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- Explanation Using the Reserve Demand Curve Model -

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■Abstract■

In Japan's money markets, negative interest rate transactions prevail under the three-tier system applied to the financial institutions' current accounts held at the Bank of Japan. This paper explains the mechanism of short-term interest rate formation under the three-tier system and the concept of market operations using a simple reserve demand curve model.

Under the three-tier system, in which current deposits are divided into three tiers and different interest rates are applied to each tier, financial institutions have an incentive to conduct money market transactions for arbitrage purposes depending on to which tier their outstanding current account balances fill up prior to money market transactions. The Bank realizes negative interest rates consistent with yield curve control by taking steps so that the "hypothetical policy-rate balance (the policy-rate balance that remains assuming that arbitrage transactions have taken place in full), " is maintained at a certain level.

The shape of the reserve demand curve is considered to be downward sloping around the boundaries of each tier due to the uncertainties over future course of current account balances. The shape and position of the reserve demand curve will change depending on the degree of the uncertainties and other factors such as the use of Special Operations in Response to COVID-19 and various loan support programs. Short-term interest rates also

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† The supply and demand in the actual money market applies to the current accounts of financial institutions at the Bank. However, in this paper, the terms "reserve demand curve" and "reserve supply curve," which are commonly used in academic papers, will be used.
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change when arbitrage transactions are not conducted in full due to market friction. It can be interpreted that the Bank influences on short-term interest rates by changing the reserve demand curve and the reserve supply curve through setting the Benchmark Ratio and carrying out market operations based on the information about these factors.

1. Introduction

More than six years have passed since the Bank of Japan decided to introduce "Quantitative and Qualitative Monetary Easing (QQE) with a Negative Interest Rate" in 2016 and adopted a three-tier system in which the outstanding balance of each financial institution's current account at the Bank (hereinafter, "current account") was divided into three tiers to realize negative interest rates. Accordingly, in the money markets, transactions with negative interest rates based on the three-tier system have become widespread.

The characteristics of the three-tier system and the market trends under the system are explained in detail in "Market Operations in Each Fiscal Year" released annually by the Bank's Financial Markets Department. Explanations in the reports are likely to be familiar to practitioners engaged in money market transactions, but for others, it may be difficult to understand the Bank's approach to market operations and the mechanisms behind it. In fact, the Financial Markets Department, to which the author belongs, has been engaged in dialogues on market operations with persons of various backgrounds, including participants in other markets and people in academia, in addition to participants in Japan's money markets, and it is not infrequent that we see signs of the difficulty people face in understanding such operations. In this regard, major foreign central banks, despite having different market operation frameworks for implementing their monetary policy, make efforts to explain the mechanism behind market operations by using a simple model of demand for reserves by financial institutions in money markets along with economic logic[1].

Therefore, this paper explains the Bank's market operation mechanism and approach by using a simple model that portrays the demand for reserves by financial institutions under the three-tier system and answers four questions that are often raised in the aforementioned dialogues[2]. Specific questions addressed: (1) the shape of the reserve demand curve under the three-tier system; (2) the mechanism by which market transactions occur; (3) the mechanism by which the Bank influences short-term interest rates; and (4) the impact on market operations when arbitrage transactions do not take place in full.

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[1] For example, Ihrig, Senyuz, & Weinbach (2020) can be referenced for information on the Federal Reserve System while Secchi (2019) can be referenced for the European Central Bank.

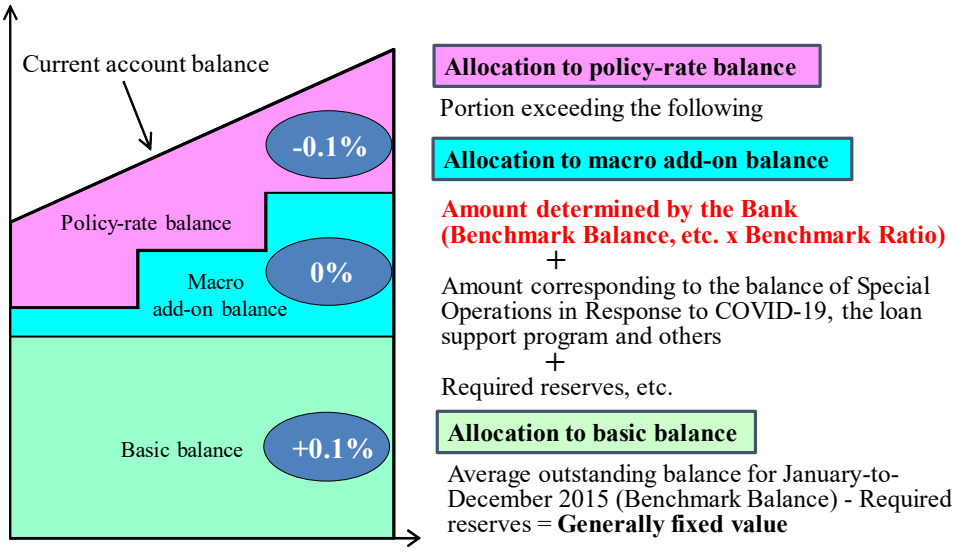
[2] In this paper, descriptions on the Interest Scheme to Promote Lending and the Special Deposit Facility to Enhance the Resilience of the Regional Financial System are omitted in light of the magnitude of their impact on interest rate formation in money markets.

The following provides an overview of the background to the above questions by first explaining the framework of the three-tier system, etc. and then reviewing actual figures for readers who are unfamiliar with the Bank's market operations.

