September 2, 2008
Bank of Japan

Technological Innovation and Central Banks

Speech at the Graduate School of Economics of Nagoya University

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Introduction

I am very honored to have the opportunity to speak here at the Graduate School of Economics of Nagoya University. My speech today deals with the topic of technological innovation and central banks. The choice of the topic is influenced in part by the fact that Nagoya is known as a center of manufacturing and technological innovation. Another reason is that, for central banks to make appropriate policy judgments, it is increasingly important to take account of changes brought about by technological innovation and to actively take advantage of such innovation.

I. Functions and Business Operations of a Central Bank

A. Functions of a Central Bank

Before discussing the topic of technological innovation, let me first provide you with an overview of central bank functions.

The term "central bank" will probably remind you of banknote issuance. Textbooks on macroeconomics and banking and finance describe central banking operations such as the conduct of monetary policy and the "lender of last resort" function. This may raise the questions of why a single institution, a central bank, is responsible for these wide-ranging activities, and also why a bank, instead of a government office, is responsible for them.

To find the answers to these questions, we should first understand that issuing money, or banknotes to be precise, is the most fundamental function of a central bank. The Bank of England, one of the oldest central banks in the world, was established in 1694 as a private bank. In those days, banknotes were issued by several private banks. However, through competition among banks, the function of issuing banknotes was gradually monopolized by the Bank of England. In 1844, it was legislated that the Bank of England be the sole issuer of banknotes, and it gradually established itself as a present-day central bank. Similarly in Japan, private banks issued their own banknotes in the early Meiji Period (around 1870). But to solve the complexities involved in having multiple currencies, the Bank of Japan was established in 1882 as the only institution to issue banknotes.

As history shows, the most basic central bank function is to issue banknotes, which are

recorded as its liabilities. To enable the public to use with confidence and convenience the banknotes it issues, public confidence in the currency must be secured. And to secure such confidence, the following two conditions must be met. First, circulation of the currency and the functioning of the settlement and financial systems that support it must be reliable and efficient. The "lender of last resort" function that I mentioned at the beginning is one of the functions of a central bank to maintain financial system stability. Second, the value of the currency must be stable, that is, price stability must be maintained. A central bank conducts monetary policy to fulfill this condition.

As I have discussed thus far, various central banking operations work to secure public confidence in the currency, with the function of banknote issuance as the starting point. As I will describe in greater detail later, these central banking operations are carried out through banking activities.

B. Central Banking Operations

1. Provision of cash and settlement services

Let me explain central banking operations in detail. I will start with the central banking operations of supplying cash and providing settlement services. The Bank, through its network consisting of the Head Office, branches, and local offices, arranges that cash is circulated throughout the country. In addition to cash, the Bank provides current accounts to private financial institutions, whose balances can be exchanged for banknotes at any time (Chart 1). Just as in the case of an individual holding an account with a private bank and obtaining loans, private banks and securities companies hold current accounts with the Bank and borrow funds from the Bank. Many of you may pay utility bills or pay for items you purchased by using funds transfer or remittances through private banks. Banks that receive such requests settle these payments among themselves by transferring funds via their current accounts with the Bank. The amount of funds settled via the current accounts with the Bank is increasing steadily and currently totals around 120 trillion yen per business day (Chart 2). Moreover, the amount of funds settled also fluctuates very much within a day. For the efficiency and safety of such settlement via the Bank's current account, the Bank operates a computer network system called the Bank of Japan Financial Network System, or BOJ-NET for short.

Let us now see how a central bank supplies funds (Chart 3). When the Bank extends loans to financial institutions or buys securities such as Japanese government bonds (JGBs) from them, funds are credited to these institutions' current account with the Bank. Such operations are called "funds-supplying operations." When cash becomes necessary at these institutions to meet customers' withdrawals, financial institutions obtain cash by withdrawing deposits from their current account with the Bank. This is the overall picture how cash is put into circulation.

These funds-supplying processes can be outlined and explained by changes in the balance sheet of the Bank (Chart 3). When the Bank, as in the example I have just given, supplies funds by extending loans to financial institutions or buying JGBs, such loans or JGBs represent an increase in its "assets." At the same time, though, the funds thus supplied represent an increase in its "liabilities," while for the financial institutions they represent an increase in their "assets" in the form of increased current account deposits with the Bank or banknotes. What should be stressed here is that the money is supplied through the banking activities of the central bank, in other words, the execution of transactions as a bank.

2. Maintenance of financial system stability

I would now like to discuss the second item on my list of central banking operations, which is the maintenance of financial system stability. As I mentioned earlier, means of payment familiar to households and firms, besides cash, include funds transfers between bank accounts. A part of private bank deposits, such as ordinary deposits, is also called "deposit money," and they function as currency based on the assurance that such deposits can be exchanged for banknotes issued by the Bank at any time.

Before proceeding further, let me briefly define terms such as "cash" and "money," since they have been used so far without a strict definition (Chart 4). "Cash," which consists of Bank of Japan notes and coins in circulation, amounts to around 80 trillion yen. The sum of current account balances at the Bank and Bank of Japan notes in circulation is called "central bank money." The amount of "deposit money" such as demand deposits held by households and firms is around 400 trillion yen, significantly larger than the outstanding

amount of cash. Money stock, which is the total of cash, deposit money, and "quasi-money" such as time deposits, all held by households and firms, is around 1,000 trillion yen.

The present-day currency system is built on a complex network consisting of the central bank, financial institutions that provide deposit money, and financial markets where financial institutions carry out their activities. Therefore, to secure the ease of use of money and its value, maintenance of financial system stability -- the stable functioning of financial institutions and financial markets -- is essential. Failure of one financial institution to meet its payment obligations may lead to problems for other financial institutions that had been expecting the transfer of funds from the troubled institution, and this may lead to a chain reaction of defaults, that is, the materialization of "systemic risk." In order to prevent the materialization of such systemic risk, central banks may temporarily extend necessary funds to financial institutions facing funds shortages. This is called the "lender of last resort" function of the central bank. In the period from the latter half of the 1990s to the early 2000s, when Japan's financial system was in turmoil, the Bank extended such emergency loans, the so-called *Nichigin Tokuyu*, to financial institutions. This is an example of the central bank assuming the role of lender of last resort.

