordination among European financial institutions poses challenges. This standardization process might delay or even prevent the introduction of sCBDCs. Furthermore, in the euro area, only banks have access to central bank money. Hence, if the ECB intends to enable other financial institutions (e.g., e-money providers) to offer sCBDCs, it would need to grant these institutions access to central bank accounts and allow the full backing of tokens with central bank reserves in dedicated escrow accounts.

Token-Based Retail CBDC

Definition. A token-based CBDC also constitutes a digital form of central bank money available to the general public. It represents a new form of central bank money—a central bank liability incorporated in a digital token (Bossu et al., 2020). In contrast to an account-based form of money, to authorize a transaction, the validity of the object transacted, that is, the token itself has to be verified. In the case of a token-based CBDC, the transacted object is the CBDC itself.

Application. Similar to an account-based CBDC, a token-based CBDC would constitute a general means of payment, potentially also available for cross-border payments. A token-based CBDC can potentially be used for industrial use cases related to the machine economy and tokenization. However, most of the existing CBDC projects fail to take into account features of programmability. Even more so, they are mostly consumer-focused and give little or no consideration to the needs and challenges of the machine economy and tokenization. Therefore, private-sector solutions might fill the gap and complement a CBDC to exploit the full benefits of programmable payments.

[7] This is subject to any regulations that may be applicable to sCBDCs that are yet to be determined.

Regulation. As in the case of an account-based CBDC, a token-based CBDC would need to be compliant with all regulatory requirements. Existing regulatory frameworks and legal concepts would have to be adapted to fully integrate a token-based CBDC, including determining its status as a legal tender and examining private law issues.

Technology. It is reasonable to assume that a token-based CBDC will be implemented using DLT. This assumption is in line with current token-based retail CBDC prototypes. Even though a CBDC would most likely be interoperable, DLT-related technical challenges remain, including scalability issues for a high volume of transactions and IT security issues.

Time horizon. A token-based CBDC might be introduced in the medium to long run. Similar to the case of an account-based CBDC, the launch of a token-based CBDC is unlikely to take place before 2026. Note that, ultimately, either an account- or token-based CBDC will be introduced. It seems unlikely that both forms will exist in parallel.

Cost and risks. As in the case of an account-based CBDC, the main risks are related to disintermediation of the financial sector, a higher likelihood of digital bank runs, and a larger balance sheet of the central bank.

4 Roadmap

In this section, we summarize the advantages and disadvantages of the payment solutions introduced in Sect. 3 and present a roadmap for the future of payments in a DLT-based European economy. The presented solutions are not mutually exclusive. Instead, they will most likely co-exist in the future, leveraging their respective strengths. The time to market will differ significantly across different solutions. Figure 2 presents a systematic overview.

4.1 Time to Market for Different Payment Solutions

Panel (a) of Fig. 2 presents the situation in 2020. Payments triggered by smart contracts can be processed via existing DLT-based payment infrastructures. However, currently, the only available means of payment on such infrastructures are crypto assets such as Bitcoin, Ether, and stablecoins.[8] The market capitalization of euro stablecoins is negligible and—currently within the EU—there is neither legal nor regulatory certainty around stablecoins. MiCA will drive this development toward

[8] Some euro-denominated tokenized e-money solutions are already available or at least being developed. However, they usually only work in closed-loop environments without multibank capabilities.

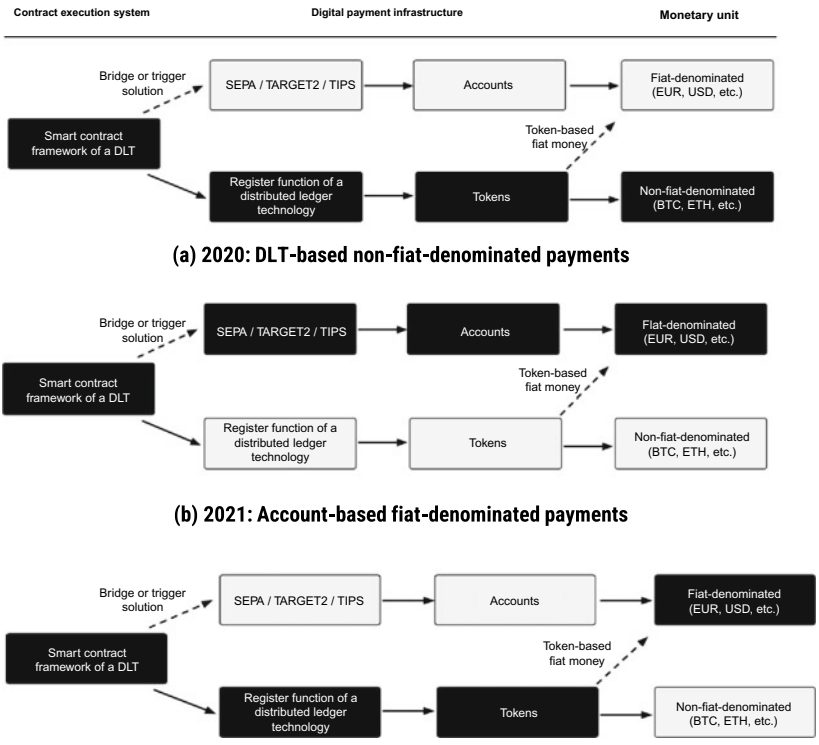

Fig. 2 Digital payments value chain in 2020, 2021, and 2022. *Notes* SEPA: Single Euro Payments Area; TARGET2: Trans-European Automated Real-time Gross Settlement Express Transfer System; TIPS: TARGET Instant Payment Settlement; DLT: Distributed Ledger Technology; BTC: Bitcoin; ETH: Ethereum. *Source* The authors

euro stablecoins becoming an adequate and uniformly regulated means of payment. Crypto assets such as Bitcoin and Ether are unsuitable as payment instruments for most DLT use cases due to their high volatility and low scalability. Consequently, there is a need for regulatory clarity and a stable, euro-denominated, regulatory-compliant payment solution.

Panel (b) of Fig. 2 illustrates how a bridge solution could help to achieve this goal in 2021. As discussed in Sect. 3.1, a wide range of use cases could be addressed by building a bridge between the DLT-based contract execution system and the existing account-based payment system. In particular, recent progress in processing real-time payments within the existing account-based payment system increases the potential number of use cases that can be accommodated using this bridge solution. Additionally, the introduction of an account-based CBDC could bring advantages by eliminating counterparty risk. However, with a bridge solution or an account-based CBDC that is not based on DLT, there remain challenges and limits with regard to

cross-border payments, micropayments, seamless settlement (delivery-vs-payment) and "true" real-time payments that are transacted in less than one second. A major advantage of bridge solutions is that they are based on existing payment infrastructures and hence can be implemented in the short term. First DLT-based payments have been processed in test mode via bridge solutions in 2021 and will enter the market soon.

Panel (c) of Fig. 2 shows the scenario of a payment system that is capable of processing DLT-based euro-denominated payments. We expect such DLT-based fiat-denominated payments to be possible on a broad scale by 2022. To address the previously mentioned shortcomings and to realize further use cases, the euro must be integrated directly onto a DLT. There are three possible solutions: (1) EMTs, (2) sCBDCs, and (3) a token-based retail CBDC. These solutions would reduce—or even remove—the previously mentioned limitations. Therefore, use cases in the area of the machine economy, automated payments, tokenization, and cross-border payments would be operable without the limitations of account-based solutions.

4.2 Fungibility and Interoperability

Any token-based form of the digital euro faces two challenges: The tokens have to be fungible and interoperable. Fungibility means that tokens are indistinguishable from one another and interchangeable regardless of which institution issues them. This problem arises only in multi-issuer settings, that is, for EMTs and sCBDCs. In the case of EMTs, fungibility might not be ensured because even though all EMTs are subject to the same regulations, they might still be subject to the counterparty risk of the bank holding customer funds. In the case of sCBDCs, fungibility is achieved by backing the tokens 100% with central bank reserves. A token-based CBDC does not face the issue of fungibility because the central bank is the sole issuer. Interoperability refers to the ability of the contract execution system to interact with the digital payments infrastructure and the ability of different digital payments infrastructures to interact with one another. To circumvent the limitations of bridge solutions, the smart contract that triggers a payment needs to be based on a DLT that is interoperable with the DLT on which the euro is based. Since it is likely that smart contracts will be based on different DLTs in the future, we either require effective bridge solutions or a euro that is available on different DLTs.

4.3 Time to Market and Use Cases for Private- and Public-Sector Solutions of the Digital Euro

Which of the DLT-based euro-denominated payment solutions—EMTs, sCBDCs, or a CBDC—is best suited to facilitate the execution of and integration with DLT-based

smart contracts? And when will they be operational? Fig. 3 presents a roadmap for the introduction of private- and public-sector solutions for the digital euro. Bridge solutions that connect DLT-based smart contracts with the euro in bank accounts are available in test mode since 2021 and will be brought to the market soon. Many of the existing use cases can be addressed based on this solution. To enable future use cases, such as related to micropayments, we need an "on-chain" euro.

The first version of such a euro could be issued in 2022 in the form of an EMT. One year later, we expect sCBDCs to enter the market. Both are private, multi-issuer versions of the digital euro, which will be subject to regulation that is currently being developed. While EMTs and sCBDCs face challenges related to fungibility and interoperability, they bring about one important advantage—enabling private institutions to issue a digital euro, in the form of an EMT or sCBDC, would allow to harness the opportunities and leverage the innovative capabilities of the private sector. Private-sector institutions are better equipped to develop payment solutions for a DLT-based economy. Leaving the issuance of tokens to the private sector facilitates a public–private partnership that exploits the comparative advantages of both sectors. The private sector (i.e., banks or other licensed intermediaries) is responsible for innovating and building intelligent solutions for end users. This includes technology choice, data management and regulatory compliance as well as customer onboarding, management, screening, and monitoring (including KYC and AML/CFT). The public sector (i.e., the central bank) focuses on regulation, supervision and financial stability.

A CBDC issued by the ECB is a single-issuer, public version of the digital euro. We do not expect a euro CBDC to be rolled out to the public before 2026. However, first tests with restricted user bases—similar to the CBDC project in China—could start as early as 2022. While a CBDC has advantages with regard to fungibility and interoperability, it might not be well suited to facilitate the execution of DLT-based smart contracts. First, introducing a CBDC takes considerable time. The demand for payment solutions for the DLT economy is increasing, and the first solutions will be needed soon. Second, the central bank does not have the necessary expertise and is not sufficiently agile to develop a token-based digital euro that caters to the fast-changing needs of the real economy. Third, and most importantly, the central

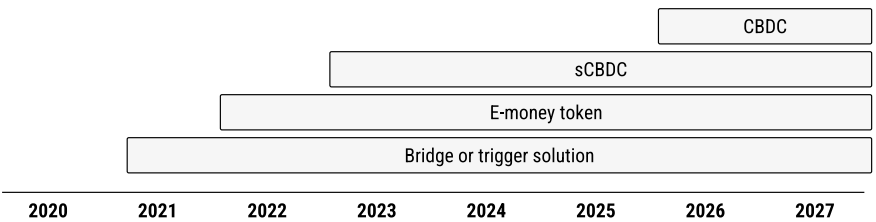

Fig. 3 Roadmap for future digital payment solutions. *Notes* (1) Fig. 3 presents a roadmap for the introduction of different payment solutions for the digital euro. Different versions of the digital euro will be introduced incrementally and will co-exist in the future. Private-sector solutions such as EMTs or sCBDCs are expected to be launched before a CBDC. (2) CBDC: Central Bank Digital Currency; sCBDC: Synthetic Central Bank Digital Currency. *Source* The authors

bank has concerns over disintermediating the banking sector because banks play an important role as intermediaries and credit providers in the economy. Therefore, the use of a CBDC will most likely be restricted (European Central Bank, 2020). Instead, a more appropriate use case of a CBDC might be to serve as digital cash. In other words, a CBDC could aim at replicating the characteristics of cash in the digital realm. This mainly includes being a risk-free and resilient means of payment that works independently of the private sector. Moreover, a CBDC should provide at least some form of anonymity that enables end users to conduct private transactions in a digital form if the use of physical cash significantly declines.

4.4 Interoperability and Efficiency

Finally, to conclude the analysis of the advantages and disadvantages of the payment solutions for the digital euro presented in this chapter, it has to be noted that each payment solution benefits from varying degrees of interoperability, efficiency, and integration. Figure 4 displays the four solutions presented in this chapter according to the two parameters of interoperability and efficiency. In perfectly interoperable systems, money does not need to pass a gateway to bridge between different payment networks, and an exchange from one type of euro to another type of euro (e.g., issued by another bank) is not required. In the short term, the bridge solution is best suited to achieve interoperability. The second dimension in Fig. 4 is efficiency. Once the euro becomes digital and can be traded with tokens representing other assets on the same

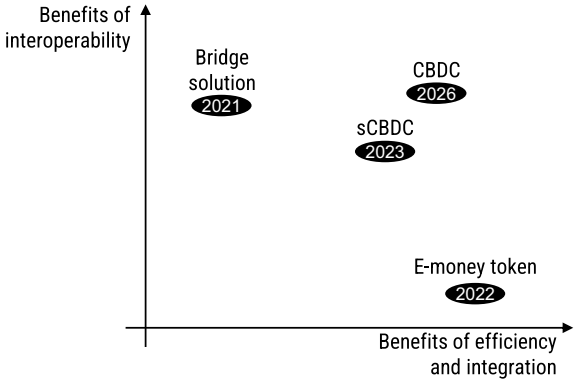

Fig. 4 Mapping payment solutions across interoperability and efficiency. *Notes* (1) Fig. 4 displays the payment solutions we present in this chapter in a two-dimensional graph. The first dimension reflects the benefits of interoperability. The second dimension reflects the benefits of efficiency and integration. The bridge solution yields high benefits of interoperability and low benefits from efficiency and integration. E-money tokens have the opposite profile. sCBDCs and a CBDC outperform other solutions with regard to the benefits but can only be expected to launch at a later stage. (2) CBDC, Central Bank Digital Currency; sCBDC, Synthetic Central Bank Digital Currency. *Source* The authors

DLT network, high-efficiency gains can be expected. For example, efficiency gains will be derived from the use of e-money tokens in the settlement of securities. The settlement of such trades would be more efficient as they would be executed entirely by computer algorithms, and no financial intermediary (i.e., a clearinghouse) would be required. Therefore, in the short term, e-money tokens are a promising means of payment for a DLT-based economy.

5 Conclusion

The aim of this paper was to respond to industry needs and the debate on the future of payments in a DLT-based European economy. We analyzed the most suitable euro-based payment systems to facilitate the execution of or integration with DLT-based smart contracts and estimated when these payment systems might become operational.

This chapter provides an analytical framework for the analysis of the payment infrastructure by dividing the digital payment value chain into three pillars; the contract execution system, the digital payment infrastructure and the monetary unit. We argue that the differentiation between these three pillars is essential since these core concepts, even though heavily interlinked, represent distinct parts of the digital payments value chain. For example, smart contracts will be implemented by industrial corporations and financial organizations, but they might not necessarily require that the euro is on a DLT-system at the same time. A short-term solution could be that the payments triggered by smart contracts (contract execution system) are settled in euro (monetary unit) through the current banking system (digital payment infrastructure). Payments in other domains such as international payments, the machine economy, or tokenization will require a different approach, where smart contracts trigger payments in euro (as a monetary unit) "on-chain." While in both examples smart contracts are essential and demanded by market participants, the digital payment infrastructures may vary according to the needs. Examples of other potential use cases are presented in the Appendix. For some use cases, the current banking system suffices as the digital payment infrastructure, and, for other use cases, a euro "on-chain" will be required. These examples illustrate that the benefit of the proposed differentiation between the three core concepts of the contract execution system, the digital payment infrastructure and the monetary unit is to provide a structured analytical framework for the debate about the future of payments in a DLT-based European economy. Furthermore, this three-pillar analytical framework is also universally applicable to discussions on digital payments beyond the European focus.

Guided by our analytical framework based on the three pillars of the digital payments value chain, this chapter identifies and analyzes four digital euro solutions for euro payments in a DLT-based European economy. The only solution utilizing existing banking infrastructure is a bridge solution connecting a DLT-based contract execution system with the legacy banking infrastructure. The remaining solutions that we identify—EMTs, sCBDCs, and CBDCs—involve integrating the euro within the

DLT-based infrastructure. There is a clearly identified need for an effective, interoperable, and regulatory-compliant euro-denominated payment solution compatible with DLT-based infrastructures. Finally, we lay out a roadmap for the future of payments in a DLT-based European economy.

Given current circumstances, we conclude that no individual payment solution will be sufficient to address all emerging use cases. Instead, a broad array of payment solutions will emerge and co-exist. It would be desirable to have the public sector, that is to say the ECB, launching a one-size-fits-all solution as soon as possible. This optimal solution would be a token-based CBDC. However, given the current discussions, it is unlikely that a euro CBDC will be implemented in the short term and that it will address all the challenges and needs of the market participants. Therefore, for the time being, a growing array of business models and use cases involving the digital euro will require a variety of diverse payment systems and solutions. There will be an increasingly complex world with the euro running on multiple infrastructures, including DLT systems, serving specific classes of use cases. We expect a broad range of payment solutions for multiple purposes to be launched at different points in time. Private-sector providers are currently exploring and developing such solutions.

However, the proliferation of private-sector solutions may also lead to a fragmentation of digital payment infrastructures in Europe and could raise issues of interoperability. While a variety of payment system solutions may address specific industry demands and cater to the emerging business models, lack of payment integration, and a uniform solution such as a euro CBDC may hinder the competitiveness of the euro and undermine the digital sovereignty of Europe. Given the strong network effects of payments, the race is on for a dominant payment solution capable of catering to the needs of a DLT-based European economy. The ECB may need to take a broader look at its mandate to meet the challenges of a DLT-based European economy and provide an alternative to potential foreign payment providers. European policymakers should also focus on providing adequate frameworks that support innovation in payment systems, mitigate risks and harness the opportunities in order to bring the DLT-based European economy of the future to the forefront in digital payments competitiveness and enhance Europe's progress toward strategic autonomy.

Acknowledgements This chapter has also been published as a whitepaper for *Blockchain for Europe*. We are very grateful for the helpful comments by Ulrich Bindseil, Claire Conby, Jacek Figula, Susan Friedman, Geoffrey Goodell, Cédric Humbert, Wojciech Janicki, Peter Kerstens, Robert Kopitsch, Maria Minaricova, Holger Neuhaus, David Putts, Lukas Repa, Ingo Rübe, Lee Schneider, Manmeet Singh, Bruno Skvorc, Ignacio Terol, Karsten Treiber, and Nick Wittek.

Appendix: Use Cases for the Digital Euro

Internet of Things. Thanks to the Internet of Things (IoT), physical assets are turning into participants in real-time global digital markets. Gartner estimates that by 2020

there will be 20 billion connected IoT devices (Hung, 2017). Autonomous agents representing such IoT devices, machines, people, and organizations can interact with each other, communicate, negotiate, and transact in real-time. Blockchain and smart contracts enable these autonomous agents to become economic actors as they can be provided with an identity, a ledger to record their agreements, and a means of payment (Minarsch et al., 2020).