2. Framework of Three-tier System and Actual Developments

The three-tier system applied to current accounts is a framework that has been introduced to realize negative interest rates while taking the impact on financial institutions' earnings into consideration. Under the three-tier system, current account balances are divided into three tiers; "basic balance," "macro add-on balance," and "policy-rate balance," with a different interest rate applied to each tier (Chart 1).

Chart 1: Overview of Three-tier System



(Note 1) Compiled with reference to Bank of Japan (2016) and Bank of Japan (2021a).
(Note 2) "Amount corresponding to the balance of Special Operations in Response to COVID-19, the loan support program and others" refers to the sum of the balances under these operations and the increase in the balance as of the end of March 2016 (the so-called "Loan Balance 2").

First, the basic balance is the current account balance up to the upper bound, which is obtained by subtracting the required reserve amount from the average current account balance (Benchmark Balance) for the reserve maintenance periods from January to December 2015 (the "reserve maintenance period" is the period between the 16th of a month and the 15th of the following month). At present, an interest rate of 0.1 percent is applied to the basic balance.

The macro add-on balance refers to the current account balance minus the upper bound on the basic balance, up to the sum of the amount of required reserves, the amount corresponding to the balance of Special Operations in Response to COVID-19[3] and the loan support program, etc. and the Benchmark Balance, etc. multiplied by the Benchmark Ratio determined by the Bank. At present, an interest rate of 0 percent is applied to the macro add-on balance.

The policy-rate balance is the balance derived by subtracting the basic balance and the macro add-on balance from the current account balance. A negative interest rate of minus 0.1 percent is applied to the policy-rate balance.

All interest is calculated based on the average current account balance for the reserve maintenance periods[4].

In order to understand the supply and demand of funds in the money markets under the three-tier system, it is particularly important to note that the upper bound on the macro add-on balance of financial institutions varies depending on the stance toward using Special Operations in Response to COVID-19, etc., and the level of current account balance varies due to differences in the trends of deposits and loans and other factors, and hence to which of the three tiers the current account balance before executing money market transactions has filled up differs from one financial institution to another.

This means that, as will be described later using an example, in the state before money market transactions are executed, some financial institutions have policy-rate balances (= current account balance exceeds the upper bound on the macro add-on balance) while other financial institutions[5] have "unused allowances" in their macro add-on balances (=

[3] Special Funds-Supplying Operations to Facilitate Financing in Response to the Novel Coronavirus (COVID-19). The content of this paper basically describes the situation up to the end of March 2022. From April 2022 onwards, Loan Balance 2 based on Special Operations in Response to COVID-19 will only apply to non-government supported loans.

[4] Under this system, for example, even when a financial institution's current account balance exceeds the upper bound on the macro add-on balance just for one day, if the balance does not exceed the upper bound on the macro add-on balance when averaged with the other days during the reserve maintenance period in which such day falls, no policy-rate balance will be generated and no negative interest rate will be applied. On the other hand, even if a financial institution's current account balance exceeds the upper bound on the macro add-on balance up to a certain day, if the upper bound on the macro add-on balance is reduced on a subsequent date during the reserve maintenance period due to, for example, repayment on maturity associated with the Special Operations in Response to COVID-19 and the average current account balance for the reserve maintenance period exceeds the upper bound on the macro add-on balance, the financial institution is recognized to maintain the policy-rate balance to which a negative interest rate will be applied.

[5] There are some financial institutions who have "unused allowances" in their basic balances because

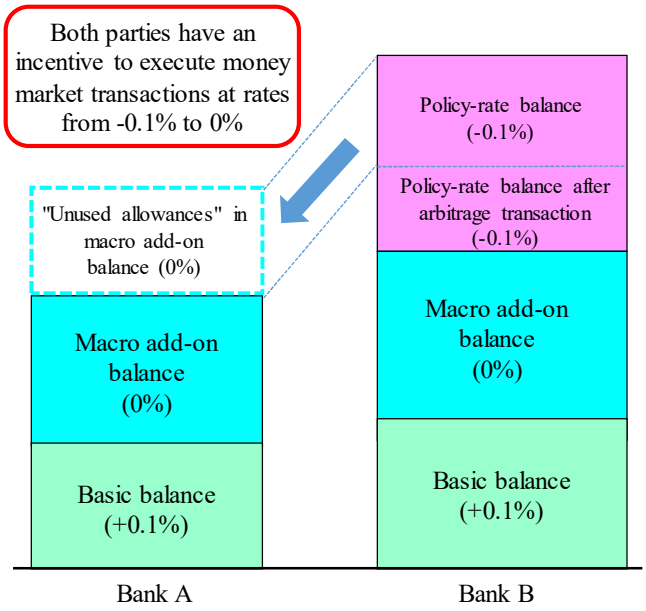
current account balance falls below the upper bound). Such differences in position among financial institutions create incentives to conduct money market transactions. In fact, transactions on such incentives (arbitrage transactions)[6] are frequently conducted in money markets.

their current account balances fall below the upper bound of the basic balances, but the actual size of the "unused allowances" is limited, and the majority of arbitrage transactions, which will be described later, are cash borrowing to fill the "unused allowances" in their macro add-on balances.

[6] Although this paper will not explicitly address this issue in the discussions hereafter, in the money markets, there is a reasonable number of transactions other than arbitrage transactions by financial institutions subject to the three-tier system. Specifically, such transactions include the cash lending by investment trusts into the unsecured call market and the cash borrowing by securities companies in the repo market. The former can be regarded as arbitrage transaction in a broad sense because behind such transaction is the action of a trust bank to avoid the generation of a policy-rate balance due to the inflow of funds from investment trusts (for details, see reference Bank of Japan (2017)); however, behind the latter are mechanisms other than arbitrage in the three-tier system (bond supply and demand, etc.) This is the reason why the GC repo rate falls below minus 0.1 percent at times in Chart 5.

