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The Laws and Economics of Payment Systems

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In designing payment systems, it is necessary to address how legal and institutional frameworks incentivize economic entities, and how their payment activities influence the safety and efficiency of overall systems as well as financial stability and market developments. Such studies and analyses are becoming all the more important in line with progress in information technology and payment innovation. In particular, we need to design a framework that continuously moves payments forward without causing gridlock or unwinding, since smooth payment flows are critical especially when highly-frequent transactions are processed back-to-back. We should also pay careful attention to network externalities and systemic risks. Information security is also a key issue, regardless of whether payments are processed in a centralized or decentralized manner.

Introduction

The analytical framework of laws and economics cannot be all-encompassing since the purpose of laws and regulations is not always limited to efficiency and welfare maximization, which are suitable for traditional economic analyses, but also extends to justice, fairness, and equality. Nonetheless, in payment activities the interests of economic entities lie mainly in transferring funds safely and efficiently. Namely, the entities want to send or receive funds faster and with lower costs and risks. Since these purposes of payment activities can be illustrated in economic terms as efficiency and risks, laws and economics may offer useful analytical tools in designing payment systems.

Moreover, since many issues in payment systems are related to traditional issues of economics such as externalities and free-riders, economic analyses of the legal and institutional framework of payment systems would be informative also in this respect. For example, it would be fruitful to examine how the legal and institutional framework incentivizes legal entities, and how their activities influence the risks and efficiency of payment systems as well as the overall costs in the economy. Various measures have already been taken to enhance the safety and efficiency of traditional payment instruments such as cash, checks, and credit transfers. These measures could also be described in economic terms, such as those for securing the value of payment instruments, avoiding unwinding, reducing costs and risks, and tackling negative externalities.

With the increasing globalization of the economy, more payments are being processed on a cross-border basis and across different time-zones. Moreover, wide-ranging new businesses such as e-commerce and the sharing economy are emerging both in Japan and abroad. These new businesses have various needs for innovative payment instruments such as those for making small-value payments even on weekends or late at night.

On the supply side, innovation in information and communication technology has extended the range of technologies applicable to payment systems. Furthermore, cutting-edge technologies closely linked to payments and settlements, such as digital currencies, distributed ledgers, and blockchains, have emerged. Accordingly, it will become increasingly important to apply economic analyses in order to design payment systems that ensure both safety and efficiency while encouraging innovation.

Based on such background, this paper applies an analytical framework of laws and economics to payment systems. In particular, the paper focuses on how relevant rules and institutional frameworks influence the incentives and payment practices of economic entities.

Various Payment Instruments

Payment instruments and their background

Various payment instruments such as cash, checks, credit cards, debit cards, pre-paid cards and credit transfers are widely used. Nonetheless, there are differences among countries regarding the popularity of each tool, reflecting the historical, economic and cultural background of each country as well as the characteristics of economic transactions. Moreover, since payment tools tend to have economies of scope and network externalities, old but popular payment tools are likely to continue to be used until new alternative measures spread among the public to a sufficient level to provide scale merits.

In Japan, cash (banknotes and coins) has long been a popular payment instrument, whereas checks have not been widely used for retail payment. Recently, electronic money, such as pre-paid cards issued by railway companies and other firms, is spreading rapidly (Charts 1 and 2). In the United States, checks have traditionally been widely used both for wholesale and retail payments. Since the U.S. banking industry has tried to replace checks with debit cards in order to reduce the costs of processing checks, debit cards are now widely used as a retail payment instrument[1].

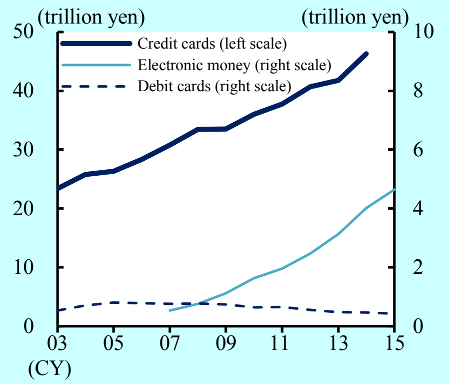
Characteristics of payment instruments and institutional frameworks

This section focuses on several traditional payment instruments. Although the legal and institutional frameworks for each instrument are basically designed to ensure the stability and efficiency of payments, there are various differences among payment instruments.

