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Price Developments of Japanese Government Bonds in 2003

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Market Review

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Interest rates on Japanese government bonds (JGBs) fluctuated widely in 2003. The interest rate on 10-year JGBs gradually declined from the beginning of 2003, reaching the mid 0.4% range in June. But then, interest rates rose sharply (i) from late June to early July and (ii) from late August to early September. These fluctuations basically reflected changes in the outlook for Japan's economy. A closer look shows that other factors also influenced the price formation of JGBs during certain periods. They include the synchronized movement of interest rates between Japan and the US, changes in expectations about the Bank of Japan's monetary policy, and the hedging strategy employed by financial institutions, some of which collectively influenced JGB price developments.

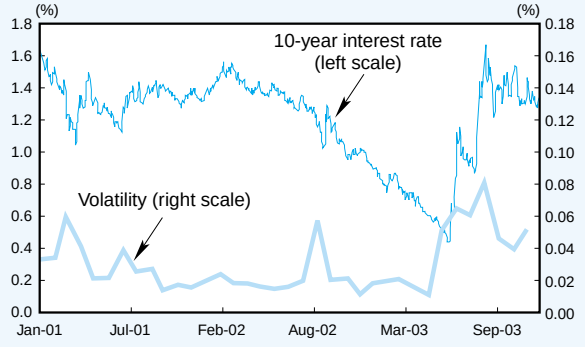
Introduction

Interest rates on Japanese government bonds (JGBs) fluctuated widely in 2003. The interest rate on 10-year JGBs gradually declined from the beginning of 2003, reaching the mid 0.4% range in June. But then, interest rates rose sharply, (i) from late June to early July and (ii) from late August to early September, temporarily exceeding 1.6% (Chart 1).

These fluctuations basically reflected changes in market participants' outlook for Japan's economy. In early 2003, there were widespread concerns about deflation or disinflation. From the middle of 2003, however, the outlook gradually improved.

Other factors also influenced the price formation of JGBs during certain periods. Such factors include the synchronized movement of interest rates between Japan and the US, changes in expectations about the Bank of Japan's (BOJ) monetary policy and the hedging strategy employed by financial institutions. In this review, we describe the price developments of JGBs, paying particular attention to these factors.

Chart 1: Interest Rate on 10-year JGBs and its Volatility



Note: Volatility is defined as the monthly standard deviation of daily changes in the interest rate on 10-year JGBs.
Source: Japan Bond Trading Co., Ltd.

Correlation of Interest Rates between Japan and Other Countries

In 2003, global topics attracted the attention of bond market participants in major countries, including concerns about global disinflation[1] and geopolitical risk related to the conflict between the US and Iraq. As a consequence, strong correlation was observed among interest rates in major countries, between Germany and the US, in particular (Chart 2). The correlation between Japan and the US was also strong, but weaker than that between Germany and the US.

The correlation between interest rates in Japan and the US weakened from May to the middle of June, although interest rates in both countries hit yearly lows in this period. In Japan, interest rates declined gradually and steadily throughout the period due mainly to active JGB investments by banks and institutional investors, such as life insurance companies and pension funds[2]. On the other hand, US interest rates fluctuated widely reflecting speculation about future monetary easing by the Federal Open Market Committee (FOMC). As these factors were unique to each country, correlation weakened.

Following this period, some US economic indicators began to show signs of a pick up and the

Chart 2.1: 10-year Interest Rates in the US, Germany, and Japan

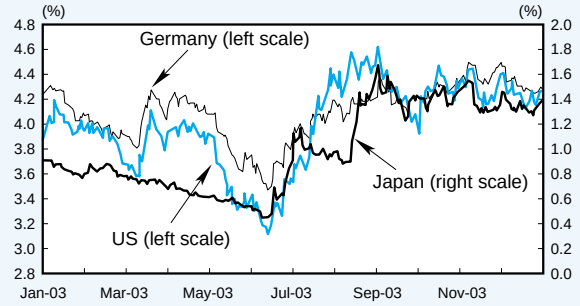


Chart 2.2: Correlation between Germany and the US

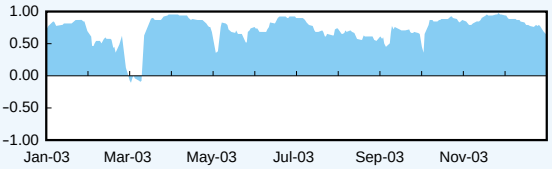
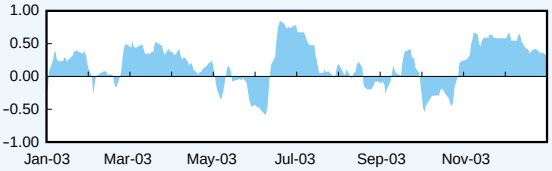


Chart 2-3: Correlation between Japan and the US



Note: Correlation is defined as the 20-day moving correlation coefficient of weekly rates of changes in interest rates on 10-year government bonds.
Source: Bloomberg.

size of the cut in the Federal Funds rate was below market expectations. These developments in the US economy pushed back overly-pessimistic views of global disinflation, which, as a result, raised interest rates in both countries. This was the major cause of strong correlation from late June to early July.