For example, turning traffic signs, charging stations, and electric vehicles into autonomous agents opens up new economic opportunities. Possibilities include an agent representing an electric vehicle that will be able to find and book a parking space and negotiate prices. The availability of real-time information, and the intelligence to analyze it, will make transportation systems more resilient and more efficient. Rerouting vehicles automatically around accidents, weather, congestion, and other delays have the potential to free up productive time for drivers and passengers (Hosseini et al., 2019).

As another example, energy management systems will benefit from the possibility of using reliable real-time information exchanged by software agents as well. Evidence exists that autonomous energy management systems for a smart home equipped with sensors can make use of the various energy consumption and production data to train agents using deep reinforcement learning (Ye et al., 2020). As a result, the agent gradually acquires the most promising energy management strategies by learning from repeated interactions through the process of trial and error. Once trained, the agent can react within milliseconds to autonomously respond to changes in the home environment in order to fulfill the homeowner's energy needs at the lowest possible price.

Transactions recorded on a distributed ledger will provide a permanent, immutable record of all activities. When coupled with machine learning and digital identities, this information can also be used to deliver additional layers of incentives for all participants in the network, including service providers and customers, and to build a reputation based on an immutable and reliable record of positive conduct and good performance. Ratings tied to the proof of delivered services can also be stored on a distributed ledger to build a comprehensive trust record that all network participants will be able to access on an open and permissionless basis. Connecting the ecosystem and enabling agents to securely transact with each other will enable a marketplace in which all stakeholders, ranging from vehicle owners to repair services to insurers to regulators and public safety agencies, can safely and securely exchange and analyze information in real-time. New business models will provide "insights as a service" that will let users unlock the wealth trapped in their transportation assets and data.

Automation. In the financial services industry, most of the automation initiatives that aim to increase process and cost efficiencies have typically targeted the conditional nature of financial products and contracts. This conditional nature refers to the construct of financial contracts in which subsequent decisions or steps (dependent conditions) in the inherent processes are predicated on the outcomes of the previous steps (precedent conditions). For instance, the payout of monthly interest in a bank savings account often depends upon both the amount of monthly balance maintained

as well as the associated interest rate for that specific monthly balance. A higher monthly balance would typically attract a higher interest rate payout. Such conditional situations are omnipresent in financial contracts across banking, insurance, equity, debt and derivative contracts.

Using software code to automate such conditional dependencies and execute these transactions is not difficult. However, establishing the precedent condition between parties is a key inhibitor to successful and error-proof automation. For instance, a typical securitization transaction could include the following precedent condition—if the default rate crosses 10%, which can be followed by the following dependent condition—a 5% additional collateral needs to be deposited. In such a situation, the additional collateral can be secured with a digital euro. A DLT-based system can ensure that both the underlying conditions precedent and dependent conditions are not only accurately and transparently recorded but that the resulting action is automated through the use of smart contracts. As a consequence, DLT-based payments can also be triggered directly by the smart contract. DLT ensures that all parties have one single version of truth with no need for reconciliation or negotiations. With an immutable audit trail, for each transaction, the condition under which auto-execution happens is recorded, providing for easy audit and dispute resolution.

The logic of these use cases can also be extended beyond transactions. For instance, a key element of a central bank's role in managing monetary policy is to ensure that banks comply with cash reserve ratio (CRR) or statutory liquidity ratio (SLR) requirements, which can be automated using DLT-based means of payments. This feature can be even further used to automate many of a central bank's monitoring functions with dependent conditions providing not only triggers and flags but also the execution of subsequent actions.

Tokenization. The progressive tokenization of both digital and real-world assets works hand-in-hand with DLT-based means of payment. Notable examples include non-fungible digital art and collectibles (non-fungible tokens, NFTs) and cooperatives. By creating an NFT, an artist can register its copyright on-chain, protecting and proving provenance. Such artwork can also be tokenized into pieces, allowing individuals to own fractions of that artwork. For example, any person can probably and irrevocably own one-tenth of Picasso's Old Guitarist. Taking the concept further, such ownership could have built-in programmable allocative efficiency—leveraging the principles of the Harberger tax—but could also be entitled to one-tenth of all future profits generated by this artwork—whether it be reproductions, gallery showings or royalties. The sale profits would be automatically deposited in the fragment owner's wallet in digital euros, and the owner would be responsible for paying the tax in regularly required installments or risk losing ownership and resetting the tax rate. As per Harberger tax rules, someone else could at any point in time pay more than the person paid for the piece and thus own it henceforth, claiming the rights to future profits.

Digital blockchain-based cooperatives are already in full swing in several projects across Europe. These projects will tokenize any real-world asset and allow partial ownership of these assets. Such a cooperative can be a neighborhood that decides to

collectively invest in a source of renewable energy. It can also be a set of completely unrelated investors investing in the fractional ownership of a building and earning parts of the building's rent proportional to the tokenized ownership they possess. In either case, transactions can be automatically executed to and from the investors, all of whom are dealing with a digital version of the euro. For example, as the euros for the building's rent drip into the building project's smart-contract-based address, the money is automatically distributed to all token holders proportionally minus maintenance fees. All token holders get automatic regular drips of income on their investment, and all renters have detailed insight into where their digital euros are being deposited and spent.

In theory, any real-world asset can be tokenized. This includes money, securities, bonds, shares, options, real estate, luxury goods (e.g., cars), works of art and private documents as well as information. Each such value can be represented as a token—a digital asset.

Cross-border payments. Token-based forms of money have the potential to transform cross-border payments. While current initiatives are focused primarily on domestic applications, numerous authorities have observed that initiatives around a digital euro have the potential to make cross-border payments more efficient and less expensive.

Several problems persist in the current cross-border payment model under which correspondent banks hold third-party bank deposits and provide those third parties with payment services. First, the number of correspondent banks has globally declined in recent years, leading to less competition and higher prices for customers. Second, correspondent banking is enabled through the pre-funding of correspondent bank accounts. This results in high compliance costs and lost opportunity costs. Additionally, this process limits the reach of efficient payment solutions to high-volume currency pairs and contributes to the high fees being charged to individuals seeking to send cross-border payments. Indeed, on average globally, currency conversions and transaction fees equal approximately 7% of the total funds sent (World Bank, 2018). Finally, the system itself is opaque and slow. Cross-border payments often take days to complete and are frequently fraught with execution risk, offering little communication or visibility to either the sender or recipient of funds.

Financial technology companies are in the process of exploring whether token-based payment solutions could reduce these limitations by enabling payments without the need to rely on the SWIFT network or correspondent banks. These offerings seek to improve existing payment infrastructures and link domestic payment systems to enable cross-border payments, including through reliance on DLT. Furthermore, interoperability is being explored. If the payment platforms being built (whether by the central banks themselves or through reliance on third parties in the private sector) are open and extensible, they may be able to deliver increased utility to users. The alignment of protocols across token-based payments (including a digital euro), private stakeholders, and cross-border payment networks could result in real-time instant settlement that is always available.

The practical impacts of these changes are potentially enormous. For example, a token-based payment solution coupled with an improved payment system could enable individuals to send remittances to their home countries cheaply and efficiently, where the funds can then be used to cover such living essentials as food, medical expenses and housing. Remittances can serve as a lifeline for the households to which they are sent (often rural and poor) as well as the larger communities in which those households live, which similarly benefit from the funds received. The successful deployment of a token-based payment solution could help ensure that more money is received by the individuals who depend on it the most.

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Digitalization of Payment Instruments: Cashless Payments and Loyalty Points Systems

Yuri Okina

1 Introduction

Cash is still the most preferred means of payment in Japan. In fact, the ratio of cashless payments was relatively low until recent years. On the other hand, Japanese people have a strong affinity for loyalty points. The loyalty point system is a mechanism that allows users to receive a discount when they shop at the same store in the future. Platform companies like Softbank (Yahoo!) are actively using these systems to quickly acquire customers who use cashless means such as PayPay by increasing the point reward rate when shopping at their member stores. This is one reason that the ratio of cashless consumer spending has been rising in recent years. Loyalty points are also used to make payments as if they were the corporate currencies among the platform companies' member stores and customers.

This chapter aims to calculate the cashless ratio of Japanese consumption expenditure using the questionnaire survey introduced in Sect. 2, and analyze the characteristics of cashless payments in Japan by annual household income, region and age, and other characteristics. Next, Sect. 3 examines the characteristics of loyalty points and their similarity to money. Finally, we describe the future outlook for cashless payments in Japan.

This chapter revises, updates, and integrates two former articles published by the author in Japanese: Okina (2019a, b).

Y. Okina (✉)
The Japan Research Institute Ltd., Tokyo, Japan
e-mail: okina.yuri@jri.co.jp

M. Heckel and F. Waldenberger (eds.), *The Future of Financial Systems in the Digital Age*, Perspectives in Law, Business and Innovation,
https://doi.org/10.1007/978-981-16-7830-1_7

2 Cashless Payments in Japan: Current Situation and Prospects

2.1 Why is Japan Encouraging Cashless Payments?

The Japanese government is promoting cashless payments as a growth strategy. There are three reasons for this. First, cashless transactions make life more convenient for consumers and stimulate consumption. For example, public transportation is much easier to use with prepaid transportation cards; tourists spend more when they have payment options other than cash. Second, cashless transactions lead to improved productivity in small and medium enterprises. For understaffed small and mid-sized restaurants and stores, closing the cash register is a labor- and time-intensive task. Cashless payments can ease some of that burden. Finally, cashless payments yield data about the purchase history of individuals that is increasingly leveraged by a range of promising services. Overseas e-commerce platforms like Amazon and Alibaba actively collect "big data" about the online purchases and behavior of individual customers. They then analyze that data and use it to provide shoppers with customized and convenient services.

2.2 Government Indicators and the Current State of the Cashless Economy

In its *Investments for the Future Strategy* document, the Japanese government outlined plans to double the percentage of cashless payments from the current 20–40% by 2025 (Prime Minister's Office of Japan, 2017). This 20% includes only credit cards, debit cards, and e-money, and is calculated using total household spending as the denominator. The government prefers this calculation method because it results in a number that can be used for international comparisons. Based on this number alone, however, Japan ranks second to last among advanced countries in the use of cashless payment methods, ahead of only Germany (Ministry of Economy, Trade and Industry [METI], 2018).

The Ministry of Economy, Trade and Industry has always highlighted four issues with the 20% estimate (METI, 2018). The first issue is that the denominator includes imputed rent of homes. Second, the 20% figure does not include transfers of money between bank accounts. Third, it also does not include services that use smartphone apps to facilitate transactions. Fourth, the figure includes the use of corporate credit cards.

To make a more accurate assessment of the current state of the cashless economy in Japan, we conducted a questionnaire survey of 3000 individuals in August 2018. The research was commissioned by the Nippon Institute for Research Advancement (NIRA). We collected responses until we achieved ratios of participants that matched

Table 1 Percentage of cashless payments by payment method

Percentage of cashless payments	51.8
Credit cards	31.4
Direct debit	10.5
Prepaid e-money	5.0
Online banking	1.4
Cash card transfers	0.9
Debit cards	0.8
Smartphone apps	0.7
Others	1.1

Source NIRA (2018)

those in the Basic Residents Register in terms of gender, age, place of residence, and similar indicators. We divided the items in the National Survey of Family Income and Expenditure into 38 categories of goods and services, then asked our survey participants to report on their consumption of these goods and services and how they paid for them. Participants also reported characteristics such as employment status and household income. This survey found that about 50% of purchases made for private consumption were paid for using cashless methods (Table 1). The findings validate the four concerns mentioned above. These results cannot be compared to figures from other countries, so they do not provide definitive proof. However, in combination with the fact that Japan was a forerunner in the development of inter-bank remittance services for payment of tuition fees, electricity bills, and similar remittances, our results suggest that Japan may not be lagging behind other countries for cashless payments. In recent years, this number seems to have increased a little due to the spread of Smartphone payments, which are actively utilizing loyalty point redemption measures described hereafter.

2.3 Why Are Cashless Payments Slow to Gain Traction?

The survey revealed some other interesting trends. First, a closer look at the use of cashless payment methods by annual household income reveals that individuals with more disposable income make a higher percentage of payments using cashless methods (Fig. 1). A regression analysis of the results also reveals that individuals who are in regular employment and have a high educational background pay with credit cards more often. This suggests that the increase in cashless transactions in Japan is driven by individuals who enjoy a stable socio-economic position that allows for easy use of credit cards.

An analysis of the percentage of cashless payments by region revealed that residents of urban areas, such as the Tokyo metropolitan area, frequently pay cashless. The percentage of cashless payments is lower among residents of the Hokuriku

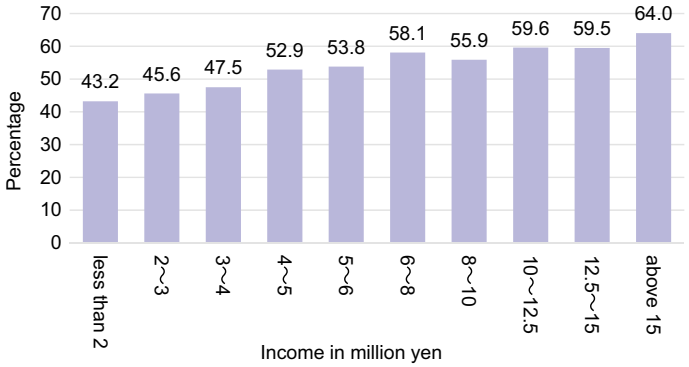

Fig. 1 Percentage of cashless payments by annual household income. *Source* NIRA (2018)

region, the island of Shikoku, and the Kinki region (except the Osaka, Kyoto, and Kobe metropolitan area). The results show that cashless payments in 2018 had become more prevalent in the Hokuriku region compared to those in 2015 (Fig. 2). This is most likely because of tourism-boosting measures such as the introduction of e-money and prepaid transportation cards. Such initiatives may have closed regional gaps in the use of cashless payment methods.

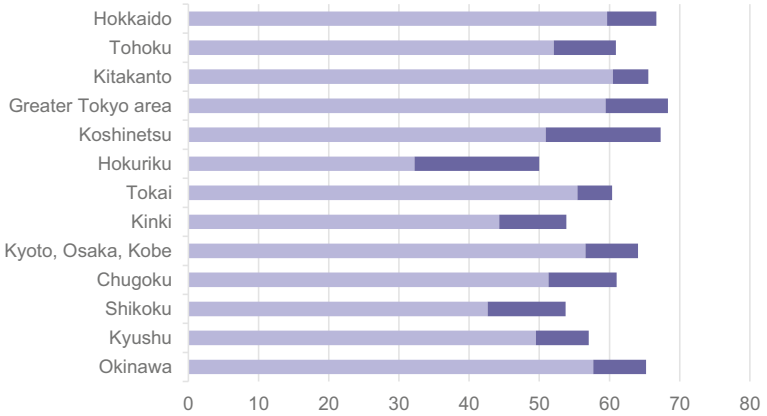

Fig. 2 Percentage of cashless payments by region in 2015 and 2018. *Note* The light and dark bars show the percentage of cashless payments in 2015 and in 2018, respectively. Visible parts of the dark bars show the percentage growth of cashless payments. *Source* NIRA (2018)

2.4 Japan Remains a Cash-Oriented Society

Table 2 shows which goods and services are often paid for in cash in Japan. Cash is still frequently used to facilitate exchanges of money between individuals, for example, for ceremonial occasions, remittances, pocket money and gifts to family members. Individuals also turn to cash to pay for public services, including postal services, nursing care and medical care.

Another notable result is that approximately 36% of individuals actively prefer to pay for daily goods and services in cash. This indicates that consumers still have a strong preference for cash, particularly those in lower income segments. When asked why they favor cash, many consumers reported security concerns related to credit cards. Many also voiced fears that credit cards would lead them to spend more than their income allows (Table 3). Resolving these concerns may increase the number of consumers comfortable with cashless payments.

Table 2 Consumption items frequently paid for in cash

Consumption item		Percentage
1	Alms, expenses for ceremonial occasions	93.1
2	Postal and shipping costs	91.7
3	Remittances, pocket money, gifts to family	85.9
4	Hairdressing, perms, haircuts	78.8
5	Taxi fares	73.4
6	Medical and nursing care	71.5
7	Other services (housework, etc.)	66.1

Source NIRA (2018)

Table 3 Reasons for preferring cash to make payments (in %)

Reason	Percentage
I don't feel like I'm spending anything if I can't touch the money, so cashless payment methods make me overspend	57.2
I worry how secure cashless payments are	34.7
I don't need to make any cashless payments	27.8
I worry about loss or theft when the money is not in cash	13.9
Cashless options are difficult to use because I need to manage my balance and my passwords	13.2
Cashless payment procedures are cumbersome	8.7
I'm not often in situations where I can use payment methods other than cash	5.8
I want to use cashless payments but don't know how	2.2
I don't have a smartphone, computer, etc	0.8

Source NIRA (2018)

2.5 We Need to Understand How Consumers Use Cashless Payments

This analysis of the current state of the cashless economy and consumer sentiment toward cashless payments reveals that acceptance of cashless payment methods depends on income level, region of residence and type of employment. To further popularize cashless payments throughout Japan, the government needs to ensure that individuals experience cashless payment systems as both secure and convenient. This requires forming a clear picture of consumers' current use of cashless payment methods, including via banks and Fintech services. It also requires nurturing private businesses that can respond to consumer needs and alleviate consumer anxieties. Finally, the government must monitor the evolving situation on the ground at fixed intervals in order to realize the development of cashless services that meet users' needs, and enable as many people as possible to enjoy the benefits of cashless payments regardless of income or region.

2.6 Areas of Competition and Cooperation for Private Companies

The survey results presented above show that consumers largely eschew cashless payments when making personal remittances or paying for public services such as postal, municipal, medical and nursing services. On the other hand, a plethora of payment services have sprung up in Japan. From a user perspective, the lack of interoperability between these services is a serious issue.

In 2012, major banks in Sweden developed and released a small mobile service for interbank money transfers called Swish. Swish played a significant role in promoting the use of cashless payments in Sweden. Users of Swish can send small remittances, for free and instantaneously, simply by entering the receiving party's cellphone number. Today, Swish has evolved into a highly interoperable network for small remittances that is used by some 70% of Swedes. The banking community is adding value to the service by enabling use of Swish in e-commerce payment services. The key to widespread adoption of Swish was BankID, which was developed in Sweden in 2011. BankID is a mobile banking ID that can be linked to a phone number, allowing easy identification of individuals. In Singapore, the United Kingdom, Australia and other countries, banks also offer mobile transfer systems for small remittances. These developments indicate that while encouraging competition between private businesses leads to more user-friendly services, businesses also need to cooperate to build infrastructure for authenticating users and sending payments. Japan is in urgent need of a mobile system for transferring small remittances, which is highly convenient, low-cost, safe and secure. Such a network will become a cornerstone of the infrastructure Japan needs to promote the use of digital currencies.