Cash (banknotes and coins), the most traditional payment instrument, is considered as having absolute "finality," which usually means that there is no unwinding of payments, and/or that payment tools are free from the risk of losses. Cash satisfies all of such criteria. For example, once a merchant has sold goods in exchange for cash, the merchant does not have to worry about the risk of being forced to return the received cash even if it had been stolen. Moreover, the receiver of cash does not need to worry about its credit risk since it is the central bank's liability, and can use the received cash immediately[2]. Such high liquidity of cash is supported also by case laws reflecting academic views, since the leading view at the Supreme Court in Japan as well as academic view is that the "possession" of cash should always coincide with its "ownership."[3]

Moreover, cash does not need any designated entity to keep a registry of its circulation. Information on the value of cash is represented by pieces of paper or metal, and cash circulates through physical transfers of those tangible materials in a decentralized manner. Moreover, cash carries solely information on "value"; other information such as that

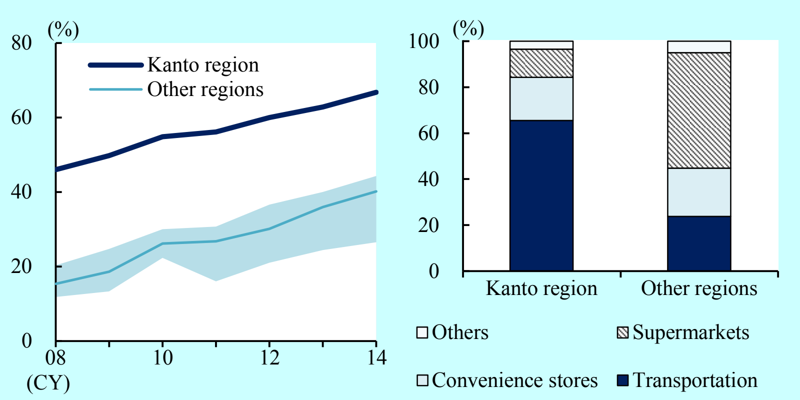
[Chart 1] Annual Transaction Value for Major Retail Payment Instruments



Notes: 1. For credit cards, there is a statistical discontinuity between the data before and after 2013 due to changes in data calculation method.
2. The figures for debit cards are for the J-Debit debit card scheme.
3. The figures for electronic money for 2007 are for the 9 months from April to December.

Sources: Japan Consumer Credit Association; Bank of Japan; Japan Debit Card Promotion Association.

[Chart 2] Use of Electronic Money by Region



Notes: 1. The percentage of households holding electronic money in two-or-more-person households. The shaded area for "Other regions" shows the percentages for regions with the smallest and largest percentages.
2. In a survey conducted in 2014, the respondents were asked to choose the venue at which they use electronic money most frequently.
3. In the Survey of Household Economy, "electronic money" refers to value issued in exchange for cash that is stored in media such as chip cards or magnetic strip cards. Use of these cards as commuter passes is not counted as use of electronic money.

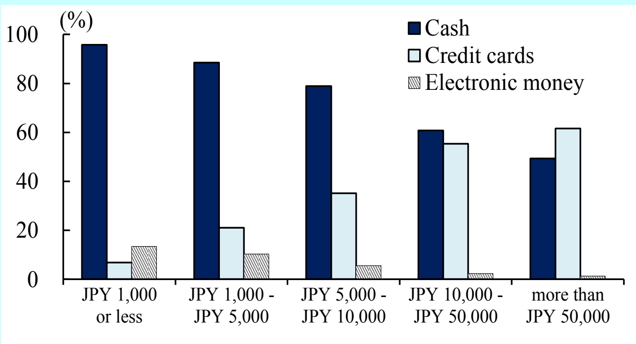
Source: Ministry of Internal Affairs and Communications, "Survey of Household Economy."

of purchased goods and the identities of counterparties is separated from cash. Such characteristics of cash have benefits in terms of information security and privacy. Furthermore, various technologies against counterfeiting have been applied to banknotes and coins, and counterfeiting of banknotes or coins is a crime that is deterred by criminal laws and penalties.

Such high liquidity and "finality" of cash have contributed to the development of economic activities while providing information security and privacy to various transactions. Nonetheless, such characteristics of cash also accompany the risk of theft and loss as well as the issues of money laundering and terrorist financing.

