



## **Central Banks' New Approach to AI : New Settlement System Applying Blockchain Technology and Issuance of Digital Currency**

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### **Introduction**

A big wave of the third AI boom that started in around 2013 against the background of emergence of big data, crowd, and deep learning has also rolled on to the financial world in the name of “FinTech.”

Heretofore, financial institutions have performed three functions of “intermediation of funds” (indirect finance), “credit creation” and “fund settlement”<sup>1</sup> and under the protection of regulations by the financial authorities they have almost monopolized the income earned by these functions. However, in parallel to a rising distrust of customers toward financial institutions triggered by the sub-prime problems and the following Lehman Brothers shock in 2007-2008, newly arising FinTech firms have made a revolution in the customer services, and they are taking over the customers and income sources from traditional financial institutions. Especially as for the function of fund settlement, researches and demonstration experiments have been conducted worldwide, with a view that blockchain technology may enable the low cost transactions while preserving their accuracy.

In this article, the author intends to explain an outline of blockchain technology and its present situation of its utilization by private companies/their consortia and central banks, and explore the prospects for its future use by central banks.

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<sup>1</sup> For example, see “Learning about banks by life stage (Basic Story about Banks), the 3<sup>rd</sup> stage; functions and roles of banks”, Japanese Bankers Association (Available only in Japanese).

## 1. Function of Fund Settlement

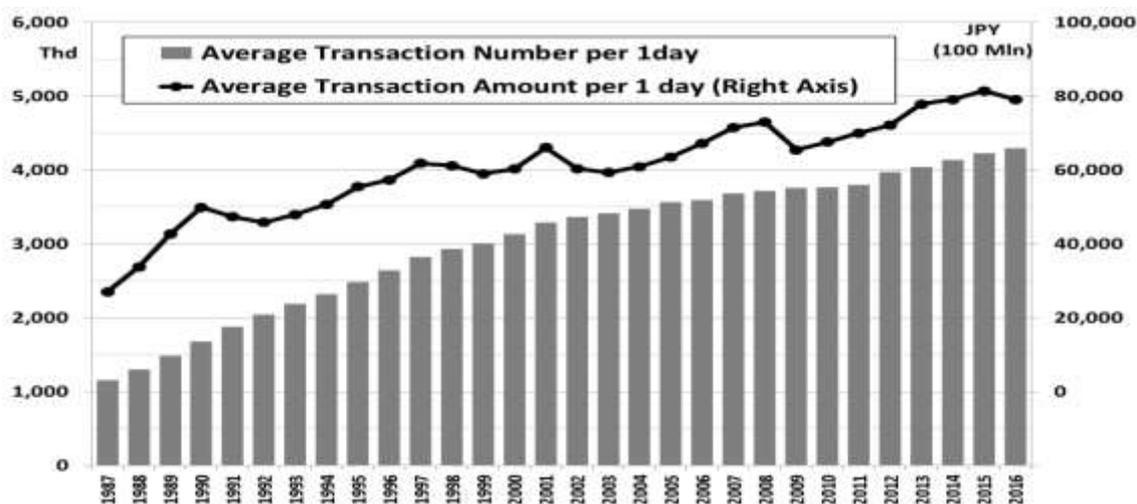
Fund settlement refers to a function by which transactions can be completed without using cash money but just by transferring funds between deposit accounts opened in financial institutions, such as payment of fund from one institution to another institution or its branch with automatic withdrawals of deposits.

This function has a merit that without exchanging real cash money (notes and coins) face to face, the counterparties can transfer funds through a financial institution in which they have opened their deposit accounts. It also provides users with a convenience that even the counterparties living far from each other can exchange funds.

In current Japan, funds in financial institutions are settled through two ways of settlement networks of “BOJ-Net” that the Bank of Japan operates, and “Zengin-System” that the Japanese Banks’ Payment Clearing Network (Zengin-Net) operates. Transfers of funds to overseas institutions are usually handled by SWIFT.