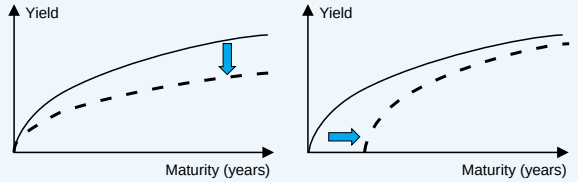
From late August to early September, correlation weakened again. In this period, Japan-specific factors influenced JGB interest rates. They include (i) changes in expectations about the duration of BOJ's quantitative easing policy, and (ii) the hedging strategy employed by financial institutions.

Shape of the Yield Curve with Duration Effect of Monetary Policy

The BOJ introduced the so-called quantitative monetary easing policy[3] in March 2001. At the same time, the BOJ committed itself to continuing the policy until the Consumer Price Index (CPI)[4] registers a year-on-year change of zero percent or above. This commitment influenced market participants' outlook for the future course of interest rates.

Here, we explain how the commitment conceptually influences the shape of the yield curve (Chart 3). Basically, expected future short-term interest rates determine longer-term interest rates. When market participants expect short-term interest rates to decline in the future, the longer-term interest rates also decline, which flattens the yield curve across all remaining maturities.

Chart 3: Two Factors that Determine the Shape of the Yield Curve (conceptual diagram)

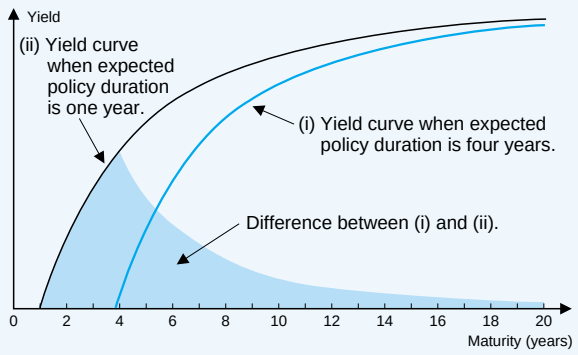


The yield curve flattens when the expected short-term interest rates decline.

The yield curve shifts to the right when the BOJ introduces the committment.

Once the BOJ introduces the commitment, the yield curve shifts to the right since market participants expect short-term interest rates to stay at almost zero percent for a certain period. We call this shift the "policy duration effect". Thus, the yield curve shifts to the left when the expected duration of quantitative monetary easing shortens. Such a shift brings about a rise both in the level and volatility of interest rates for maturities reached by the expected policy duration (see Chart 4 and Box).

Chart 4: Shift of the Yield Curve When the Policy Duration Effect Shortens (conceptual diagram)

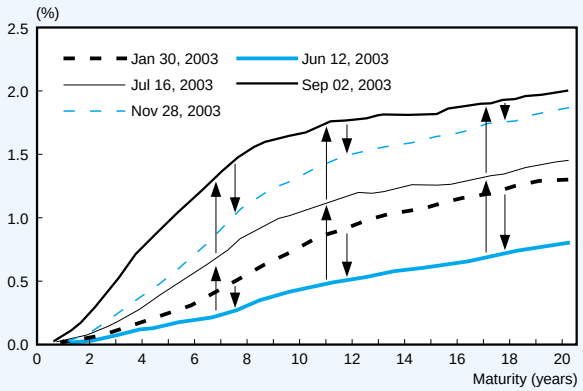


Based on the above conceptual framework, let us review actual developments in the yield curve during 2003 (Chart 5).

From January to June, concerns about global disinflation, along with the strong policy duration effect, significantly flattened the yield curve.

During the first phase of the interest-rate surge, from late June to early July, as concerns about global disinflation eased, expected short-term interest rates rose, which steepened the yield curve across all

Chart 5: Actual JGB Yield Curves



Note: Yield curves are derived from zero coupon yields estimated from JGB prices.
Source: Estimation by the Bank of Japan based on the data released by the Japan Securities Dealers Association.