2.7 Can a Loyalty Points System Boost the Spread of Cashless Payments?

To reduce the impact of the October 2019 increase in consumption tax, the Japanese government introduced a reward or loyalty points program for nine months.[1] To promote the use of cashless payments in small- and medium-sized enterprises, the government shoulders the cost of a system, which allows consumers to earn reward points for cashless payments that can then be redeemed in the form of discount tokens usable upon a later purchase at the store. The system can lead to substantial discounts that somewhat alleviate the cost increases that consumers face after the tax hike. It simultaneously encourages shoppers to pay cashless.

Japanese e-commerce platforms such as Rakuten and the SoftBank (Yahoo!) Group have begun creating digital point systems that let consumers pay in points for a range of day-to-day products and services (Okina, 2019b). These systems have popularized the concept of paying with points, which function as a kind of corporate currency. Indeed, points are increasingly functioning as regular currencies. Many points can be exchanged for different points or converted into cash. Recent years have even seen the development of systems that enable the use of points for investment purposes.

The Japanese Financial Services Agency encourages these initiatives in its policy agenda (Financial Services Agency, 2019). Naturally, points still lack much functionality that would be expected of a currency. Many are only valid for a limited time, for example, or can only be used as a means of exchange in particular stores. Still, consumers are increasingly embracing points systems as a part of the economy. The promotion of points systems is part of the range of policy measures used by the Japanese government to encourage cashless payments, that these points are being used as a form of virtual currency, and that the concept of a currency is becoming increasingly diversified. The following sections will take a closer look at the prevalence and nature of loyalty systems in Japan and their relation to cashless payments.

3 Prevalence and Nature of Digital Points Systems

3.1 Are Loyalty Points Japan's Corporate Pseudo-currency?

How close have retail loyalty points come to being a form of currency? Retail outlets in Japan, such as cake stores, give out loyalty points in the form of paper stamps. Once customers have collected enough points, they present them to the store to receive a discount on their next cake purchase. This does not imply however, that the paper

[1] See https://cashless.go.jp/. In the text that follows, the terms reward points system and loyalty points system are used interchangeably.

stamps themselves constitute a means of payment. When platform provider-style companies issue loyalty points, however, they seem to be creating credit in their own private currency. These points, which can be used at member stores, have begun to gain general acceptance; together with a customer's purchase history, they are stored as digital data on point cards, electronic money, credit cards and other media. Customers appreciate the points they receive as much as they would a cash rebate. The points are eventually converted to yen and treated as a discount on the price of a subsequent purchase.

Digital reward points function as a means of digital payment for a range of goods and services at member stores. New participants in the electronic money arena have recently begun competing to grant more loyalty points to consumers, and this approach is expected to become more widespread in the future, with loyalty points expected to gain an increasing presence as a means of electronic payment. Nonetheless, loyalty points have many characteristics that distinguish them from cash (banknotes), or legal currency. They perform a function similar to that of money, but do not seem to be in competition with legal currency. Here, I would like to deepen the discussion on the features of Japan's characteristic systems of loyalty points as currencies, and examine several issues that should be considered in the future.

3.2 The Scale of Loyalty Points Systems

The value of reward points issued is estimated by the Nomura Research Institute (NRI) to amount to one trillion yen annually (NRI, 2016). According to the same study, excluding points issued by individual companies, such as electronics retail stores, airlines, and gas stations, the value of points issued by platform provider-style companies is around 700 billion yen.

Loyalty points have gained significant acceptance as a pseudo-currency. In a questionnaire survey by NIRA, 95% of respondents used loyalty points, and 50% used them frequently (NIRA, 2018). Assuming, therefore, that 70% of the points are used, it seems that the equivalent of around 500 billion yen in points are used as a means of payment for goods and services in a variety of stores annually. The balance of points outstanding depends on expiry dates. Consequently, the total value of outstanding points is not certain, but it is unlikely to be significantly greater than the amount issued in one year. Table 4 shows the scale of point usage, assumed to be 500 billion yen, compared to other payment methods.

Assuming the value of loyalty points used as a generally accepted payment method is around 500 billion yen per annum, then it is certainly quite small compared to the value of bank deposits or payments using bank deposits, yet somewhat significant compared to the overall value of electronic money (297.5 billion yen). In reality, however, the scale of annual loyalty point usage is quite small when compared with the amount of payments for retail transactions, and is equivalent to only one tenth of annual payments using electronic money, or one third of payments using debit cards.

Table 4 The scale of payment methods

Average balance of money stock and balance of electronic money (as of May 2019)
• Deposit currency (M1 based checkable deposits): 699 trillion yen
• Cash currency in circulation: 102 trillion yen
• Electronic money: 298 billion yen
Payments associated with deposits (as of May 2019)
• Average business day payments over one year for the Zengin System (interbank payments system):*1 13,009.2 billion yen (1.87 million yen per transaction)
• Average business day payments for the Core Time System (interbank payments system):*2
• 3789.7 billion yen (0.59 million yen per transaction)
• Average business day payments for the average week-day payments for the Core Time System (interbank payments system)*3
• 79.8 billion yen (0.16 million yen per transaction)
Payments through methods other than deposits (fiscal year 2018)
• Electronic money payments (annual): 5479.0 billion yen (936 yen per transaction)
• Debit card payments (annual): 1413.1 billion yen (5368 yen per transaction)
• Credit card payments (2018): 56,711.5 billion yen

Notes (1) Of which 9,379.5 billion yen are large-scale internal currency transactions. (2) System for small-scale currency transactions, operating from 8:30 a.m. to 3:30 p.m. on weekdays. (3) System for small-scale currency transactions, operating when the Core Time System is closed, such as at night, in the early morning and on weekends

Sources Bank of Japan Payment and Settlement Statistics, and Japan Consumer Credit Association Statistics

The relatively low transaction figure may reflect the fact that loyalty points do not circulate like other forms of payment do.

3.3 The Incomplete Function of Loyalty Points as Currency

Loyalty points are used as a means of payment when purchasing goods or services, and are often exchanged for other points. It is clear that points issued by platform provider-style companies in particular are gaining general acceptance, and some have begun to take on a currency-like aspect. Their main features in this respect are listed below:

- issued by companies rather than a central bank, representing a liability for the issuing company,
- electronic (digital) in many cases,
- token-based rather than deposit-style (account-based) in many cases,
- consumers can use the points within an extensive "economic zone" defined by the issuing company's network of member stores.

In categorizing various kinds of money, economists at the Bank for International Settlements (BIS) recently introduced the concept of the "Money Flower" (Carstens, 2018). The "money flower" is a taxonomy, which classifies various kinds of money

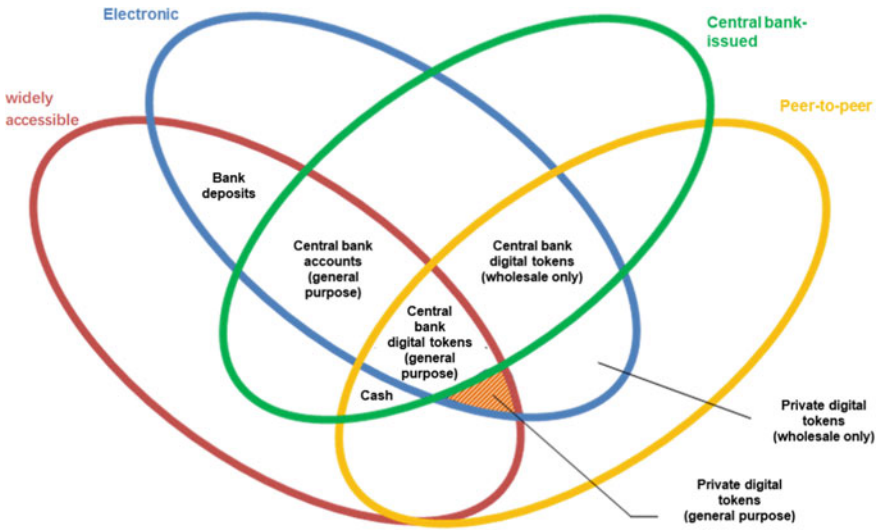

Fig. 3 Positioning of loyalty points on the Money Flower. *Source* Carstens (2018), revised by the author

using four supply-side criteria: issuer central bank or not, electronic (digital) or not, widely used or not; and token-type (peer to peer) or account-type. According to this classification, loyalty points are supplied by companies, are mostly electronic, are widely used and represent a token-type money (Fig. 3).

From the perspective of consumers, however, loyalty points exhibit characteristics that distinguish them from other forms of money and electronic means of payment.

- The value per unit and the terms of exchange vary widely: one point cannot usually be exchanged for one yen, points are worth more for purchases at the issuing company, or terms of exchange differ depending on where they are exchanged.
- They can be used for payment only within the issuer's platform, and can be exchanged only between a limited number of companies. As a rule, they cannot be exchanged between individuals. Points with an exchange-like function, however, can be exchanged with a relatively wide range of other points.
- With some exceptions, most have an expiry date, and become void after expiry. These may be converted to cash in order to avoid losing all value, but at unfavorable terms of exchange.
- Balances held by consumers do not increase, as most points are used up in the consumption of goods and services, do not recirculate, and become void upon expiry.
- Points can be accumulated and then redeemed by making payments (by purchasing products, or using cashless payment methods). However, any points saved do not attract interest.

Table 5 Comparison between loyalty points and legal currency

Three functions of currency	Characteristics of loyalty points	Bank deposits	Cash (banknotes)
Unit of account	Value varies depending on when and where points are exchanged	Fixed	Fixed
Medium of exchange	Only exchangeable with specified companies in the same platform	Exchangeable between bank accounts	Exchangeable between individuals
Store of value	Can be accumulated but have an expiry date	Can be used as a store of value	Can be used as a store of value

Source The author

In summary, loyalty points differ from other means of payment such as cash or bank deposits as they do not fulfil the typical three functions associated with a currency, such as store of value, unit of account or medium of exchange (Table 5).

3.4 How Platform Companies Turned Loyalty Points into a Pseudo-currency

Considering the origin of loyalty point services as a way for company groups to capture (lock in) customers from competitors, the ability to exchange points represents a reduction in consumers' switching costs. In principle, exchanges thereby diminish the economic effectiveness of loyalty points for the issuing company, and therefore should be limited for use only with those companies that are not competitors of the issuer. In this sense, the networks that allow points exchanges are thus necessarily asymmetrical and unidirectional. Consequently, it is hard to conceive of most loyalty points issued by individual companies, in particular, ever spreading enough to become an instrument like a common or legal currency that can be used to pay for goods and services at any company. Points can be exchanged only within somewhat closed networks that exclude competitors.

By contrast, PayPay bonuses, LINE points, credit card points and other points issued by platform provider-style companies create their own point-based economic zones through collaboration with member stores and partners, even including rival companies. Therefore, as networks expand, the points gain increasing general acceptance. Being used as a means of payment within the company's own ecosystem, they become a kind of pseudo-currency. In addition, common or universal points purely for the purpose of exchange, issued by companies without their own products or services, although still small-scale, are gaining general acceptance, and function very much like a currency (https://www.g-plan.net/). These points can also be converted into cash, and can be used to make investments. They are being utilized in ways that increasingly resemble bank deposits and other similar financial instruments.

In this way, at present, while the loyalty points issued by individual companies work as a tool to increase switching costs and to capture and lock in customers, those issued by platform provider-style companies are aimed at gaining greater general acceptance and enhancing convenience. They are consequently gaining a greater presence in the context of economic transactions. The issuance of loyalty points is expected to continue to increase in the future. Points issued by platform provider-style companies, in particular, are anticipated to strengthen their currency-like characteristics.

3.5 Fun Features Differentiating Loyalty Points from "Money"

The "Cashless Payment Survey" (NIRA, 2018) reveals that consumers save up points to purchase specific products and services at a discount, that they like to exchange points, and that, unlike money, collecting and using points provide them with a kind of "fun" factor. This relates well to the attraction of digital tokens described by Hatogai (2019), which cannot be experienced with conventional money.

Examining the NIRA survey by attribute reveals that more than 50% of respondents in each age group, with the exception of those in their 60s, like loyalty point services. There is no gender difference between respondents, but in terms of attitudes, female respondents had a 10% higher positive response to survey questions mentioning savings awareness, effective utilization, enjoyment from saving up points and enjoyment from exchanging points (Fig. 4). These results indicate the high degree of interest in points among women. An average of 37.4% of respondents across all age groups enjoys saving up points, but this proportion is higher, 41.3%, among respondents in their 20s, whose income is still low. The younger generation, in particular, finds the act of accumulating points itself enjoyable. A survey of the ways of using points shows that an overwhelming proportion of respondents, 82.7%, use them for discounts on purchases, while 53.2% of respondents exchange points for cash or vouchers, 27.7% exchange them for promotional gifts and the like, and 6.5% use them for donations or other social contributions.

Seen in this way, consumers appear to regard loyalty points not so much as a form of currency, but rather as tokens, which are attractive in different ways. The reverse logic of "saving up by purchasing" constitutes a fun factor. Also, points systems encourage small contributions to society that consumers would not otherwise consider when using money.

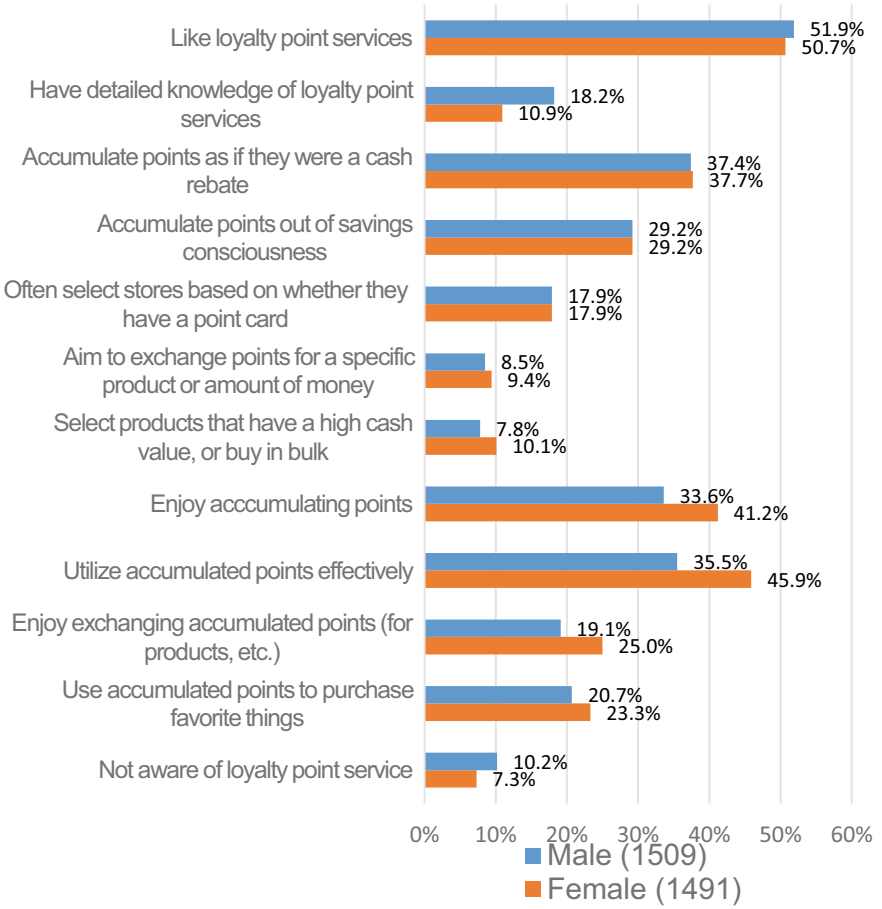

Fig. 4 Attitudes towards loyalty points (by gender). *Note* Percentages represent proportions of responses; multiple responses are allowed. *Source* NIRA (2018)

3.6 Latent Regulatory Issues

Even if loyalty points increasingly resemble currency, they are predicated on the profitability of private companies, and the trust placed in them must be considered in comparison to the creditworthiness of the bodies that issue currencies: central banks and governments as well as commercial banks. To establish trust with regard to financial soundness, safety, and the protection of privacy market competition alone will not suffice.

If the platform companies issuing points go bankrupt, then problems arise in terms of consumer protection. It is even possible that, if the scale of points systems is large enough, such an event might affect the stability of the financial system. Therefore, if points become widely used within an economy, it will become necessary to consider

some form of protective measures to prepare for the possibility of such a bankruptcy similar to those in place for electronic money. In any case, it will be necessary to monitor future trends in loyalty points as a means of payment.

The growth of loyalty points necessitates some degree of monitoring, as described above. However, they do seem to outshine legal currency in terms of convenience and "fun." With such attractive features, loyalty points do not rely on existing currency systems, and can open new paths for currency diversity.

4 The Future of Cashless Payments and Digital Points Systems

The cashless ratio in Japan was estimated to be 50% of consumer spending in 2018. Since then, the government used point returns for nine months from October 2019 to stimulate consumption and promote cashless payments when the consumption tax was raised. In addition, the cashless ratio in Japan is gradually increasing, as companies are also actively utilizing point redemption. Currently, the Financial Services Agency has no intention of regulating points, but it will be necessary to monitor the market size of points issued by platform companies.

In Japan, the spread of COVID-19 after 2020 is also considered to be increasing the tendency toward a cashless society. It was announced in August 2020 that convenient, low-cost, and interoperable remittance methods between banks will be introduced by the end of 2022 by the MUFJ Bank, SMBC (Sumitomo Mitsui Banking Corporation), Mizuho Bank, Resona Bank and Saitama Resona Bank Group.[2] It is expected that the cashless ratio will gradually increase in Japan in the future. The issue of the digital divide should be addressed so that as many people as possible can enjoy the benefits of cashless payments. In addition, it is hoped that private-sector cashless means, which are safe and convenient for users, will spread while ensuring interoperability. Supervisors will need to monitor the development and soundness of cashless businesses, paying attention to payment security and consumer protection.

[2] https://www.bk.mufg.jp/news/news2020/pdf/news0806_1.pdf.

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The Changing Landscape of Retail Banking and the Future of Digital Banking

Anna Omarini

1 Introduction

The banking industry in Europe is being changed by the emergence of new technologies, new players, and favorable regulatory frameworks such as the European Commission's Payment Service Directive 2 taking effect in 2018. Fintechs[1] have allowed the introduction of new services and have changed the way of interacting with customers to satisfy their financial needs. Techfins[2] have followed.

The Fintech landscape is constantly evolving. Different business value propositions are entering the financial services industry, ranging from enhancing user experience to developing a time-to-market framework for banks to innovate products, processes, and channels of contact, improving cost efficiency and looking to "partner on order" to lighten regulatory burdens. In many areas of business, banks are changing

[1] Financial technology (Fintech) describes a wide array of innovations and actors in the rapidly evolving financial services environment. It covers digital and technology-enabled business model innovations in the financial sector that can disrupt existing industry structures and blur industry boundaries, facilitate strategic disintermediation, revolutionize how existing firms create and deliver products and services, provide new gateways for entrepreneurship and democratize access to financial services, but can also create significant privacy, regulatory and law enforcement challenges (Omarini, 2019). See also Chishti and Barberis (2016) and McKinsey (2020).

