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**FinTech Special Edition**  
—Financial Innovation and FinTech—

**Payment and Settlement Systems Department**  
**Bank of Japan**  
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## **(Payment and Settlement Systems Report Annex Series)**

The Bank of Japan regularly publishes the Payment and Settlement Systems Report with the aim to provide an overview and evaluate the development of its payment and settlement systems. The report also introduces the engagement of the Bank of Japan and relevant organizations to improve the safety and efficiency of the payment and settlement systems.

The Payment and Settlement Systems Report Annex Series provide in-depth analyses about specific themes concerning those systems. This report focuses on FinTech, which has now developed on a global scale, applying new information technologies to various financial services and market infrastructures. It also considers the implications of FinTech for the financial system and the real economy. The report then outlines the engagement of the major central banks after touching on technological developments behind FinTech.

This document is an abridged English translation of the Japanese original published on February 7, 2018, with the exception of the footnote for the Project Stella.

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## **Payment and Settlement Systems Report: FinTech Special Edition**

### **— Financial Innovation and FinTech<sup>1</sup> —**

#### **Summary**

In recent years, financial innovation, called FinTech which combines financial services with new information technologies, has been attracting global attention. Indeed, FinTech has an extensive impact on financial services. It enables those services to spread to the whole world including emerging and developing economies. This is often called "financial inclusion". It also facilitates new entries to the financial sector and enhances competition between incumbents and entrants. Furthermore, it highlights the growing importance of big data and IT platforms.

This report highlights the actions taken by relevant entities applying these technologies to various financial services such as payments and settlements. It focuses on three areas in which technologies have substantially advanced in this decade: i) smartphones, ii) artificial intelligence (AI) and big data analyses, and iii) blockchain and distributed ledger technology (DLT).

FinTech has the potential to spread financial services throughout the world and to promote the "globalization" of those services. It can also contribute to the "personalization" of financial services, involving the provision of those services tailored to each user's needs by using AI, big data analyses and smartphones. It can further contribute to making both financial and non-financial services "seamless". It will help new economic activity and development visible thus contributing to the solution of social challenges such as protecting the elderly from fraudulent activity.

For further development of FinTech, the report calls for the following measures. First, communication and cooperation should be promoted among a wide range of players in the private sector and the public entities. Second, in pursuing new types of financial transactions such as those related to crypto-assets, participants need to recognize the extent of risks inherent in such transactions, and relevant service providers ought to provide appropriate information and explanation to consumers and investors. Third, in order to prevent those risks from materializing, relevant entities need to take measures which include enhancing information security and preventing cyber-attacks.

Central banks are making efforts to engage in research and experimentation in the field of FinTech. The Bank of Japan established the FinTech Center in its Payment and Settlement Systems Department in April 2016. The Center performs a range of operations to promote FinTech. The Bank is also participating in international discussion as well as conducting research activity through its own initiatives such as Project Stella, a joint research project on DLT with the European Central Bank.

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## 1. Background of FinTech

In recent years, financial innovation, called FinTech which combines financial services with new information technologies (ITs), is progressing worldwide, not only in developed economies but also in emerging and developing economies. Behind such development, there are both demand and supply factors.

On the demand side, users' appetite for financial services has become increasingly diversified and more sophisticated reflecting their desire to pursue diversified life-styles against the background of globalization and digitization of the economy.

For example, the demand for faster and less-costly cross-border remittances is increasing in particular for those in emerging and developing economies. The demand for new financial services has also risen in light of the expansion of e-commerce and the proliferation of the sharing economy. Online shopping for second-hand goods has become popular and this has been made possible on the back of technological development surrounding FinTech. In fact, sellers and buyers of those goods may have no acquaintance with each other and those buyers tend to shop online in the evenings and on weekends. FinTech allows such transactions—even small-amount transactions—to take place without sharing credit card information. These types of transactions had not been feasible under old technologies.

On the supply side, a range of new ITs, which have made significant impact on financial services, have emerged almost at the same time. First, smartphones have rapidly spread across the borders since the launch of iPhone in 2007. They have become new vehicles to provide financial services instead of relying on traditional brick and mortar branch networks and ATMs.

Second, the amount of data in the society has rapidly increased due to the development of SNS and mobile applications. In association with the use of big data, artificial intelligence (AI) has also been developing. While AI itself is not a brand new technology, recent progress in the quality of AI—with the application of deep learning—has been significant.

Third, blockchain and distributed ledger technology (DLT) have been heavily explored since the release of the paper by Satoshi Nakamoto<sup>2</sup>. While the technology itself was developed for the purpose of introducing Bitcoin, it is expected to be widely applicable to a system managing ledgers under de-centralized structure.

Such historical "coincidence" that involves several important ITs emerging in around 2008 was an important factor underpinning the development of FinTech from the supply

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<sup>2</sup> Nakamoto, Satoshi, "Bitcoin: A Peer-to-Peer Electronic Cash System"

side.

On top of such developments, financial regulation was reinforced on a global scale after the global financial crisis. In some economies, public funds were injected to prevent their financial systems from collapsing. Public opinion was not favorable to such public supports to incumbent financial institutions; as a result, they welcomed new entrants to financial services in order to encourage competition. This has also become one of background factors behind the development of FinTech.

The core of financial services is information processing, and most of the new ITs that have recently appeared are related to the fundamentals of financial infrastructure, namely money and ledgers. It is for that reason that the IT innovation has been making a significant impact on financial services in the form of FinTech.

At the same time, FinTech represents information revolution or data revolution in the field of finance. In this sense, FinTech is not simply a notion applying internet and smartphones to existing financial services. Instead, it helps economic activity develop beyond its original domain by realizing, for example, sharing economy in which unemployed resources and unsatisfied demand of end-users will be met. Under these circumstances, financial services which are made possible by FinTech will be bundled with a range of non-financial services thereby allowing services to be seamlessly provided via application software.

Against such background, financial infrastructure is rapidly changing. In the traditional commercial banking, deposits were at the core of their businesses. In addition, banks provide credit intermediary services as well as payment and settlement services. In order to provide those services, fixed assets—such as brick and mortar branches, ATMs and mainframe computer centers—have become an essential part of their businesses. Recently, however, deposits are being taken over by big data and IT platform as the core of financial businesses. Instead of branches and ATMs, they use the smartphone applications and rely on cloud services. Such changes appear to be accelerating.

In terms of enhancing competition, many entrants in the financial services focus on specific areas such as money transfer and investment advisory services without providing a full range of traditional banking services. In addition, some players combine those services with non-financial services such as e-commerce and rental businesses. In this way, the unbundling and re-bundling of financial services are simultaneously progressing with the development of FinTech.

## **2. Basic Technologies behind FinTech and its Possible Application**

This section will focus on possible application of the following technologies to financial services. They are namely i) smartphones, ii) AI and big data analyses, and iii) blockchain and DLT.

The application of these technologies to businesses varies depending on the extent of their progress. For example, most of the engagement in the application of blockchain and DLT still remains at the level of research and experimentation with the exception of a few. By contrast, the offering of services via smartphones has already become one of the main means to access end-users for various businesses including finance.

### **2-1. Smartphones**

Since the launch of iPhone in 2007, smartphones have spread to the world. This has a significant implication for the global expansion of financial services.

Smartphones have rapidly spread even in emerging and developing economies where the networks of branches and ATMs of traditional commercial banks have not fully developed. It enables various financial services to be performed, without necessarily building such networks, through its application software in the form of mobile banking and mobile payments.