A simple example of arbitrage transaction is shown in Chart 2. For Bank A, the upper bound on the macro add-on balance is higher than the current account balance before the execution of money market transactions due to the active use of the Special Operations in Response to COVID-19 and loan support program, etc. As a result, the bank has "unused allowances" in its macro add-on balance. Bank B, on the other hand, is in a situation where its current account balance significantly exceeds the upper bound on the macro add-on balance due to the large inflow of deposits and other reasons, resulting in the bank having a policy-rate balance.

Chart 2: Arbitrage Transaction

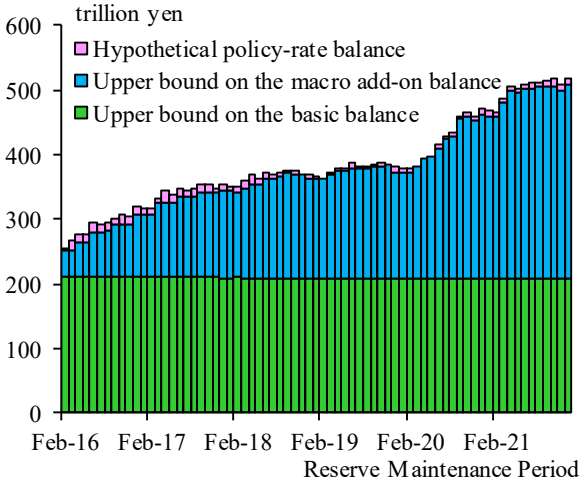


In this case, both parties have an incentive to carry out arbitrage transaction in money markets at negative rates ranging from minus 0.1 percent to 0 percent (related to questions (1) and (2) in 1.) This is because Bank A can earn profits from arbitrage transactions by managing the funds borrowed at a negative rate in the "unused allowances" in the macro add-on balance at 0 percent, while Bank B can manage funds at a rate higher than minus 0.1 percent applied to the policy-rate balance.

Next, situations under the three-tier system will be reviewed with numbers. Looking at the aggregated balances of financial institutions by tier (Chart 3), the basic balance has generally remained flat (about 200 trillion yen). While the upper bound on the macro add-on balance has continued to increase, the hypothetical policy-rate balance (hypothetical policy-rate balance assuming that arbitrage transactions have taken place in full) has remained at a lower level than the other two tiers, with some fluctuations.

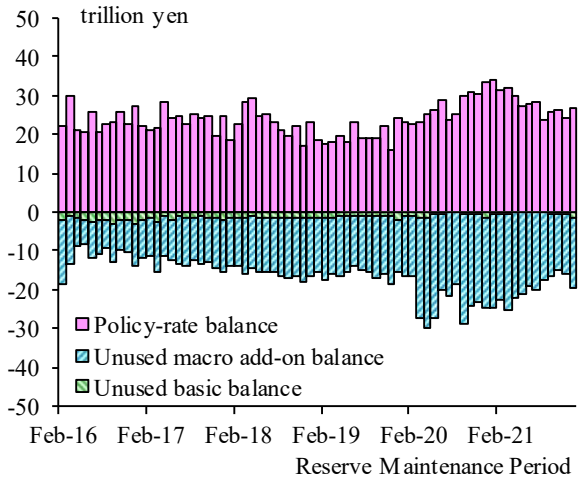
The increase in the upper bound on the macro add-on balance, particularly since 2020, is attributed to the increase in the amount outstanding of Special Operations in Response to COVID-19 introduced in the wake of the coronavirus crisis. With a view to promoting the use of the operations, the financial institutions' upper bound on macro add-on balances are increased twice as much as the amount outstanding they borrowed through the operations. Therefore, an increase in the balance would reduce the policy-rate balance, which is the source of negative interest rate transactions. For this reason, in market operations, the Bank sets the Benchmark Ratio low enough to adjust the upper bound on the macro add-on balance so that the level of short-term interest rates stays within negative territory and is consistent with the market operation policy[7] (Question (3) in 1.). While the hypothetical policy-rate balance has remained at a low level, there are always "unused allowances" in macro add-on balances that remain unarbitraged even after money market transactions have taken place, and the policy-rate balance has increased accordingly[8] (Chart 4; Question (4) in 1.).

Chart 3: Balance by Tier in the Three-tier System



Source: Bank of Japan

Chart 4: Unused Balances



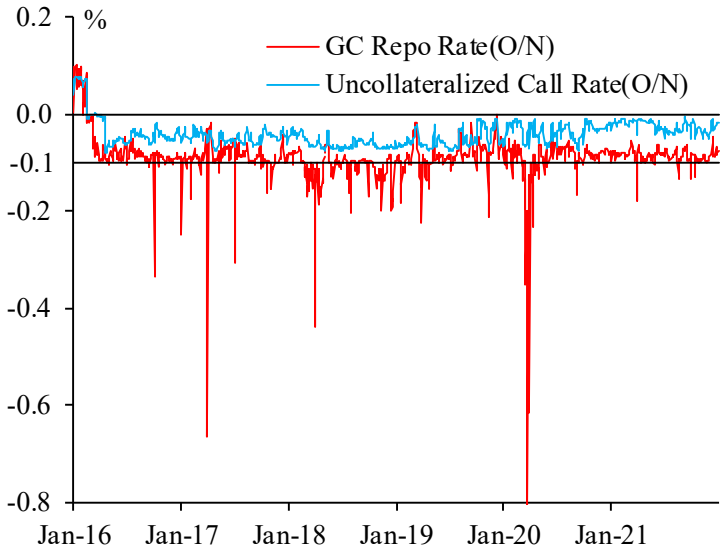
Source: Bank of Japan

[7] Currently, the Benchmark Ratio is set within the range where the hypothetical policy-rate balance comes to about 5 trillion yen, depending on market conditions.