Due to the risks of theft and loss regarding cash, tourists usually use credit cards instead of physically carrying large amounts of cash. Since credit cards involve a time-lag between payment at a store and consequent debit from the holder's bank account, credit card users can stop the consequent transfer of bank funds if their credit card or number is stolen or fraudulently used. Such characteristics of credit cards are supported by the credit provided by credit card companies, and the accompanying credit costs are covered by the membership fees and fees paid by payees (such as shops, restaurants, and hotels). In addition, once credit card information is fraudulently used even for a small-value payment, it might lead to substantial amount of loss[4]. Therefore, credit cards are usually used for larger payments compared with cash (Chart 3).

[Chart 3] Retail Payments Used by Payment Size



Notes: 1. In a survey conducted in 2015, the respondents were asked to choose up to two payment instruments they use for ordinary expenses (such as shopping). The denominators for obtaining the percentages of the use of payment instruments exclude non-respondents.
2. Electronic money includes debit cards.
Source: Central Council for Financial Services Information in Japan, "Public Opinion Survey on Household Financial Assets and Liabilities."

Nonetheless, both cash and credit cards are designed to move payments forward without gridlock or unwinding of payments. Cash avoids such gridlock and unwinding by its own absolute "finality," while credit cards avoid them through insurance schemes to cover the losses. Since credit card loans have similar risk profiles, the law of large numbers can be used to estimate the approximate aggregate losses and to enable loss-sharing through insurance schemes.

In credit transfers, payments are processed through banks' books (registries), which record information regarding the ownership of bank deposits. In this sense, credit transfers could be regarded as centralized payment tools, while cash does not need any designated bookkeeper[5], and bank regulation can be understood also as securing the safety of deposits as payment instruments and appropriate record-keeping by banks.

Checks constitute payment instructions directed to banks. Similar to cash, the information is printed and contained on a piece of paper, and the check is circulated in the form of its physical transfer. From a legal viewpoint, securities laws are applied to checks so as to facilitate their circulation. Various techniques against counterfeiting, such as the writer's signature, are used to protect the information of checks, and counterfeiting is deterred by criminal laws. Moreover, endorsement of checks enables their receiver to verify the continuity of their circulation, and strengthens their creditworthiness.

As illustrated above, each payment instrument has its own characteristics, and the availability of various payment instruments that enable the users to choose the most suitable instrument among them increases economic welfare. Nonetheless, since payment tools tend to have economies of scale and positive network externalities, if the network of each payment instrument is too small, economic welfare will be impaired even though there are many instruments. Thus, it is important to strike an appropriate balance between facilitating choice for users and achieving sufficient versatility of payment instruments.

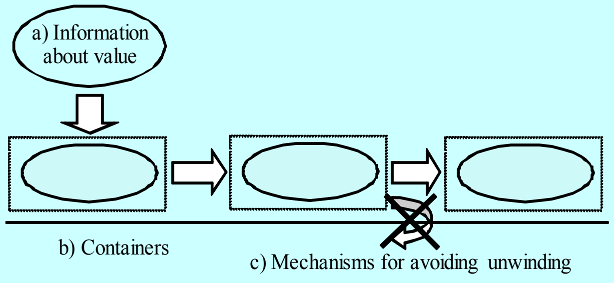
There are also similarities in various payment instruments as well as in their institutional frameworks. Those similarities can be described by the following three common elements or features of payment instruments (Chart 4):

1) Every payment instrument has information on value, which is transferred from one party to another.
2) This information is protected by some "containers" so that it cannot be damaged or altered. Those containers may have various forms such as paper-based technologies (e.g.,

signature of checks, hologram of banknotes), digital technologies (e.g., cryptography) and institutional frameworks (e.g., collateral, insurance scheme)[6].

3) Every payment instrument is accompanied by mechanisms that move forward those containers with information without gridlock or unwinding.

[Chart 4]
Common Elements of Payment Instruments



Payment Innovation and Designing the Institutional Framework

This section focuses on the issues regarding the design of payment systems in view of the development of information technology and payment innovation.

Costs of various payment instruments

Every payment instrument bears some costs: banknotes and checks require costs for printing, physical transfer, and safe storage. Electronic payment instruments require costs for infrastructure and telecommunication. Moreover, payment instruments entail costs for securing the information necessary for payments through various measures. They also require costs for protecting their value through deposit insurance and guarantees, for example.