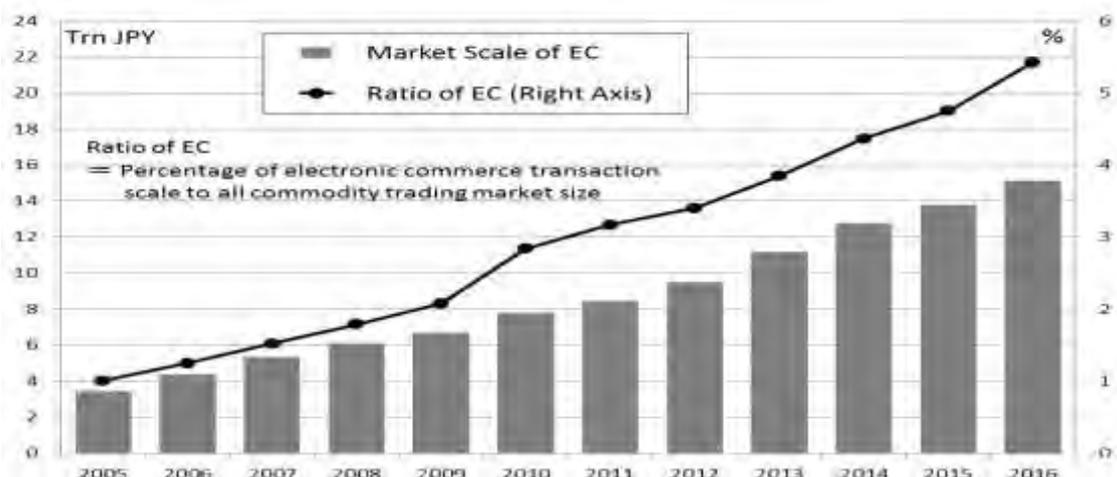
With the rise of business to consumer electronic commerce (BtoC-EC) from around the middle of the 1990s, the number of transfer of funds to other financial institutions and their amounts almost quadrupled from 20 years ago. As the importance of settlement system has increased, so has been increasing its system load (periodic renewals, various maintenance costs, etc.) necessary for securing high stability, reliability and accuracy.

Chart 1 : Number and amounts of payments to other financial institutions



(Source : Based on Data of Japanese Bankers Association)

Chart 2 : Market size of Japan's BtoC-EC and Ratio of EC



(Source : Based on the data by METI)

## 2. What is blockchain technology?

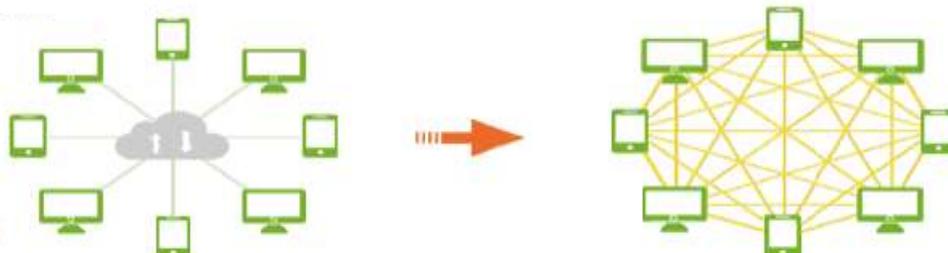
A blockchain is a new technology that has gathered attention in the field of settlement. The pillar of a settlement system lies in “how to achieve the completion of payments without fail.” In the past, it was a “centralized system” where a responsible trustee of a central bank or financial institutions centrally controlled “the authentication of transactions, its related operations, and security management.”

In contrast, there is another settlement system called “distributed ledger technology (DLT) where settlement is credibly completed, instead through centralized body, by using computer networks of distributed ledgers. A blockchain is one of the technologies that realize this process. Specifically, at the same time it guarantees continuous operations of the network by storing the records of transactions at every point (server) of participants that are scattered in many places, all participants mutually administer and supervise the records so that they can guarantee the authenticity of the records that are kept by them.

Chart 3 : Structure of Centrally controlled system and Distributed ledger system (Images)

[Centrally controlled]

[Distributed ledgers]



As the image above suggests, blockchain technology is believed to have following characteristics (merits).

(1) High resistibility to system failures

Since all participants connected to a network preserve the historical records of transactions, even if a part of a network or a server fails, there is no missing of information or stoppage of the system as long as other parts of the network are under operation.

(2) High transparency

As all the records of transactions are disclosed to the participants, management and oversight of them are easily made.

(3) Hard to manipulate the transactions

Blockchain technology has a characteristic that it keeps all transactions from the past in blocks and connects them like a chain. Therefore, if one wishes to manipulate any transaction record, one has to go through the following process:

- ① Temporally undo the connected chains up to a particular block.
- ② Rewrite, without being noticed by other participants, the record of transactions that are contained in the block where the targeted transactions are kept.
- ③ Connect again, also without being noticed by other participants, the chains from the targeted block to the nearest block.

However, given the processing capacity of current computers one cannot go beyond ③ above without the false manipulation being noticed by others, so manipulation is regarded as impossible to implement. Thus the recorded information is highly reliable.