[8] From the latter half of 2020 to the first half of 2021, there was a slight increase in unarbitraged balances. See reference Bank of Japan (2021b) for the background of this trend and its impact on interest rate formation in money markets.

Finally, looking at the transition of short-term interest rates under the three-tier system (Chart 5), both the uncollateralized call rate and the GC repo rate, which are representative benchmark interest rates, have been in negative territory, generally ranging from minus 0.1 percent to 0 percent, since the application of negative interest rates began in the February 2016 reserve maintenance period. This is because arbitrage transactions that bring the current account balance closer to the upper bound on the macro add-on balance are dominant market transactions.

Chart 5: Trends in Short-term Interest Rates



(Note) Figures up to May 1, 2018 indicate T/N rates. Based on start date.

Source: Bank of Japan, The Japan Securities Dealers Association

3. Explanation Using the Reserve Demand Curve Model

The mechanisms of interest rate formation observed in Japan's money markets and the Bank's approach to market operations under these mechanisms are explained below by responding to the four questions presented in Section 1.

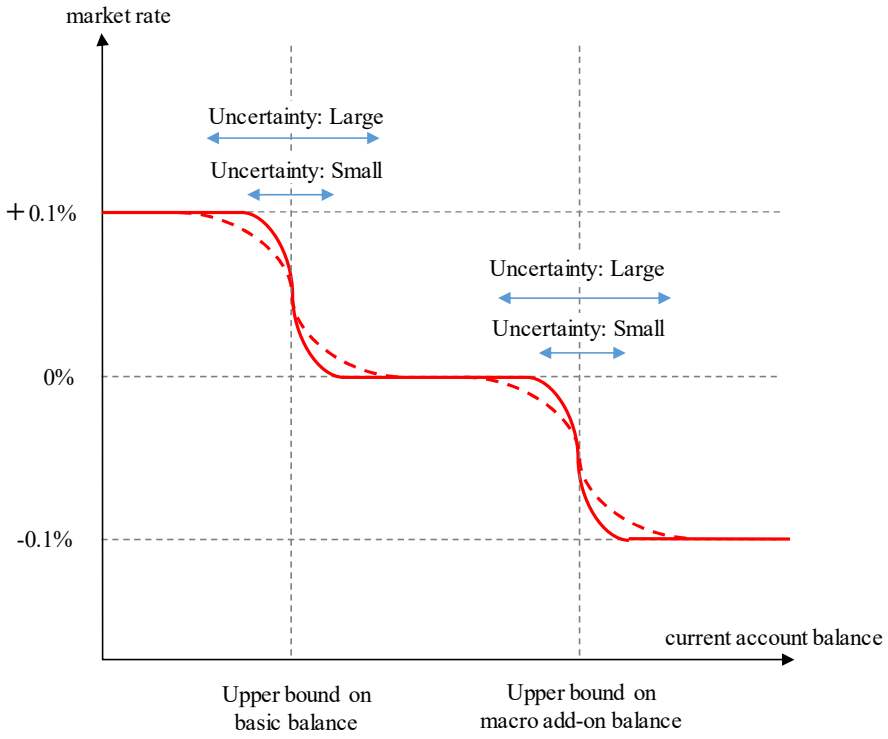
(1) What is the shape of the reserve demand curve?

Although each financial institution not only borrow cash but also lend cash in the money market, all financial institutions can be regarded essentially as demanders of current account deposits. This is because the central bank is the only entity that can ultimately determine the total amount of current account deposits (supply for current accounts).

As explained in Section 2, the demand for current accounts of financial institutions under the three-tier system is based on an incentive to match the average current account balance during the reserve maintenance period with the upper bound on the macro add-on balance through executing money market transactions. At the beginning of a maintenance period, a typical financial institution predicts the future fluctuation of the current account balance during the reserve maintenance period considering seasonality as well as other factors, and then plans the transactions needed during the reserve maintenance period. In reality, since unexpected flows of funds occur on a daily basis during the reserve maintenance period, the prediction and trading plan must be revised correspondingly.

Based on these assumptions, the reserve demand curve of a typical financial institution for a single day under the three-tier system can be illustrated as shown in Chart 6[9].

Chart 6: Reserve Demand Curve of a Typical Financial Institution



[9] The impact of uncertainty over the current account on the slope of the demand curve was formulized in Poole (1968). Further, in Boutros & Witmer (2020), the reserve demand curve in a tiered structure was formulized by expanding on Poole (1968). The description here is based on these reference documents. Theoretically, when the level of current account balance is extremely low, the demand for current account balance to meet the required reserves arises in addition to the demand for current account for arbitrage activities under the three-tier system. However, since this demand can be discarded at the present level of current account balance, the term "reserves" is used in this paper to mean "excess reserves".

The reserve demand curve shows a downward sloping between the interest rate levels applied to the balances of each tier (0.1%, 0%, -0.1%) around the upper bound on the basic balance and the macro add-on balance. On the other hand, where the current account balance is far from the upper bound on the basic balance and the macro add-on balance, the curve is very close to being horizontal at the interest rate level applied to the balance of each tier.