As a result, people living in those economies, particularly those living in remote areas that are difficult to reach, have much greater accessibility to those services (Chart 1). This offers a greater opportunity for those economies to expand the access to those services, thereby promoting financial inclusion. It will further contribute to catching up with developed economies without necessarily building an infrastructure of bank branches and ATM networks.

The smartphone is a device designed as "one for each person". It enables the provision of financial services which are tailor-made to the need of each customer. In addition, it has been used as a device to access various services covering the owner's daily life. Using SNS and downloading the application software are a few examples in which the owner enriches his/her life through the device. This means that the smartphone is a powerful device to bundle financial and non-financial services.

Chart 1: Examples of Financial Services Overseas Using Smartphones, etc.

China	Companies offering various services including payment and settlements using smartphones, such as Alipay and WeChatPay, are growing rapidly. The users of these services have expanded to hundreds of millions of people.
Sweden	Swish is a money transfer service operated cooperatively by major Swedish banks, which is accessible through mobile phones even during weekends and at night (24/7).
Kenya	M-Pesa, a money transfer and financing service using mobile phones has rapidly spread in Kenya. The service is available without a bank account.
India	Unified Payments Interface (UPI), a mobile settlement platform operated cooperatively by the central bank and the bankers' association, is in operation.
Thailand	PromptPay, a mobile money transfer system that operates by linking bank accounts and mobile phone numbers under the initiative of the central bank is spreading in Thailand.

Most of the payment and settlement services using smartphones incorporate a digital wallet. This wallet has the following features.

1. A user downloads the application software including the wallet and deposits money by linking that wallet with his/her own bank account or credit card.
2. A user (payer) initiates a funds transfer to another user (payee) through their wallets.
3. Once received, the payee can transfer the funds to his/her bank account or credit on the card. The funds can also be transferred directly from the payer's wallet to the payee's.

The retailer can receive a payment through the wallet by way of the following options. First, it can debit the payer's account by reading his/her QR code. Second, it can present its QR code to the payer who will read the code and instruct the payment. Using the QR code has its own merit in that the retailer can increase its customer base without installing the IC card reading device which tends to be costly.

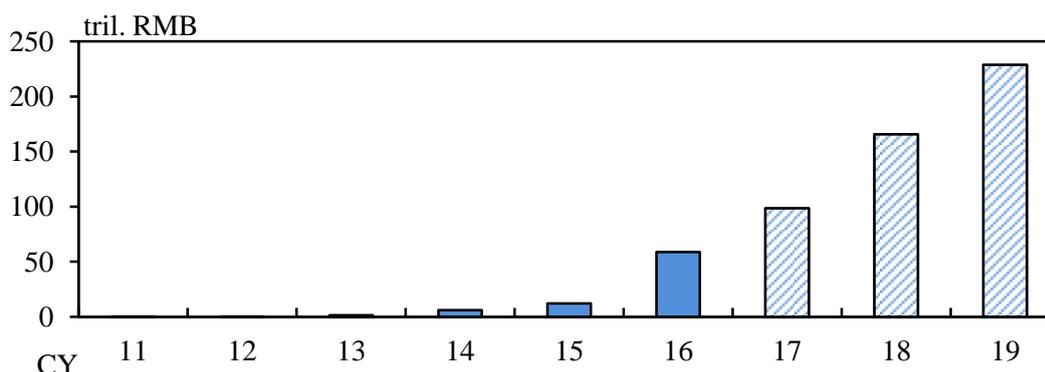
At the same time, using the QR code inevitably entails risks such as stealing a payer's QR code and presenting a fake QR code on the retailer so that the payment will go into another wallet rather than the retailer's.

For new entrants offering this type of payment and settlement platforms, the offering of such platforms does not necessarily constitute their source of earnings. Instead, they tend to focus on the business models in which they will raise profits from broadening their customer base as well as expanding the range of services on top of the platforms they provide. This will allow them to collect and accumulate big data. Using the data, they intend to provide services tailor-made to the needs of respective customers.

## Box 1: Settlements via Smartphones in China

In China, the market for payment and settlement services using smartphones, such as Alipay and WeChatPay, has been increasing rapidly. These services are widely used for purposes ranging from payments and settlements in stores using a QR code to personal money transfers and more ritual deliveries of money such as those on New Year's Day. Reflecting these movements, the cashless society is progressing (Chart B1-1).

Chart B1-1: Progress of Mobile Settlement Amounts in China

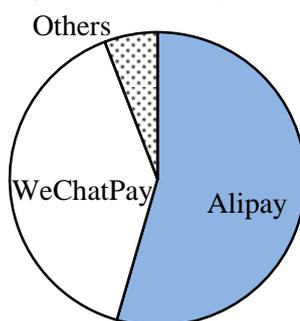


(Source) iResearch

(Note) Estimated figures from 2017

One of the characteristics of Chinese mobile payments is that the parent companies of the service providers (Alibaba for Alipay and Tencent for WeChatPay) are not financial institutions in origin. They were providing services such as e-commerce, games and SNS, and then used their networks, which had been expanded by these businesses as a vehicle for financial services including payments and settlements.

Chart B1-2: Share of Mobile Settlement Amounts in China (Second Quarter of 2017)



(Source) iResearch

For these companies, offering both financial services and non-financial services on the same platform has been a "basic" business model since their inception. They do not have to depend on the payment fees for their earnings. Instead, their aim is to earn through customer retention and collection, including the accumulation and wide use of big data (which, in terms of customers, is a mechanism to use inexpensive financial services in return for providing the data about themselves).

## **2-2. Artificial Intelligence (AI) and Big Data Analyses**

Artificial intelligence (AI) is generally defined as a research area in which human-like intelligence is artificially realized with the help of the computer's handling of big data.

Although AI itself is not new, recent advancement in deep learning and deep reinforcement learning (i.e., the combination of deep learning and reinforcement learning) has enabled its various applications. Owing to such development, AI research and its application have accelerated.

In the meantime, the quantity of data produced in the society has been dramatically increasing as the Internet and SNS prevail. It has now become critical for businesses to explore how to efficiently collect and effectively use those data. In this sense, AI is expected to play a pivotal role in processing big data most efficiently. Big data analyses using AI are being used not only for identifying the customers' attributes but also for forecasting demand and exploring possible application for financial services in, for example, risk management. Indeed, the application of AI and big data has spread from economic analyses to weather forecasts and medical research.

From the viewpoint of FinTech, the application of AI and big data analyses is the focus of attention because the fundamental function of finance is to produce and process information.

When assessing credit risk, financial intermediaries collect and analyze a wide range of data including financial conditions of potential borrowers and the prospects of their projects. In this regard, big data obtained through the services those intermediaries provide contain information which had not been available to them before. To be precise, information about "when, where and what did the customer buy" is likely to contribute to improving their risk management capability. This will also contribute to streamlining the resources allocated for such risk management; in fact, some entrants which specialize in short-term credit provision have substantially reduced human resources allocated for credit risk analysis and have instead relied on AI to handle such analysis.

AI and big data analyses have also made it easier to offer services that are tailored to respective users' lifestyles and are intended to meet the ad hoc needs of those customers in combination with smartphones. In financial markets, they have been increasingly applied for algorithm transactions and high frequency trading.

Also, the application of AI and big data to financial services and transactions in financial markets is expected to improve the price discovery functioning by capturing data attributes which had not been possible to collect before and by processing large amount of data expeditiously. This may also contribute to improving the efficiency of resource allocation.

As such, AI and big data analyses have the potential to improve financial intermediary functioning through actively using a wide variety of data. In addition, the improvement of market transactions by engaging in high-frequency transactions may enhance market liquidity.

On the other hand, if many market participants rely on the same algorithm, the price movements in financial markets may be skewed toward one direction. It is in this sense that the application of new ITs has to be carefully assessed by examining its impact on market prices.