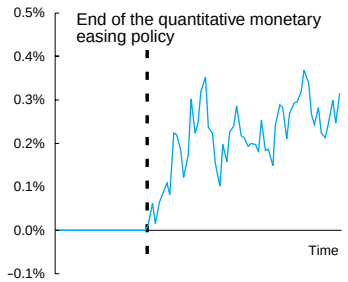
maturities. Meanwhile, the market view about expected duration of monetary easing policy seemed unchanged.

In the second phase of the interest-rate surge, from late August to early September, the yield curve shifted upward mainly in the medium-term[5] zone. In this period, Japan's economy gained momentum toward a recovery while the size of the fall in the CPI became gradually smaller[6] (Chart 6). These changes shortened market participants' expected policy duration, which resulted in a rise in medium-term interest rates. We can also infer the change in expected policy duration from developments in the euro-yen futures rates[7] (Chart 7).

BOX: A Term Structure Model of Interest Rates with Policy Duration Effect

Here, we introduce a term structure model of interest rates with policy duration effect*. This model is based on a standard spot rate model in which the trajectory of short-term interest rates determines longer-term interest rates. It explicitly incorporates the policy duration effect by imposing the following two assumptions: (i) the short-term interest rate is always zero percent under the quantitative monetary easing policy, and once the BOJ discontinues this policy, it will fluctuate stochastically (Boxchart 1); and (ii) each market participant forms his or her own expectations about policy duration. The expected duration, however, follows the standard gamma distribution as a whole.

Boxchart.1: Trajectory of Short-term Interest Rate in the Model

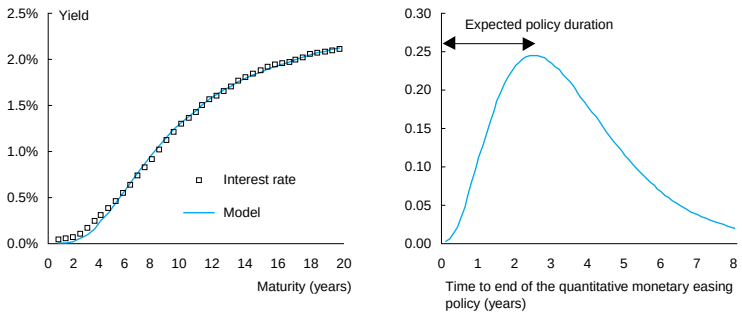


This setting enables us to describe a yield curve with two factors: (i) the level of expected future short-term interest rates; and (ii) the expected policy duration. Also, we can extract market participants' expected duration of the quantitative monetary easing policy from this model. Boxchart 2 shows an example of the fitting of the model to the actual yield curve as of December 28, 2001 and the distribution of expected policy duration extracted from the same yield curve. This result shows that policy duration expected by most market participants is about two and half years.

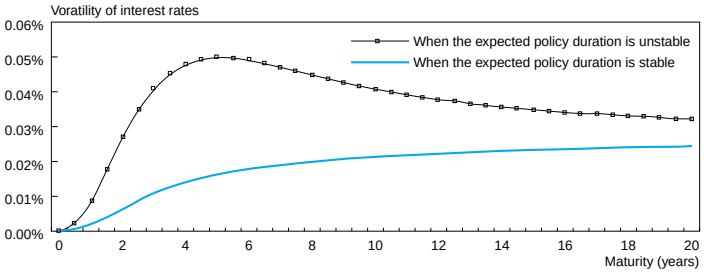
Simulations based on this model tell us how the term structure of interest-rate volatility is formed when the expected policy duration fluctuates. If the expected policy duration becomes unstable, volatility rises particulaly in the medium-term maturity (Box-chart 3).

* See "Extracting Market Expectations on the Duration of the Zero Interest Rate Policy from Japan's Bond Price," Bank of Japan Working Paper Series, for details.