The reason why the demand curve is downward sloping around the upper bound on the basic balance and the macro add-on balance is because financial institutions try to take economically rational actions in accordance with market interest rates by comparing the possibility of leaving "unused allowances" with the possibility of generating a policy-rate balance when facing uncertainties over the future course of current account balances.

To illustrate this point, let us suppose a financial institution that pursues arbitrage transaction through cash borrowing since its current account balance before the arbitrage transaction in money markets is somewhat below the upper bound on macro add-on balance. In the absence of uncertainties, this financial institution would borrow cash on a daily basis so that its current account balance on each business day matches the upper bound on the macro add-on balance and would have the incentive to borrow cash as long as the trading rate is lower than 0 percent even by just a little[10].

On the other hand, when there are uncertainties over the future course of current account balances, the optimal action for this financial institution is to minimize the expected loss by comparing (i) the opportunity loss of arbitrage profit that could have gained if it borrowed a higher amount of cash today, and (ii) the expected loss occurred from the policy-rate balance when the average current account balance exceeds the upper bound in the future because of the amount of the cash borrowed today exceeds the amount needed.

When the current account balance is slightly lower than the upper bound on the macro add-on balance, as the opportunity loss occurring due to (i) is higher than the expected loss occurring due to (ii), the financial institution that conducts such financing activity will pursue additional borrowing even at a slightly higher rate. On the other hand, in the case where the current account balance is slightly higher than the upper bound on the macro add-on balance, since the expected loss occurring due to (ii) is higher than the opportunity loss occurring due to (i), the financial institution will not pursue borrowing

[10] Therefore, in the absence of uncertainties, the reserve demand curve is considered to be vertical at the upper bound of each tier.

unless the rate is lower and the arbitrage profit is larger so as to compensate for the loss occurring in the case of (ii). Given this principle of action, when the market rate is between minus 0.1 percent and 0 percent, the demand curve makes a downward slope across the upper bound on the macro add-on balance[11] (For the same reason, if the market interest rate is between 0 percent and 0.1 percent, the demand curve makes a downward slope across the upper bound on the basic balance).

The degree of this downward slope is considered to be dependent on the degree of uncertainties over the future course of current account balances assumed by the financial institution. In other words, when there is a high uncertainty about the future course of current account balances at the beginning of the reserve maintenance period, for example, even if the financial institution has "unused allowances" at the time, it is still possible that the upper bound will be exceeded in the end. Therefore, it is desirable for cash borrowing to be pursued cautiously with a flattened slope of demand curve (dashed line in the chart). On the contrary, when the uncertainty declines toward the end of the reserve maintenance period, for example, the demand curve will become steeper[12].

When the current account balance is adequately distant from the upper bound on the basic balance or the macro add-on balance, the reserve demand curve is less susceptible to such uncertainties and hence is very close to being horizontal at the level of the interest rate applied to each balance. This can be easily understood by considering the incentive of a financial institution whose current account balance is sufficiently higher than the upper bound on the basic balance while being sufficiently lower than the upper bound on the macro add-on balance. For this financial institution, the expected loss described in (ii) is extremely small compared to the expected loss described in (i). Therefore, this financial institution will have an incentive to borrow cash if the market interest rate falls even marginally below 0 percent.

(2) How can market transactions be illustrated?

This section explains how market transactions between financial institutions can be depicted using the framework of the reserve demand curve set up in (1), taking into

[11] This is based on the assumption that the expected fluctuations in current account balances are zero and that the probability distribution of future changes in current account balances assumed by the financial institution is symmetric. Therefore, the upper bound on the macro add-on balance is represented as being located at the center of the downward sloping curve.

[12] Looking at the actual movements of short-term interest rates, interest rates tend to fluctuate more significantly toward the end of reserve maintenance periods due to the decline in uncertainties.

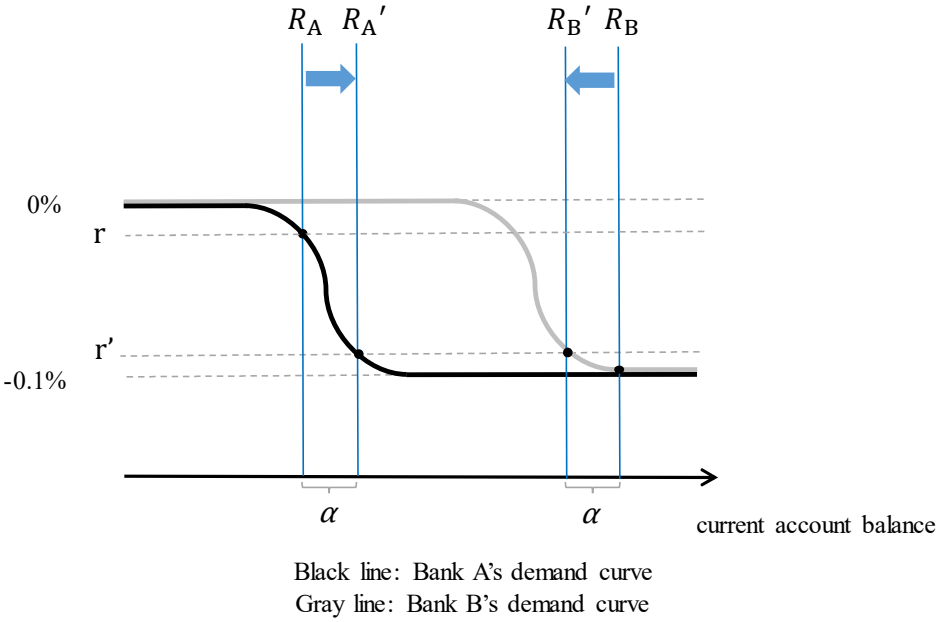
account the actual conditions observed in the market[13].