Last, AI and big data analyses are increasingly being applied to a wide range of fields—such as marketing, the handling of back-office operations, regulatory compliance and reporting requirements—which are not necessarily bound to financial services. In some cases, the application of these technologies to non-financial services is producing new expertise which can be applied in finance as well. Overall, it is expected that AI and big data analyses will expand the frontier to financial services.

### **2-3. Blockchain and Distributed Ledger Technology (DLT)<sup>3</sup>**

The concepts of blockchain and distributed ledger technology (DLT) were introduced in the paper of Satoshi Nakamoto, published in 2008, where the idea of a crypto-asset—Bitcoin—was explored.

DLT is a technology in which ledgers are managed under the distributed structure by combining the existing cryptographic technologies without depending on a trusted third party to perform the book-keeping functions.

For example, the record of bitcoin transactions can be shared among all the participants. In this structure, they put multiple transactions into a "block" and record those transactions in "chained" blocks by including data with summary information about the previous block, which is called a hash, in a new block. To create a new block, a hash fulfilling some specific conditions is required. To get a new hash, a vigorous calculation competition method—which is called "mining"—is conducted and the participant who first finishes this calculation will be given new bitcoin as a reward. An important feature of the blockchain is the mechanism in which the correctness of the ledgers is secured through an economic incentive; even if there is someone who has the ability to tamper with the transaction history, it is better to do mining rather than tampering in this system.

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<sup>3</sup> The word "blockchain" is used in a narrow sense as a technology base for crypto-assets such as Bitcoin, while it is also used for the overall technologies which enable to ledgers to be managed dispersively, including the blockchain. In this report, we call the overall technologies "blockchain & DLT", which does not definitely distinguish between both meanings.

After Bitcoin was introduced, various types of DLT have been invented. There is a type of technology in which participants are first chosen and the correctness of the ledgers is secured by information exchanges only among those participants instead of the calculation competition among a large number of unspecified participants.

The application of DLT is not necessarily limited to crypto-assets. It is used to record the transfer of valued information and assets. The distributed ledger allows recording and sharing information among the participants. It also enables to incorporate functions such as a "smart contract" to automatically execute the agreements between the relevant parties. Accordingly, DLT is expected to be used for the management of transferring and recording various assets (e.g., intellectual properties such as paintings, jewelry and medical records).

### Box 2: Advantages and Challenges of DLT

As for the advantage of DLT, there are three issues that are often pointed out: first, the savings in the cost for the establishment and maintenance of centralized computing centers; second, the enhancement of the resistance against system failures and cyber-attacks; and third, the establishment of a system which will work 24 hours a day, 365 days a year without the limitations of the operation hours of centralized computing centers.

Under DLT, when some participants face a system failure or a cyber-attack, the system may continue to operate if the ledgers of other participants and the system itself function as normal. As such, DLT is expected to enhance the availability of the system as a whole.

At present there are different types of DLTs ranging from distributed types—such as Bitcoin—to the eclectic type combining the traditional centralized and distributed types. The latter allows only specific participants to manage the ledgers (Chart B2-1). In light of the variety of DLTs, it is important to consider which types of DLTs should be used depending on the business case for which DLT is expected to be applied.

Chart B2-1: Features of Main DLTs

	Bitcoin	Ethereum	Hyperledger Fabric	Corda
Summary	A crypto-asset in operation since 2009. A number of unspecified participants do the mining to verify transactions.	A crypto-asset in operation since around 2013. Ethereum allows a smart contract to be implemented.	Developed by IBM with more than 180 IT companies.	Developed by a consortium of R3 (US venture) with more than 70 financial institutions.
Public/Private	Public	Public	Private	Private
Data Sharing	All the participants	All the participants	Related participants only	Related participants only
Manager /Operator	Does not exist	Does not exist	Exists	Exists

The blockchain technology supporting Bitcoin is called a "public type", because anyone can participate in verifying transactions. In this type, there are no central book-keepers; in other words, the credibility of the system can be maintained through the process of reviewing transactions (i.e., mining) by the network participants. On the other hand, the technology also has some disadvantages; the review performed by a large number of unspecified participants consumes significant electricity and it takes some time to build a block. Efforts are currently being made to improve the performance of the public type by processing the redundant information (e.g., signature data) outside the blockchain.

Some DLTs that were invented after Bitcoin are called a "private type" or "consortium type". They have limited participants in the transaction verification process or they sometimes have an operator who manages the network. The merit of these types of technology is that the time needed to build a consensus for the transaction verification is shortened and a large amount of electricity for the verification is not required. On the other hand, the original merit of the public type—that is, no "single point of failure" or a critical target for cyber-attacks to stop the whole system—becomes diluted because it is an "eclectic mix" with a traditional centralized technology.

### **3. Impacts of FinTech on the Financial Economy**

FinTech, or the application of new information technologies to a wide range of financial services, may have impacts on both global financial services and economic activities.

#### **3-1. Impacts of FinTech on Financial Services**

##### **("Globalization" of Financial Services and Financial Inclusion)**

First, FinTech has the potential to spread financial services over the world.

Smartphones are rapidly becoming prevalent across countries including emerging and developing countries in which financial services had been immature. In these countries, people can now access financial services through the Internet and smartphones, even though a fixed infrastructure—such as branch offices and ATMs of financial institutions—is underdeveloped.

Through the application of big data analyses and AI, individuals (such as immigrants) and SMEs that previously experienced difficulties in accessing financial services are being given larger accessibility. In this way, FinTech has expanded the accessibility to financial services and has promoted financial inclusion. From the perspective of emerging and developing countries, this offers a great opportunity to catch up quickly with developed countries by skipping the process of building branch offices and ATMs.

In China, the payment services offered by relatively new companies, such as Alipay and

WeChatPay, have become an important infrastructure for the Chinese economy, acquiring hundreds of millions of users in a relatively short period of time. In Kenya, M-Pesa—a payment service offered by a mobile telecommunications company—has similarly become a dominant part of the nation's infrastructures.

### **("Personalization" of Financial Services)**

FinTech has been expanding the provision of financial services that are tailored to each user's demand through the use of a smartphone, a device designed as "one for each person", and the application of big data and AI. Together with the globalization of those services, FinTech has enabled the provision of financial services tailored to each person all over the world.

The detailed risks and attributes of each user can be captured by collecting and accumulating the big data. Those data can be used for credit risk management and new service offerings. At the same time, it will be necessary for the service providers to take appropriate measures in data security and privacy protection when offering those services.

### **("Seamless" Financial Services)**

FinTech involves information/data revolution surrounding the whole economy. As the IT revolution facilitates the development of various new economic activities such as e-commerce and a sharing economy, FinTech financial services are increasingly being provided in combination with those new non-financial services.

At present smartphones—by downloading various applications—have become devices covering overall lifestyle of people. When smartphones are used as new devices, financial services tend to be offered with other services in a seamless manner. For example, a car dispatch service using a smartphone application overseas has a series of automated processes including automated payment at a destination on top of reservations and guidance to the destination. There are also seamless services for a wide range of activities related to each user's lifestyle: movie theater reservations, booking of airplane and train tickets, asset management, and insurance sales. Those services are likely to create a virtuous cycle which supports the development of FinTech while stimulating the users' potential demands.

Furthermore, by using a smart contract, new automated procedures and processes—such as the issuance and allotment of equity, payment of dividends—are currently under consideration. These will likely integrate services related to corporate action.

### **("Virtualization" of Financial Services)**

FinTech is also expanding the likelihood of offering financial services that are not dependent on fixed infrastructure such as branch offices and ATMs as well as large

computing centers.