Those costs are ultimately shared by the users of payment instruments. For example, the costs for checks are partially covered by relatively low interest rates on checking accounts. The costs for credit cards are covered by the fees paid by the member merchants and the cardholders, and bank customers pay transaction fees for credit transfers.

In addition, under ordinary market conditions, holding liquidity for payments also entails some opportunity costs, which coincide with the difference between the yields on liquid and illiquid assets.

Moreover, those costs may change as the available technologies and economic environment develop. For example, the progress in information technology and the development of digital infrastructure reduce the costs of digital communication, thus highlighting the relatively high costs of storing and transferring physical paper. In the Nordic Baltic countries, digital payment instruments have been replacing physical cash also in retail transactions, and such developments seem to reflect technological developments and increasing social needs for electronic payment instruments that can substitute physical cash.

Also, changes in the financial environment, including the level of market interest rates, influence the opportunity costs of holding liquidity for payment.

Risks of various payment tools

Payment instruments are also accompanied by risks, and the risks and costs of payment instruments are sometimes the opposite sides of the same coin. For example, payment instruments could be the target of theft and cyber attacks which are regarded as risks, while countermeasures against those risks require some costs.

Moreover, some risks stem from the design of payment arrangements. For example, the difference in the timings of the transfer of goods and the payment could be a source of principal risks. In addition, the unwinding of payments that were thought to be "final" could cause serious negative impacts on consequent transactions, and trigger a systemic crisis especially when large numbers of transactions are processed back-to-back.

Such systemic risks could be regarded as negative externalities. In today's financial markets where complex and frequent transactions are continuously processed, it is becoming critical to consider systemic risks for the stability of the financial market infrastructure.

Economies of scale and network externalities of payment systems

Most payment instruments tend to have economies of scale and network externalities. In line with the development of digital payment instruments and payment networks, such characteristics are becoming more pronounced. To build payment infrastructure such as digital payment networks requires a substantial initial investment, which constitutes a fixed cost of payment instruments. Also, payment networks tend to have network externalities, in which a new entrant in a network increases the utility of all the members in the network[7].

Because of those characteristics, payment systems may have the following attributes:

a) For each economic entity, it is difficult to invest in brand-new payment infrastructure unless other entities are expected to participate, thus achieving a certain level of scale merits.
b) It is sometimes difficult for a new payment means, even if technologically advanced, to compete with existing traditional payment means that are already in widespread use.
c) When a new payment means gradually spreads among people and exceeds a certain critical point, it tends to spread drastically. For example, in some developing countries where access to banking services is not nationwide, mobile payment services through smart phones and other mobile outlets have been spreading very rapidly, as in the case of M-Pesa in Kenya.

Toward safer and more efficient payment systems

Incentives and cooperation

In order to avoid inefficiency and dead-weight losses due to distorted resource allocation among various payment instruments, we must consider externality issues and incentives for economic entities. In particular, it is important to fill the gap between the entities who can take initiatives in choosing payment instruments and the entities who bear the costs and risks of them.

Moreover, we also need to pay attention to economies of scale and network externalities of payment systems. As more advanced, safe and efficient payment instruments become technologically available, they may be used sub-optimally for various reasons. New payment instruments struggle to achieve scale merits and network effects at an early stage, making it difficult for participants to invest in brand-new payment infrastructure. Initiatives to encourage communication and coordination among relevant entities are needed to achieve optimal payment systems.

In the case of checks, the costs of check collection are initially covered by banks, and the holders of checking accounts indirectly bear those costs by accepting lower interest rates than those of non-checking deposits. In the United States where checks are widely used also for retail payments, the banking industry has taken initiatives to reduce the cost of physically transferring checks. First, banks tried to digitize the information on checks through "truncation." Then, they encouraged the use of debit cards as retail payment instruments through building infrastructure. The banks had both the incentives and the tools to reduce the cost of checks, and so cooperated to replace paper-based instruments (checks) with advanced digital instruments (debit cards).

In the expansion of multi-purpose pre-paid cards like Suica issued by JR East Railway Company in Japan, railway companies have cooperated to enable the pre-paid cards to be used across a wide range of public transportation. As a result, the cards have swiftly come to be held by millions of people primarily for commuting and transportation, and have reached a sufficient volume to produce scale merits and network effects. Many commercial firms are now working to increase the versatility of those cards.