[2] According to Zetzsche et al. (2018), Techfins start with technology, data, and access to customers. Then they move into the world of finance by leveraging their access to data and customers and seek to out-compete incumbent financial firms or Fintech startups. They sell the data to financial service providers or leverage their customer relationships by serving as a conduit through which their customers can access financial services provided by a separate institution. This allows them to later develop a different strategy by providing financial services directly themselves.

A. Omarini (✉)
Bocconi University, Milan, Italy
e-mail: anna.omarini@unibocconi.it

M. Heckel and F. Waldenberger (eds.), *The Future of Financial Systems in the Digital Age*, Perspectives in Law, Business and Innovation,
https://doi.org/10.1007/978-981-16-7830-1_8

their value chain structures and adjusting their business models accordingly. Strategists no longer take value chains as a given. Banking is shifting significantly from a pipeline, i.e., vertical paradigm, to open banking where open innovation, modularity, and ecosystem-based banking business models become the new paradigm to follow and exploit. In such an environment, which continues to evolve under the impact of digital technologies, opportunities and threats for banks are manifold. More than ever, technology[3] has become a strategic choice. It will decide the future of banking and the degree to which intermediary financial institutions like banks can redefine their role in the market.

This chapter analyzes the above developments by looking at banking in continental Europe. Section 2 describes the traditional banking business model and its evolution, and outlines the renewed interest in retail banking. Section 3 covers the digital transformation in banking and the role regulation plays in this process, while Sect. 4 describes the stages of this digital transformation. Section 5 explains where banks and Fintechs currently stand, and provides examples of opportunities for new forms of collaboration. Finally, Sect. 6 presents a brief conclusion and describes upcoming challenges for the industry.

2 Retail Banking from Past to Present

In every country, banks have long played an important role in providing answers to customers' financial needs (Office of Fair Trading, 2010). However, the underlying business models were not uniform, neither across countries nor over time. For example, as a response to national banking crises in the late 1920s and early 1930s, governments in the US and Japan placed considerable restrictions on the scope of business banks could conduct; the separation of commercial or retail banking from investment banking being the most important among them. In central Europe, such restrictions were not applied. The universal banking model allowed banks to provide a whole range of financial services to both private and corporate customers—deposits, loans, asset management, and payment services—with the general exception of insurance.

Up until the early 1970s, business activities by central European banks were nevertheless restricted by a variety of factors such as domestic regulations constraining free competition and regulating interest rates for the sake of financial stability, a fixed exchange rate regime with its corresponding restrictions on international capital transfers, and underdeveloped primary and secondary capital markets, which limited the volume of emissions and the trading of bonds and equities. However, the strong postwar growth—combined with the strong dependence of companies on loans, high household saving rates and restrictions on competition—provided incumbent players with a prosperous business environment. Applying a business model perspective, this phase is often characterized as the "production" stage (AT Chumakova

[3] See also European Central Bank (1999).

et al., 2012; Kearney, 2021; KPMG, 2014; Omarini, 2015). Banks focused on "producing." In the context of their role as financial intermediaries, this basically meant turning savings into loans while offering standardized payment services by administering customers' current accounts. Given the strong demand for deposits, loans, and payment services, banks would not have to worry about "sales." As a consequence, they had a predominantly inward focus and would pay little attention to the market side of their business.

After the early 1970s, when the fixed exchange rate regime faltered, macroeconomic growth rates dwindled and capital market and interest rate liberalization set in, competition started to intensify. As a response, bank management began to shift their attention towards "product quality" by improving their service offerings. There was increasing recognition among banks of the necessity to identify customer needs. At the same time, also being increasingly recognized, was the need to advertise and the potential of marketing. The concept of selling and developing a sales culture became more strongly emphasized, and product promotion was given a higher strategic priority.

From the 1980s onwards, market orientation became more and more relevant as competitive threats from the financial and non-financial sectors continued to grow. However, retail banking developed in different ways and at varying speeds, although all systems shared the common trend and strategic shift toward a stronger market orientation (European Financial Marketing Association [EFMA] and Microsoft, 2010). In some countries, especially more deregulated ones like the UK, retail banks were already about to enter the final stage, the "market-led" era in which marketing drives the whole organization. In such a world, banks attempt to proactively anticipate and meet customer needs. Customer service and quality become dominant strategic concerns.

The shift from a supplier-oriented financial system in which traditional retail banks dominate, to a market-oriented system characterized by highly contestable markets in which new competitors can easily enter and erode any excess profit was brought about by technological advances, regulatory reforms, and changes in customer attitudes. This was further accelerated by the world financial crisis in 2007/2008 and in Europe by the eurozone crisis starting in 2010. As the following sections exemplify, the trends affected the business environment, the internal organization of bank holding companies, and the design of bank services and their delivery. The profound restructuring even put into question the traditional definition of retail banking as a fixed bundle of financial services related to savings, loans, and payments.

Competition in retail banking has become multifaceted as competitors enter from different industries, especially in the areas of payments and consumer loans, taking advantage not only of the above-mentioned trends, but also of incumbents' weaknesses. In this new environment, satisfying both shareholder and customer interests is of vital importance (DiVanna, 2004; Edward et al., 1999). It means combining strategies aiming at higher productivity through cost-cutting measures with strategies aiming at enhancing customer loyalty through better service quality and improved customer convenience. However, the true challenge is how to implement such an

approach in an effective manner. The execution of a real market-oriented strategy was, and still is, a weakness of traditional retail banking (Omarini, 2015).

The European Commission's view on retail banking in Europe, including its different national structures and prospects in 2007, is articulated in the below text (see Box 1).

Box 1: The European Union (EU) Perspective on Retail Banking Before the Crisis

Retail banking is an important industry for the European economy. According to one EU document (European Commission, 2007) it represents over 50% of banking activity in Western Europe. It is estimated that in 2004, retail banking activity in the EU generated a gross income of €250–275bn, equivalent to approximately 2% of total EU GDP. As a whole, the banking sector in the EU provides over three million jobs.

Market structure differs considerably across the EU and this applies to the degree of market concentration as well as to the identity of the main players. Some retail banks have specialized origins, for instance, as mortgage or online banks and, therefore, only offer a limited range of retail banking products and services. However, there is also a growing trend in Europe, particularly among large banks, to operate as financial conglomerates in a range of financial service markets such as life insurance or asset management, as already mentioned. Another aspect to consider is market concentration. Though concentration can be described as modest in most member states, some countries such as Belgium, the Netherlands, Finland, and Sweden have significantly higher concentration ratios. Retail banking in the Benelux and Nordic countries is also characterized by significantly greater cross-border activity and, consequently, a higher degree of market integration. Other countries such as Germany or Spain are dominated by savings or co-operative banks with a strong regional focus. Subsidiaries of foreign banks have a major market presence predominantly in the new member states.

In June 2005, the European Community initiated sector inquiries into retail banking. As outlined in the EU document (European Commission, 2006), European retail banking markets were characterized by the following features:

- A high degree of international and national regulation
- A high level of co-operation among banks (e.g., payment infrastructures)
- Significant market fragmentation and differences regarding market structures
- Entry barriers due to regulatory or behavioral causes
- A fragmented demand side (individuals, small enterprises) characterized by information asymmetry, customer immobility, and very limited bargaining power

At roughly the same time, the European Commission identified carefully two evidence-based initiatives that would bring benefits to the EU economy:

- Investment funds
- Retail financial services

The Commission believed that further action was needed to open up the fragmented retail financial service markets. It took a targeted and consultative approach, involving all market participants at every stage of its policymaking. In December 2005, the future strategy on financial services was presented in the White Paper on Financial Services Policy 2005–2010. This document identified as priorities the extension of better regulation principles into all policymaking and the strengthening of competition among providers, particularly in the retail banking sector. Other noteworthy findings include concerns that consumer protection rules for retail banking vary considerably across member states, which raises the cost of entering new markets and maintains market fragmentation.

Source European Commission (2007), adapted.

Before going on to discuss in detail how the digital transformation changed retail banking, three basic aspects related to banking should be noted. First, retail activities are organized along three principal dimensions: the products and services offered, customer relations, and the channels by which products and services are delivered to customers. Second, an important portion of the value that banks provide through their services is intangible. Third, the core intangible asset involved is trust. Among service providers, banks' services enjoy a high level of trust based on their professional capabilities. It is not an overstatement to say that trust forms the foundation of the business in which banks and other financial service providers operate. The aforementioned trends and the digital transformation discussed below will not change the trust-based nature of banking.

3 Digital Transformation in Banking

There are four major driving forces changing the banking landscape today:

- Technology
- Regulation
- New competitors
- Consumer attitudes and behaviors

First, technology in banking has always had the power to impact the fundamentals of business, such as information and risk analysis, distribution, monitoring, and processing (Llewellyn, 1999, 2003). However, it can be useful to make a distinction

between technologies of the past and the digital technologies of the present. The latter not only have the power to improve efficiency and effectiveness in services but have also started to exert increasing influence on banks' products and delivery methods (European Central Bank, 1999). Digitalization also contributes to innovation leading to further improvements in profitability. Today, the capacity of a company to adapt to technology and exploit its potential depends overall on its capacity to translate those benefits into products and services, processes and new business models, and to secure and improve its competitiveness. If we take a broader industry perspective, we see that technology is also able to enhance economies of scale, thus changing the proportion of fixed versus variable costs, but also lowering entry barriers. This may increase the contestability of banking markets, and invites more agile companies to populate the banking landscape.

All of the above is possible because digital technologies are highly malleable. They open larger domains to new potential functionality (Yoo et al., 2010), introducing in every industry disruptions of various degrees. This is because they extend the innovation systems concept to the societal level (Alijani & Wintjes, 2017; Wintjes, 2016). It is on the borderless extension of financial innovation at the societal level where the big changes occur and where the new Fintech phenomenon has started developing and reshaping the industry's value propositions and related business models.

In the literature, this is also being addressed by the term "open innovation." Open innovation is widely understood as a process by which outside partners join in the development of innovative solutions, thus exploiting advantages of specialization, economies of scale and scope, as well as cost and risk sharing (Chesbrough, 2003, 2006, 2011; Chesbrough et al., 2014; Enkel et al., 2009). In other words, through open innovation, banks combine both internal and external resources to create new products (Chesbrough, 2011), increase the flexibility and timeliness in the way they respond to market demand and tailor their services to customers' individual tastes (Schueffel & Vadana, 2015).

The second driving force is regulation. Digital technologies have attracted remarkable attention from legislators. Regulators and authorities, having become aware of the power and magnitude of innovation, have started to invite the financial services industry to embrace the potential of new technologies by introducing legal certainty to previously unregulated services. While after the financial crisis, compliance issues and financial stability were the main regulatory concerns, the second EU Payment Services Directive (PSD2) shifted the focus to boosting technological innovations and reshaping the industry by introducing an open banking framework with the potential to further evolve towards open finance (see Box 2).

Box 2: The Payment Service Directive 2 in Europe: a Boost Towards an Open Finance Framework

This piece of regulation was adopted in 2015 and enforced from January 13, 2018. It aims at revolutionizing the European Union payments landscape and the whole banking industry.

PSD2 represents a key contributing factor in shaping and changing the banking industry and the way financial services are conceived, produced and delivered—their value chain. The new directive encompasses several goals at different levels, including: the harmonization of payment services in the EU, putting them under common standards, the enhancement of transparency; incentives for new players introducing innovative services to enter the market; the enhancement of security standards; and increased competition and choice to benefit the consumer (EY, 2017).

In addition to consumer protection and compliance in security standards, the centrepiece of the regulation is the obligation to provide third parties, if the customer authorizes them, with access to the data and information of the payment account the customer holds within a bank. This, as intended by the European Commission, would put consumers at the very centre of the landscape, where they could freely choose among a wide array of services from different providers, as banks are mandated to open current account information and interact with all other industry players. PSD2 requires banks to enable customers to authorize licensed third parties to access their transaction history. In effect, under PSD2 banks are mandated to be able to provide "access to account" and communicate to authorized third parties, their customer and payment account information. This allows new players to thrive not only in the payments segment, but as an extension, in other segments as well once they are able to tap into account information.

Among established providers, the directive categorizes new services as follows:

(1) Payment Initiation Service Providers (PISPs). They initiate the transaction and mediate between the user and his or her bank. They may establish a software bridge between a merchant's website and an online banking platform. These third parties are authorized by the customer. They can be, for example, merchants, who initiate a payment directly from the customer's bank account to another party through use of dedicated interfaces such as application programming interfaces (APIs)—bypassing the need for a credit card transaction and thereby using direct channels into the bank.
(2) Account Information Service Providers (AISPs). They access and consolidate users' information from all their accounts under the prescription of open information. In this way, they give consumers the opportunity to review their various bank accounts on a single platform.
(3) Card Issuer Service Providers (CISPs). They provide new modalities of fund checking for a payment request and the ability to issue decoupled cards.

According to competition Policy Commissioner Margrethe Vestager, PSD2 provides a legislative framework to facilitate the entry of (such) new players

and ensure they provide secure and efficient payment services. This makes it easier to shop online and enabling new services to enter the market to manage (their) bank accounts, for example, as well as keeping track of their spending on different accounts (European Commission, 2015a, b).

In the literature, Cortet et al. (2016) maintain that PSD2 goes a step beyond a regulatory scope. The directive is indeed an impressive accelerator of the digitization process that has already started to appear within banking. In particular, it should be noted that this regulation would have a severe impact on revenue streams that were considered "sticky" by banks.

PSD2 is of course a further regulatory response to technological changes and behavioral changes among consumers. The directive aims at fostering a further transformation through the prescription of a higher level of openness. This in turn will accelerate the fragmentation of the value chains in the banking sector, as consumers become free to choose services provided by a third party on the basis constituted by the (open) account that they hold within a bank. Those banks, in effect, will not be the only channels through which consumers will be able to access related services, thus separating a rather sticky account service relationship from the related services that banks could sell through that (once) preferential gate. The big mindset shift needed in order to bring this about is that of making everyone aware to move from controlling to managing customers' money (Omarini, 2019).

Source Author's elaboration.

The move to open banking is already spreading globally, though its actual impact depends to a large extent on the regulatory environment, not only in banking, but also in areas such as open finance and the data economy. Some countries, such as Australia and Singapore, are already undertaking this further evolutionary step while others continue to study the situation.

The European Union passed another important piece of regulation useful to the implementation and reinforcement of the aforementioned one, which is the General Data Protection Regulation (GDPR). This regulation has been in force since May 25, 2018. In the EU, GDPR and PSD2 are both developing a regulatory approach to establishing a foundation for open banking.

Finally, one also needs to consider the launch of the Regulatory Technical Standards (RTS) in September 2019 aimed at strengthening customer authentication and secure communication. These standards are key to achieving the objectives of the PSD2, namely, enhancing consumer protection, promoting innovation and improving the security of payment services across the European Union. Also, in the UK, the same situation is brought about by the Competition and Markets Authority's (CMA) Open Banking initiative, which mandates the nine largest banks in the country to provide access to banking data via a standard secure API so that personal and small business customers can manage their accounts with multiple providers through a single digital app.

The third driving force is concerned with new competitors. The potential for banks to open up a wide array of APIs and services exceeds the minimum levels mandated by legislation. Open banking enables the development of premium APIs, which, when fully developed, will allow data sharing practices to be effectively applied to a plethora of new sectors. A world without borders is becoming both an opportunity and a challenge for managers and policymakers. It is under these conditions, that technology start-ups found a way to enter the financial services industry and offer products and services directly to consumers and businesses.

Fintechs started entering the market by leveraging technology and regulation. In particular, they started targeting three retail banking areas—payments, lending, and financial advice, where they have worked at reducing the gap between what customers expect and what they actually get. In doing so, they have looked for and leveraged the relationship with customers by developing their business models in line with the following main characteristics: simplicity, transparency, ease of customer acquisition, ease of distribution, and commercial attractiveness, which refers to value creation and relationship characteristics boosting customer engagement. In contrast to traditional banks, Fintech companies share attributes, such as being young, aspirational, visionary, and capable. They are also freed from the constraints of legacy technology and tend to be highly specialized. They used to be backed by rising levels of venture capital. Recently, however, these funds have declined as investors are looking for ways to cash in on their investments.

Finally, the fourth driving force is the way consumer attitudes and behaviors are reacting to these changes while boosting them at the same time. Open finance empowers consumers to access their financial data beyond current accounts, extending for example to mortgages, credit, student loans, automotive finance, insurance, investments, or pensions and loans. Ultimately this allows for the delivery of additional value in the form of saving-related services, identity services, more accurate creditworthiness assessments, or tailored advice and financial support services. However, the success of open finance depends on customers being prepared and educated to engage, and willing to allow third-party providers access to their financial data such as transaction information.

It is worth remembering that consumers are human beings, which implies that what they want and expect from banks can only be partially defined in financial terms. Indeed, consumers want their life to be easy and the same is required for the path to their goals to be a simple one (Omarini, 2019). At present, the most common set of attitudinal and behavioral characteristics consumers show that what they demand are:

- convenience, implying speed and timeliness, due to scarcity of time (Oliver Wyman, 2018) so that banking is increasingly done in real time and available 24/7 (Accenture, 2019)
- product simplicity and ease of use (PwC, 2014)
- cost savings as a result of low-income growth (Oliver Wyman, 2018)
- personalized offerings

- experiential and functional elements.[4]

The COVID-19 pandemic has further incentivized customers' shift away from traditional branches to using digital channels. According to BCG (Boston Consulting Group)'s most recent retail-banking survey (Brackert et al., 2021), an average of 13% of respondents in 16 major markets used online banking for the first time during the pandemic (12% for mobile). In some markets, the percentage is substantially higher. Cashless payments have also been receiving a major boost during the crisis. More than 20% of respondents reported increasing their use of digital payment solutions, such as those provided by internet banking and third-party apps, and more than 10% said the same about credit and debit cards. This shift to digital channels is likely to be permanent. Digitally savvy customers will defect to more digitally advanced incumbent competitors or nimble and innovative challengers. This presents a real risk for traditional banks.

The combination of the above factors is fundamentally transforming the industry with intensified competition and shrinking profit margins (KPMG, 2016). Bank managers can no longer focus solely on costs, product, and process quality, or speed and efficiency. They must also strive for new sources of innovation and creativity. These increasingly complex forms of competition force everyone into being in the business of being chosen by customers (Omarini, 2013) so that every business is confronted by a formidable and constant challenge. Customers are more and more aware of what is available in the market and are ever more demanding. These high expectations tend to lower the level of satisfaction. Thus, the paradox of the twenty-first century economy: consumers have more choices that yield less satisfaction. Top management, too, has more strategic options that yield less value (Prahalad & Ramaswamy, 2004).

Today, financial products and services move onto interconnected platforms, where collaboration is becoming the new rule in offering integrated consumer banking. This new approach was neither premised on—nor measured by—volume of sales, but rather on the ability to provide solutions to customers through span of life changes: employment, unemployment, marriage, divorce, child-rearing, retirement, and so on. The result is that customers require help with a much wider range of problems, which are often influenced by emotion. Managing such customer relations entails the use of new and unfamiliar methods, such as the processing of situational information in ways that communicate a sense of care—even gossip, awareness of social responsibility, and customer education are included here.