In addition, to prevent the materialization of systemic risk, central banks should always monitor whether activities of financial institutions and the functioning of the payment and settlement system are sound, and provide advice as necessary. To this end, the Bank is continually monitoring the situation in financial institutions and in financial markets. The Bank also conducts on-site examinations of financial institutions, in which the Bank's staff visit the premises of these institutions to examine in detail their financial soundness and risk management.

3. Conduct of monetary policy

The last item on my list of central banking operations is the conduct of monetary policy, which aims at maintaining stability in the value of the currency, in other words, at maintaining price stability. Central banks maintain price stability through controlling the amount of currency they supply and the level of interest rates, that is, the price of money.

If the Bank supplies abundant funds to the market, the market interest rate -- the uncollateralized overnight call rate -- will decline, reducing the funding costs of financial institutions. This will influence other interest rates such as those on loans to households and firms. Through the change in interest rates, the cost of funds necessary for the economic activities of firms and households will change, and this will stimulate overall economic activity. As a result, this will alter the economy's supply and demand balance of goods and services, and will in turn affect prices.

Monetary policy is not enforced by legislation or through administrative discretion. Rather, as I have explained, it is conducted through the central bank's banking operations, with private financial institutions as its counterparts.

As we have seen so far, the various roles played by the central bank are conducted through its banking operations, and this is the very reason why they are undertaken by a bank instead of a government office.

II. Technological Innovation and the Bank of Japan

A. Changes Brought about by Technological Innovation

Central bank functions, which we have just looked at, have differed from country to country and from time to time, but are now well established in the major countries. However, the specifics of central banking operations enabling central banks to fulfill their role have been changing continually. Especially in recent years, the environment surrounding central banks has altered significantly and rapidly through economic globalization, the globalization of financial markets, and advances in financial engineering techniques such as those in the field of derivatives. These changes have been driven by technological innovation particularly in information and communications technology. In view of such changes in the environment, the Bank has been making efforts to properly conduct central banking operations that proactively pursue the achievement of its mission. Let me introduce to you the efforts that the Bank has been making with regard to its three central banking operations that I described earlier.

B. Technological Innovation and Central Banking Operations

1. Provision of cash and settlement services

My first topic with respect to central banking operations is the provision of cash and settlement services.

a. Provision of cash

What is most important in securing the public's confidence in the use of money is to ensure their confidence in cash. The issuance of paper money, that is, of banknotes, in itself is the result of technological innovation. The oldest paper money in Japan is said to be the *Yamada Hagaki*, which was circulated near Nagoya, in the Ise Yamada area (now Ise City, Mie Prefecture) around the 1600s [References 1 and 2]. The history of paper money can also be said to be the history of anti-counterfeiting, and at the Bank we continually examine the authenticity of cash and carry out research and development on anti-counterfeiting technologies. Banknote counterfeiting increased rapidly in the 2000s: the annual number of counterfeit notes detected surged from previously several hundreds to approximately 26,000 in 2004. This is due to the wider use of digital imaging devices such as color copiers and printers, and counterfeit notes have become even more sophisticated with the further technological development of such devices.

Technological innovation is partly responsible for the increase in counterfeit banknotes, but at the same time it also contributes to providing anti-counterfeiting measures. Banknotes incorporate many security features such as meticulous designs, watermarks, and luminescent ink that prevents the reproduction by color copiers or similar devices. The new series banknotes issued since 2004 are equipped with state-of-the-art security features (Chart 5) [References 3 and 4]: one is a hologram at the lower left corner of 5,000 and 10,000 yen notes, which changes its color and pattern when the notes are tilted. Another feature is intaglio printing, and the ink on the new series notes is raised higher than the ink on the previous ones. The number of counterfeit banknotes has clearly decreased due to the issuance of the new series notes equipped with such high security features. Only one out of one million banknotes in circulation is counterfeit in Japan, which is very low compared to one out of 10 thousand in the United States. This is attributable to the high sophistication of banknote production technologies in Japan. However, the Bank needs to

make persistent efforts to deal with the rapid progress in technologies that make counterfeiting possible. Given the globalization of currency counterfeiting, the Bank has been conducting joint research on anti-counterfeit technologies with other central banks, law enforcement agencies, and manufacturers of cash handling machines.

Various types of electronic money have been introduced and used as a new means of retail payment. However, these types of electronic money cannot immediately replace cash in terms of general acceptability and anonymity, both of which are characteristics of cash, as evidenced by the fact that their use is restricted mainly to small-value retail payments and closed networks. A recent survey conducted by the Bank shows that the outstanding value of electronic money is approximately 77 billion yen, equivalent to only 0.1 percent of the outstanding value of cash (notes and coins) and 1.7 percent of that of coins [Reference 5]. With the recent rapid increase in its use, however, electronic money seems to have become widely established as a means of small-value payments. The Bank has been working on research and analysis on electronic money, paying due attention to how such a new means of payment will change the concept of money and the design of payment and settlement systems, and how these changes may affect the Bank's policy and business operations in the future. In addition, the Bank, as the secretariat of Japan for the Technical Committee for Financial Services of the International Organization for Standardization (ISO), participates in the standardization of information security technologies such as cryptography and biometrics, and the coding of message transmissions among financial institutions. Making use of the results of these efforts, the Bank supports Japan's financial industry to take advantage of new information technologies.

b. Enhancement of settlement services

Reflecting the progress in information processing technology and the increase in financial institutions' need for more advanced settlement services, the Bank has also been working to improve the safety and efficiency of settlement via current accounts at the Bank, which is another means of settlement the Bank offers. I will briefly explain the history of large-value interbank funds settlement as a good example of how technological innovation has contributed to the evolution of financial transactions.

Most central banks, including the Bank of Japan, used to conduct interbank settlements on a net basis at designated times during the day. The settlements between private financial institutions are completed by transferring funds between current accounts that they hold with the Bank. In this settlement mode, called "designated-time net settlement," funds transfers were made at designated times of the day, four times per day in Japan. At each designated time, the net settlement position of each financial institution was calculated simultaneously and its account at the Bank was credited or debited. With this settlement mode, financial institutions need only the funds equivalent to their net debit positions at the time of settlement, and thus, it is an efficient mode from the viewpoint of the management of liquidity and business operations. Under this mode, however, if a single financial institution in the system were to fail to meet its obligations, all payments would inevitably be suspended. In the worst case, this would lead to a chain of defaults at financial institutions. Since the total daily value of settlement via the current accounts at the Bank is substantial, reaching around 120 trillion yen, the effects of this risk could be grave.