Boxchart.2: Model Fitting and Extracted Distribution of Expected Policy Duration

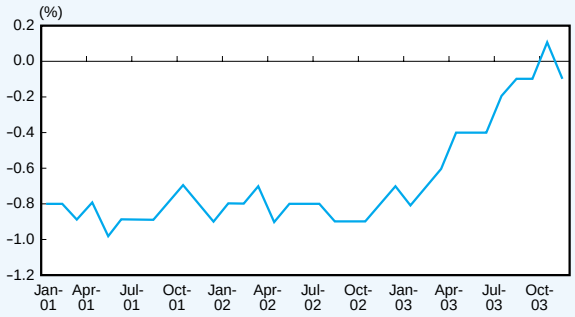


Boxchart.3: Simulation Result of Term Structure of Volatility



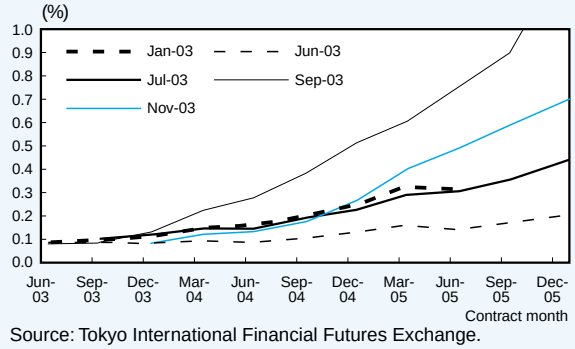
Note: Volatility is defined as the standard deviation of daily interest rate changes. We computed the fluctuations by generating random numbers via computer simulation.

Chart 6: Consumer Price Index (year-on-year rate)



Note: Excluding perishables; base year=2000
Source: Ministry of Public Management, Home Affairs, Posts and Telecommunications.

Chart 7: Three-month Euro-yen Futures Rates



Source: Tokyo International Financial Futures Exchange.

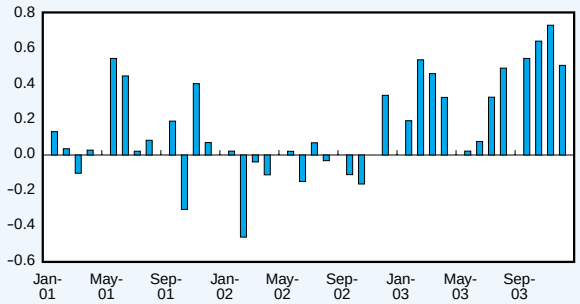
Entering October, the yield curve flattened as markets calmed down. At the monetary policy meeting (MPM) held on October 10, the BOJ clarified its commitment by issuing a more detailed description[8]. This clarification contributed to a downward shift of the yield curve by dispelling concerns that the BOJ might discontinue its quantitative easing policy in the near future. Such changes in expectations lowered medium-term interest rates, but long- and super long-term interest rates were little changed since those rates had already factored in a recovery of Japan's economy. The relationship between stock prices and interest rates seems to support this view. The correlation between the Nikkei 225 and the 10-year interest rate became strong toward the end of 2003 (Chart 8). This result suggests that both markets became more focused on the fundamentals of Japan's economy.

Policy Duration Effect and Volatility of Interest Rates

Many market participants pointed out that the rise in the volatility of interest rates amplified the rise in interest rates. First, let us explain why the volatility of interest rates rose.

A term structure model of interest rates explicitly

Chart 8: Correlation between Nikkei 225 and 10-year Interest Rate



Note: The correlation is defined as the monthly coefficient correlation of daily changes.
Sources: Japan Bond Trading Co., Ltd.; The Nihon Keizai Shimbun.

incorporating the policy duration effect shows that the volatility of medium-term interest rates rises when the expected policy duration fluctuates widely (Box). Indeed, volatility in the medium-term zone rose the most among all maturities in the second phase of the interest-rate surge (Chart 9). Market participants' expected duration of monetary easing raised not only the level but the volatility of interest rates in the same maturity zone.

Toward November, the volatility of interest rates declined across almost all maturities (Chart 9). The clarification of the commitment at the MPM on October 10 seems to have successfully stabilized the expectations of market participants, lowering the volatility.

Chart 9-1: Term Structure of Interest-rate Volatility

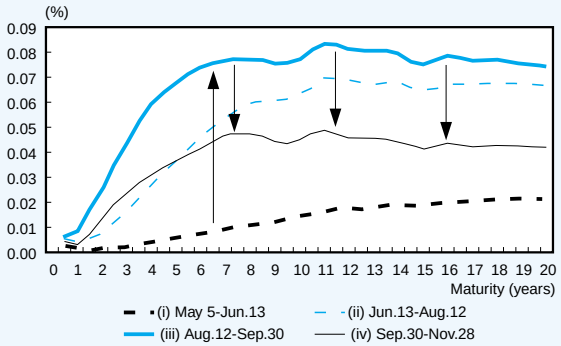
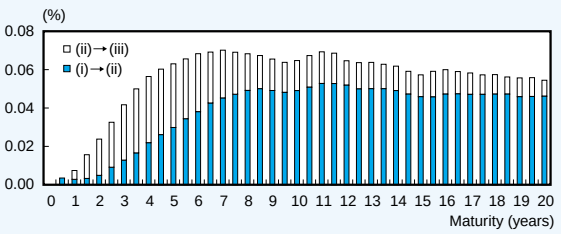


Chart 9-2: Changes in Interest-rate Volatility



Note: Volatility is defined as the monthly standard deviation of daily changes in the interest rate on 10-year JGBs.
Source: The Bank of Japan's estimation based on JGB prices released by the Japan Dealers Association.