The provision of solutions to customers through digital platforms is transforming the business ecosystem. A business ecosystem is a community of interacting entities.

[4] Both belong to the value customers assess while purchasing a given product/service. The experiential elements are related to the experience customers have when buying something, which impacts consumers' mental processes and loyalty intentions after purchase. Experiences are inherent in the minds of everybody, and are the results of being involved in physical, emotional. and cognitive activities. Experiences come from the interaction of personal minds and events, and thus each person's experience is unique. Functional elements, instead, are answering the customer's need (paying, investing, managing risks, time management, etc.).

These entities can be organizations, businesses, or individuals, which create value for one another by producing or consuming goods and services that support each other mutually. Digital platforms are able to reduce transaction costs related to the interaction between different entities. In this way, the ecosystem will become more integrated and agile.[5]

For retail banking[6] in Europe, the advent of digital platforms can be expected to cause a shift away from the traditional universal bank business model in which economies of scale and scope dominated strategic thinking and where conflicting interests between business sections could easily arise within the same legal entity, toward a new customer-centered universal banking model (integrated consumer banking) in which unbundling and re-bundling of services and respective business models are chosen for a purpose, i.e., solving a customer's use case or improving quality and customer experience. The focus will be more and more on customer needs and not on what banks can and may want to sell to the market. This means organizing around value streams and developing a series of value-adding activities that lead to overall customer satisfaction. The new banking paradigm is supported by the open banking and finance frameworks, the digital environment and the increasing role banks might play in re-bundling fragmented financial services in the evolving banking landscape.

4 The Future of Banking

4.1 The Future of Banking is Digital

All the elements cited above make it clear that technology is transforming the fundamental value chain of financial services and, unlike in other industries, is affecting at the same time both the "production" as well as the "distribution" phases. The pillars on which the old banking model was built were "differentiated distribution" and "commoditized products." In contrast, at present, the basis of the new banking model situation is "commoditized distribution" and "differentiated products." Products are now designed to address customer needs and to satisfy their desires through customization and personalization. This is because of consumer data accessibility and financial products embedded into clients' daily lives. All this is feasible because banking is conducted predominately online, and a huge amount of people can connect to the same platform to obtain the service they want. This is the stage in which the interconnection of platforms, systems, and applications is increasing.

In the meantime, technological innovations, such as APIs and cloud computing, have raised the contestability of banking markets, while the developments of technology have reduced the significance of entry and exit barriers in the banking

[5] See also Iansiti and Levien (2004a, b).

[6] For more information on retail banking also see Capgemini (2019, 2020); Frazer and Vittas (1982); Leichtfuss et al. (2010); Omarini (2018).

industry. This is the advent of technology combined with the unbundling of products and services into their component parts, that have enabled new entrants to become competitive within the industry. Indeed, this unbundling has given new players the possibility to deliver their innovative solutions without undertaking all of the processes involved in a particular service and to enter the business without the substantial fixed costs involved in certain processes.

In this ever-changing scenario, to remain competitive, banks need to make new strategies and Fintechs need to make their business models more profitable and resilient to the many risks related to their specific business arena (payments, lending, investment, etc.) and those under the umbrella name of cyber risks. For example, they have to move from freemium to premium pricing; that is to say, move away from a pure free pricing model and push customers to pay for the value delivered. However, they also have to actively select customers and drive their future actions from customer acquisition to customer retention.

In the following, I outline three main stages within which the financial industry is undergoing its deep transformation: the "unbundling" stage; the "fragmentation" stage, and the "cooperation/partner" stage.

4.2 Three Stages of Evolution

The first stage is characterized by the entry of Fintech in the market arena, when they were seen as "disrupters." They entered the market by focusing on a set of specific businesses from the vast retail banking arena (such as payments and lending). The unbundling wave separated the financial services value chain into different modules of products or services with the peculiarity of developing infinite ways of combining them. This is when we may say the industry began reconsidering its shift from a vertically integrated business (pipeline business model[7]) to a fragmented distribution of financial services where the business model framework is that of a platform structure, in which different actors—producers, consumers, etc.—connect and conduct interactions with one another using the resources provided by the platform. Some industry experts argue that the traditional pipeline business model will be squeezed out (Deutsche Bank, 2017), while others suggest that the "platformization" of the economy will continue but that the traditional business model will continue to exist at the same time thanks to the fact that pipeline companies are less complex and provide owners with more control (Pan and van Woelderen, 2017).

[7] They have been the dominant models of business when the main business idea has been that of producing something, pushing it out, and selling it to customers; where value is produced upstream and consumed downstream, where there is a linear flow of information, data, etc., and where value is created by controlling a linear series of activities—that is the classic value-chain. Therefore, the focus is on growing sales. Goods and services delivered, and their related revenues and profits, are the units of analysis (Omarini, 2019).

The second stage is characterized by a situation strictly linked to the way customers react to newcomers. The more customers are looking for a fresh choice, multi-experiences, simplification, best-of-breed products as well as personalization, the more the market has to advance. As a consequence, re-bundling offerings is the norm. Under these circumstances, on the one hand, Fintechs are under considerable pressure to engage in re-bundling activities to retain customers. On the other hand, incumbents need to close the gap in customer experience and satisfaction. In this stage, some banks have started considering Fintechs as valid partners to boost their capabilities to develop innovation thus considering the open innovation approach as an effective way to develop time-to-market solutions. Partnerships and value co-creation with other players will pave the way to the banks' overall mission to transform innovation into superior customer experience and to reach a more cost-efficient situation that finally improves their profitability.

Banks seeking to claim a solid position in the open banking landscape will need to move beyond merely offering high-quality documentation, sandboxes, developer tools, and seamless access to APIs. Most importantly, they need to build, grow, and nurture their open banking community to strengthen their position and accelerate their commercial efforts. Specifically, banks are in a position to increase the number of developers using their APIs, obtain more direct input and feedback, signal intent for innovation, and collaborate with the aim of developing relevant products and services. Overall, this contributes to better facilitation of API ideation and use-case development to drive reach and adoption among end users.

Finally, in the third stage, business ecosystems evolve as a way of acquiring, engaging, and retaining customers. In platform businesses, ecosystems are more agile in reacting to customers' demands and are able to reach large masses of people. It is important for banks and the financial sector in general to develop economies of scale and scope in their businesses and services. This process is accompanied to a significant degree by digital technologies. The future bank, in fact, cannot operate with the present cost structure and be competitive. Digitalized processes, increased efficiency, and cost optimization are imperative. In this connection, cloud computing is enabling organizations across the economy to innovate more rapidly by reducing barriers to entry and acquiring high-quality computing resources. More specifically, it enables more convenient, on-demand access to computing resources, e.g., networks, servers, storage, applications, and services.

4.3 Present and Future Developments in Value Chains

The nature of economic competition is changing. New players view value for customers differently and their organizations are more customer-committed than some of the traditional service providers. This is because the core business for them is the value transferred to customers through ease of access to service and a more caring system, rather than the business of controlling the entire value chain of a given product or service.

This move toward value for customers requires a change in mindset and a critical rethinking of strategy and managing business solutions within the digital ecosystem. Here, a high value is placed on networks, which requires a more holistic approach to customer knowledge as a basis for a new and wider business portfolio.

Therefore, the current outlook for the banking industry reveals a nascent set of ecosystems of independent service providers, where the traditional supply-centered oligopoly is coupled with Fintechs, Techfins, retailers, etc. At this point, PSD2 in Europe (see Sect. 3), and similar trends in other markets, are viable tools for enabling this new reality.

To make sense of these developments, there are two observations that should be considered. The first is that, like their traditional counterpart, new financial service providers aspire to develop the core purposes of financial intermediation with new methods and tools such as robo-advisory services that offer financial advice to a wider market. Parallel to this are the crowdfunding platforms that are increasing financial inclusion while also offering new investment and lending opportunities.

The second observation is that more often than not, there is still a banking organization somewhere in the Fintech stack. Just as third-party app developers rely on smartphone sensors, processors, and interfaces, Fintech developers need banks somewhere in the stack for such things as access to consumer deposits or related account data, access to payment systems, credit origination or compliance management.

As a result, two main new trends and related risks are emerging:

- Banks and other financial service providers are relying on third-party providers more and more, which increases their mutual interconnection raising concerns about the potential risks related to this. In particular, systemic risks may arise from being "too-connected-to-fail" rather than being "too big to fail."
- Banking is more and more embedded in customers' everyday lives. Therefore, the more banking will be embedded in such a way, boosted by an ever-improving user experience, the more it will be invisible to customers. That change will not occur overnight, but its seeds are already sprouting in a number of different areas. For example, banks might offer short-term loans through a given merchant that may encourage customers to buy a given product or service. Customers may believe the loan comes from the retailer, not the bank itself and the bank may be comfortable about being invisible in that transaction as long as the customer receives a good loan. The worst-case scenario would be one in which a loan is not suitable for the customer or that he or she is unable to provide the appropriate cash flow to repay it, etc. This risk may require a higher degree of transparency when financial services are embedded in a different value proposition.

Against this oncoming configuration of markets, a focus on control and ownership of resources is giving way to a focus on the importance of accessing and leveraging resources through unique models of collaboration. According to Prahalad and Ramaswamy (2004):

> The co-creation process also challenges the assumption that only the firm's aspiration matters. [....] Every participant in the experience network collaborates in value creation and competes

> in value extraction. This results in constant tension in the strategy development process, especially when the various units and individuals in the network must collectively execute that strategy. The key issue is this: How much transparency is needed for effective collaboration for value co-creation versus active competition for co-extracting economic value? The balancing act between collaborating and competing is delicate and crucial. (p. 197)

If co-creation is fundamental to the industry, it must draw on a wider customer perspective. This, in turn, would require introducing the idea of developing ecosystems in which the customer is truly free to move and choose the best deal in more competitive markets. These markets would let consumers make informed decisions that could offset potential market concentrations amongst market providers. This new configuration of markets represents a new paradigm of competition in which business ecosystems consist of a variety of industries with potentially increasing convergence.

5 The Changing Landscape: Where Do Banks and Fintechs Stand in the Market?

5.1 Four Strategies to Counter Fintechs

This section analyzes how incumbent banks are reacting to the threats posed by Fintechs. There are four different strategies that are the most widely used for successfully expanding a firm's innovation portfolio (adapted from Borah & Tellis, 2014; Wilson, 2017).

- The "hold" strategy
- The "make" or "build" strategy
- The "ally" strategy
- The "M&A" strategy

First, the "hold" response means that the incumbent bank continues its business as usual, but with some revitalization to minimize potential challenges. Revitalization is a concept especially developed for product design and a way to change the life cycle. It is a technique used to give a new lease of life to an existing product by bringing it up-to-date in its design (styling), performance, costs, or other features.

Second, the "make" response implies that the incumbent bank decides to react to the new entrant's business model innovation by developing a new product, service or another internal solution. This is possible when the traditional player has the necessary resources, capabilities, and competencies required to develop innovative solutions independently.

Third, incumbent banks can decide to confront the challenges of digitalization by cooperating with financial technology firms. Specifically, by adopting the "ally" response, the incumbent chooses to pursue a path of collaboration. Under the term "ally" are included all forms of collaboration in which the incumbent and the entrant

continue as separate firms. The "ally" strategy is preferred when the perceived degree of disruption or challenge to market-centered business model innovation is low while the perceived degree of disruption or challenge to technology-centered business model innovation is high (Anand & Mantrala, 2019). Indeed, if the perceived threat posed by the Fintech to the incumbent on the market-centered dimension is low, it means that the bank is not intensively exposed to the risk of losing its core customer base. This usually happens when the incumbent has cultivated strong relationships with its clients with a high level of trust and loyalty toward the bank. However, the high intensity of technology-centered challenges means that the incumbent does not have the required capabilities and skills to easily replicate or reproduce the entrant's new technologies in-house. It could be argued that, since the bank is not in serious immediate danger of losing its current target customers, it would be unnecessary to ally with a Fintech firm or with other companies. It can be assumed that the majority of current clients would not abandon the traditional bank's services and products to adopt the solution created by the new Fintech company. Nevertheless, the bank may lose potential customers who may prefer technology-driven financial providers. As a consequence, some forms of alliance are mutually beneficial as both players have something the other needs: the bank needs the Fintech's new technologies and the Fintech needs access to the bank's large customer base, compliance competencies, and brand reputation.

A report published by McKinsey & Company (Engert et al., 2019) highlights, that alliances are becoming increasingly relevant as banking advances further into digitization and advanced analytics. Before deciding to ally with a company, incumbents need to define a clear strategic objective and business case for the partnership. Indeed, for the "ally" response to be successful, banks must delineate a pre-launch partnership structure, a methodology for evaluating each partner's contribution and a clear and coherent vision for the end state. Moreover, they should stipulate with the counterpart governance arrangements, transition and operational support agreements, and restructuring and exit provisions (Ruddenklau, 2020).

The fourth and final strategy is the "M&A" strategy. Banks adopt the "M&A" response when they acquire a competing challenger. This means that the Fintech company is completely absorbed by the bank's organization and only the acquiring firm remains at the end of the process. The bank usually decides to buy when it faces a double threat (Anand & Mantrala, 2019). This means that the two dimensions, i.e., the perceived degrees of disruption to market-centered business model innovation (BMI) and of disruption to technology-centered BMI, are both high. In this scenario, the incumbent is seriously threatened by the entrant's BMI under one or more aspects of its cost-volume profit and, from a technology point of view, is unable to match and reproduce the entrant's innovations internally. It is important to remember that the underlying condition enabling a bank to make an acquisition is the availability of financial resources and human capital. This raises the question of why the bank should mobilize a huge amount of resources in order to acquire a Fintech rather than choosing a "make" or "ally" strategy. The answer is that the "make" response may not be feasible, primarily because, for the incumbent, it would be difficult to match the

User Needs	Traditional Model	FinTech Challenges/Influences	FinTech Solutions	Gaps
Pay	Cash/ATM Check Debit/Credit cards	Very High	Virtual currencies DLT-based settlement P2P payments B2B transactions Mobile payments Mobile PoS	Speed Cost
Save	Bank deposits Mutual funds Bonds Equity	High	Virtual currencies Blockchain bonds Mobile market funds	Transparency
Borrow	Bank loan Bonds Mortgages	Very High	Platform-lending Crowdfunding Blockchain bonds	Access
Manage Risks	Insurance Structured products Brokerage underwriting	High	Smart contracts Crypto-asset exchanges	
Get Advice	Financial planner Investment advisor	Medium	Robo-advising Automated wealth management	Security

Fig. 1 A Fintech framework for collaborative opportunities. *Source* International Monetary Fund and World Bank (2019), adapted

challenger in technology and related competencies, while the "ally" response may not be available as the challenger may not be interested in an alliance or cooperation.

Figure 1 provides a stylized map summarizing how user needs for financial services have been satisfied traditionally, the key gaps related to financial issues, and the new Fintech solutions on offer to potentially address these problems. The aim is to verify whether all the potential sub-businesses of an incumbent bank—each responding to a different client need—are affected by the emergence of Fintech, the intensity of the potential threat as well as opportunities for collaboration.

Figure 1 shows that Fintech is having global impact on the provision of financial services, and all traditional solutions to users' needs for financial services, activities, support, and demands. It flags the key gaps that technology seeks to fill in regard not only to all banking sub-businesses (payments, lending and borrowing), but also additional fields of insurance, wealth management, and advisory sectors. It is noteworthy that the impact of technological advances on the need for "getting advice" is relatively low, meaning that the threat in this industry is currently less intense. Traditionally, wealth managers have offered a holistic range of financial services, from investment advice to general financial planning, all based on broad expertise. Even if it is true that wealth managers are increasingly using analytic solutions at every stage

of the customer relationship to increase client retention and reduce operational costs (PwC, 2016), the shift from technology-enabled human advice to human-supported technology-driven advice is happening at a slower pace. This paradigm shift can be completed only when Fintechs have developed all the required capabilities and skills and have built the level of consumer trust essential to succeed in the advisory industry. In contrast, the intensity of the threat is very high in the business areas of "pay" and "borrow." This is in line with predictions in the above-mentioned PwC report Global FinTech survey (2016):

> Payments and consumer banking are likely to be the most disrupted sectors by 2020…The payments industry has indeed experienced in recent years a high level of disruption with the surge of new technology-driven payment processes, new digital applications that facilitate easier payments, alternative processing networks, and the increased use of electronic devices to transfer money between accounts. (p. 6)

Finally, it seems that cooperating rather than competing is much more rewarding both for banks and Fintechs. As a matter of fact, on the one hand, banks can provide the Fintechs with what they now lack, be that data, brand, distribution, or technical and regulatory expertise (Belinky et al., 2015), or a large customer base, stable infrastructure, and deep pockets to fund new projects. On the other hand, Fintechs can provide incumbents with out-of-the-box thinking, technical expertise and the agility to quickly adapt to change. The limitations of Fintechs are precisely the strengths of incumbent banks and vice-versa, and the future for both of them lies in pursuing a collaborative relationship (Meere et al., 2016). By mixing the different skills and new solutions offered to the market, new data collection and data management may increase and become the most interesting and insightful byproducts that the different frameworks of collaborations may produce.

5.2 The Bank–Fintech Relationship: The Other Side of the Coin

In this section, I have described how banks' responses to Fintechs' challenges are affected by a multitude of factors such as cultural issues, resource availability and governance inputs, to mention only a few. In making their decision, bank managers have to weigh up the advantages and disadvantages and choose the strategy whose benefits outweigh the costs—not only in a strict economic sense, but also considering those related to change in people's mindsets and new ways of collaborating such as agile methods of working.

The last subsection seems to suggest that collaborative strategies and partnerships between incumbent banks and Fintechs are a win–win solution. However, this assessment is far from reality. The World Retail Banking Report 2019 and the subsequent World FinTech Report 2020 describe the current situation of many bank–Fintech relationships. The former shows that only 19% of banks have a dedicated innovation team with an independent decision-making authority, only 27% find it easy to

onboard Fintechs, only 21% engage with external experts for mentorship and evaluating start-up maturity, and only 21% of banks say their systems are agile enough to collaborate (Capgemini, 2019).

The latter report indicates that seven out of ten Fintech firms disagree with their bank partners culturally and organizationally, in terms of banks' legacy infrastructures, and point out that banks' complex processes impede Fintechs' naturally fast-paced workstyle. Furthermore, more than 70% of Fintechs report that they are frustrated by incumbents' process barriers. More than half of Fintech executives say they have not identified the right collaborative partner. Finally, Fintech struggle to understand banks, their business activities, their products, and their scalability, which tends to create a mismatch during collaboration, eventually even causing some projects to fail (Capgemini, 2020).

5.3 How Are Banks Responding to the Changing Game?

In this subsection, I briefly introduce how some banks are reacting to digital disruption as described in Sect. 5.1. The overall situation shows that no one approach fits all.