In order to reduce such risk, in 2001, the Bank converted the designated-time net settlement to a settlement mode in which funds transfers are made immediately and individually. This mode is called "real-time gross settlement (RTGS)." In RTGS, each payment instruction sent by financial institutions for a funds transfer through current accounts at the Bank is settled immediately and individually upon receipt. Therefore, negative effects of one financial institution's failure to pay would be limited to counterparties to that institution and would be minimized for other institutions and the overall settlement system. While this is a considerable advantage, there is an issue specific to RTGS that need to be addressed. Namely, it requires financial institutions to prepare larger amounts of intraday liquidity for settlement compared with the designated-time net settlement. In the current RTGS mode, if each and every financial institution holds back its payments until it receives payments from others, there is a possibility that all system participants would end up short of funds and settlements would not be processed (Chart 6). If such behavior became widespread, it could lead to gridlock, and smooth settlement, the aim of RTGS, would not be achieved.

The breakthrough in addressing this issue was the substantial progress in information processing technology. The Bank has been working on the implementation of the

next-generation RTGS (RTGS-XG) project, and is planning to introduce new functions, "queuing and offsetting mechanisms," into the BOJ-NET Funds Transfer System in October 2008 [Reference 6]. The "queuing mechanism" will place payment instructions in the BOJ-NET central queue. The "offsetting mechanism" will then identify sets of payment instructions in the queue that can be offset simultaneously and settle these individually, as in RTGS. The "offsetting mechanism" will carry out bilateral offsettings continuously throughout the day, and multilateral offsettings four times a day. The RTGS-XG project, therefore, aims to achieve efficient settlement by maintaining the advantage of the RTGS mode, its stability, while reducing the liquidity necessary for settlement. The results of running tests of RTGS-XG, in which many financial institutions participated, show that the aim of the project, that is, improving the efficiency of settlement and minimizing the liquidity necessary for settlement, will be achieved with the introduction of the above mechanisms (Chart 7). RTGS-XG was made possible with the increase in information processing capacity, and this is a good example of how technological innovation has contributed to improving the safety and efficiency of financial transactions.

2. Maintenance of financial system stability

Technological innovation has also posed a great challenge to central banks' efforts to maintain financial system stability. Advances in information processing have facilitated financial innovation and created new financial instruments such as derivatives and securitized products. These have enabled financial institutions to unbundle and reallocate risks of various kinds, such as credit and interest rate risks, based on diverse and complex methods for analyzing and managing risks.

Let us take securitization of mortgages, the root of the U.S. subprime mortgage problem, as an example. Mortgages involve various risks. For instance, a lender or an investor may face credit risk, the risk of loss resulting from the counterparty's failure to perform its financial obligations, as well as interest rate risk, the risk of loss from a rise in interest rates during the loan term. Needless to say, regular bank loans entail similar risks; however, mortgages present larger risks due to their extremely long maturity, and the risk management of mortgages is more difficult. Securitization is an example of the enhancement of risk management techniques achieved through advances in information

processing.

When mortgages are securitized, a number of mortgages are packaged together and securities backed by these mortgages (mortgage-backed securities, [MBSs]) are issued (Chart 8). Because interest payments on, and redemptions of, the securities are covered by the payments of interest and principal on a large number of mortgages, there is a greater diversification of risk when compared with individual mortgages. For example, creating MBSs by packaging a number of mortgages whose borrowers are scattered over a wide geographical area can diversify risks, such as the catastrophe risk associated with a particular area, and risk quantification becomes easier because of the law of large numbers. Securitization also allows financial institutions to restructure the packaged mortgages into multiple securitized products with different risk profiles that meet specific investor needs with various degrees of risk acceptance and preference and to sell these products. What is more, as the financial intermediary function of the mortgage market becomes more efficient through these schemes, there are greater opportunities for borrowers to obtain mortgages on favorable terms.

On the other hand, if we fail to properly understand new financial engineering techniques, this will lead to a failure in risk management. For example, even when a securitized product is backed by a large number of mortgages for the purpose of risk diversification, the law of large numbers will not work if the economy as a whole is experiencing a housing bubble and the individual loans backing such securities as a result take on similar risk profiles. Global financial markets have been in turmoil stemming from the U.S. subprime mortgage problem since summer 2007, and one of the causes was the excessive risk-taking arising from the false assessment of such risks amid the rapid expansion of the market for securitized products. I hasten to add, however, that just blaming securitization will not solve the problem. Providing financial services is difficult, and this can be understood if you put yourself in the position of mortgage loan suppliers. For an economy to prosper, someone has to provide credit while managing the risks involved, namely, the credit, interest rate, and liquidity risks. Just like manufacturing, the provision of financial services requires specialized skills, and financial institutions need to adapt their services to changes in the financial environment.

At the same time, central banks and supervisory authorities around the world face new challenges in their quest to maintain the financial system stability as a result of such changes in the financial environment. While such challenges span various areas, a key prerequisite is a proper understanding of the risks involved in individual financial transactions. In this regard, the Bank has been conducting surveys and research on ways to properly assess and analyze the risks involved in new financial engineering techniques and financial instruments, and has made use of the findings in its market monitoring and discussions with financial institutions in on-site examinations. At the same time, it is important to identify risks in the financial system as a whole in a cross-sectoral manner. These are indeed very extensive and difficult issues, and central banks and supervisory authorities around the world have been deliberating on how to improve financial regulation and supervision by making use of the lessons learned from the U.S. subprime mortgage problem.

3. Issues regarding the conduct of monetary policy

I will now move on to the last topic in the area of central banking operations, the conduct of monetary policy, which covers a wide range of issues. Today, I will focus on two of them: first, how the Bank makes use of the fruits of technological innovation in the development of monetary policy tools; and second, what challenges technological innovation poses concerning the Bank's assessment of the economic and price situation.

a. Advancement of monetary policy tools

Let me begin with changes in the ways in which the Bank supplies funds to financial institutions by extending loans and executing money market operations. Currently, the whole process of the Bank's funds-supplying operations, involving notification by the Bank of such operations, financial institutions' application for such operations, the transfer of funds to financial institutions' current accounts at the Bank, and their repayment of funds to the Bank, are executed electronically. Swift processing of transactions and settlements is essential as prices in financial markets change by the second in response to various news, and the Bank's processing system is now an indispensable infrastructure for conducting money market operations flexibly so as to maintain stability in financial markets.