(4) Low cost of network operation

A centralized network system that collectively and centrally records and administers the track record of transactions requires various security measures such as equipment of plural computers to prevent power shortage and crimes, development of special program to prevent falsification of transaction records, etc., but DLS network is believed to require no such measures or otherwise to be less expensive. Theoretically, therefore, its operation cost is expected to be lower than in the case of centralized network system. In fact, the Banco Santander S.A. in Spain estimates that utilization of the technology enables the banking society to reduce their cost by \$20 billion annually.

(5) Reduction of fees by elimination of intermediators

Blockchain technology does not require any establishment of a third party institution to guarantee the credibility of transactions and therefore the payment of fees to them is not necessary.

### **3. Moves to utilize blockchain technology by private entities and their alliance in and out of Japan**

Blockchain technology is said to have been originally invented in 2008 as a base technology to support a crypto currency called a “Bitcoin.” Consequently, blockchain technology is often misunderstood to be the one related to crypto currencies. However, the scope for application of this technology is not limited to crypto currencies but is considered to spread to a broader use including management of various movable assets and properties, registration of conveyance, etc.

Already in many countries experiments and practical application of blockchain technology have been initiated mainly by private companies and their consortia, demonstrating the bigness of its impact.

For example, in July 2016, SAP of Germany, together with a US venture firm Ripple Labs Inc., made an experimental transfer of an international payment of CA\$ 1000 (€667) from ATB Financial Bank, a Canadian local bank, to ReiseBank in Germany. It took about 20 seconds, they announced, for the payment that usually takes 2 to 6 business days in its handling of communication with the correspondent bank and checking of accounts.

Also the US NASDAQ started in October 2015 stock issuance and its dealing first with 6 companies, in parallel with development of Nasdaq Link that utilizes blockchain technology to deal with unlisted stocks. Besides, NASDAQ has been making an experimental operation of electronic shareholders’ voting system in Estonia utilizing the technology.

Furthermore, major financial institutions, IT firms and settlement agencies are making cooperative researches and demonstration experiments using blockchain technology to develop an institution that alternates the current international cash transfer system of SWIFT. “Hyper Ledger project” and “R3 Consortium” are some of their representative bodies.

In Japan, 42 financial institutions, together with the SBI Ripple Asia Co. that extends next generation settlement base utilizing the blockchain technology, established in October 2016 a “Consortium to Study Unification of Domestic and External Foreign Exchange Transactions” (participating financial institutions increasing to 54 as of April 2017). They collectively make demonstration experiments to utilize blockchain technology and study multilaterally the ways for establishment of cash transfer application common to all participating financial institutions, and resolution of legal problems. In December 2016, National Bankers Association established a “Study Group on Applicability of Blockchain Technology and its Challenges,” and released a Study Group’s report in March 2017. In the report, the group members emphasized the importance not only of competing efforts by individual financial institutions but also of cooperative efforts by public-private parties concerned for promoting the verification and examination on how the blockchain technology/diversified ledger technology can be utilized and they proposed to establish a “Blockchain Public-Private Cooperative Initiative.” (Table 1)

Table 1 : Main points of “Blockchain Public-Private Cooperative Initiative”

①	Establishment of a Platform of Bank Alliance for Utilizing Blockchain Technology (tentative name)
②	Strategy for accommodating international standards
③	Examination of possible utilization of blockchain technology on financial infrastructures
④	Cooperation with related authorities for the utilization of blockchain technology / distributed ledger technology (DLT)
⑤	Cooperation with the central bank for the utilization of blockchain technology / DLT
⑥	Improvement of operation of safety standards
⑦	Formation of blockchain community

Further, 6 major banks in Japan, the US, Europe and Australia that include the Bank of Tokyo-Mitsubishi UFJ, Bank of America Merrill Lynch announced that they would start from early 2018 an overseas remittance service using blockchain technology that enables a real time settlement.

#### 4. Moves of monetary authorities and central banks

Of course, it is not to say that the monetary authorities and central banks of major countries have stood by and passively watched the moves noted above by private companies and their consortia. Actually, they are trying to deepen their understanding of blockchain technology to prevent possibly increasing difficulties in grasping the flow of funds as a result of increased fund settlements by private companies and consortia that utilize blockchain technologies. (Table 2)