There is significant variation among banks in their reactions to digital disruption. However, globally, more innovative incumbent banks and financial institutions are moving rapidly to embrace digitalization. Most of them have invested heavily in transaction migration. They have also significantly upgraded web and mobile technologies and created innovation and testing centers, both in-house (e.g., J.P. Morgan) and through an innovation division separate from the broader business (e.g., Citi Fintech).

Some other banks have decided to develop new products, some of them new Fintech products in the form of end-to-end digital banking, digital investment services, electronic trading, and online cash management, while others are collaborating with Fintech companies to improve their consumer offerings. Cases of the latter are J.P. Morgan's with OnDeck, a lending platform for small and medium enterprises that is able to process loans in a single day, Roostify, which is a mortgage process provider that makes the online lending process faster, less costly and more transparent for everyone involved, and Symphony, a solution provider for sales and trading, operations and other activities. There are many other leading banks, including those at the cutting edge of digital transformation, such as Banco Santander, Bank of America, Barclays, Banco Bilbao Vizcaya, BNP Paribas, Citi, HSBC, Royal Bank of Scotland, Société Générale, UniCredit, and Wells Fargo.

Looking at the responses and strategies covered in Sect. 5.1 reveals that the adoption of the "ally" response by large or regional banks remains debatable. On the one hand, some experts argue that regional banks, more than large money center banks, lack the economic resources required to conduct mergers and acquisitions (M&A), and sometimes also the digital resources needed to align their business with those of the acquiring entities. For these reasons, they need to have access to a wide variety of partnership opportunities, ranging from strategic partnerships to contractual alliances

(Ruddenklau, 2020). On the other hand, some researchers, using hand-collected data covering the largest banks from Canada, France, Germany, and the United Kingdom, have found that large, listed, and universal banks are more likely to establish alliances with at least one Fintech, as compared to smaller, unlisted, and specialized banks (Hornuf et al., 2018). In the same paper, the authors, using detailed information on strategic alliances made over a 10-year period (2007–2017), have identified two main forms of alliance: financial engagement and product-related collaboration. The former may come in the form of minority stakes in a Fintech while the latter refers to a contract-based partnership, enabling banks to broaden their portfolios. The authors have found that among the 469 unambiguously identified alliances, 39% are financial engagements with minority interest investments, 54% are product-related collaborations while the remaining 7% includes other types of interaction. Other evidence suggests that since larger banks have deeper pockets to buy Fintech firms, in the case of large banks and small Fintechs, financial engagements are more likely than product-related forms of collaboration. However, both in market-based economies (Canada and the United Kingdom) and bank-based countries (France and Germany), alliances are most often characterized by product-related collaboration, which is a comparatively less institutionalized form of alliance that offers little or no control in the Fintech product development process (Hornuf et al., 2018).

Moving from a general perspective to one of studying a specific group of banks—namely, JP Morgan Chase & Co., Citi, and Banco Santander—can provide insights into how these institutions have faced the threats posed by Fintechs.[8] The below analysis applies to the 6-year period from 2015 to mid-2020.

J.P. Morgan Chase & Co. has followed a mixed approach in which the in-house development of products and services has been completed with partners and the acquisition of Fintech companies. Citi has focused more on "make" and "ally" responses, investing in Fintechs predominately through Citi Ventures, its strategic investment and innovation arm. In contrast, the Spanish multinational financial services company Banco Santander has mainly adopted a *make*-oriented strategy. The majority of its acquisition and partnerships were made with the aim of acquiring the technological skills and competencies required to enhance its own existing services or build new innovative solutions internally.

Despite the differences in terms of choices adopted, it is possible to identify some common patterns between the three strategies. First, in accordance with what the PwC Banking 2020 Survey reported, the executives of the three banking institutions have made "implementing new technology" one of their main investment priorities. This is also confirmed by the fact that for all of the three banks, technology expenses have steadily increased over time. Second, with reference to the types of threats, all three strategies tried to respond effectively to customers' changing needs, the expectation of immediacy and to the necessity of incorporating technological developments into products and services. There are numerous partnerships and acquisitions aimed

[8] Some of this information has been retrieved from the analysis developed under my supervision of Francesca Caturano's MsC thesis (2020).

primarily at gaining access to innovative technologies. Moreover, all three incumbents are aware that one of the most important challenges they face as a sector is digital disruption so that they must be able not only to offer their services in the most agile and simple way possible, with personalized and customized products, but also understand clients' new consumption patterns and anticipate their needs, which change faster than ever before. Finally, the openness of the three banking institutions towards technological innovations, their use of technology to connect people, and their organizations and resources, make it clear that they have all adopted a platform business model.

Turning now to the critical factors driving banks' responses, the three banks have shown that the need to accelerate innovation processes can be considered the main factor leading institutions to embrace Fintech solutions. Nonetheless, the statements expressed by Fintech executives when a partnership or acquisition with one of the three financial institutions is announced, reveal that expanding their networks and acquiring new potential customers are the main reasons for entering into relationships with incumbents. Related to this point, it is noteworthy that around the year 2015 they all started developing in-house initiatives. From 2016 onwards, they had added ally projects and moved later to M&A strategies.

As a last point of discussion, the study confirmed that the payment business is the one most affected by the Fintech revolution. It makes payments the business area in which the incumbents-Fintech relationship is more competitive. Indeed, many of the "make", "ally", and "M&A" responses were conducted within this area.

6 Outlook

As products and services are increasingly embedded in digital technologies, it is becoming more difficult to disentangle business processes from their underlying IT infrastructures. This trend is likely to continue, which means that banks will become even more dependent on technology, both at an operational and strategic level.

Retail banking will continue to become more modular, flexible, and contextual. Retail customers now expect to be able to integrate e-commerce, social media, and retail payments. As a result, services will become less visible to customers as they are increasingly embedded in and combined with non-financial offers and activities.

The competitive game is constantly spiraling into new forms. New innovative concepts of products and services enhance customer engagement. The spread of mobile devices enables the onboarding of customers to platforms where their activities generate data. Data collection and analysis span all areas of business such as advertising, financial advice, credit scoring, pricing, claims management, or customer retention. Locking customers into a given platform while granting them seamless switching across platform services, generates further data. Supported by artificial intelligence and machine learning, the analysis of the wide array of data streams will allow companies to continuously offer products and services that are increasingly better fit for purpose. Just how much additional value can be generated by knowing customers better seems to be limited only by the ingenuity of the platform company and the actors in the related business ecosystem (Omarini, 2018).

To stay in the game, banks need to reframe the way they perceive and manage value chains. Data-sharing forms are becoming the basis for competitive advantage influencing how services are conceived, produced, delivered, and consumed. Therefore, partnerships with other companies solely for the purpose of data collection can be expected to increase.

As banking moves onto digital platforms, cross-industry interconnections will increase and result in new competitive threats. Providers of banking services will come to see themselves more and more in the role of "enablers" of transactions occurring on platforms and within business ecosystems. As enablers, retail banks will shift from being "content" gatekeepers to becoming "customer" gatekeepers. However, even in this new role, trust will remain a core business asset.

As the lines between banks and Fintech companies become blurred, traditional definitions of banks and financial services become obsolete. Banks need to redefine themselves and their business. In the end, they will need to move closer to their customers. The goal is to not be perceived as an impersonal service provider, but as the individual customer's personal bank. Such a new strategic positioning requires not only new skills and communication approaches, but also a fundamental change in the mindset of retail banks.

The above trends raise two important questions in the European context. First, will we see a full convergence of national retail banking systems? Second, will retail banking become dominated by global platform companies located mainly outside of Europe? One might expect that both answers warrant a simple "yes," but the future remains unpredictable. As for the first question, there is certainly a strong push towards a convergence created by technology and platform structures. However, one should not underestimate the path dependencies created by national institutions such as regulatory frameworks, industry structures, consumer preferences and consumption patterns. Similarly, while the dominance of non-European platform companies cannot be denied, their position is continuously contested, and they are also constrained by the legislative and judicial powers of the EU with respect to security, privacy, and anti-monopoly regulations.

The importance of national context is apparent in the answers reported in the recent PwC Banking Survey, which asked about the perceived threats and opportunities created by non-traditional players in the banking industry (see Fig. 2). For emerging markets and Asia Pacific regions that mostly consist of countries with underdeveloped banking and financial systems, the new players are not so much challenging established structures, but rather have the opportunity to leapfrog by creating new systems without the time-consuming process of copying the traditional structures found in advanced economies. So here, a significantly higher share of respondents perceived opportunities for non-traditional players. The contrasting responses from the US and Europe suggest that US banks have more to fear from US-grown BigTech and startups than banks in Europe. The latter might feel more secure because of the protective nature of the aforementioned national institutional and regulatory frameworks as well as social and political conditions.

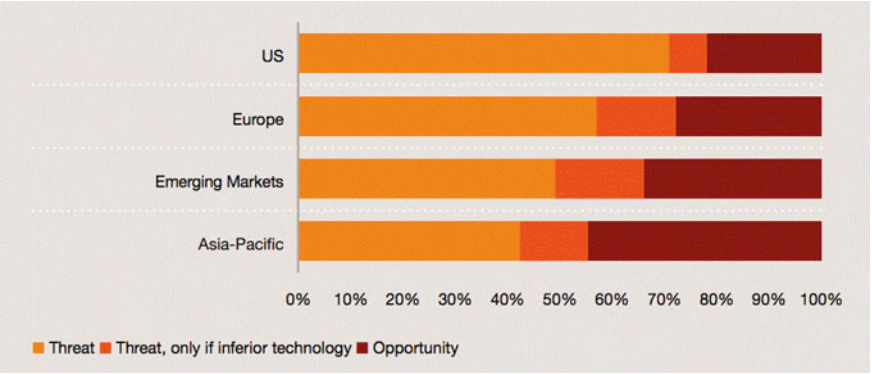

Fig. 2 Non-traditional players: Threat or opportunity? *Source* PwC (2020)

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High-Frequency Trading in Japan: A Unique Evolution

Takahide Kiuchi

1 Introduction

1.1 Is High-Frequency Trading Fintech?

High-frequency trading (HFT), which has been actively practiced in the US since the early 2000s, began spreading more widely in Japan around 2010. Today, after some ten years, opinion is still divided regarding the impact of HFT on Japanese financial markets, and many aspects of its effects have yet to be fully evaluated. HFT defies straightforward judgment, due to a marked lack of clarity regarding matters such as the actual status of HFT activity, its effect on financial markets and the possible existence of unfair trading.

Does AI-driven algorithmic trading, together with HFT as one of its subclasses, really constitute fintech? If fintech is understood in the broadest sense as a fusion of finance and technology, then algorithmic trading and HFT are undoubtedly fintech fields. However, defining fintech more narrowly as innovations in financial services that enhance the convenience of end users creates greater ambiguity about whether or not HFT is actually fintech, because it is at best only experienced by end users of financial services indirectly.

1.2 Recognizing the Social Significance of HFT

In the author's understanding of public discourses, many people seem to have a negative impression of HFT, such as "a way for only a few market participants to

T. Kiuchi (✉)
Nomura Research Institute, Tokyo, Japan
e-mail: t-kiuchi@nri.co.jp

M. Heckel and F. Waldenberger (eds.), *The Future of Financial Systems in the Digital Age*, Perspectives in Law, Business and Innovation,
https://doi.org/10.1007/978-981-16-7830-1_9

make money," or believe that "advances in HFT technologies have not led to win–win situations that benefit more participants, but rather to zero-sum games," or that "HFT manipulates the market and harms the interests of other investors, particularly individual investors."

Professor Joseph E. Stiglitz of Columbia University concluded that, while HFT firms profit from making trades faster than other firms do, such activity leads to excessive investment and wasted costs in social terms. Moreover, the involvement of HFT is suspected each time a "flash crash" occurs, where prices in equities, bonds, or Forex markets fluctuate significantly over a short space of time. Consequently, HFT is often criticized for having a destabilizing influence on financial markets (Financial Services Agency, 2016).

Nonetheless, considerable empirical analysis in Japan and throughout the world indicates that HFT enhances market performance, including increasing the liquidity and improving the efficiency of markets (Brogaard et al., 2014a; Benos & Sagade, 2016; Zhang & Riordan, 2011). There is a far greater volume of research demonstrating HFT's positive impact than empirical analyses showing that HFT destabilizes financial markets. It may, therefore, be reasonable to suggest that HFT has broad social significance, benefitting society as a whole by enhancing market functioning. The importance of this impact should not be underestimated.

1.3 The Movement Toward Greater Regulation of HFT Around the World

Even if HFT clearly enhances market performance under normal conditions, can the same be said in the case of a crisis or an emergency? It is arguable that if markets become turbulent for some reason, HFT may actually amplify this instability. To date, however, there has not been sufficient evidence of this effect.

In addition, there is good reason to believe that HFT firms may, deliberately or unintentionally, as a result of their nature of operation, be engaged in unfair trading practices, such as market manipulation (Niwa, 2016). It is also possible that trading by HFT firms may deprive other investors, particularly individual investors, of opportunities to gain profits. These issues, which are focusing on market efficiency, but are more concerned about the distribution of profits, still await thorough evaluation.

Throughout the world, countries have proceeded to strengthen regulation and implement systems to respond to the risks potentially associated with HFT. In Japan, for example, a registration system for HFT firms was instituted in April 2018.[1]

The regulation of HFT requires sophisticated technology, and represents a new frontier for regulators. In fact, the level of technology used by regulators has been cited as one reason why, in Japan, very few cases of unfair trading by HFT firms have been exposed to date. In order to improve the level of technology available to regulators, more collaboration with the private sector will be needed.

[1] Amendment of Act No.37 of 2017.

It is to be hoped that this increase in regulation will not overly constrain those HFT activities that contribute to the public good, including its improvement of market functioning, but rather mitigate risks that may result in the potential problems described above.

1.4 HFT May Play a Role in Shaping Business Models in Japan's Securities Industry

Included in this chapter's review of the latest trends in the activities of Japan's securities companies and HFT firms is an examination of the mechanism, already common in the US, whereby an online securities broker may pass on share trading orders submitted by individual investors to an HFT firm in return for compensation in the form of a rebate from the HFT firm. Japanese online securities brokers have begun adopting this practice, leading to an increasingly strong relationship of mutual dependence between HFT firms and securities companies.

Japan's online securities brokers face an extremely fragile earnings base due to a persistent low interest rate environment. In the future, it is conceivable that these brokers may, therefore, grow even more dependent than their US counterparts may on rebate income from HFT firms.

Continued, strict monitoring will be necessary to ensure that these practices are not conducted in ways that significantly damage the interests of individual investors.

2 Algorithmic Trading and HFT

2.1 Algorithmic Trading

HFT is one form of algorithmic trading. Algorithmic trading can be defined as the repeated trading of securities where the timing and volume of orders placed is determined automatically by a computer system, according to a predesignated procedure.[2] The main objective of algorithmic trading is to achieve stable profits. To this end, it seeks to pursue maximum returns while controlling risk and reducing costs.

Algorithmic trading itself has been used for quite some time. In many cases, it is not particularly sophisticated, consisting of nothing more than the automation of conventional trading procedures. Indeed, a significant proportion of algorithmic trading is not actually high-frequency, high-speed trading. Recently, however, there has been an increase in sophisticated algorithmic trading utilizing AI technologies based on machine learning.

[2] See definition from the glossary of securities terminologies provided by Nomura Securities (https://www.nomura.co.jp/terms/japan/a/algorithmic.html).

Institutional investors, proprietary firms such as investment companies that invest using only proprietary funds for direct gains rather than for commissions, proprietary trading and brokerage divisions of securities companies, and even individual investors all engage in algorithmic trading. For all of these players, with the exception of the brokerage divisions of securities companies, the main objective of algorithmic trading is achieving maximum profits. For the brokerage divisions of securities companies, the main objective is fulfilling their duty of best execution; that is, their obligation to ensure that customer orders are executed under the best possible conditions.

2.2 Types of Algorithmic Trading

Algorithmic trading can be classified into six types according to its objective and procedure: (1) execution algorithms, (2) benchmark execution algorithms, (3) market-making algorithms, (4) arbitrage algorithms, (5) directional algorithms, and (6) market manipulation algorithms (NTT DATA Financial Solutions Corporation, 2018).

(1) **Trading using execution algorithms**
Algorithms for executing trades automate the splitting and timing of buy or sell orders placed by investors, choose optimal markets, and make other adjustments, in order to achieve objectives such as cost reduction. Some of these algorithms are designed to conceal the execution of trades from other investors, thus mitigating market impact cost, i.e., the price change that occurs from the action of buying or selling a security. Others incorporate mechanisms to ensure compliance with market rules.

Splitting large orders into smaller ones, and placing these smaller orders gradually over time, is an effective way of reducing market impact cost. However, the longer it takes to complete the execution of an order, the greater the risk of market price movements (timing cost). Therefore, one important role of execution algorithms is to determine and implement the optimal timing that will minimize the sum of these two costs.

(2) **Trading using benchmark execution algorithms**
Benchmark execution algorithms, aimed at ensuring that the results of order execution approximate a defined benchmark, are used when executing large orders. For example, when splitting a large order into several smaller ones in order to limit market impact cost, a benchmark execution algorithm may be designed and applied to ensure that the average price of each small order approximates a benchmark such as the market closing price.

(3) **Trading using market-making algorithms**
Just as regular market makers do, market-making algorithmic traders place both buy and sell limit orders. By placing such orders simultaneously, at prices more favorable than the current market price (mid-price), and then awaiting other market participants to trade with, market-making algorithmic traders aim

to profit from the difference between the market price and the bid or ask price. If buy and sell orders of the same size are executed, the trader will then profit from the combined bid–ask spread.

Such trading by market makers provides market liquidity, thus contributing to the stability of markets. Investors utilizing market-making algorithms must constantly adjust spreads and order sizes to respond to the movements of markets and order books, repeatedly place new orders, adjust, and cancel orders in accordance with these changes.

(4) **Trading using arbitrage algorithms**

When the prices of identical securities, or other equally valued products or instruments, differ at the same point in time, arbitrage algorithms seek to generate profits by simultaneously selling at the higher price and buying at the lower price, and then closing these positions after the prices converge. In this way, traders can make profits while limiting the price change risk (market risk). To the extent that the application of arbitrage mitigates or eliminates distortions in markets, it can be said to contribute to enhancing market efficiency.

Four processes must be completed before arbitrage trading can generate profits: the discovery of arbitrage opportunities; the opening of arbitrage positions; the total or partial resolution of price distortions; and the closing of the arbitrage positions. Because the effect of arbitrage is to eliminate price distortions, the investor who first takes advantage of an arbitrage opportunity can make the greatest profit. Therefore, speed is vital in the first and second arbitrage processes: the discovery of arbitrage opportunities, and the opening of arbitrage positions, respectively.

(5) **Trading using directional algorithms**

Directional algorithms are used to predict changes in market prices using market data such as prices and trading volumes as well as news and other event data. They are also used to generate profits from trading based on these predictions. The strategy behind their use is to profit from unidirectional changes in market prices. This style of trading is generally high-risk and high-return.