Chart 7 shows banks facing two different situations. First, Bank A has a strong incentive for arbitrage through cash borrowing because its current account balance (R_A) before conducting money market transactions is below the upper bound on the macro add-on balance. Bank B, on the other hand, has a strong incentive for arbitrage by cash lending because its current account balance (R_B) exceeds the upper bound on the macro add-on balance.

For this reason, Bank A recognizes that it is acceptable to pursue cash borrowing as long as the rate is no more than r, which is the intersection point of R_A and the demand curve, while Bank B recognizes that it is acceptable to lend cash as long as the interest rate is slightly higher than minus 0.1 percent because there is a high possibility of generating a policy-rate balance if no action is taken. As a result of these parties attempting to conduct transactions by quoting rates in the market, the current account balances of both Bank A and Bank B change, and money market transactions will likely be executed until the rate perspectives of both banks coincide (until trading volume achieves α in the chart). Under these circumstances, short-term interest rates will remain between minus 0.1 percent and 0 percent (r' in the chart).

[13] For convenience of explanation, the narrative here describes a transaction between just two parties, which does not fully reflect the process of forming a strict market equilibrium. A general model assumes that market equilibrium is formed by profit-maximizing actions taken in the market by an unspecified number of players with different positions.

Chart 7: Transactions Depicted Using the Reserve Demand Curve



(Note) For simplicity, only the reserve demand curve around the upper bound on the macro add-on balance is shown.

(3) Mechanism by which the Bank influences short-term interest rates[14]

As shown in Chart 8(a), the Bank, as the sole provider of current accounts, decides the short-term interest rate r_1 at the point of intersection by determining the current account balance and forming a vertical reserve supply curve against the macro reserve demand curve, which is formed by adding up the reserve demand curves of individual financial institutions. The supply curve is located around the upper bound on the macro add-on balance, which is why market interest rates have generally ranged between minus 0.1 percent and 0 percent. Since the introduction of the three-tier system, the upper bound on the macro add-on balance has continued to increase and therefore is far from the upper bound of the basic balance. For this reason, the part of the reserve demand curve that is downward sloping across the upper bound on the basic balance has limited impact on actual interest rate formation.

[14] The current policy on money market operations stipulates the following: "The short-term policy interest rate: The Bank will apply a negative interest rate of minus 0.1 percent to the policy-rate balances in current accounts held by financial institutions at the Bank." There is no explicit reference to short-term interest rates formed in the market. However, the Bank conducts market operations so that short-term interest rates formed in the market are consistent with yield curve control.

The reserve supply curve is not the only factor influenced by market operations under the three-tier system. This point will be explained using the framework of the reserve demand curve, taking as an example of the use of Special Operations in Response to COVID-19, which increased from 2020 onwards, and the reduction of the Benchmark Ratio.

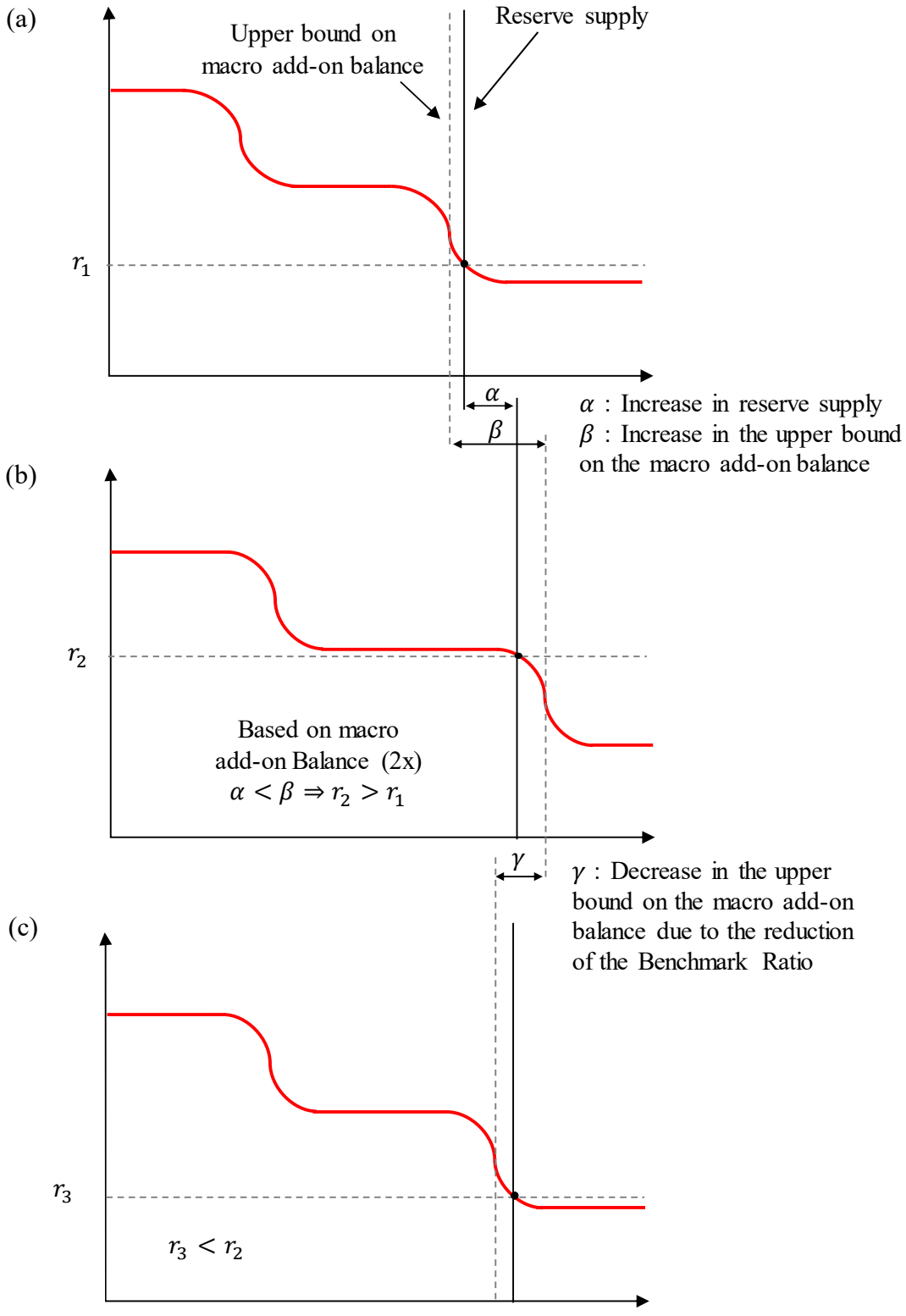
Chart 8(b) shows a case where the use of Special Operations in Response to COVID-19, etc. increases by α.While the reserve supply also increases by α, the upper bound on the macro add-on balance increases by β (≒2α) unless the Benchmark Ratio is adjusted since in using Special Operations in Response to COVID-19, etc., financial institutions can basically be rewarded twice as much as the amount it borrowed from the Bank through the operations. As a result, the hypothetical policy-rate balance, which is derived by subtracting the upper bound on the macro add-on balance from the Bank's reserve supply, will decline from the level before the rise in the use of the Special Operations in Response to COVID-19, and the short-term interest rate will increase to r_2 ($r_2 > r_1$).