Risk reduction through delivery-versus-payment

In commercial transactions, the gap between the timings of the delivery of goods and the payment gives rise to substantial risks. Japanese contract law (Article 553 of the Civil Code) gives the parties to a contract the right to require simultaneous delivery and payment. Similarly, in securities transactions through electronic book-entry systems, it is important that the payment and settlement systems offer a facility for delivery-versus-payment (DVP) in order to reduce principal risks. In 1994, the BOJ-NET, the large-value payment and settlement system operated by the Bank, introduced a DVP facility between fund transfers and JGB transfers. Also, many overseas settlement systems as well as private-sector systems have adopted DVP facilities.

In 2001, CLS Bank, supported by major central banks, started to reduce settlement risks in foreign exchange transactions by facilitating payment -versus-payment (PVP) of multiple currencies, although issues remain to be resolved, such as how to facilitate DVP for a wider range of financial assets and cross-border DVP[8].

Reduction of systemic risks through RTGS

In recent years, the risk associated with unwinding of payments is increasing since it would lead to substantial systemic risks as financial market transactions are becoming more frequent. From the viewpoint of financial stability, it is critical to avoid such unwinding especially in large-value payments, since unwinding of payments could have systemic consequences in continuous chains of transactions. Nonetheless, since the value of each payment can be substantial in a large-value payment system (LVPS), it would be difficult to apply an insurance scheme to cover the relevant losses, and real-time gross settlement (RTGS) has been the most effective arrangement so far to avoid unwinding and to reduce systemic risks in LVPSs.

In LVPSs in the past, the designated-time net settlement (DTNS) scheme was widely used. DTNS calculated the net amount of payment instructions on a multilateral basis at a designated time, and each participant was required to pay only the calculated net amount, thus reducing the volume and amount of actual fund transfers needed. Moreover, payment system participants enjoyed lower opportunity costs of holding liquidity, since they were only required to keep enough liquidity to cover the net amount instead of the gross amount. Nevertheless, if any of the participants fails to pay its netted obligation, DTNS systems are forced to unwind all the payments. If this were to happen, payment obligations on a gross basis, which were thought to have been settled, would reemerge and cause substantial negative systemic impacts. In addition, information technology has reduced the cost of transferring digitized data, and so the benefits of DTNS over RTGS in terms of the volume of data exchanges are less significant than before.

Nonetheless, although each payment system participant can easily see the cost of replacing DTNS with RTGS, it is difficult to immediately appreciate the whole benefit of RTGS, since RTGS mainly reduces the risks for other participants. In this regard, the systemic risks involved in DTNS are typical negative externalities. Accordingly, central banks (or other public authorities) would have to play a catalytic role in enhancing mutual communication among relevant entities in order to achieve the optimal LVPS for the markets and the economy.

In 2001, the Bank introduced RTGS in its BOJ-NET. Likewise, the introduction of RTGS into the LVPSs of many developed countries was led by central banks. Like the Bank, major central banks adopted RTGS in their own payment systems, and as a result market participants gradually became more sensitive to the risks stemming from payment unwinding. As such, both the enhanced risk awareness of private market participants and central banks' initiatives have jointly contributed to the innovation of LVPSs, including the adoption of RTGS.

In some countries, market participants' awareness of systemic risks has also contributed to establishing new legal frameworks that reduce the possibility of payment unwinding. For example, some countries limit the retroactive power of bankruptcy proceedings, and the zero-hour rule, which used to apply in some European countries, has been eliminated.[9] In addition, some countries have made new laws that guarantee the effectiveness of payment instructions issued before the initiation of bankruptcy proceedings.[10]

Since systemic risks in payment systems are regarded also as negative externalities, we must consider free-rider incentives. Most countermeasures against systemic risks such as exposure limit, collateral requirement, and capital burden may increase the cost for each participant while the benefits of the countermeasures are shared by all the participants. Accordingly, each participant might have incentives to be a free-rider on payment systems that become safer at the expense of others, while minimizing its own expenses. If such incentives lead to sub-optimal efforts for risk reduction, aggregate risks would become larger than optimal. In order to reduce such systemic risks in payment systems, it is important to enhance communication and coordination among entities.