Table 2 : Moves of monetary authorities toward utilizing blockchain technologies

Gov. Agencies	Recent Developments
Bank of England (Central Bank)	<ul style="list-style-type: none"> <li>In June 2016, Governor Carney revealed that the BOE was promoting R&amp;D to improve its own RTGS, while exploring the application of blockchain technologies.</li> </ul>
European Central Bank (ECB)	<ul style="list-style-type: none"> <li>In February 2016, the Bank published a consultative report on RTGS, "Eurosystème's Vision for the Future of Europe's Financial Market Infrastructure", in which it revealed it was exploring the ways to utilize the blockchain technologies within the ECB.</li> </ul>
Hong Kong Monetary Authority	<ul style="list-style-type: none"> <li>In September 2016, HKMA revealed its plan to establish a hub-station to make demonstrating experiment of blockchain, in collaboration with Hong Kong Applied Science and Technology Research Institute (ASTRI).</li> </ul>

(HKMA)	<ul style="list-style-type: none"> <li>At the innovation hub, it assumed to make a proving test of blockchain technology while taking into account actual adaptation of the technology and to have discussions among regulatory authorities, firms concerned and start-ups.</li> </ul>
Monetary Authority of Singapore (MAS)	<ul style="list-style-type: none"> <li>In July 2016, MAS revealed a development plan to make innovation center for blockchain in collaboration with IBM and Economic Development Bureau. It aims at application of the technology to the fields of finance and trade.</li> </ul>
	<ul style="list-style-type: none"> <li>In August 2016, Bank of Tokyo-Mitsubishi UFJ and Hitachi Ltd. announced it would start a demonstration experiment with the help of regulatory sandbox provided by the MAS on how to apply the blockchain technology to computerized checks.</li> </ul>
Russia Bank (Central Bank)	<ul style="list-style-type: none"> <li>In October 2016 a group of biggest banks in Russia including Sberbank, Alpha Bank, Tinkoff Bank, etc completed an initial test of messaging system that used DLT, called Masterchain.</li> </ul>
	<ul style="list-style-type: none"> <li>Prototype is a networking tool with which market participants including financial institutions mutually exchange financial messages. They reported they confirmed the implementation of data transactions in real time.</li> </ul>
Russian Ministry of Telecom (Roskomnadzor)	<ul style="list-style-type: none"> <li>May 2017, it announced it plan to enact the "Law concerning Blockchain Technology" by 2019.</li> </ul>
Central Bank of Cambodia	<ul style="list-style-type: none"> <li>April 2017, the Bank disclosed a plan to improve its lagged settlement infrastructure utilizing the blockchain technology developed by a Japanese venture firm.</li> </ul>
Financial Services Agency (Japan)	<ul style="list-style-type: none"> <li>Working Group on Payments and Transaction Banking of Financial System Council (October 2014 ~April 2015, total 12 meetings)</li> </ul>
	<ul style="list-style-type: none"> <li>Working Group on Payments and Transaction Banking of Financial System Council. (July 2015~December 2015, total 7 meetings)</li> </ul>
Bank of Japan (BOJ)	<ul style="list-style-type: none"> <li>FinTech Forum (August 2016~present, total 3 meetings)</li> </ul>

(Source : Based on the HP of each institution and Media information)

For instance, the Bank of England, which leads the world in the efforts to deal with the issue, set up a FinTech Accelerator in June 2016 to explore an introduction of DLT, since they are faced with an impending need for renewal of its Real Time Gross Settlement System (RTGS) after almost 20 years from its introduction in 1999 when they introduced it to reduce systemic

risks at a time of bankruptcy of financial institutions. They are considering, fully utilizing the merits of blockchain technologies that make manipulation difficult and enable unstoppable flow of network management, to rebuild on that foundation a low-cost and high-security settlement system and environment for management of securities.

In addition, international regulatory authorities also have set up working groups in rapid succession, to extend their knowledge about blockchain technologies. The Committee on Payment and Market Infrastructure (CPMI) of the Bank for International Settlements (BIS) established a “Working Group on Digital Innovation” to make a solid groundwork before central banks themselves start to apply FinTech to their work, while establishing at the same time information sharing with the Financial Stability Board (FSB) and the International Organization of Securities Commission (IOSCO).

Also in Japan, in tandem with the overseas tide, there are active moves mainly by the Financial Services Agency and the Bank of Japan for hearing from knowledgeable persons and improving legal systems. In December 2016, for instance, the BOJ reached an agreement with the European Central Bank (ECB) to establish a collaborative project for studying feasibility of application of DLT to financial market infrastructure. Although the details are not published yet, Mr. Mersch, Member of the Executive Board of the ECB, told in his speech on December 6, 2016 that “This work can help define how new technologies can change the global financial ecosystem of today and ensure that central banks are adequately prepared,”<sup>2</sup> suggesting that they would make a substantially in-depth study. The main results will be published sometime in 2017.