It has now become possible to establish a virtual financial services company with no fixed assets, if it uses the Internet and smartphone applications to liaise with its customers, and relies on the cloud services and AI to avoid owing large computer centers. Today, a number of financial services companies with few fixed assets have been established around the globe.

### **3-2. Impacts of FinTech on the Financial Infrastructure**

Each country is now making efforts to establish a flexible system with scalability and evolvability in consideration of the wide application of ITs to financial services.

It includes actions such as enabling money transfers using mobile phones and real-time money transfers 24 hours a day 365 days a year ("24/7 real-time payment"). It also includes promoting collaboration between traditional financial institutions and new FinTech companies through standardizing and opening Application Programming Interfaces (APIs) which are the bases for various services as a conduit between their systems.

The 24/7 real-time payment was introduced in the United Kingdom in 2008 and a similar service has been offered in Sweden since 2012. In the euro zone, a new transfer service based on the European common rules for 24/7 real-time payment has started in November 2017.

In the United States, the Federal Reserve presented its vision to provide a 24/7 real-time payment across the country through private sectors and the Faster Payments Task Force was established in 2015. More recently the Clearing House (TCH), a private clearing house, started a new system (Real-Time Payments) to facilitate 24/7 real-time payment in the United States in November 2017.

Turning to Asia, a 24/7 real-time money transfer service was introduced in Singapore in 2014. In Australia, a "New Payments Platform" will be launched in 2018. With this platform, there will be a common infrastructure with the participation of all banks, which will enable 24/7 real-time money transfers. Overlay services will be provided to improve the technological revolution and to flexibly add value to the underlying services.

In Japan, a 24/7 money transfer service will be introduced through the "More-Time System" (Zengin Data Telecommunication System) from October 2018. In addition, the financial Electronic Data Interchange (EDI) will be launched toward the end of the year. The EDI will enable the integral processing of financial and commercial information accompanying the commercial transactions (see "Private FMIs and FinTech" for more details).

Turning to the standardization and opening of the APIs, Europe disclosed a common API framework and the revised Payment Services Directive (PSD2) was published. PSD2 aims to facilitate the entry of FinTech companies into the payment and settlement fields and to encourage the development of revolutionary mobile and online settlements. Such initiatives will lead to the improvement of third parties' accessibility to bank accounts.

In Japan, after the amendment of the Banking Act in June 2017, FinTech companies are now required to register as an "electronic payment service provider". Financial institutions, in return, are required to disclose their APIs based on the agreement between the two. Furthermore, those institutions need to prepare and disclose their policy for coordination/collaboration with the payment service providers. The government's growth strategy (Investment for the Future Strategy 2017) set a numerical target to facilitate the engagement of open APIs, while the Review Committee on Open APIs of the Japanese Bankers Association—in which the Bank of Japan participates as an observer—published guidelines for user protection and security with respect to open APIs. In this way, Japan is aiming to promote open innovations in which FinTech companies, financial institutions and the government are able to collaborate.

### **3-3. Impacts on Financial Stability and the Real Economy**

#### **(Impact on Financial Stability)**

Financial services are based on information processing, and FinTech is designed to revolutionize such processing using new ITs.

The improvement of risk management using FinTech may also contribute to financial stability. Using big data, new correlations between various assets could be detected and that may help portfolio managers to disperse risks through the diversification in different asset classes.

Meanwhile, FinTech may intensify competition in financial services due to the new entries of FinTech companies. In particular, when the existing financial institutions with a heavily-fixed infrastructure compete with agile FinTech firms, competition may adversely affect the profitability of incumbent institutions, at least in the short run.

On the other hand, the entry of FinTech companies may provide new business opportunities for those financial institutions if they can cooperate with each other. In emerging and developing countries where the financial infrastructure had yet been developed, some companies with a large IT network acquired through their operations in e-commerce and SNS have built a significant presence in financial services.

Meanwhile, in developed countries where the existing financial institutions have a strong presence, some institutions are incorporating FinTech into their businesses through the

acquisition of FinTech companies. In credit intermediation, emerging IT companies are entering the business via P2P lending and cloud funding, while banks have begun to share the intermediation business with those IT companies; likewise, some banks and IT companies are working together to establish an investment-type cloud funding platform.

The application of new ITs has also improved the way of handling risks which had not been addressed before. In the insurance sector, the challenge associated with moral hazard and adverse selection is being addressed by changing the way in which policy-providers monitor policyholders' behavior real-time and accordingly change the original terms and conditions. In other words, the contents of the insurance contracts can be flexibly adjusted according to the policyholders' behaviors—such as their attitudes toward safe driving (e.g., frequent braking and compliance with the legal speed limits)—by using big data analyses and smart contracts. In this way, the potential to overcome the issues associated with traditional information asymmetry is expanding.

By contrast, there may be a case in which new transactions will increase without being aware of the risks associated with FinTech, or where additional measures will be necessary to address information security, cyber-attacks, Anti-Money Laundering and Combating the Financing of Terrorism (AML/CFT). Failure to address those issues may lead to a new risk for financial stability.

The quantity of information and data accompanied with financial services is dramatically increasing under the IT revolution. Mishandling of information and data may lead to the violation of privacy causing damage to customers and increasing the risks resulting in cyber-attacks, while new information technology may contribute to the better sophistication of hacking and cyber-attacks.

As a result of the extensive use of the Internet and smartphones, financial network has now become more open. This inevitably means that the targets for cyber-attacks are increasing. Measures to enhance information security and prevent cyber-attacks have become more important than ever.

If these risks materialize, users will become more cautious about new financial services using ITs. That may deter financial innovations. In this regard, the providers of new financial services need to take appropriate measures for information security and the prevention of cyber-attacks.

### **(Crypto-assets and ICO)**

Regarding crypto-assets, having gone through a volatile phase since the start of 2017 and the increase of the Initial Coin Offering (ICO), central banks and regulatory authorities have been closely monitoring the developments of crypto-asset markets to ensure that any

problems in those transactions and the funding of crypto-assets will not impair the credibility of the financial system.

Crypto-assets—such as Bitcoin—tend to be volatile in part reflecting the inflow of speculative funds and moreover due to the lack of price anchors such as underlying assets (see Chart 2). The volatility may put those assets unfit for payment and settlement means. When the price of crypto-assets is expected to rise, people tend to keep those assets in order to gain capital gains; when the price is expected to decline, they do not accept those assets to avoid capital losses. In fact, most crypto-assets including Bitcoin are regarded as speculative investment opportunities and few are used for payment and settlement purposes. Meanwhile, the share of Japanese yen in bitcoin transactions has been increasing since 2017 (see Chart 3).