Financial institutions put up collateral when they receive loans from the Bank, and the management of such collateral has been carried out under an integrated online system called the "pooled collateral" system since 2001. The system made possible a more efficient use of collateral by financial institutions and improved significantly the administration of collateral by the Bank and financial institutions. The Bank started to accept, in addition to conventional financial assets such as JGBs and corporate bonds, new, innovative financial assets, such as securitized products and dematerialized commercial paper, as collateral from financial institutions. These changes are technological innovations in monetary policy tools, achieved through the progress in information processing and financial engineering.

b. Challenges with respect to the assessment of the economic and price situation

Next, I will discuss the last issue, the challenges technological innovation poses regarding the assessment of the economic and price situation, which forms the basis for the appropriate conduct of monetary policy by the Bank.

Monetary policy aims to contribute to the sustainable growth of the economy through the maintenance of price stability. Technological innovation raises practical issues when an accurate measurement of the price level using price indexes, such as the consumer price index and the corporate goods price index, becomes difficult as a result of technological progress itself. Let me explain this issue from three aspects. First of all, to grasp price developments accurately, new products and services, continuously introduced as the fruit of technological innovation, need to be incorporated swiftly among the items comprising these price indexes. Second, quality improvements need to be considered when measuring prices. The quality of a product improves with technological innovation, but often its price is kept unchanged, and this can be taken as a price decline in real terms. Price indexes take this point into account, but it is difficult to assess quality improvements and to what extent this should be considered as a change in prices. Let me take computers as an example. Statistically, an increase in memory capacity is regarded as a decline in price. From a consumer's viewpoint, however, it is difficult to judge whether the increase in memory capacity should be regarded as a reduction in the price of computers, because this assessment will depend on the consumer's individual taste and requirements of a computer.

And third, identifying the most typical sample price for a good or service has become more difficult with the progress in technological innovation. For example, recently, there have been an increasing number of services that award benefits to the customer after certain conditions are satisfied, such as loyalty cards and mileage services. These are examples of so-called "nonlinear pricing" systems. As a result of such highly distinct price setting, a particular good or service has various prices, making it difficult to determine the most typical sample price for each item when compiling price indexes.

Effects of technological innovation are also significant in the assessment of economic activity. Measurement of real GDP or productivity is based on the assumption that nominal values can be broken down accurately into price and volume. Naturally, however, if price measurement through indexes becomes difficult, it is also difficult to assess volumes. In addition to these measurement problems, there are also difficult conceptual problems. For example, making judgments with regard to what effects technological innovation is having on productivity in the overall economy, in other words, the potential growth rate, is crucial in assessing the tightness of supply and demand conditions, the so-called output gap. Let me take an example to illustrate this point. Beginning in the early 1990s, the U.S. economy experienced a long phase of expansion and the unemployment rate fell significantly, while prices remained stable. It has often been argued that this expansion was attributable to a rise in productivity brought about by the IT revolution heralding the arrival of the so-called "new economy." Under such circumstances, a central bank should examine carefully whether productivity of the economy is indeed rising, because if productivity growth is real, the central bank should not raise interest rates unnecessarily so as not to hamper the opportunity for economic growth. On the other hand, if productivity growth is overestimated, the central bank might miss the opportunity to implementing a necessary raise in interest rates, and as a result, inflation or an economic bubble might occur. For this reason, it is essential that, in its conduct of monetary policy, the Bank grasps accurately developments in productivity.

Closing Remarks

As I have discussed, technological innovation is ongoing, and just as for private firms and financial institutions, the environment in which central banks operate is continuously

changing. I would like to close my speech by noting a few points that I believe to be important for central banks in confronting these changes.

First, central banks must strive to clearly understand changes in the environment and make constant efforts to review their operations. Central banks are decidedly practical institutions that perform banking operations. As I said at the outset, in order to enable the public to use money with confidence and convenience, central banks must strive to provide high-quality central banking services by making full use of the fruits of technological innovation. Although monetary policy does not directly contribute to raising the productivity of the economy, central banks' banking services, such as settlement, do.

Second, technological innovation may bring about various uncertainties regarding the assessment of the economic and price situation as well as the conduct of monetary policy on the basis of such assessment. In order to make appropriate policy decisions under such circumstances, central banks must continuously improve information gathering methods and analytical tools. Looking back at cases both in Japan and abroad where central banks were accused of making monetary policy mistakes, such mistakes arose when the central bank failed to properly understand major changes in the environment and their significance.

With regard to both of these points, central banks must continue to make efforts to continually grasp changes in the environment surrounding them and examine their actions in light of these changes. That is to say, central banks must constantly be willing to learn. It is my belief that to this end, interaction between theoretical research in academia and our practical experience plays an important role. Of course, I understand that the standpoint of an academic and that of a policymaker differ. For an academic, what is important is to present new points of view and be prepared to examine the persuasiveness of his or her theories. And on occasion, it may be necessary to propose bold hypotheses or interpretations. Good theories are likely to be those that, as the result of such efforts, have stood the test of time. In contrast, a policymaker cannot wait until a theory regarding a particular issue has been confirmed, nor can he or she put all eggs in one basket and embark on an untested policy course. A policymaker must make use of the various theories available at the time in making judgments and must sometimes deal with situations where

conventional theories do not apply. For this reason, a policymaker must be willing to continue to learn and take every opportunity to exchange views and opinions with academics. At the same time, there may be cases where issues faced by central banks and their experiences may offer new perspectives for academic research. Therefore, it is important that academics and policymakers recognize the differences of their roles and respect each other's work. I think it is this interaction between theory and practice that will stimulate further evolution in central banking operations.

I hope my speech today will serve to facilitate this interaction. Thank you very much for your attention.