## **5. Final aim of Central Bank is at issuing digital currency ?**

Are the monetary authorities making study and researches on blockchain technologies just for the purpose of “substituting the existing settlement system”? At least, some central banks seem to have been making researches and demonstration experiments with a view to future realization of “digital currency issued by the central bank.” Actually, almost at the same timing of the study and verification of blockchain technologies by monetary authorities seen in Table 2 above, reports and publications have increased on the start of basic study on digital currency by central banks and their demonstration experiments in collaboration with private financial institutions. (Table 3)

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<sup>2</sup> For details see <https://www.ecb.europa.eu/press/key/date/2016/html/sp161206.en.html>

Table 3 : Moves of Central Banks concerning Digital Currencies

Central Banks	Recent Initiatives
Bank of England (BoE, the UK)	<ul style="list-style-type: none"> <li>In February 2016, a researcher at University College London, after discussions with BOE staffs, published an essay to propose the central bank issue digital currency (RSCoin). Although it applies blockchain technology, it differs from Bitcoin in that it aims at "centralized provision of currency."</li> </ul>
De Nederlandsche Bank (DNB, Netherlands)	<ul style="list-style-type: none"> <li>In its annual report released on March 16, 2016, the bank announced that it has been making efforts to develop a prototype of a crypto currency (DNBCoin).</li> <li>The report noted "it will be completed within that year", but there is no announcement on its completion by May 2017.</li> <li>The report says that the DNBcoin was developed for mainly internal experiment within the bank with no plan for a wider circulation.</li> </ul>
Danmarks Nationalbank (Denmark)	<ul style="list-style-type: none"> <li>In December 2016, Governor Lars Rohde responded to the media that it is planning to issue digital currency (E-Krone) applying blockchain technology.</li> </ul>
Sveriges Riksbank (Sweden)	<ul style="list-style-type: none"> <li>In March 2017, it revealed a three-staged roadmap to introduce a digital currency (E-Krona).</li> <li>It plans, after making theoretical verification (with a deadline of November 2017) and implementation test, to determine by the end of 2018 whether it should issue E-Krona or not.</li> </ul>
Bank of Canada (Canada)	<ul style="list-style-type: none"> <li>On June 15, 2016, the bank revealed at a closed session held in Calgary the contents of its efforts on a development and its proving test (proof of concept) of a digital currency (CAD-Coin) that are aimed at constructing a large-scaled interbank settlement system.</li> <li>Major Canadian banks that include Bank of Montreal, CIBC, Royal Bank of Canada, Scotiabank, TD Bank participated in the demonstration experiment.</li> <li>It is reported to be a system under which participating financial institutions deposit their cash with the BOC to exchange it to CAD-Coin and make interbank settlement.</li> </ul>

Reserve Bank of Australia (Australia)	<ul style="list-style-type: none"> <li>• In February 2016, Mr. Tony Richard, in charge of settlement policy division, announced that, focusing on the possible increase in demand for crypto currencies like Bitcoin, he expects that the bank will eventually issue a digital currency and put it into circulation in the future, although there is no plan for an aggressive introduction of a digital currency</li> </ul>
People's Bank of China (China)	<ul style="list-style-type: none"> <li>• On January 20, 2016, a study team for Bitcoin and other crypto currencies published a statement they are making efforts aiming at launching its own digital currency on an early date.</li> <li>• In December 2016, the bank announced it succeeded in the test on the payment and settlement among banks applying blockchain technology.</li> </ul>
Hong Kong Monetary Authority (HKMA)	<ul style="list-style-type: none"> <li>• In April 2017, HKMA acknowledged that it started to study about the feasibility of introduction of a digital currency together with 3 major financial institutions like HSBC that issue the HK dollar notes.</li> </ul>

(Source : Based on the HP of each institution and media information)

The Bank of Japan has also been diligently engaged in the study of a digital currency. (Table 4) In the BOJ Review released in December 2015, the technological features of blockchain technologies were mainly introduced, but in its issue of November 2016, the BOJ stepped further to introduce the cases of central banks on dealing with the digital currency and discuss the costs and benefits of issuing digital currency.

Further, at a conference titled “FinTech and the Future of Money,” co-hosted by the Center for Advanced Research in Finance (CARF), the University of Tokyo, and the Payment and Settlement Systems Department of the Bank of Japan on November 18, 2016, Deputy Governor Nakaso gave opening remarks in which he emphasized, while prefacing that “The BOJ has no specific plan at present to issue a digital currency that can replace the current bank notes”, “The need to deepen the understanding on such new technologies as blockchain and distributed ledgers, and it will continue to make study and research on them including the case whether or not there is any room to improve our own infrastructure by utilizing such technologies in the central bank’s activities.” In the panel discussions that followed, there was a lively exchange of views among the participants, academia and senior officials of the BOJ on the role to be played by a central bank in case it issued a digital currency and related matters.