Chart 2: Bitcoin Price

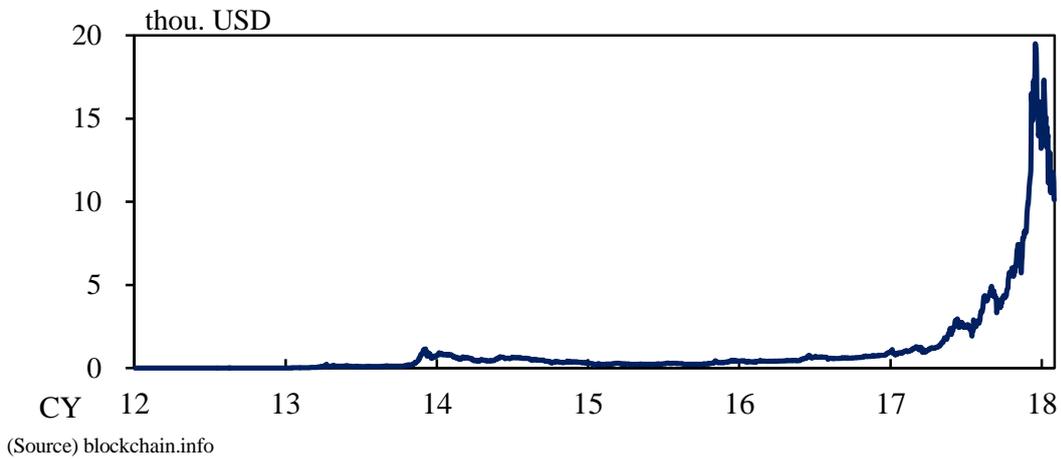
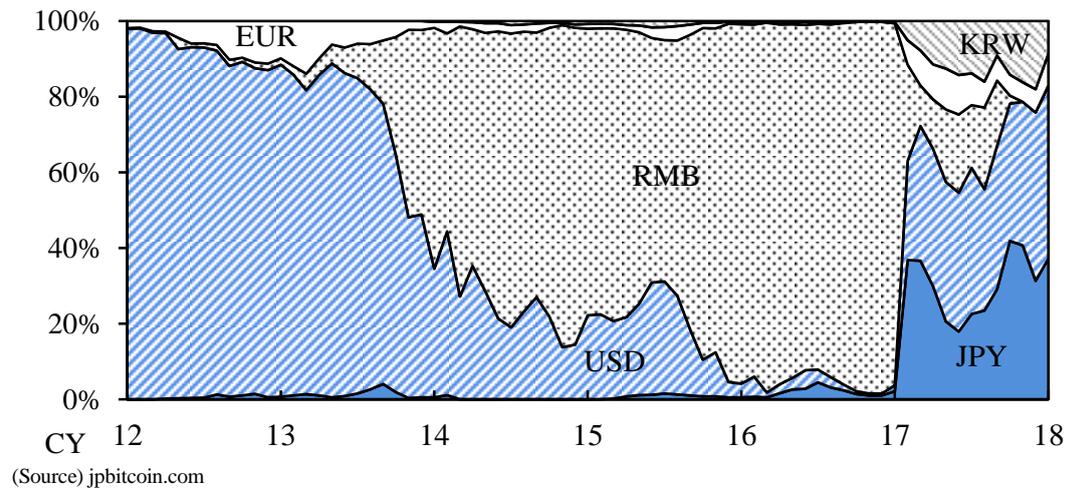


Chart 3: Shares of Currencies in Bitcoin Transactions



Crypto-assets such as Bitcoin are not a legal tender, and their use for payment and settlement depends on the counterparty’s willingness to accept them. Currently, the extent of

acceptance is somewhat limited. Furthermore, their volatility is likely to be a barrier as a means of payment, and holders of those assets will not earn any interests or dividends. The participants in crypto-asset transactions need to understand the nature of those assets and the risks associated with their transactions.

ICO is a form of funding in which existing crypto-assets such as Bitcoin and Ethereum will be exchanged for new crypto-assets or tokens. In many economies, it has been put under regulation and closely monitored as these may be used to avoid security-related laws and regulations, which may lead to losses for investors and consumers (Chart 4). On October 27, 2017, Japan Financial Services Agency issued documents to warn investors against ICOs and on January 18, 2018, the International Organization of Securities Commissions (IOSCO) Board released a document titled "IOSCO Board communication on concerns related to Initial Coin Offerings". In this document, the IOSCO Board states that there are clear risks for ICO and that investors should bear in mind that they should act very prudently when making investment decisions, because the ICO tends to be highly speculative and there are also some cases of fraud. All investors who participate in the ICO are required to understand these risks well.

Chart 4: Regulations regarding Crypto-assets and ICOs

United States	The Securities and Exchange Commission (SEC) issued a warning document about the risks of using the ICOs.
China	The People's Bank of China and other authorities issued a joint announcement to ban ICOs and major exchanges were closed after the announcement.
Korea	The Financial Supervisory Service (FSS) published a ban of ICOs. Regulation requiring stricter identification regarding crypto-asset transactions was introduced.
Indonesia	Bank Indonesia banned payments with crypto-assets and warned against such transactions.
Philippines	The SEC ordered an ICO project to be suspended.

**(Vitalization of Economic Activities and Resolution of Social Problems)**

FinTech is expected to vitalize economic activities.

Through financial inclusion, FinTech offers a wide range of opportunities for individuals and businesses to access financial services. This has particularly been the case in emerging and developing countries where such access had been difficult before due to the lack of financial infrastructure.

FinTech will also promote the development of economic activities that are connected to financial services such as e-commerce, a sharing economy and the IoT (Internet of Things). It will furthermore encourage investment in financial businesses.

In addition, FinTech is expected to contribute to the resolution of various social problems.

Due to the acceleration of the aging society, the security of financial transactions by the elderly has become more important. Biometric identification and AI could be used for the improvement of identification and the detection of fraudulent transactions. These are expected to contribute to better security of the elderly and protection against fraud.

#### **4. Engagement of Overseas Central Banks for the Promotion of FinTech**

Central banks are responsible for the stability of payment and settlement systems. They also conduct oversight activities on major financial market infrastructures (FMIs). From this perspective, they ensure the soundness of market infrastructures and financial systems while creating a conducive environment in which new ITs will enhance the efficiency and convenience of financial services.

Central banks also provide basic infrastructures of the economy. These include a large-value settlement system and securities settlement system in their jurisdictions. From this standpoint, central banks continue to make efforts to improve their infrastructures by applying new ITs.

Furthermore, they serve as a catalyst for promoting communication and cooperation among various bodies such as financial institutions, IT companies, start-ups and users.

In light of these functions, major central banks have engaged in research activities and experimental studies to understand the technologies behind FinTech and their potential. Those central banks have also conducted activities such as facilitating discussion and cooperation among a wide range of entities in the private sector by actively participating in discussions worldwide.

## 4-1. Organizational Responses and Engagement for the Promotion of FinTech

Many central banks have established a new function in charge of promoting FinTech activities (see Chart 5).

Chart 5: Organizational Responses to FinTech

Bank of England	Launched FinTech Accelerator and conducted joint experiments with the private sector on the application of FinTech to central banking.
Monetary Authority of Singapore	Established a new division called the FinTech & Innovation Group and developed policies related to FinTech as well as managing a joint laboratory with a number of companies. Established the cooperative organization of the domestic authorities and made agreements on the promotion of FinTech with many foreign authorities including those in England, Japan and Australia.
Bank of Canada	Established a new digital economy team and conducting research studies to understand the impact of technological innovations such as the policy transmission mechanism.
European Central Bank	Established a group to analyze issues about the possible application of DLT to settlement systems and to study the economic implication of the digital currency issued by the central bank.
Federal Reserve System	Organized a liaison group to meet and analyze various issues related to FinTech by gathering the cross-sectoral expertise of staff in the fields of settlements, research, and technology.

The Bank of England launched a project called the "FinTech Accelerator" in June 2016 with the aim to improve their businesses by using FinTech in collaboration with firms specialized in FinTech. In this engagement, the Bank first called for ideas about specific topics set by the Bank. They then assessed those ideas and conducted collaborative experiments with some of those private companies. Specifically, those include i) management and transfer of virtual assets using DLT, ii) review of the resistance against cyber-attacks using new technologies, and iii) anonymization of confidential data using new technologies in order to be shared for further analyses.