References

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Technological Innovation and Central Banks

Charts

September 2, 2008

Chart 1

Settlement via Bank of Japan (BOJ) Current Accounts

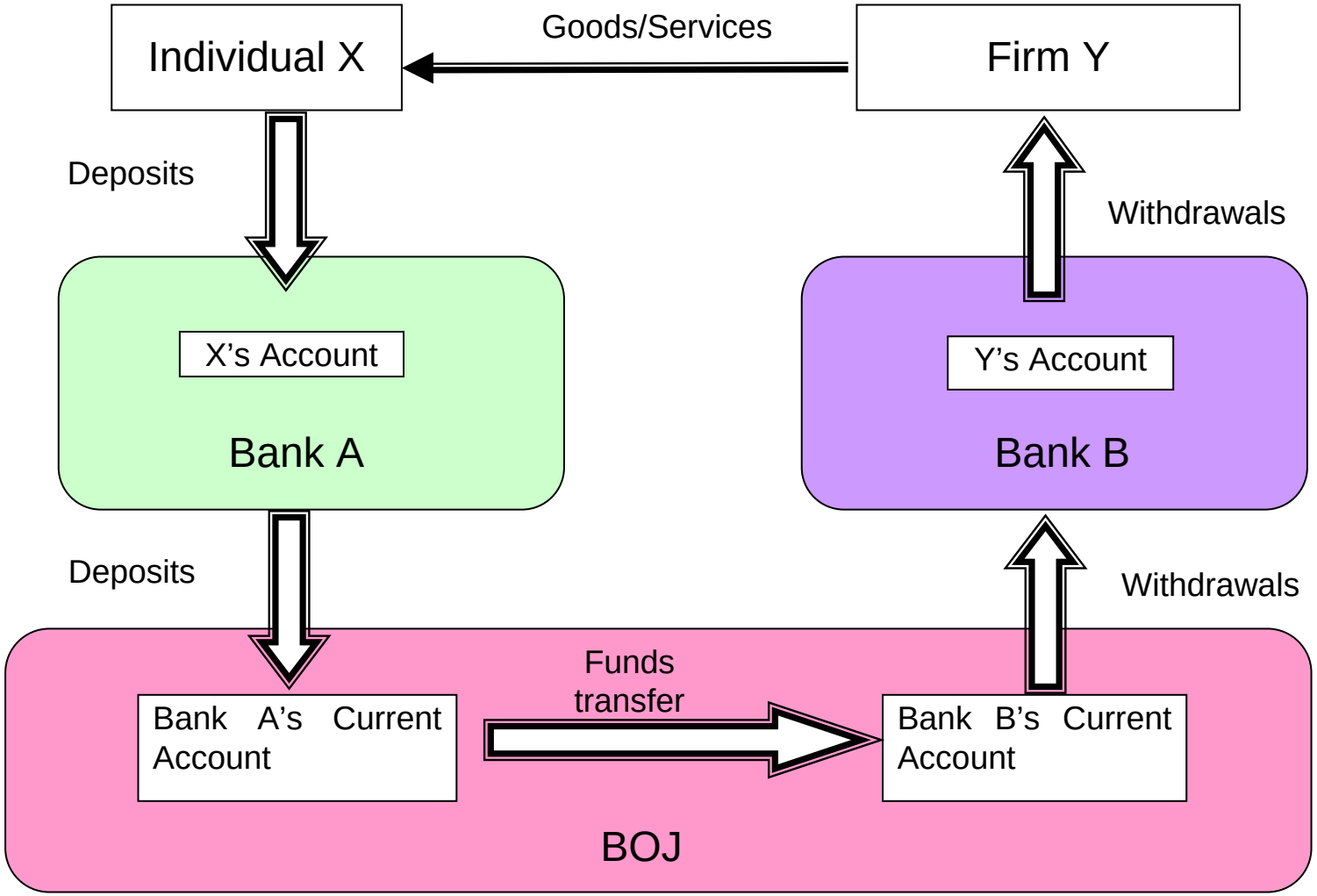
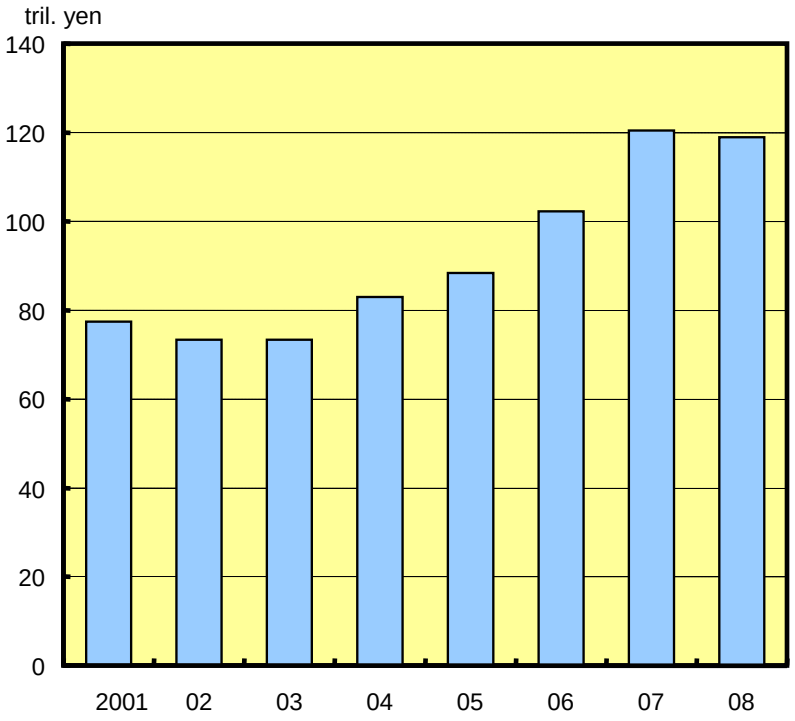