Further, at a “Forum towards Making Effective Use of the BOJ-NET” held on April 21, 2017, Deputy Governor Nakaso greeted the members and said: some people argue that central banks

should consider issuing digital currencies that could partially replace banknotes. Such arguments would mean applying digital technology even to banknotes, which have always been based on paper-based technology. Then he asked a broader range of users for continued exchange of candid and constructive opinions, since “this could have a substantial impact not only on the traditional concept of “banknotes” but also on the way of management of the “central bank settlement system.”

Table 4: Moves of the Bank of Japan on a digital currency

Dates	Media/Speaker	Reports / Speeches
December 2015	Bank of Japan Review (2015-J-13)	Features of "Digital Currencies" and International Discussions (available only in Japanese)
November 2016	Bank of Japan Review (2016-J-19)	Digital Currencies issued by Central Banks — International Discussions and Demonstration Experiments — (available only in Japanese)
November 18 2016	Deputy Governor Nakaso	FinTech -Its Impact on Finance, Economies and Central Bank (Remarks at the University of Tokyo-Bank of Japan Joint Conference in Tokyo on "FinTech and the Future of Money")
April 21 2017	Deputy Governor Nakaso	Future of Central Bank Payment and Settlement Systems under Economic Globalization and Technological Innovations Remarks at the “Forum toward Making Effective Use of the BOJ-NET)”

(Source : Based on the HP of the BOJ)

In the background of this development, there seems to have been a sense of crisis about rapid spread of use of crypto currencies including Bitcoin. A crypto currency means the one that simultaneously satisfies the following conditions:

- ① That has a convertibility with the legal currency.
- ② DLT prevents the currency from manipulations like falsification or extinguishment of the currency.
- ③ It does not depend on any specific nation or central bank.

As of May 29, 2017, there existed about 730 kinds of crypto currencies with the total face

value amounting to almost \$72.8 billion (approx. ¥81 trillion).<sup>3</sup> Among them, Bitcoin account for almost 50% (about \$35.5 billion / ¥39.4 trillion), but they equals only to 1.04% of M1 in the US (dollar cash and liquid dollar deposit kept in the domestic banks), which outstands at about \$3.4 trillion as of end-March 2017.<sup>4</sup>

Nonetheless, based on the November 2016 issue of the BOJ Review, there is following four reasons why the central banks are discussing issuance of digitalized currencies.

#### (1) Improvement of convenience to users

As there is an increased consciousness about handling cost of paper bank notes (packaging and shipping costs) and storing cost (storage in a safe does not generate any profit), issuance of digital currencies by the central banks applying new information technologies would enhance convenience to users.

For instance, the handling cost of paper based settlement like cash money and checks is estimated to amount to 0.52% of GDP in Singapore, and the authorities are making efforts to encourage the shift of settlements from cash money to electronic means of settlements. Also in Europe, cashless society is prevailing centering around Northern Europe. Especially in Sweden, reflecting a wide use among the people of settlement application called Swish that is installed in smartphones, commercial banks are promoting a move to reduce cash-related services or integrate their shops to cut costs.

#### (2) Strengthening of raison d'etre of the central banks

With a penetration of crypto currencies into the world, prices of Bitcoin have been renewing record highs since February 2017 after repeated volatile fluctuations. (Chart 4)

Although the market value of Bitcoin, a most accepted crypto currency, equals to only 1.04% of the US M1 outstanding as noted above, we cannot ignore the possibility that given the recent soaring prices of Bitcoin the presence of Bitcoin could increase to be comparable to a legal tender (sovereign currency) issued by a central bank. If the crypto currency becomes commonly used in the goods and services transactions, the relative presence of a central bank could be reduced with its reason d'etre weakened. Actually the CPMI of the BIS pointed out in its report on "Digital currencies" released in November 2015 that crypto currencies supported by blockchain technology may increase its presence to the extent that they could outstrip a central bank currency.<sup>5</sup>

In that context, it also says that if a central bank issues a digital currency, it will be able to avoid the situation that the bank notes are replaced by crypto currencies only because of its cost of paper.