The Monetary Authority of Singapore also set up a new FinTech-related department. They manage a research facility together with private companies and promote experiments in collaboration with the emerging IT companies that provide the technological base for DLT. In addition, they regularly hold a large international event called the FinTech Festival to exchange ideas with the relevant companies and authorities inside and outside of Singapore, and proactively conduct activities such as "hackathons" where participants compete in programming.

On top of these activities, major central banks have made more opportunities to disseminate information related to FinTech and ITs more generally. Speeches and lectures by executive members of those central banks focusing on FinTech have regularly been held. These speeches and lectures address a variety of topics ranging from FinTech in general to

the possible application of blockchain and DLT to their own settlement infrastructures as well as pros and cons of digital currency issued by the central bank.

## 4.2 Engagement in Blockchain and DLT

In parallel with the organizational responses and information dissemination, the major central banks are also making efforts such as research studies and experiments related to blockchain and DLT (see Chart 6).

Chart 6: Engagements of Major Central Banks in DLT

European Central Bank	Published a survey paper about the applicability of DLT to security post-trade services. Conducted a joint research with the Bank of Japan to further understanding of DLTs (Project Stella).
Deutsche Bundesbank	Conducted an experimental study about the applicability of DLT to security/fund transactions in cooperation with a securities exchange.
Bank of England	Examined the applicability of DLT in a connection between RTGS systems and the securities business. Contributed to a research paper on the central bank digital currency, published by the University College London.
Riksbank	Started an "e-krona" project to explore possible introduction of a central bank digital currency.
Bank of Canada	Examined the applicability of DLT to interbank settlements (Project Jasper).
People's Bank of China	Disclosed an intent to issue a central bank digital currency in the mid to long term.
Hong Kong Monetary Authority	Examined the applicability of DLT to trade finance (collaboration with Monetary Authority of Singapore).
Monetary Authority of Singapore	Examined the applicability of DLT to security/fund transactions and interbank settlements (Project Ubin). Considered the applicability of DLT to trade finance (collaboration with Hong Kong Monetary Authority).

Amongst all, there are many cases in which central banks are conducting research and experiments with the possible application of the new ITs to the central bank money (banknotes and the central bank's reserves). These research studies and experiments are not necessarily aimed at issuing new forms of money with the application of new technologies; instead, they aim to deepen understanding of the new technologies from the central banks' perspectives. Project Stella, a joint research project between the European Central Bank and the Bank of Japan, has also been initiated with such a spirit.

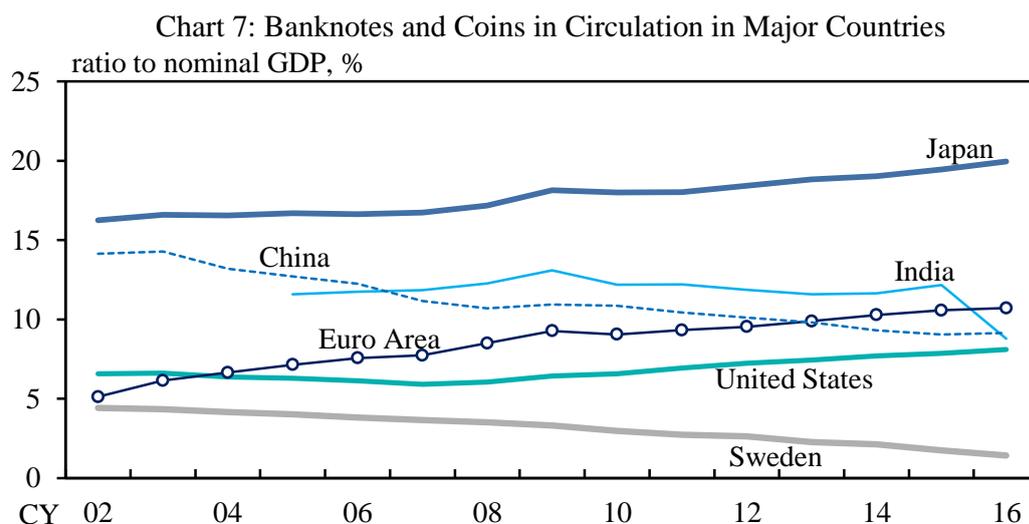
The application of new technologies to central bank money is classified into two: i) exploring the possibility that the central bank can issue a digital currency to complement physical forms of central bank money (i.e., banknote) and ii) applying DLT to the central bank's current accounts—which have already been computerized and digitized—to enhance the efficiency of central bank services.

### (Central Bank Digital Currency for General Purposes)

Central banks issue banknotes which can be used by households and businesses as a means of payment 24 hours a day, 365 days a year. Banknotes are issued in the physical form (i.e., paper or polymer); they use printing technology. Using new ITs, some argue that the central banks should start issuing a digital form of banknotes which are available to anyone 24 hours a day, 365 days a year.

Riksbank in Sweden is now considering whether they should issue central bank digital currencies (CBDCs), called e-krona. The People's Bank of China has also outlined the concept for issuing a digital currency in the future. However, other major central banks seem to be taking somewhat a measured approach to the issuance of CBDCs for general purposes. Among them is the Bank of Japan, which does not have a specific plan at this juncture to issue a CBDC as an alternative to paper-based banknote.

In Sweden, cash demand has been rapidly decreasing in recent years (Chart 7). The ratio of banknotes and coins in circulation relative to nominal GDP was over 4% in the early 2000s; more recently, however, it declined close to 1%. Under such circumstances, Swedish commercial banks, in some cases, stopped transactions using banknotes. Likewise, some retail shops appear to have suspended the handling of cash. The Governor of Riksbank, Stefan Ingves, suggested in a speech<sup>4</sup>, a possibility that cash is losing its "network externality", which is one of the most crucial attributes for payment instruments. Governor Ingves explained that Riksbank was considering the issuance of e-krona in consideration of its responsibility as the central bank to provide a means of payment which does not entail a credit risk.



Sources: BIS and IMF

Note: Most of the data are based on the "Red Book Statistics" compiled and published by the BIS. For China, the figure was calculated using the IMF statistics.

<sup>4</sup> Ingves, Stefan, "Do We Need an e-krona?", Swedish House of Finance (December 8, 2017)

Among the countries considering the issuance of CBDCs, many of them are still under the development phase of their cash infrastructures or rely on the legal currency issued by other sovereign states, most likely the USD. For those countries, introducing a CBDC is a possible way to leapfrog their infrastructures without necessarily building a legacy platform throughout their countries. They are likely to improve their payment and settlement infrastructures by adopting new ITs rather than being preoccupied with the existing infrastructure.

In addition to upgrading financial infrastructures, some other countries stress the merit of introducing CBDCs to curb money laundering, tax avoidance and other criminal activities. The People's Bank of China mentioned in its press release<sup>5</sup>, published in January 2016, a concept regarding the issuance of a digital currency. It also mentioned the possibility that the issuance of a CBDC may reduce money laundering and criminal behaviors.

#### **(Applicability of DLTs to Large Value Settlements)**

Apart from the consideration of a CBDC for general purposes, many central banks are conducting research and experiments to study whether these technologies can be applied to interbank large-value payments and securities settlements.

Under the Bank of Canada's Project Jasper and the Monetary Authority of Singapore's Project Ubin, the first phase of experiments was conducted by applying DLTs to the quasi-environment of interbank large-value payment. Important knowledge has been acquired from these studies. For instance, in Project Jasper, it was reported that: i) it is difficult to create clear value-added only by applying DLTs to large-value settlements, compared to the existing centralized system; and ii) to create value-added by applying DLTs, it is necessary to achieve more efficient procedure of the system, through applications to the broader range of financial infrastructures.