Moving payments forward

As illustrated above, in designing payment systems, it is important to continue moving payments forward without causing unwinding or gridlock. Nonetheless, payment system participants tend to pay as late as possible, since they want to minimize the opportunity cost of holding liquidity and to avoid principal risks. If some participants delay the throughput of their payments, the consequent payment flows will also be affected due to the lack of liquidity, and overall payment flows will also be delayed. Such delay in the timings of overall payments could also be regarded as negative externalities, in the sense that one participant's reduction of risks and costs are realized by increasing the costs and risks of all the other participants.

Such incentives to delay the timing of payments are one of the problems to be resolved in introducing RTGS instead of DTNS. In DTNS each payment participant is only required to have enough liquidity to cover the net payment obligation at the designated time for settlement. On the other hand, in RTGS each participant may need to have enough liquidity to cover the gross amount of each payment in order to move payments forward. Therefore, participants in RTGS may have incentives to wait for incoming payments before making their outgoing payments. Such incentives may delay the timings of overall payments in RTGS.

In designing an efficient RTGS, it is important to reduce such incentives of delaying throughput; DVP facilities could be an effective tool in this regard. Under DVP, market participants do not have to worry about principal risks, and if market participants want securities at the earliest opportunity, they can and need to issue payment instructions from their side. As such, a DVP facility could be beneficial also for avoiding undue delay in the timing of payments related to securities transactions.

Also, from the viewpoint of opportunity costs of holding liquidity, the liquidity-saving facility in RTGS could also be effective in avoiding undue delay in the timing of payments. RTGS with a liquidity-saving facility is able to place payment instructions in a queue and to arrange optimal matching of incoming and outgoing payments by using algorithms, so as to enable liquidity savings while avoiding overdraft. In RTGS with a liquidity-saving facility, participants can issue payment instructions at any time without worrying about insufficient balance. Namely, liquidity-saving functions could satisfy both the needs for systemic risk reduction through RTGS and for moving payments forward. The Bank introduced such liquidity-saving features into its BOJ-NET in 2008.

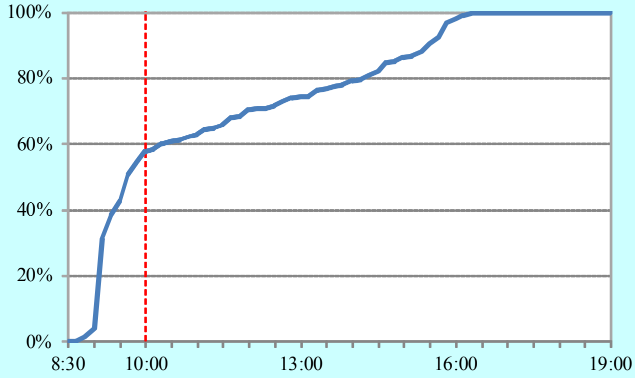
It is also meaningful for market participants to share common trading practices in order to enhance payment efficiency and to reduce risks. For example, money market participants using the BOJ-NET share common practices that payment instructions have to be issued within one hour after the relevant deals, and that the market participants who have an obligation to pay back interbank loans have to make the relevant payments immediately after the market opening. As such, money market participants in Japan understand the importance and the benefits of moving payments forward, and most interbank transactions are settled in the morning hours through BOJ-NET (Chart 5).[11]

Central banks' role in designing payment systems

Such characteristics of payment systems including economies of scale, network externalities, and systemic risks also require central banks to play critical roles in enhancing the safety and efficiency of payment systems.

In the modern economy, all transactions are ultimately settled through central bank money including banknotes and transfers among central bank accounts. Indeed, most central banks operate their own LVPSs as basic infrastructure in the economy in order to enhance the safety and efficiency of payments and economic transactions. In line with the digitization of payments and the development of payment networks, the safety and efficiency of central bank payment systems are becoming all the more important, since most digitized transactions are also ultimately settled through central bank LVPSs.

[Chart 5] Intraday Pattern of Settlement of Interbank Transactions through BOJ-NET



Note: Cumulative percentage of the daily value of interbank transactions settled in the Queuing and Offsetting Account on December 30, 2015.
Source: Bank of Japan.