Chart 2

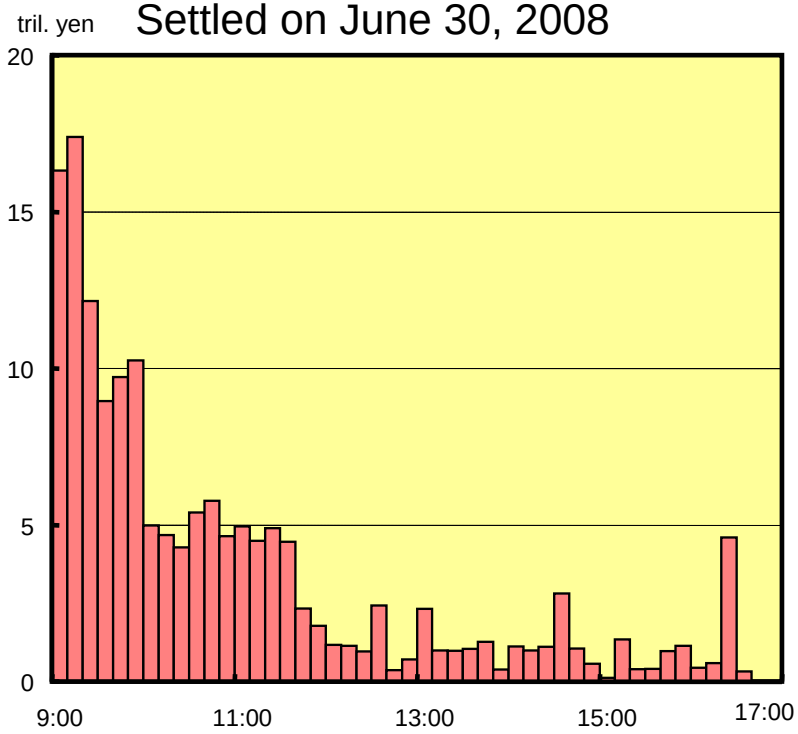
Value Settled via BOJ Current Accounts

Average Daily Value Settled



Note: Data for 2008 are the average for the January-July 2008 period.

Distribution of Value Settled on June 30, 2008

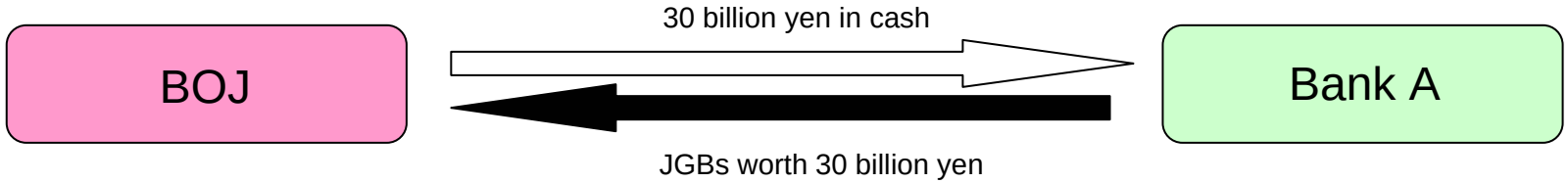


Note: Value settled in each ten-minute period.

Chart 3

Funds-Supplying Operation by the BOJ

Supply of 30 billion yen by the BOJ through outright purchase of Japanese government bonds (JGBs)



BOJ's balance sheet

bil. yen

(Assets)	(Liabilities)
JGBs 0 → 30	BOJ current account 0 → 30

Bank A's balance sheet

bil. yen

(Assets)	(Liabilities)
BOJ current account 0 → 30	
JGBs 30 → 0	

Withdrawal of 10 billion yen by Bank A from BOJ current account after the operation