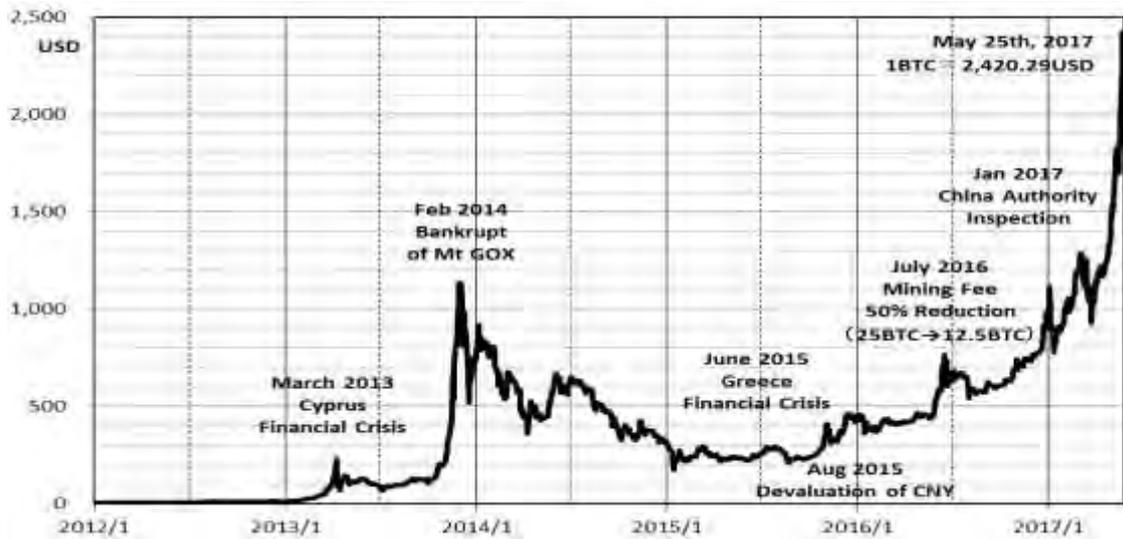
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<sup>3</sup> For more details please see <http://coinmarketcap.com/>

<sup>4</sup> The ratio of face value of Bitcoin against Euro M1 (about €7.4 trillion or \$7.9 trillion) was 0.45%, and 0.57% against M1 of Japan (¥699 trillion or \$6.2 trillion), based on the statistics for March 2017.

<sup>5</sup> For details please see <http://www.bis.org/cpmi/publ/d137.pdf>

Chart 4 : Price development of Bitcoin (up to May 25, 2017)



(Source : Datastream)

### (3) Secured efficiency of monetary policy

The greatest merit of a central bank digital currency (CBDC) for a central bank will be in that it can manage the money supply more effectively as the currency is under the control of a central bank. There is also a view that by controlling the outstanding of the CBDC, the central bank may be able to introduce more easily such policies as negative interest rate or helicopter money, as well as to reduce savings under the mattress or bank runs.

### (4) Seigniorage and others

There is an argument that by issuing a CBDC, the central bank will have a competitive advantage to other crypto currencies that have no issuing entity and therefore it can limit to the minimum the decrease in seigniorage.<sup>6</sup> Also there is an argument that the CBDC may contribute to prevent anti-social behaviors and tax evasions as it records all the transaction history.

<sup>6</sup> However, this argument assumes that the credibility on the central bank has a superiority over that on crypto currencies. For instance, it is considered that even if the central bank issued a digital currency in an environment it has lost its credibility, as in Zimbabwe around 2007, the digital currency will not go into circulation as the central bank had originally planned.

## **6. Challenges for CBDC and points of attention**

In addition to the references in the November 2016 issue of the BOJ Review and speech of Deputy Governor Nakaso, various issues and points to be noted have been raised by many think-tanks.

### (1) Issues on lowering functions of “fund intermediation (indirect finance)” and “credit creation” of private financial institutions

As the CBDC becomes widely used, end-users would shift their funds from deposit accounts kept in private financial institutions to digital money (stored in the application in the smartphones). As a result, there is a dilemma in the private financial institutions that not only the fund intermediation (indirect finance) function will be weakened but also their credit creation function may be lowered. This is also an issue that involves the way of finance itself of how to share between the central bank and private financial institutions the roles of managing the various transactions concerning money.

Further, there is a concerned voice if a stress like financial crisis should happen it might accelerate fund shifts from deposit accounts in the private financial institutions to digital currencies only to cause more frequent liquidity shortages among private financial institutions.

### (2) Problems on information security

While the fact that all participants in the network of a digital currency preserve all the history of transaction has a merit to prevent any manipulation of transactions, there arises a demerit that those participants can look into the history of a third party's transactions as well as its outstanding amount.

As the central bank also can get the whole picture of the holders and history of all their transactions on a real time, it has a merit of being able to quickly comprehend the whole domestic flows of funds on the one hand, but it is pointed out that it violates privacy of the holders on the other.