Since payment systems tend to have economies of scope, network externalities, and negative externalities linked to systemic risks, rational decision-making by each participant will not necessarily lead to the optimal state of payment systems for the overall economy. Under such environments, central banks may need to play catalytic roles in enhancing communication and coordination among relevant entities and promoting the use of common market practices, while improving the safety and efficiency of their own LVPSs. Moreover, central banks sometimes have to make proposals in order to facilitate the shift toward more advanced payment systems.

Payment and New Information Technology

Recently, many international forums have focused on the possible impacts of new information technology such as blockchains and distributed ledgers on payment systems and other market infrastructure. It is therefore worth reviewing payment issues from the perspective of information.

This paper raised three elements that are critical in payment systems:

a) information on value;

b) containers, which are the infrastructure to protect the information from various risks including those of alteration, losses and attacks;

c) mechanisms to move forward the information containers without causing retrogression.

Traditional payment tools such as banknotes and checks have been based on paper-based technology. In the case of banknotes and checks, the relevant information is printed and contained in physical paper, and protected also by paper-based technology such as signatures and holograms. Since payments through banknotes and checks are processed through their physical transfers, they are regarded as a decentralized system without any designated bookkeeper.

On the other hand, bank transfers and book-entry systems for securities can be regarded as centralized systems in the sense that they need designated bookkeepers, such as banks for deposits and CSDs (central securities depositories) who keep the records of ownership and transfers of securities as digital data.

Blockchains and distributed ledgers are different from such systems. They are based on electronic technology and digital data, but do not need any designated bookkeeper. In other words, blockchains and distributed ledgers will enable decentralized systems, which were formerly available through paper-based technology, with digital technology, and thus have the potential of wide-ranging application.

Nonetheless, many issues remain to be solved in applying blockchains and distributed ledgers to market infrastructure and various businesses:

- Will there be effective containers to protect information also in blockchains and distributed ledgers? In other words, are there any mechanisms, like signatures and holograms in paper-based technology, to protect information from various threats including alteration and cyber attacks?
- Will those mechanisms for protecting information be sustainable in terms of costs and incentives?[12]
- How will those mechanisms be supported by legal and institutional frameworks, some of which seem to be based on paper-based technology or centralized bookkeeping?

Central banks and other entities should conduct further research on these challenging frontiers.

[1] Federal Reserve System (2013), "The 2013 Federal Reserve Payments Study," December 2013, pp. 7–11.

[2] Several laws such as those for bankruptcy procedures and consumer protection can make sales invalid. Nonetheless, such cases are not regarded as unwinding of payments themselves.

[3] For example, see the opinion expressed by the Supreme Court on January 24, 1964.

[4] In e-commerce such as internet transactions involving used products, new payment tools offered by non-banks (for example, PayPal) are spreading globally. As payment tools for e-commerce, they have several advantages such as that they can be used 24/7 and through internet and mobile phones, even for small amounts, and do not inform counterparties of credit card numbers.

[5] Book-entry systems for securities also work as designated bookkeepers and process their settlements.

[6] As a representative article emphasizing the importance of technology for data protection in payments, see Mitsuru Iwamura and Hideki Kanda, "Data –Hogo No Gijutsu To Hou (Law and technology for data protection)" (July 1995).

[7] In the case of credit cards, the increase in the number of member shops that accept credit card payments enhances the utility of having the card. At the same time, the increase in the number of card holders enhances the benefits of becoming a member shop. Such network externalities can also be observed in most payment infrastructure including clearing and netting systems.

[8] In order to tackle principal risks in retail payments where many small-value transactions are settled, it is also possible to make use of insurance schemes, as used in credit card schemes. Indeed, some of the new payment instruments for e-commerce have adopted such insurance-type schemes to avoid principal risks.

[9] The zero-hour rule may have risks of unwinding payments that were thought to be final. Bankruptcy laws in Japan do not have zero-hour rules.

[10] For example, see Settlement Finality Directive 98/26/EC, which defends the finality of payment instruction regardless of the initiation of bankruptcy proceedings.

[11] Oliver Armantier, Jeffrey Arnold, and James McAndrews (2008), "Changes in the Timing Distribution of Fedwire Funds Transfers," FRBNY Economic Policy Review, September 2008, pp. 83–112.

[12] Distributed ledgers can be regarded as protecting authenticity of information through incentives of many participants without relying on a designated bookkeeper. There remain various issues such as the sustainability of incentives to continue verifying (mining) the chain of transactions.

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