For this reason, in order to suppress a rise in interest rates, the Bank will lower the Benchmark Ratio so that the upper bound on the macro add-on balance be reduced by γ, and thereby increasing the hypothetical policy-rate balance by the amount (Chart 8(c)). As a result, the short-term interest rate falls to r_3 ($r_3 < r_2$). Since the Benchmark Ratio is set with this mechanism, while the use of Special Operations in Response to COVID-19 was on the rise, the Bank lowered the Benchmark Ratio to respond to the upward pressure of short-term interest rates.

In practice, the Benchmark Ratio is determined prior to the reserve maintenance period based on the projections on the use of Special Operations in Response to COVID-19, etc by financial institutions[15]. Therefore, even if the Benchmark Ratio is lowered in anticipation of an increase in the use of Special Operations in Response to COVID-19, the actual use of such operations may further exceed the projection, resulting in a rise in the upper bound on the macro add-on balance and causing upward pressure on short-term interest rates. In such a case, the Bank, if necessary, can divert the upward pressure on short-term interest rates by increasing its reserve supply through, for example, purchases of JGBs under repurchase agreements[16].

[15] This is for the convenience of the management of current accounts by financial institutions.
[16] For example, in late December 2021, early January and early March 2022, in response to rising pressure on short-term interest rates, the Bank conducted unscheduled purchases of JGBs under repurchase agreements to provide ample funds.

Chart 8: Setting the Benchmark Ratio Based on the Use of Special Operations in Response to COVID-19, Etc.



(4) How to carry out market operations when arbitrage transactions do not take place in full

The discussion thus far has been based on the assumption that there is no friction in the market and that arbitrage transactions proceed as financial institutions take economically rational actions. However, as stated in Section 2., there are some financial institutions that have retained their policy-rate balances at a significant level, while other financial institutions have retained a significant level of "unused allowances" in their macro add-on balances.

There are various factors behind this. For example, in uncollateralized call transactions, from the viewpoint of credit risk management and regulations to avoid credit concentration, it is common for cash lenders to restrict their counterparties or set the amount of credit to be extended (credit line) to each counterparty. Therefore, due to such restrictions, there are cases where cash cannot be lent sufficiently in comparison with the economically reasonable amount when considering only the principle of arbitrage previously mentioned. In repo transactions, in which current account deposits are exchanged with bonds that serve as collateral for financing, there are relatively few such restrictions, but the mismatch caused by insufficient collateral held by the financing side may result in the cash-lending party not being able to fully release the funds. Even if these factors are excluded, a certain profit margin is required in market transactions because commission, labor costs and other transaction costs are involved. In the actual market, full arbitrage is not realized due to such circumstances, and a certain amount of unarbitraged balance is constantly generated.

The occurrence of an unarbitraged balance results in the generation of a gap between the macro demand and supply of funds, which assumes that arbitrage transactions have taken place in full as described in (3), and the actual market demand and supply of funds. The impact on short-term interest rates may be in both upward and downward directions, depending on the financial institutions' positions and what degree of exposure they have to the aforementioned restrictions. In this section, as a simplified example, I try to explain how short-term interest rates change and how they are influenced by market operations when a financial institution with a large cash-lending position (a party that would incur a large policy-rate balance if it did not lend cash in the money market) does not participate

in the market while other financial institutions intend on conducting economically rational transactions in the market[17].

Non-participation in the market by a party with a large cash-lending position means that the amount of funds actually released into the market decreases by the amount of the position of the party. As a result, there will be substantially less cash supplied to the market, and short-term interest rates will rise (r -> r′ in Chart 9 (a)).