BOJ's balance sheet

bil. yen

(Assets)		(Liabilities)	
JGBs	30	Banknotes	0 → 10
		BOJ current account	30 → 20

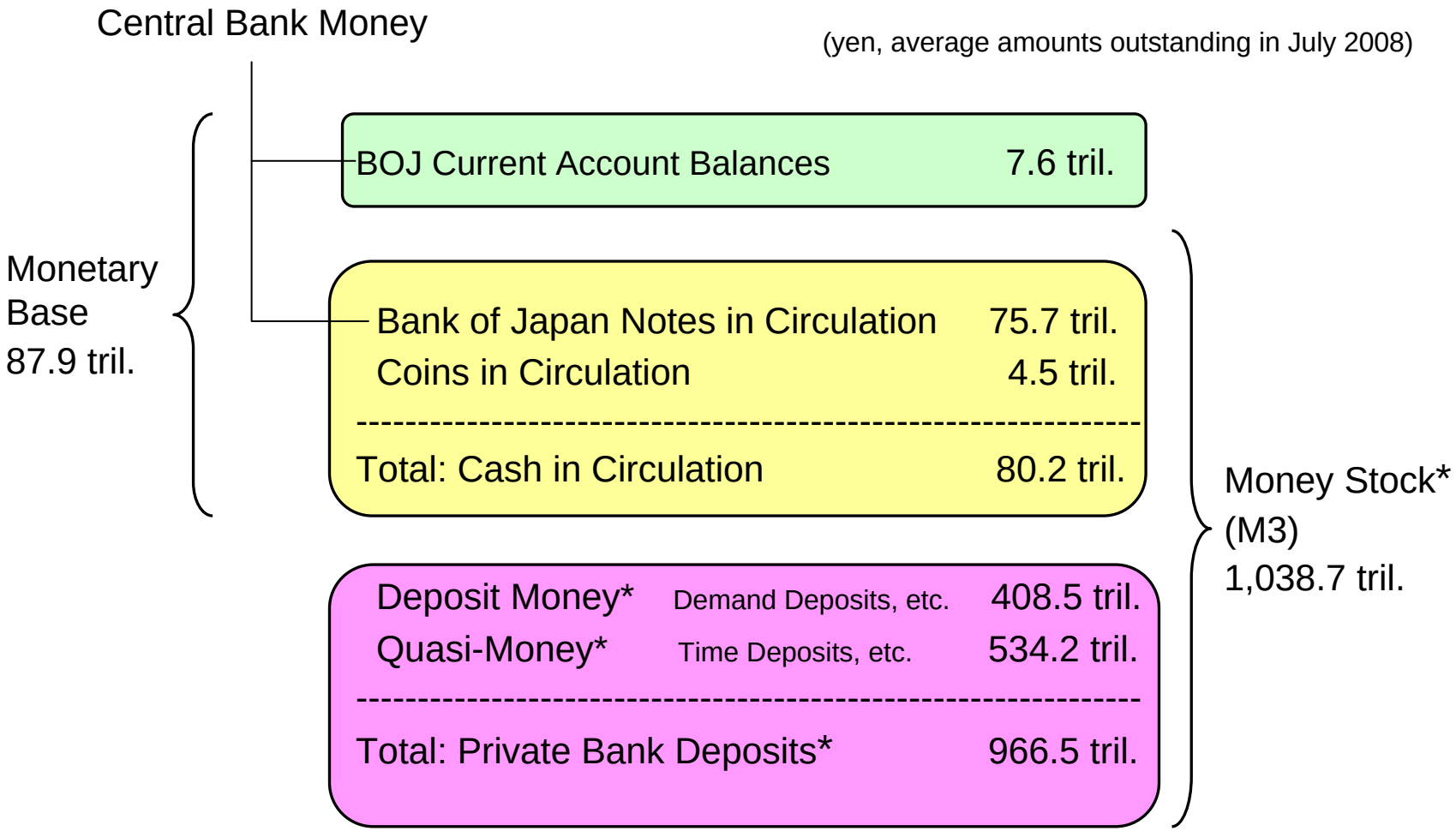
Bank A's balance sheet

bil. yen

(Assets)		(Liabilities)	
Banknotes	0 → 10		
BOJ current account	30 → 20		
JGBs	0		

Chart 4

Classification of “Money”



Nominal GDP of Japan in fiscal 2007: 515 tril. yen

* Deposits of financial institutions and the central government are not included.

Chart 5

Security Features of the Bank of Japan Notes

Security Features of 10,000 Yen Note

Luminescent ink
The Governor's seal on the front side and some parts of the background pattern fluoresce under ultraviolet light.

Intaglio printing
Raised printing is used for some features of the note.

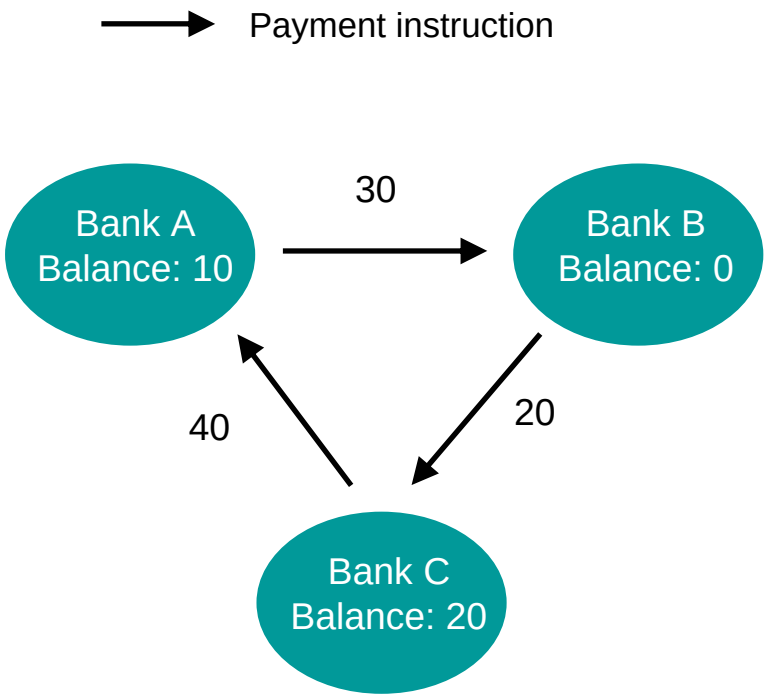
Hologram
When the banknote is tilted, the color and pattern of the design change.

Latent image
When the banknote is viewed from a certain angle, the number "10000" appears on the bottom left of the front side, and the word "Nippon" on the top right of the back side.

Pearl ink
When viewed from different angles, a semi-transparent pattern printed with pink pearl ink appears in the blank areas of the left and right margins of the front of the note.

Watermark-bar-pattern
When the banknote is held up to the light, three vertical watermark bars become visible. This feature is more difficult to reproduce with personal computers or color copiers than the traditional watermark.

Gridlock in the BOJ-NET RTGS System



Current BOJ-NET RTGS System

- In order to send a payment instruction, each bank needs to have a sufficient balance in its BOJ current account.

- All three banks in this example do not have sufficient balances.

- If each bank waits for the other to pay first, gridlock occurs, and none of the payment instructions will be settled.

New BOJ-NET RTGS System

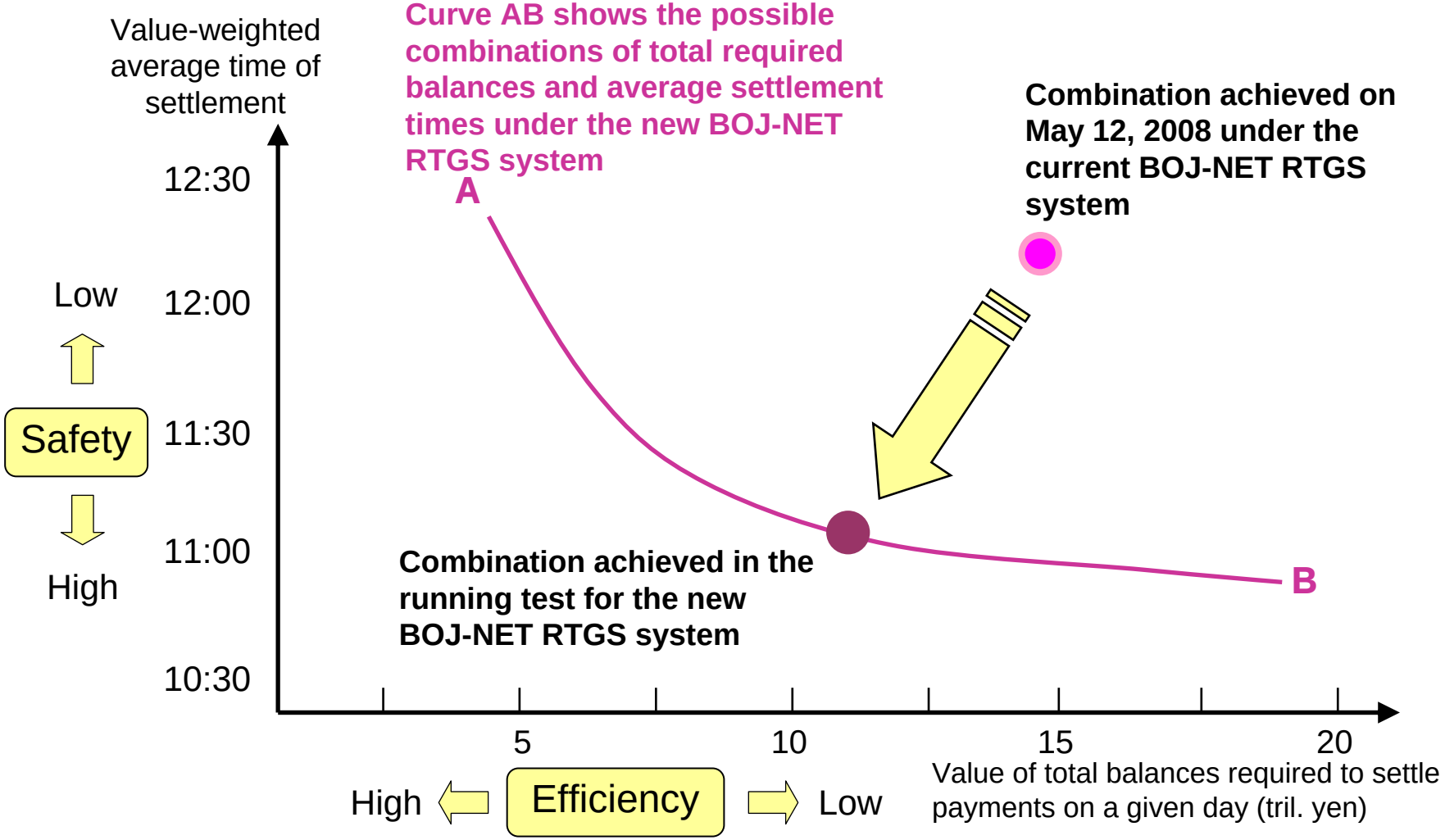
- If a bank does not have a sufficient balance in its BOJ current account, the payment instruction will be stored in a centralized queue.