Based on these findings, recent projects have applied DLTs to several financial infrastructures or to more complicated transactions. In the subsequent phase of Project Jasper and Project Ubin, the experiments have applied DLTs to delivery-versus-payment (DVP) settlements of funds and securities. Deutsche Bundesbank is also proceeding with a project to consider the application of DLT to DVP settlements in cooperation with Deutsche Börse (a German securities exchange). Furthermore, the Monetary Authority of Singapore and the Hong Kong Monetary Authority have been diligently conducting projects to consider the possible application of DLTs in trade finance.

As the number of research projects and experiments for a wide range of financial

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<sup>5</sup> "The People's Bank of China held a meeting to discuss the digital currency in Beijing" (January 20, 2016). The original text is available only in Chinese.

infrastructures is increasing, cooperation among central banks has become crucial. More research and experiments are also being performed in cooperation among central banks, private companies, and financial market infrastructures.

The Bank of Canada and the Monetary Authority of Singapore are proceeding with experimental projects in cooperation with the emerging IT companies which provide a technological base for DLT. Recently, these central banks began cooperating on a project aimed to study the applicability of DLTs to cross-border transactions. The Monetary Authority of Singapore and the Hong Kong Monetary Authority began an engagement to connect their platforms with each other for the application of DLTs to trade finance.

These applications of new technologies in large-value payments and securities settlements are expected to involve the central bank's current accounts and book-entry securities, which have already been digitalized and computerized. Therefore, they may have less impact on private bank accounts or financial intermediation compared to that of a CBDC. However, given that financial market infrastructure requires to be highly credible, in particular when the existing centralized infrastructure has already achieved very high credibility, it may be premature to conclude that the current infrastructure should be replaced by the one with new de-centralized technologies.

## **5. Engagement of the Bank of Japan for the Promotion of FinTech**

The Bank of Japan has been making every effort, as a central bank, to encourage financial innovations and FinTech so that it will contribute to enhancing the utility and efficiency of payment and settlement systems and to securing the safety of market infrastructure and the soundness of financial system as a whole.

Its engagements cover a broad range of activities reflecting that i) the Bank exercises an oversight of the financial market infrastructure; ii) it operates fundamental infrastructure, such as its large value settlement systems and securities settlement systems, for the economy; and iii) it works as a catalyst to facilitate communication and collaboration among a wide-range of entities related to FinTech.

More specifically, the Bank has been promoting the following activities: 1) research and studies for understanding FinTech and its main technologies; 2) communication with wide range of entities; 3) promotion of communication and cooperation among related parties through hosting various forums and conferences; 4) information dissemination through speeches and research papers; and 5) active participation in internal and external discussions.

### **(Establishment of the FinTech Center)**

In April 2016, the Bank established the FinTech Center within its Payment and Settlement Systems Department, aiming to play an active role as a catalyst to link financial practices with advanced technologies and research studies as well as to meet the demand of the society in the digitized world.

### **(Information Dissemination and Participation in International Discussions)**

The Bank, mainly through the FinTech Center, has held various meetings related to FinTech such as several FinTech Forums and collaborative conferences with the University of Tokyo and other entities (see Chart 8).

These meetings are characterized by: i) multifaceted discussions with a wide range of participants including financial institutions, IT companies, FinTech ventures, and academic institutions; ii) important information dissemination platforms by providing presentations and speeches; iii) a transparent framework such as the disclosure of meeting documents and meeting minutes on the Bank's website, since open discussion is critical for promoting FinTech.

Furthermore, the Bank is proactively participating in discussions in international forums related to FinTech and financial innovations, such as the BIS Committee on Payments and Market Infrastructures (CPMI), as well as various domestic conferences.

### **(Research and Studies on FinTech)**

The Bank is also engaged in various research and studies related to FinTech.

It began the publication of the annex series of the Payment and Settlement Systems Report in addition to its regular edition. Furthermore, the Bank has been making efforts for the timely disclosure of the research outcome on FinTech and financial innovations by using various vehicles such as its working papers and review series.

Chart 8: List of FinTech-related Events and Survey Reports Provided by the Bank of Japan

Events held by the Bank of Japan		Year/ Month
<b>FinTech Forums</b>		
FinTech and Information Security		16/ 8
Open Innovation in the Financial Services		11
Utilization of DLT in Financial Services		17/ 2
Bigdata use cases in FinTech		11
Prospects for Blockchain and DLT		18/ 2
<b>Conferences</b>		
FinTech and the Future of Money (co-hosted by the Center for Advanced Research in Finance (CARF) of the University of Tokyo and the Bank of Japan)		16/11
AI and Financial Services/Financial Markets		17/ 4
<b>Reports (available only in Japanese except as otherwise noted)</b>		
<b>Payment and Settlement Systems Report Annex Series</b>		
Features of Japanese Retail and Large-Value Settlement Systems in Terms of BIS Statistics on Settlement		17/ 2
Recent Trends of Debit Cards		5
Current Situation and Challenges of Mobile Settlement		6
FinTech Special Edition – Financial Innovation and FinTech – (Japanese original of this report)		18/ 2
<b>Bank of Japan Review Series</b>		
Features of Digital Currency and International Discussion		15/12
Central Bank Digital Currency – Discussion and Experiment Overseas –		16/11
Introduction of 24/7 Real-time Payment and Development of Settlement Services in Major Countries		17/ 3
Engagements in Improving Convenience of the Euro in Europe – Integration and Development of European Settlement Infrastructure –		10
Risk Management of Banks in the FinTech Era		10
<b>Working Papers</b>		
Laws and Economics of Blockchain and DLT		17/ 3

**(Joint Research with the European Central Bank: Project Stella)**

In December 2016, the Bank of Japan, in collaboration with the European Central Bank, started Project Stella, a joint research project to study the possible use of DLT for financial market infrastructures.

The first report, published in September 2017, summarized the interim results of in-depth experiments on whether specific existing functionalities of the payment systems in their jurisdictions could be run in a DLT environment in an efficient and safe manner<sup>6</sup>.

One of the findings of the analysis was that DLT-based solutions could meet the current performance needs of the existing real-time gross settlement systems. It was also confirmed

<sup>6</sup> The Bank of Japan and the European Central Bank, "Project Stella: a joint research project on Distributed Ledger Technology (DLT) – Payment systems: liquidity saving mechanisms in a distributed ledger environment "

that the performance depends on the network configuration of the system. For example, the bigger the network (i.e., the higher the number of nodes) and the longer the distance between the network nodes, the longer it takes for a payment to be processed. As for the safety of the financial infrastructure, it was confirmed that the DLT solutions could be resilient to the failure of individual network nodes; thus maintaining the functioning of the infrastructure as a whole<sup>7</sup>.

Experiments also found that using liquidity saving mechanisms, which enable a more efficient use of central bank reserves, it was feasible to implement a "smart contract", a collection of program codes deployed and executed on each node to append the ledger. More concretely, the smart contract could replicate the function to hold the payment instructions in a queue and to settle multiple payment instructions at the same time in accordance with the pre-determined algorithm.

The Bank of Japan will continue to work on Project Stella in cooperation with the European Central Bank and promote in-depth analysis and experiments including the application of DLT to several financial infrastructures in order to further its understanding of new information technologies and possible impacts on market infrastructures and financial system.