### (3) Problem of opening central bank accounts

Currently, only financial institutions are allowed to open deposit accounts with the central bank and individuals and corporates other than financial institutions have no other choice but to open their deposit accounts with individual financial institutions. .

However, when the central bank supplies digital currency to the general public in a way to replace the banknotes, the above constraint will be completely removed and all the individuals and corporates will be able to open deposit accounts with the central bank. If the central bank permits all the entities to open deposit accounts, it is likely to invite a deterioration of fund intermediation function (indirect finance) and credit creation function of private financial

institutions, as noted above (1).

Therefore, it is important to make the definition clarified in advance as to what kind of entities the central bank allows to open the deposit accounts.

#### (4) Problem of grasping the possible cost when a hidden risk comes up to the surface

Under the present “centralized” infrastructure, the central bank, a central manager of ledgers, is in a position easier to grasp the risks of the whole infrastructure, and can relatively easily make investment and take measures needed to deal with them, allotting the costs to all the participants in the infrastructure.

On the other hand, under the distributed ledger style of infrastructure, there is a case where individual participants underestimate the risks or otherwise the superficial costs have been lowered by avoiding the costs to build a governance structure to prepare for emergencies, and this could all the more increase the costs to the entire economy when the risks come to the surface.

As the programs developed applying blockchain technologies cannot be altered or ameliorated in principle after put into operation, it is necessary to make a careful test working beforehand. When bugs are found after commencing the operation, participants may suffer a heavy loss.<sup>7</sup>

#### (5) Issue of co-existence with cash

The young people in their 10s and 20s who have had smartphones before they started to form their own thoughts are supposed to have less strong feeling of hesitation, but the elders are likely to have a stronger feeling of safety toward cash. Particularly, Japanese people generally have a strong “cash-oriented attitude”, and there are bank notes in circulation equivalent to about ¥100 trillion at the end of April 2017. In such an environment, it would cause a social turmoil if the central bank tries to shift to a digital currency in a short time.

Therefore, the central bank would have to operate for a certain period of time both the current payment and settlement systems in parallel with the digital currency operation system that is based on blockchain technology. This would pose on the central bank double the costs for operation and maintenance until the digital currency management system is fully introduced.

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<sup>7</sup> “The DAO incident” which happened in June 2016 was believed to have been caused by an insufficient test working before it was judged safe at the time of verification. Therefore a malicious third party who found the bugs in the program unfairly drew out the funds equivalent to ¥5 billion.

## **Conclusion**

One of the reasons why blockchain technology has attracted attention despite its various challenges and points to be noted would be because the existing financial system and services could no longer have satisfied the needs of customers.

With the globalization and strengthened management system, there are increasing needs by the customers of financial institutions (specifically by general business firms), for cross-business cash management and effective fund settlement, integrated information on business transaction and settlement,

In the meanwhile, the system infrastructure of financial institutions to support internationalization, innovation and speed-up of financial transactions has not been changed so much from old times. In addition, in the internal operation, various systems run in a complexly intertwined way to deal with deposit, lending, securities, risk management, regulatory obligations, etc. The bottleneck caused by the lag in the development of financial system as compared to the development of information society has been recognized for long in the financial world, but there has been little incentive for the managers of financial institutions to completely switch the current system that has been working with so many improvements and so much reliability to another system. And there comes blockchain technology. Momentum is now rapidly growing in the financial world to explore its application to their operation on the hope that it can break through the limitation of the current financial system.

The right of issuing a currency which is now monopolized by the central banks dates back to the Bank Charter Act of 1844 (so-called “Peel Banking Act of 1844”) when the Bank of England (BOE) obtained a virtual monopoly of right of issuing British pound notes. Since then, it has been believed that “the currency issued by the central bank has a value,” but there has emerged a possibility that that common sense is likely to be defied by blockchain technologies and virtual currencies that go in circulation on the foundation of them. So the central banks have started to make genuine efforts to conduct researches on the technologies.

In a sense, the expectations on the application of new technologies are widely preceding the implementation. Also sophisticated studies and frequent test workings are required before various financial services applying blockchain technologies are actually provided because high level of information security management (secrecy, completeness, availability) is required for a financial infrastructure. Anyway, it is apparent that since 2016 initiatives for constructing new financial services applying blockchain technology are developing at an accelerated pace, involving industry-government-academia people all around the world.

Taking into consideration the direction of international discussions and the results of research and analysis taken by the central banks, it will be all the more important for Japan to keep up

with the developments of fund settlement, digital currencies and new system infrastructure that support them, confirming every impact that these developments may have on the fund settlement system and financial system in general.

<End>

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