(6) **Trading using market manipulation algorithms**

Market manipulation algorithms are applied to move market prices in a favorable direction by issuing orders designed to mislead other market participants with respect to information, such as the provision of liquidity or the intention to buy or sell. Using these algorithms can enable the user to achieve considerable profits. In some cases, these algorithms can operate to reduce trading costs by attracting significant liquidity to the market. They can also delay or prevent the execution of orders by other market participants by causing the repeated cancellation of large orders.

2.3 Using Machine Learning in Algorithm Construction

Two types of methods are used to construct the algorithms used in the trading strategies described above; a theoretical approach and an empirical approach (NTT DATA Financial Solutions Corporation, 2018). Using the theoretical approach, the designer establishes certain assumptions regarding price movements and the mechanisms that determine market conditions, and constructs a model based on this. In contrast, using the empirical approach, a computer is programmed to discover patterns in historical data using AI technologies, such as machine learning, and then search for a model that matches these patterns.

The theoretical approach facilitates the validation of the assumptions made and the correction of any problems, as the designer understands the mechanism of the algorithm. At the same time, however, the strength of the theoretical approach is dependent on the designer's individual experience and is constrained by the fact that there is a limit to the number of theoretical causal relationships that any designer can recognize and understand. Consequently, it can be anticipated that using the empirical approach to construct models based on more extensive and diverse case data will lead to better trading performance. Therefore, a combination of theoretical and empirical approaches is often used in algorithm construction.

2.4 The Struggle Between AI Technologies

Among the forms of algorithmic trading described above, competition often arises between the AI technologies used by the brokerage divisions of securities companies in their execution algorithms, and market-making algorithms used by HFT firms. The execution algorithms used by securities companies automatically determine a series of processes for the execution of large orders received from customers, such as order splitting, order timing adjustment, and the selection of optimal markets. In this way, execution algorithms try to prevent these large orders from being detected by other investors, and to execute them without giving rise to market price movements. In contrast, HFT firms using market-making algorithms aim to profit from rapidly placing, altering, and canceling both buy and sell orders. Rather than preventing the detection of large orders, as execution algorithms do, these market-making algorithms operate to quickly detect the existence of large orders in the market and then profit by anticipating their execution. This leads to an intense struggle between the AI technologies designed to conceal the existence of large orders, and the AI technologies designed to uncover them.

2.5 What is HFT?

HFT refers to a type of algorithmic trading where securities are bought and sold at high speed and high frequency. The Committee on Economic and Monetary Affairs of the European Parliament (2012b) defines high-frequency trading as "algorithmic trading in financial instruments at speeds where the physical latency of the mechanism for transmitting, canceling, or modifying orders becomes the determining factor in the time taken to communicate the instruction to a trading venue or to execute a transaction" (art. 4, para. 2(30a)). The Committee further characterizes a high-frequency trading strategy as a trading strategy that involves high-frequency trading and satisfies two of the following five conditions:

(i) The utilization of co-location services (services that allow trading participants to place servers and other devices that execute trades physically close to the trading system operated by the securities exchange), direct market access or proximity hosting
(ii) The daily trading value is at least 50% of the portfolio
(iii) The order cancellation rate is higher than 20%
(iv) The majority of positions taken are unwound within the same day
(v) There are discounts or rebates on more than 50% of transactions or orders (art. 4, para. 2(30b)).

Trading algorithms used in HFT

Of the six forms of trading algorithms examined above, three in particular tend to be used in HFT: market-making algorithms, arbitrage algorithms, and directional algorithms. The most common of these are market-making algorithms. High-frequency, high-speed trading is effective for market-making, because of the need to constantly place, alter, and cancel orders according to changes in market prices and liquidity.

For arbitrage, the greatest profits can be generated by algorithms that are able to discover price distortions—arbitrage opportunities—and execute arbitrage trades the fastest. In this context too, the use of HFT is effective. This type of algorithmic trading, HFT, was described in *Flash Boys: A Wall Street Revolt* by Michael Lewis, published in 2014. In the US, New York is the hub for trading individual stocks, while trading of equity index futures is centered in Chicago. A direct fiber-optic cable was laid between these two cities with the aim of encouraging arbitrage trades between their two markets.

Similarly, in the case of directional algorithms, the use of HFT is effective when the aim is to attain trading profits over a short period of time.

2.6 Background to the Growth of HFT for Arbitrage in the US

Regulatory reform in the US provided the opportunity for more active use of HFT in arbitrage. The US Securities and Exchange Commission (SEC), uneasy about the monopoly exercised over equities trading by the New York Stock Exchange (NYSE) and Nasdaq, promoted regulatory reform aimed at stimulating competition between securities exchanges. As a result, from the 1990s onward, markets became increasingly fragmented, with orders executed on a greater number of exchanges or alternative trading systems (ATS), or by market makers other than exchanges.

The more places—markets—where a stock is traded, the greater the number of possible discrepancies between indicative prices and, therefore, the greater the opportunity for arbitrage. Investors progressively introduced high-speed trading systems capable of rapidly responding to changes in order book information. At the same time, markets, i.e., securities exchanges, themselves also increased the response speed of their order execution systems in order to meet the needs of these investors.

In Japan, however, with the Tokyo Stock Exchange accounting for around 90% of the total value of trades, the use of HFT for arbitrage is relatively minimal. Rather, the use of HFT in Japan centers on market-making algorithms.

2.7 Will HFT Approach the Speed of Light?

A relatively small number of emerging companies manufacture network switches that enable the processing of transactions at the equivalent of the speed of light. In 2016, *The Wall Street Journal* reported that network switches manufactured by Metamako, based in Sydney, Australia, and xCelor, based in Chicago, required just four nanoseconds, i.e., four billionths of a second to relay information such as data sent from a securities exchange to an electronic trader (Sprothen, 2016). Consequently, for some HFT processes, trading really is approaching the speed of light. Does this mean that the competition for greater speeds in HFT is coming to an end?

As the speed of trading almost literally approaches the speed of light, the amount of investment required to increase this speed so that it is even fractionally higher than that of competitors is growing exponentially. With the marginal cost of greater speeds becoming higher, HFT firms can be expected to stop making additional investments in speed when the marginal cost of such investments matches the marginal expected return. As I will discuss later, the proportion of HFT within all equity trading in the US has actually been decreasing since its peak around 2009. Some have cited this as an indication that the investment in speed has already reached just such a critical point at which the cost of such investment is no longer worthwhile. Nevertheless, in the US, firms still compete to achieve speeds even fractionally faster than that of their competitors moving ever closer to the speed of light. Clearly, the critical point has not yet been reached.

3 Reviewing the Historical Development of HFT in Japan and Around the World

3.1 HFT First Flourished in the US

It was in the US that HFT first became popular. By the mid-2000s, many HFT firms were already participating in US markets. The percentage of HFT in all stock trades increased rapidly through the second half of that decade, and had reached 61% by 2009, according to an estimate by Valerie Bogard of the Tabb Group, a US research firm (Bogard, 2014).

After this peak around 2009, however, the percentage of HFT in total market activity began to decrease. Excessive competition and declining profits were likely the reasons for this decline. In many ways, HFT is a zero-sum game, and an increase in HFT firms tends to decrease each firm's profits. According to the Tabb Group's estimates, in 2012, the HFT industry earned a combined revenue of 1.8 billion dollars on US stock markets. This represents a decrease of roughly 70% from the 5.7 billion dollars earned in 2010 (Tabb, 2012).

It is also possible that the sudden drop in stock prices in May 2010—the so-called flash crash—contributed to reduced participation in HFT. Subsequently the HFT firm Eladian Partners was driven out of business in 2012. It was followed by Infinium Capital Management in 2014.

By 2014, the percentage of HFT as a proportion of the total value of all trades as estimated by Bogard had decreased to 48.5%. Since then, HFT's share of trading value appears to have remained relatively stable. Because this proportion is close to 50%, it may be inferred that a situation exists in which each trade involves an HFT firm on one side and a non-HFT counterpart on the other. If this proportion were to exceed 50%, then the struggle between HFT firms on both sides of trades to achieve profits would lead to the elimination of some of them. A proportion of around 50% is thus regarded by some observers as the upper limit of sustainability for HFT. According to such analyses, the proportion of over 60% seen in 2009 is gone and never to return, as this would be unsustainable.

In Europe, HFT activities were much like those in the US, albeit with a lag of several years. The percentage of HFT as a proportion of equities trading in Europe based on the total value of all trades was 29% in 2009, and reached 38% in 2010 (World Federation of Exchanges, n.d.). Subsequently, however, it trended downwards, and is estimated to have sunk to 24% by 2014 (European Securities and Markets Authority, 2014).

3.2 HFT Firms Move to Japan from Saturated Markets Such as the US

The spread of HFT in Japan occurred later than in Europe or the US, where its share of market trading peaked around 2010. Its initial spread in Japan was driven by the launch of the Tokyo Stock Exchange "arrowhead" equities trading system in 2010 aimed at delivering high performance and ensuring reliability through world-class speed, reliability, and extendibility, all of which facilitated high-speed trading. The introduction of the arrowhead system paved the way for full-fledged HFT.

In 2010, just as the proportion of HFT in the US had begun declining from its peak, HFT activity began spreading rapidly in Japan. It is possible that the spread of HFT in Japan was also boosted by HFT firms shifting their activities to Japan from the saturated US markets, which were becoming less profitable.

In *Analysis of High-Frequency Trading at Tokyo Stock Exchange* (Hosaka, 2014), HFT represented 25.9% of the equity trading (value based) in Japan in 2014. This is roughly equivalent to the level in Europe at around the same time. However, it has been suggested that the proportion of HFT in Japan has grown since then, given the upgrade of the "arrowhead" equity trading system by the Japan Exchange Group in 2015,[3] and the quantum increases in trading speed and the number of transactions processed. Current levels of HFT in Japan, although lower than those in the US, are quite possibly higher than in Europe. It should be noted that the percentage of HFT as a proportion of equity trading in Australia was estimated to be 27% from January to March, 2015 (Australian Securities and Investments Commission, 2015). On the other hand, the proportions of HFT in two Asian markets, the Hong Kong and Singapore trading markets are thought to be very low (Wheatley, 2011) (Fig. 1).

3.3 Activities of HFT Firms in Japan's Highly Concentrated Market

Compared to markets in Europe and the US, Japanese equity markets are highly concentrated, meaning that the level of market fragmentation is low. This is reflected in the Tokyo Stock Exchange's overwhelming share in equity trading.

As can be seen by the description of the nature of HFT trading in the US found in *Flash Boys*, the dispersion of trading over many different markets creates an environment that enables HFT firms to profit from arbitrage. Moreover, a large number of markets translates to a large number of opportunities for HFT firms to engage in market-making. In this sense, the greater the market fragmentation in a country, the more profit opportunities it provides for HFT, and the more attractive it is for HFT firms.

[3] See https://www.jpx.co.jp/english/systems/equities-trading/01.html.

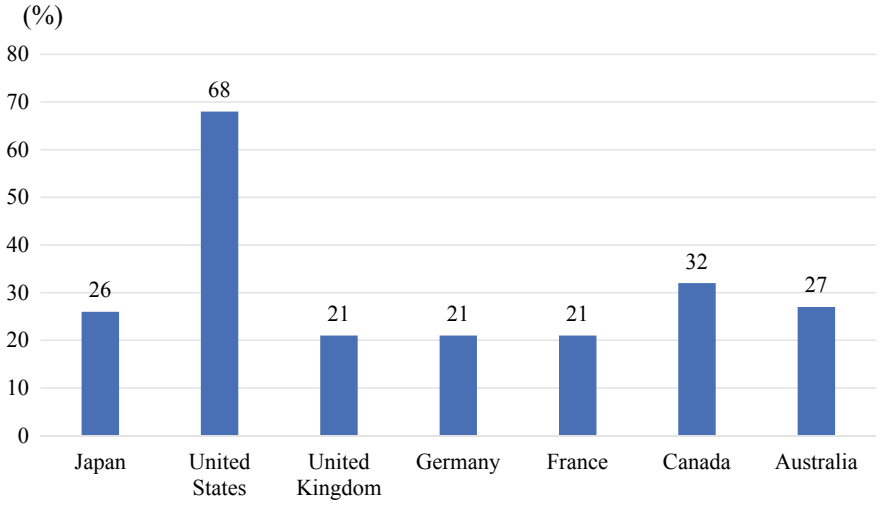

Fig. 1 International Comparison of the Proportion of HFT in Equity Markets. *Source* Interim Report of 'The Conference on the Impact of IT Innovation on Securities Markets' (Fukuda, 2015). *Notes* (1) Comparisons are based on the total value of all trades. (2) Measurement periods are as follows. Japan: September 2012, January, and May 2013; US: January 2008–February 2010; Canada: August–November 2011; Australia: May–July 2012. All other countries: May 2013

From this perspective, Japan, where equities trading is largely concentrated on the Tokyo Stock Exchange, may not at first glance appear to be an attractive market for overseas HFT firms. The fact that, as discussed below, foreign HFT firms are nevertheless highly active in Japan, is explained perhaps by the saturation of overseas markets, leaving Japan as a place where they can still survive and profit.

3.4 The Domination of the Japanese Market by Foreign HFT Firms

Japan introduced a registration system for HFT firms in April 2018. As of October 15, 2020, 55 HFT firms officially referred to as "those engaging in High Speed Trading" had been registered. With the exception of one Japanese firm, the head offices of all the registrants are located in countries other than Japan (see Table 1). The clear domination of Japan's HFT by foreign players seems to indicate that HFT firms from the saturated US markets have now moved to Japan seeking profit opportunities.

It is therefore quite likely that much of the profit from HFT in Japan is flowing out of the country. This situation may place domestic investors, particularly individual investors who are not engaged in HFT, at a disadvantage.

And yet, as of today, there does not appear to be much criticism of foreign domination of Japan's HFT market in the country. Perhaps this is because there is a stronger

Table 1 Location of the Head Offices of Registered HFT Firms in Japan (as of October 15, 2020)

Hong Kong	14
US	13
Singapore	12
Australia	7
United Kingdom	2
Israel	2
Netherlands	2
Germany	1
Ireland	1
Japan	1

Source Financial Services Agency

awareness among market investors and other relevant parties of the positive contributions of HFT, such as supplying the market with liquidity. Or perhaps the paucity of criticism is due to a lack of awareness of the very existence of HFT firms among the general public in Japan.

Eventually, however, foreign HFT firms may one day be subject to closer scrutiny by the Japanese population. The situation is reminiscent of the time when some overseas investment funds, referred to as "vulture funds," which invest in weak or even defaulting debt, beat down the prices of Japanese companies, resulting in a particularly cautious stance among the Japanese population.

4 Evaluation of the Impact of HFT on Financial Markets

4.1 HFT Effectively Enhances Market Functioning

Both the positive and negative effects of algorithmic trading, and of HFT in particular, have been the subject of debate from a variety of perspectives. First, considering the market-making algorithms used by the majority of HFT firms for trading, one of the most often cited positive effects of HFT is its role in supplying liquidity. Not only does the HFT activity of placing both buy and sell orders contribute to the supply of liquidity, but it is also instrumental in maintaining market stability.

Second, HFT trading based on arbitrage algorithms, another of the main forms of trading algorithms used by HFT firms, eliminates price divergence by rapidly placing orders whenever an arbitrage opportunity is discovered. To the extent that HFT eliminates these price differences, or market distortions, it can be viewed as improving market efficiency.

Therefore, given HFT's impact on supplying capital, stabilizing markets, and enhancing market efficiency, it seems clear that HFT-style algorithmic trading effectively enhances overall market performance.

4.2 *Empirical Research Overseas on the Effect of HFT on Market Performance*

There is a large body of empirical evidence from outside Japan on how HFT supplies and enhances market liquidity. Table 2 shows some representative examples of this research.

Empirical research from the US and Canada indicates that HFT effectively enhances market liquidity. Supporting these findings from a different perspective is an empirical analysis from the United Kingdom showing no evidence that increased HFT leads to higher trading costs for market participants by reducing market liquidity (Brogaard et al. 2014b).

Moreover, the conclusions drawn from significant empirical research conducted outside of Japan indicate that HFT has the effect of enhancing market efficiency. Table 3 shows some representative examples of this research.

The contribution of placing orders using HFT in determining efficient price levels has been confirmed through empirical analysis in the US and UK.

Table 2 Empirical research on the supply of liquidity by HFT

• Empirical analysis of equity markets in the US: Zhang and Riordan (2011) → Tendency to draw liquidity away from highly liquid stocks, and provide liquidity to less liquid stocks
• Empirical analysis of equity markets in the US: Brogaard et al. (2014a) → Institutional investors' trading costs (the costs of correcting for market movements) have not increased, despite an increase in the proportion of HFT due to system renewal
• Empirical analysis of equity markets in Canada: Brogaard et al. (2014a) → Observed reduction in HFT and shrinking in the bid–ask spread after an increase in trade commissions

Source Nomura Research Institute, from various materials

Table 3 Empirical research on HFT's enhancement of market efficiency

• Empirical analysis of equity markets in the US: Zhang and Riordan (2011) → HFT rectifies divergence from efficient price levels
• Empirical analysis of equity markets in the UK: Benos and Sagade (2016) → HFT actively promotes movement towards efficient price levels, and tends to anticipate orders that may cause price divergence

Source Nomura Research Institute, from various materials

4.3 Results of Research in Japan

In Europe and the US, there is a significant body of academic research on HFT's impact on markets. Much of this research presents a positive assessment of HFT's impact on equity markets insofar as it contributes to enhancing the price discovery function and increasing liquidity.

The large amount of research on the subject in Japan, a relative newcomer to HFT, is notable for its focus on the changes in markets that occurred due to the advent of full-fledged HFT following the launch of the "arrowhead" trading system in 2010. For example, an analysis conducted by the Tokyo Stock Exchange (Hosaka, 2014) clarifies the characteristics of HFT firms by classifying orders into those placed by HFT firms and those placed by others, based on attributes of HFT as defined by the Committee on Economic and Monetary Affairs of the European Parliament (2012a) of having an order execution rate of less than 25%, and an order cancellation rate of more than 20%. According to Hosaka's study: (1) few orders were placed in after-hours trading; (2) market orders were extremely rare; and (3) many orders were limit orders, placed outside the best bid and ask prices, which therefore tended not to be filled immediately, but rather to remained in the order book, unfilled, for a long period of time. This suggests that the orders placed by HFT firms provide the market with liquidity, and contribute to market stability.

Table 4 shows the results of some representative examples of empirical research into the impact of HFT on market liquidity in Japan.

Table 4 Empirical research on HFT's enhancement of market efficiency

• Uno and Shibata (2012) → High-speed trading grew after the launch of "arrowhead," and the supply of liquidity became more dynamic as a result
• Arai (2012) → The introduction of "arrowhead" made the supply of liquidity more dynamic for stocks subject to large price movements, and resulted in lower trading costs
• Hosaka (2014) → Many of the executed orders placed using HFT provided liquidity through this transaction. Many HFT limit orders are placed outside the best bid and ask prices, thus increasing the depth of the order book. Many HFT orders work to suppress price movement, softening the movement of stock prices
• Ōta (2016) → Spreads shrank markedly after the introduction of "arrowhead"

Source Nomura Research Institute, from various materials

4.4 The Possibility That HFT May Destabilize Markets

Despite extensive research about HFT throughout the world indicating that HFT effectively increases market liquidity and enhances market efficiency, there are others who argue that HFT-style algorithmic trading destabilizes financial markets. As already mentioned, the involvement of HFT is immediately suspected each time a "flash crash" occurs. Indeed, it is possible that in the event that markets become unstable for some reason, algorithms may act in unforeseen ways, resulting in an amplification of market instability.