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<sup>7</sup> In March 2018, the second report of the project, "Project Stella: a joint research project on Distributed Ledger Technology (DLT) – securities settlement systems: delivery-versus-payment in a distributed ledger environment", was released. Moving from payments to securities settlement, it explored how the delivery of securities against cash could be conceptually designed and operated in a DLT environment by drawing on existing delivery-versus-payment (DVP) approaches as well as innovative solutions currently being discussed for DLT. One of the main findings was that DVP could run in a DLT environment subject to the specificities of the different DLT platforms. DVP could be conceptually and technically designed in a DLT environment with cash and securities either on the same ledger (single-ledger DVP) or on separate ones (cross-ledger DVP). Moreover, the report found that DLT offered a new approach for achieving DVP between ledgers without any connection between ledgers. In cross-ledger DVP, that was a novel feature which does not exist in today's set-up.

## Addendum: Private FMIs and FinTech

This addendum will introduce the engagements with regard to FinTech by the private financial market infrastructures (FMIs) in Japan.

### (Engagements for the Application of DLT to Financial Services)

Some FMIs are considering and conducting experiments about the application of blockchain and DLT to the financial business.

In August 2016, the Japan Exchange Group (JPX) published the results of experiments to apply DLT to the post-trade processing of securities transactions, in cooperation with the Japan Securities Depository Center and five other participants (mainly securities companies). In March 2017, JPX launched a cross-industry collaboration project to conduct DLT experiments, based on the consideration that continuous technological experiments and cross-industry discussions are necessary for the utilization of DLT in financial markets (see Chart A-1). Currently, with 33 participants including the Japan Securities Depository Center and a number of securities companies, joint experiments are being conducted on the procedures for the reconciliation of securities settlement instructions and "Know Your Customer (KYC)" procedures.

In December 2016, the Japanese Bankers Association established its "Review Committee for the Possibility and the Challenges of Utilizing Blockchain Technology". It also published a report in March 2017, after reviewing the possible application and issues of DLT in the banking field including application of the technology to financial infrastructures. In addition, it has prepared an environment for collaborative and joint experiments mainly involving banks with the aim to facilitate collaborations for the practical use of DLT and to reduce the development cost. As a first step of an experiment under such an environment, the Densai Net, an electronic monetary claim recording institution is conducting an experiment of applying DLT to recording the accrual and assignment of electric debts (see Chart A-2).

Chart A-1: Experimental Environment of the Securities Market Using DLT

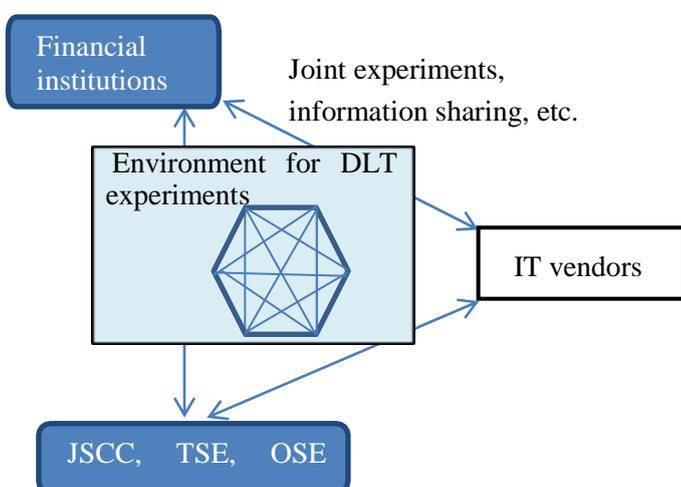
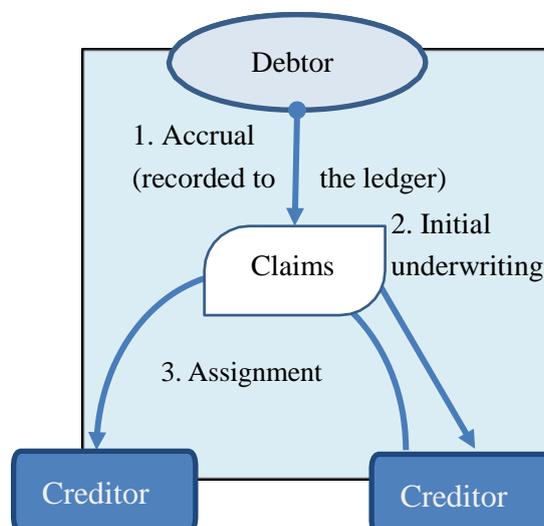


Chart A-2: Experiment of Densai Net Using DLT



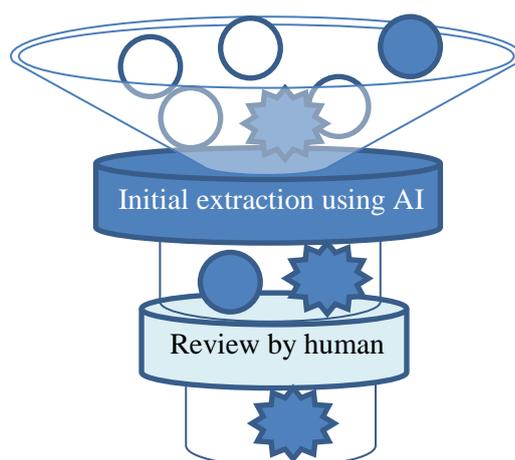
### **(Market Monitoring Using AI)**

Several institutions are proceeding with improvement of transaction monitoring using AI.

Among them, the JPX has been conducting experiments to improve elaboration and efficiency of transaction assessment by extracting suspicious transactions using AI and preparing for its introduction (Chart A-3). It aims to implement such a monitoring tool by the end of the fiscal year of 2017 (i.e., March 2018).

The Tokyo Financial Exchange, Inc. (TFX) is also conducting experiments to improve elaboration and efficiency of market management using anomaly detection technology of AI.

Chart A-3: Image of Extraction of Fraudulent Trading using AI



### **(Infrastructure Development for New Services)**

In addition to the improvement of the efficiency of FMI's own services and its markets mentioned above, engagements to develop an infrastructure for future FinTech services are being conducted. The Japanese Bankers Association is organizing the financial "Electronic Data Interchange (EDI)", a mechanism to electronically process from sales order management to cash settlement as a package by integrating the information on financial settlement and those on transaction of products, which used to be separately exchanged among the companies. The EDI (Zengin EDI) will be launched in December 2018 (see Chart A-4). This engagement is expected to create an infrastructure for the financial institutions to offer new financial services by collecting and accumulating commercial data.

The Japanese Banks' Payment Clearing Network (Zengin-Net) will launch the

"More-Time System", a new platform to cover bank transfers at night and early in the morning, as well as on weekends, which may promote transfer services using mobile devices regardless of the time (Chart A-5).

Chart A-4: Zengin EDI System

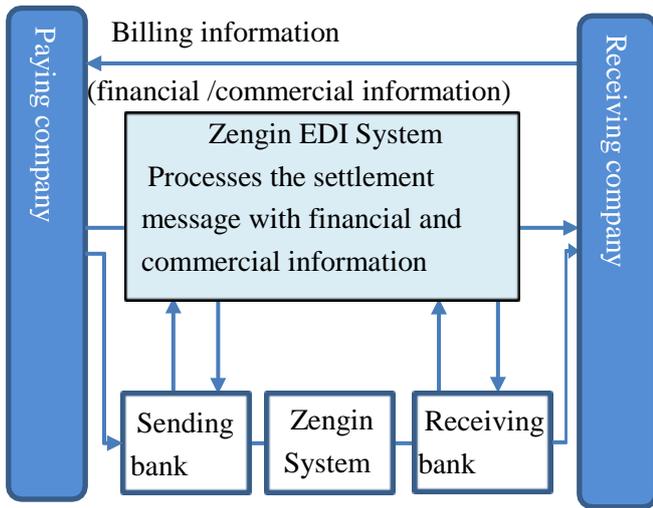


Chart A-5: Zengin More-Time System