- The system will identify sets of payment instructions in the queue that can be settled when taking into account incoming payments as a source of liquidity, and will settle them simultaneously.

- Gridlock will not occur in this example, because payment instructions will be settled simultaneously.

Chart 7

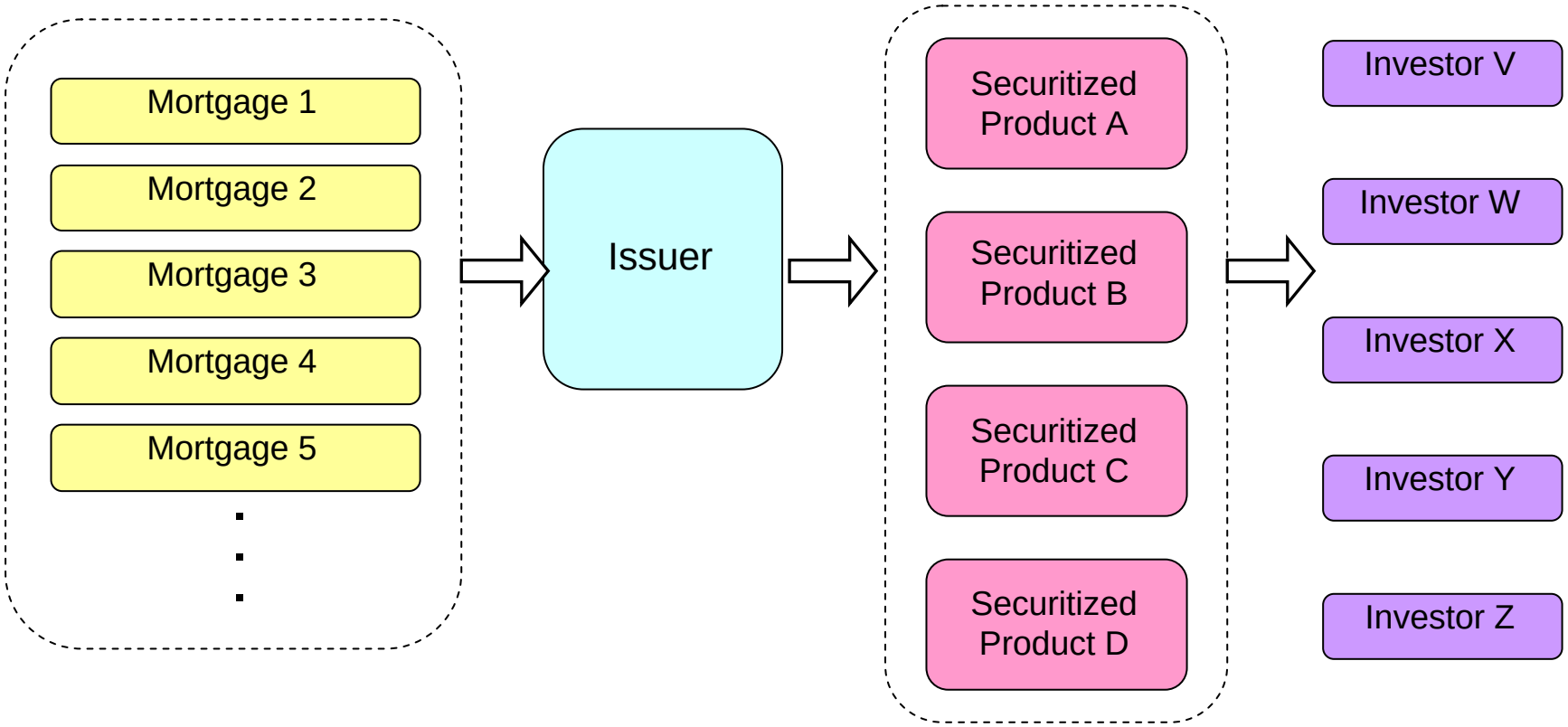
Safety and Efficiency Achieved under the New BOJ-NET RTGS System



Note: Under the new BOJ-NET RTGS system, payments that are currently cleared in the Foreign Exchange Yen Clearing System and settled at 14:30 on a net basis in the current BOJ-NET RTGS system will be settled on a gross basis.

Chart 8

Securitization of Mortgages



A large number of mortgages are packaged to diversify risks.

Securitized products are created by unbundling and reallocating cash flows and risks.