Others have pointed out the possibility that a "runaway" algorithm, whether caused by a malfunction or some other factor, might cause disruption in markets. In addition, it is possible that, because HFT firms place, alter, and cancel orders swiftly and frequently, a few HFT firms may dominate price formation, with other investors unable to accurately grasp market conditions, thus resulting in price formation distortions. However, these effects remain in the realm of conjecture, as, in contrast to the abundance of research on the HFT's positive effects on markets, there appears to be relatively little research on its negative effects. Nonetheless, it cannot conclusively be determined that the positive impact of HFT on markets outweighs its negative effects, as research on HFT's negative effects may simply be more difficult to carry out due to data and technical limitations.

4.5 Conflicting Opinions on Whether HFT Amplifies Market Disruption

Even if it is now clear that HFT effectively enhances market functioning under normal, calm conditions, uncertainty remains regarding the value of HFT in times of crisis. It could well be that when markets become turbulent for some reason, HFT amplifies this turbulence. However, to date, this effect has not been supported by sufficient research.

In one example of such research regarding the relationship between HFT and the flash crash of 2010, Professor Andrei Kirilenko of MIT writes that when the flash crash occurred and price movements were accelerated, automated programmatic trading by HFT firms immediately withdrew the best bid and ask orders, which amplified price movements. He concludes that, when markets are under stress, biases in HFT order flows become more pronounced, leading to further price movements. In brief, HFT amplifies market disruptions (Financial Services Agency, 2016).

The above represents one view, although opinions about the potential harm caused by HTFs remain widely divided. Professor Terrence Hendershott of the University of California, Berkeley, writing that no meaningful evidence exists that the algorithms used in HFT vary their volume of trading according to changes in volatility, argues that algorithmic trading works to suppress rather than heighten volatility (Financial Services Agency, 2016).

4.6 The Issue of Fairness in Trading

Others claim that HFT, because of its ability to capture trading opportunities that might exist for only a moment, something which is difficult for average investors, creates what could be considered unfairness among investors. For example, even if average investors make decisions and submit orders based on the current market order book, by the time these orders reach the exchange, the order book will often have changed due to high-speed trading by HFT firms.

In addition, it is often pointed out that some HFT consists of market manipulation and other unfair trading practices. As stated, HFT entails the frequent placing, altering and canceling of large orders, and some have argued that these orders include some practices that are banned as market manipulation, such as "layering," where traders place large orders that they have no intention of executing, and then cancel them when they are close to being filled. Indeed, there have been a few cases in Japan, where trading has been conducted with the intent to manipulate markets, and HFT firms have been exposed as the perpetrators.

5 HFT Regulation as a Preventive Measure

5.1 HFT Regulation and System Response in the US

Despite the extensive research on the possible impact of HFT, the underlying trading strategies used by HFT firms remain a black box; as a source of firm revenue, they are deliberately made difficult to discover. In response to a growing perception that HFT may lead to market disruption, and concern that some HFT firms may be involved in unfair trading such as market manipulation, despite there being no conclusive evidence of either, there is increasing public pressure to implement measures to prevent problems arising from HFT. These measures consist of the introduction of various rules by self-regulating bodies, and of regulation by authorities.

In Europe, regulators began by providing a clear definition of HFT for the purpose of regulation. By contrast, no such clear definition of HFT exists in the US. Even the definitions provided by the Commodity Futures Trading Commission (CFTC) and Securities and Exchange Commission (SEC) in 2010 are very general. Consequently, no regulation directly targeting HFT specifically has been introduced in the US. Still, the US is notable for its progressive application of regulations targeting some forms of HFT-style trading.

For example, the US bans naked trading, the practice of granting traders direct access to securities exchanges unfiltered by brokers' order placement systems and without any intervening system to check customer orders. Where such a system exists, it is referred to as sponsored access. This ban on naked access substantially reduces excessive competition between securities companies to acquire HFT customers.

The use of stub quotes, which are limit orders that are deliberately set far lower or higher than the prevailing market price, is also banned in the US. They are used by market makers seeking to meet their price quote obligations without any intention of having their orders executed.

5.2 HFT Regulation in Europe

HFT is clearly defined in the EU through the Markets in Financial Instruments Directive II (MiFID II), a new, comprehensive regulative framework for financial and capital markets. Under this directive, all algorithmic trading firms, including HFT firms, have an obligation to report the details of their trading to the regulatory bodies. Additionally, securities exchanges are required to ascertain whether or not each order originates from an algorithmic trading firm.

Registration is also required for algorithmic trading firms that implement market-making strategies, and they must meet certain standards for supplying the market with liquidity.

5.3 HFT Regulation in Japan

In Japan, government and cabinet office ordinances regulating HFT came into force in April 2018, pursuant to amendments to the Financial Instruments and Exchange Act. HFT firms ("those engaging in High-Speed Trading") are now required to register and provide prior notification of their trading strategies, and registration will be rejected if there are any shortcomings in the firm's equipment or systems. As already noted, 55 HFT firms were registered as of October 2020.

A definition of HFT firms has been established in Japan, although it is not as clear as the definition established in Europe. In Japan, HFT is commonly understood as trading where methods are implemented to transmit orders, etc. in a shorter time than usual, and mechanisms are established to prevent competition with other ordinary orders.[4] In addition, HFT firms have an obligation to prepare and preserve trading records. The supervisory authority can demand and inspects reports, and issue business improvement orders.

Regulation was not introduced in Japan with the intention of eliminating HFT firms on the basis of any inherent impropriety on their part. Rather, Japanese regulation aims to enable regulators and securities exchanges to obtain an accurate understanding of the actual status of HFT firms, which would otherwise be unclear, and to promote the establishment of an environment for enhancing their supervision.

[4] High-frequency trading is defined in article 2, paragraph (2) of the FIEA; for obligations of HFT traders, see article 66–67 of the FIEA.

The registration system was introduced because it was judged, with reasonable grounds, to be necessary for authorities to grasp the de facto situation regarding HFT. Many HFT firms are unlisted and disclose little information publicly. This makes it difficult for authorities to gain an understanding of their actual status and activities. Without the registration system, it would be necessary for the Tokyo Stock Exchange and other private sector companies to monitor the situation autonomously. This would entail significant cost, and certain aspects that could be difficult to implement. By introducing a registration system, Japan has clearly indicated its position, with the national administration responsible and paying for the system, and taking measures when any unfairness is exposed. There were some initial concerns that the introduction of a registration system would inhibit HFT activities, but at present, there is no evidence to support these concerns.

5.4 Few Cases of HFT Unfair Trading Have Been Exposed in Japan

To date, very few cases of unfair trading related to HFT have been exposed in Japan. Three reasons can be suggested for this.

First, markets in Japan are not as fragmented as those in the US. As a result, there is relatively little market distortion, and far less HFT in Japan than in the US or Europe. In addition, even if unfair trading by HFT firms is discovered, some aspects of exposing such trading may be difficult due to the limitations placed on regulatory controls in Japan. Finally, it is possible that regulators have not been able to trace unfair trading by HFT firms due to inadequate technology.

Of these reasons, the last seems the most likely to have affected HFT regulation in the past. Indeed, it seems that it was technically difficult for regulators to detect unfair trading by HFT firms due to the extremely short timeframes involved.

With the introduction of a registration system however, regulators' grasp and assessment of unfair trading are becoming increasingly more effective. Moreover, private-sector initiatives are also helping enhance monitoring functions through the application of machine learning to vast quantities of market data using AI technologies, and these are becoming more adept at discovering suspicious activity.

Stronger relationships between the private sector and regulators, including the broad supply of information to regulators by private sector companies, should contribute to suppressing unfair trading.

According to the Japanese Financial Services Agency, "In contrast with Europe and the US, the amount of trading in Japan that unfairly exploits market fragmentation, etc. is limited. Even so, there have been cases of market manipulation using algorithmic trading, or working with algorithms, where corrective action has been required." It goes on to describe cases where monetary penalties have been imposed in cases involving market manipulation activities in which the offenders placed trading orders that they never intended to execute (Financial Services Agency, 2016).

6 HFT and the Securities Sector in Japan Today

6.1 Japanese Securities Companies Delayed the Introduction of Practices from the US

Finally, I would like to focus on two recent trends in the activities of HFT firms in Japan. In both, HFT firms are thought to benefit in some way by obtaining information on stock orders placed by investors. These cases have once again ignited the smoldering debate in academia on whether, after all, HFT benefits or damages the interests of other investors.[5] The mechanism behind both these HFT activities was imported from the US. In this sense, Japan, a relative newcomer to HFT, is following in the footsteps of the US model.

The first trend concerns smart order routing (SOR), a common practice in the securities business in the US. Securities companies have an obligation to execute orders received from their customers at the best terms possible, based on publicly available information on bid–ask quotes and trades, after considering factors such as prices, costs, speed, and the possibility of order execution. This is referred to as their duty of best execution. SOR is an automated system aimed at helping securities companies fulfill this duty of best execution by applying an algorithm to instantaneously select the market offering the best price.

6.2 Smart Order Routing and Order Book Information

According to a report in *The Nikkei* in November 2019 ("Japan's *Flash Boys*"), published by Ken Kawasaki (2019), an online securities broker working under the umbrella of one of Japan's financial groups, received orders from customers, many of whom were individual investors. He placed these orders on the optimal market, and used SOR between the Tokyo Stock Exchange and the financial group's own proprietary trading system (PTS). It should be noted that, in Japan, the obligation to trade stocks only through exchanges was abolished in 1998, and the ban on the proprietary trading system operation was lifted as a result.

After receiving a customer order, the online securities broker in question sent it first to the PTS, and then to the Tokyo Stock Exchange, if this was judged to be the optimal market. Even if the order eventually wound up on the Tokyo Stock Exchange, it would be exposed for a certain period of time on the PTS order book. This time was around 0.1–0.3 s. This may seem like only an instant, but for HFT firms, the interval of 0.1–0.3 s is an extremely long time.

It appears that HFT firms were able to obtain information on these customer orders, and then swiftly place orders on the Tokyo Stock Exchange in anticipation of these orders arriving. When this happened, the HFT firm that anticipated the order

[5] See, for example, Dalko and Wang (2019) and Dalko et al. (2020).

may have been able to profit from the trade, and the individual investor whose order was anticipated may have been forced to trade at a less favorable price as a result. According to *The Nikkei,* this scheme was introduced in October 2019.

6.3 The Emergence of Japan's Flash Boys?

The scheme described above closely resembles that described in Michael Lewis' *Flash Boys*, where an HFT firm obtained information on orders placed by other investors from the order book, and profited by instantly placing, altering, and canceling orders accordingly (Lewis, 2014). Their strategy was analogous to cheating at rock-paper-scissors, waiting to see their opponent's move, then playing their hand an instant later. The scheme described above is sometimes referred to as Japan's *Flash Boys.*

The aim of temporarily exposing customer orders on a PTS is sometimes explained as an attempt to stimulate counter orders, thus enhancing trading activity and improving execution rates. The Japanese financial group concerned revised its SOR execution method in November 2019, perhaps in view of criticism from some quarters, to prevent information on customer orders being temporarily visible from the outside.

However, it has been pointed out that even after this revision, in the case of customer orders that are sent by SOR to the PTS but which cannot be executed there and are thus transferred to the Tokyo Stock Exchange, there is still room for HFT

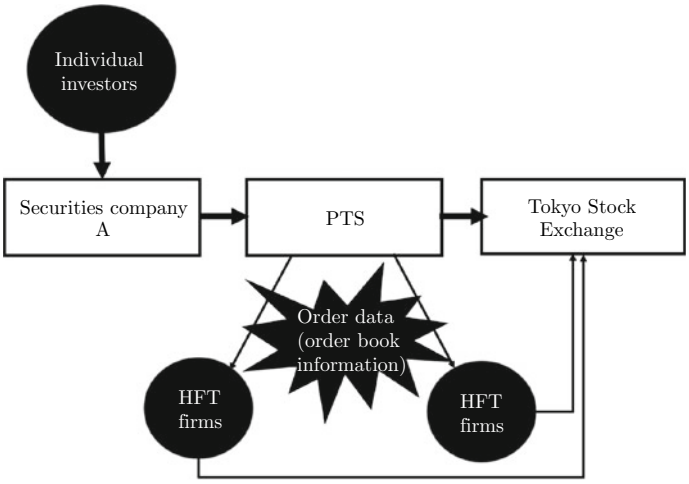

Fig. 2 Are HFT Firms Anticipating Orders by Individual Investors? Nomura Research Institute, from information published in *The Nikkei* newspaper

firms to anticipate and profit from the arrival of these unexecuted orders. Figure 2 shows SOR and a flow of individual investor orders to HFT firms in Japan.

6.4 *The Movement to Introduce Payment for Order Flow in Japan*

The other trend that I would like to focus on is the spread of payment for order flow (PFOF) to Japan, a practice common among securities companies in the US. This refers to a scheme whereby a securities company passes customer orders (transaction rights) on to market makers such as HFT firms, and receives a rebate (compensation) in return.

The setting for this scheme is, of course, the security company's PTS. HFT firms pay commissions to the PTS, and the PTS pays rebates to the online securities broker. In other words, rebates flow indirectly from HFT firms to the online securities broker via the PTS.

It is thought that HFT firms are willing to pay rebates for information on orders issued by individual investors because this allows them to enhance the precision of their proprietary algorithmic trading by analyzing this big data using AI, and utilizing it for purposes such as predicting the trading trends of individual investors in Japan.

Figure 3 shows how Japanese online securities brokers receive rebates from HFT firms under PFOF practices.

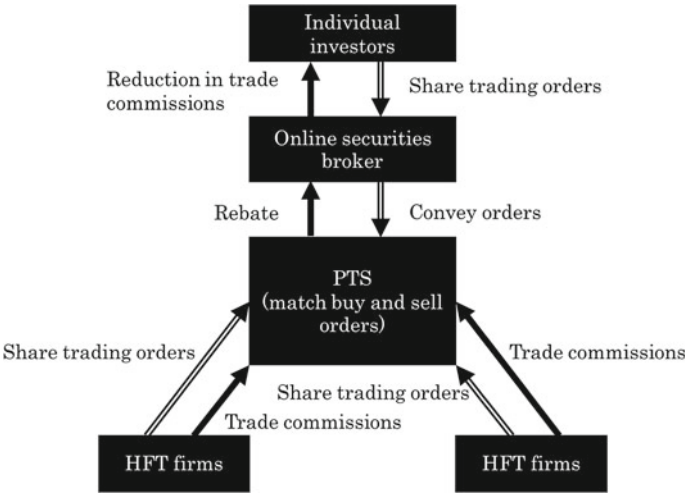

Fig. 3 Spread in the Receipt of Rebates from HFT Firms. Nomura Research Institute, from information published in *The Nikkei* newspaper

6.5 Information on Orders by Individual Investors is Valuable for HFT Firms

It may seem that, unlike orders by large investors, which can cause significant movements in the market, the small-scale orders placed by individual investors provide HFT firms with few profit opportunities. However, the accumulation of many of these small-scale orders by individual investors can have a substantial impact on the market. Moreover, large orders by institutional investors are sent to the market after being split into small portions by securities companies, to prevent them from affecting market prices, or even to prevent them from being detected by other market players. By analyzing orders by individual investors, HFT firms may well be able to enhance the precision with which they can differentiate between small-scale orders and large orders that have been split into several portions. If the presence of a large-scale order is detected, then they will be able to anticipate the arrival of later portions of the split order on the market, thus achieving significant profits.

It is reasonable to suggest that for these reasons, information on orders placed by individual investors is valuable for HFT firms, and they are thus willing to pay fees to obtain it.

6.6 Against the Backdrop of Commission-Free Trading

In this way, the movement by Japanese online securities brokers to introduce the US-style practice of PFOF undoubtedly represents an effort to secure new sources of revenue. In recent years, there has been a clear trend towards lower trade commissions (transaction fees) for share trading around the world. Japan is no exception.

Securities companies require other sources of income to supplement the reduction in revenue from lower commissions. Generally speaking, these consist of sources such as interest revenue from money lent to customers for margin trading, and stock loan fees changed for lending customers' shares to third-party investors wishing to a take a short position in that stock.

In Japan, however, with its extremely low interest rates, interest revenue from margin trading and stock loan fees from lending shares have both sunk to very low levels. It was in this context that Japan's online securities brokers began to seek to secure a new source of revenue through the introduction of PFOF. In addition, it is also possible that Japan's online securities brokers may be shifting their business models progressively to resemble more that of US Robinhood-style operations. Robinhood, an online (app-based) securities broker in the US that offers almost entirely commission-free trading, passes almost all the orders that it receives from customers to HFT firms. It is estimated that, as of early 2018, it derived more than 40% of its revenue from rebates from HFT firms.

6.7 Are the Interests of Individual Investors Being Protected?

Under PFOF systems, securities companies provide HFT firms with big data on orders, most of which have been submitted by individual investors, and receive rebates in return. These rebates are used by securities companies to fund the provision of commission-free trading platforms to individual investors. This scheme closely resembles the business models used by digital platformers, which provide users with free online services funded by external income from targeted advertising, etc. utilizing personal data acquired through these online services.

In this way, individual investors are effectively providing their order data to HFT firms in return for lower, or zero, trade commissions. It is possible however, that through this exchange, individual investors are being driven into a more disadvantageous trading environment by HFT firms. From this perspective, it is still not entirely clear whether, in fact, individual investors are receiving equivalent value in return. Further verification of this point is necessary in the future.

Japan's securities companies, operating under a persistent low interest rate regime, have a weaker earnings base than their US counterparts. For online securities brokers in particular, the importance of rebates from HFT firms may eventually be even more important than in the US. If this arrangement becomes institutionalized, then HFT firms active in Japan would play an even more important role than those in the US or elsewhere in supporting business models in the securities industry. Securities companies and HFT firms would be mutually dependent, bound together by a shared fate.

6.8 Research on HFT is Still in Its Infancy

As shown above, despite a relatively clear consensus on the contribution made by HFT firms to enhancing market efficiency, it is still undetermined whether HFT amplifies market disruptions, and whether it damages the interests of other investors, including individual investors. This uncertainty is no doubt due partly to a lack of clarity regarding the actual nature of HFT, conducted at speeds and frequencies that defy human comprehension. For both regulators and academics, research into HFT is still in its infancy.

As research on the subject advances however, and the merits and deficiencies of HFT become clearer, perhaps HFT will be able to evolve into a factor that contributes to further market development and new business models for the securities industry, such as those described in the last section. In this context, further developments in HFT research are to be welcomed.

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M. Heckel and F. Waldenberger (eds.), *The Future of Financial Systems in the Digital Age*, Perspectives in Law, Business and Innovation,
https://doi.org/10.1007/978-981-16-7830-1

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