If short-term interest rates are likely to rise excessively due to this background, the Bank can take two responses to take in terms of market operations. The first response is to lower the short-term interest rate at the point of intersection with the substantial reserve supply by lowering the Benchmark Ratio at the turn of the reserve maintenance period to reduce the upper bound on the macro add-on balance. (Chart 9 (b)). The second is to increase the current account balances of a wide range of financial institutions by increasing the reserve supply from the Bank through purchases of JGBs under repurchase agreements in the reserve maintenance period to encourage the substantial reserve supply to shift rightward (Chart 9 (c)). By taking these measures, it is possible to exert downward pressure on short-term interest rates.

[17] When this cash-lending party does not participate in the market, the macro demand curve will also shift leftward. We will examine the case where the point of intersection of the real reserve supply curve and the reserve demand curve becomes high even if this factor is netted, It is also possible to depict the market equilibrium by building up a reserve demand curve that takes into account the transaction costs, etc. of a party that does not carry out arbitrage transactions in full, as presented in Nakamura (2021).

Chart 9 (a) Market without a Major Cash-Lending Party

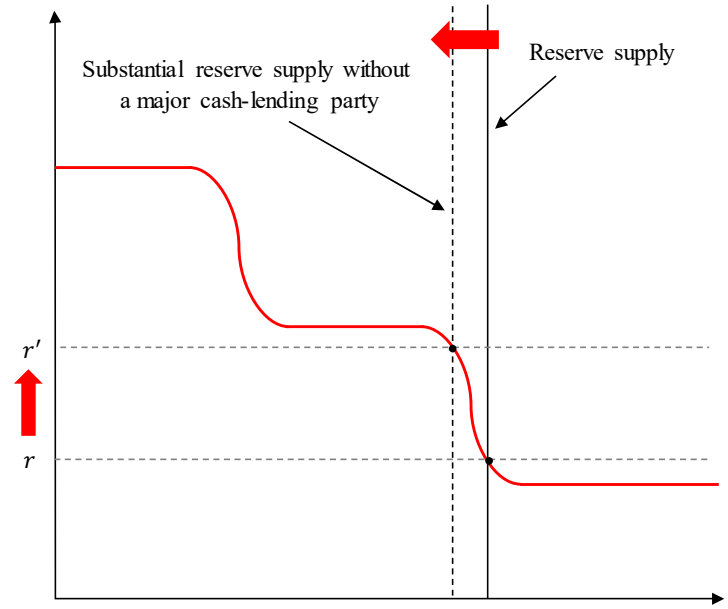


Chart 9(b) Lowering the Benchmark Ratio

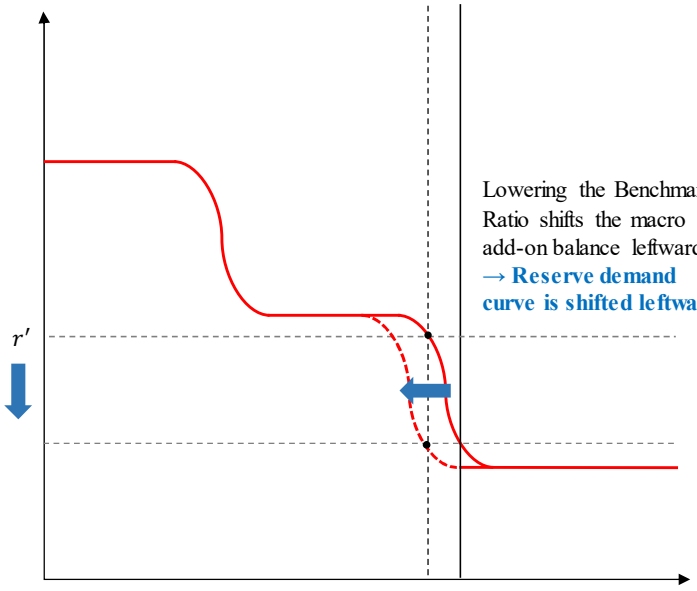
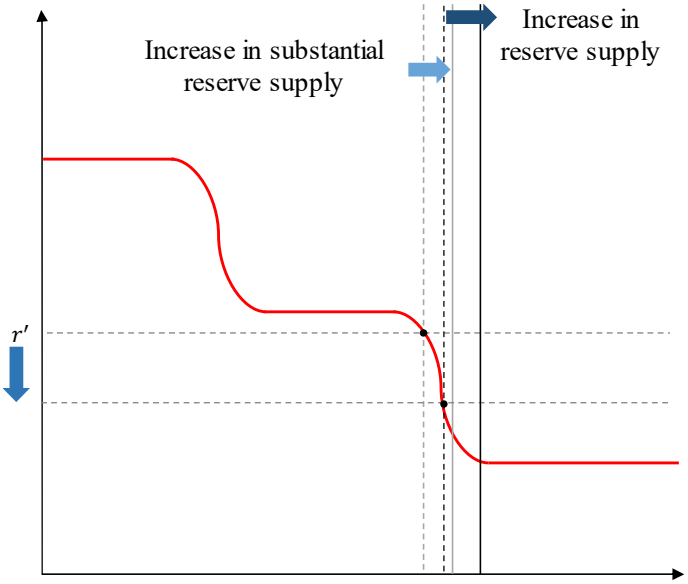


Chart 9(c) Increasing the Reserve Supply



4. Some Concluding Remarks

In this paper, a framework that applies the reserve demand curve model to the three-tier system adopted by the Bank was used to explain the practices in market operations and the mechanisms behind them.

Market operations are part of the frontline operation that the Bank carries out to respond appropriately and promptly to daily market trends in order to implement its guidelines for market operations decided at the Monetary Policy Meeting. Behind these operations are not only practical viewpoints but also economic perspectives and mechanisms. I hope that this paper will contribute to promoting the understanding of market operations and future discussions among practitioners, academia and others.

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