Increase in the amount of Risk

The rise in volatility of interest rates had ripple effects on the interest-rate swap and repo markets.

When the volatility of interest rates rose in late June (Chart 1), the amount of risk per unit of JGBs also rose. Some of Japan's leading banks had to reduce the total risk amount of their JGB portfolios since it almost reached the limit of their risk tolerance levels[9]. In early 2003, most banks actively invested in JGBs to make up for lending, which continued to decrease due mainly to lack of business borrowing demand. They were also required to reduce their stock-holdings due to regulatory requirements.

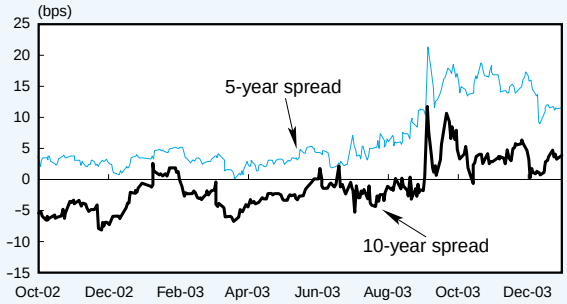
Selling JGBs in the markets is the simplest way of reducing risk. Banks, however, were caught in a situation where sales would cause a further rise in interest rates. It would also bring about larger losses on their JGB portfolios, requiring them to fix their losses. As a consequence, they chose to reduce the risk amount of their JGB portfolios by hedging interest-rate risk rather than selling JGBs. They had several choices in hedging interest-rate risk, including bond futures[10], euro-yen futures[11], interest-rate swaps[12], and bond options[13]. Among them, they mainly chose interest-rate swaps. The swap market is quite large, thus having high liquidity, and is easier to use, particularly in hedging the interest-rate risk of medium-term JGBs[14], which account for a major portion of banks' bond portfolios.

Hedging with Interest-rate Swaps

Banks' extensive use of interest-rate swaps as a hedging tool significantly widened swap spreads, which are defined as the difference between an interest-rate swap rate and a JGB interest rate of the same maturity. During the periods of the interest-rate surge, the medium-term swap spread, particularly around the 5-year maturity, widened significantly (Chart 10). This observation supports the inference from the above discussion that the banks' needs to build swap positions paying a fixed rate and receiving a floating rate in the medium-term zone were stronger than other maturity zones.

Banks' hedging strategy had a ripple effect on repo markets. Special collateral (SC) repo rates fell to well below zero percent. An SC repo is a transaction in which the borrower of a bond receives a specified bond and lends funds to the lender of the bond for a contracted period[15]. The SC repo rate is defined as the difference between an interest rate of cash and a premium for the collateral bond. When there is excess demand for a certain bond, the premium for it as collateral will rise. The SC repo rates often fall below zero percent in the current environment where short term interest rates are basically at zero.

Chart 10: Interest-rate Swap Spreads



Note: A swap spread is defined as the difference between a swap rate and a JGB interest rate of the same maturity.
Source: Bloomberg

In late August, Japan's leading banks reduced their interest-rate risk by building up swap positions that pay a fixed rate. Swap counterparties were often foreign securities companies. In turn, the interest-rate risk of such counterparties mounted as their fixed-rate receiving swap positions became large. To avoid losses brought about by a potential rise in interest rates, foreign securities companies built up short positions in medium-term JGBs, which they borrowed through SC repo transactions (Chart 11). Deepening negative SC repo rates in this period (Chart 12) imply that such foreign securities companies actively built up short positions in JGBs. Eventually, Japan's leading banks' hedging strategy caused a further rise in interest rates contrary to their initial intentions.

Chart 11: Relationship among Swap, JGB, and Repo Markets

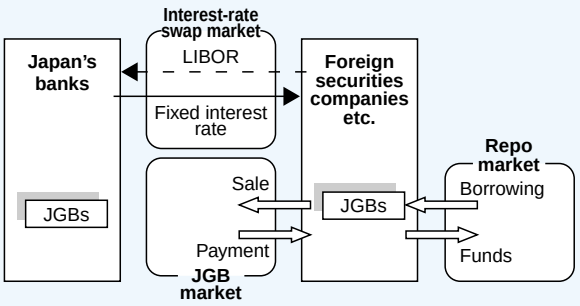
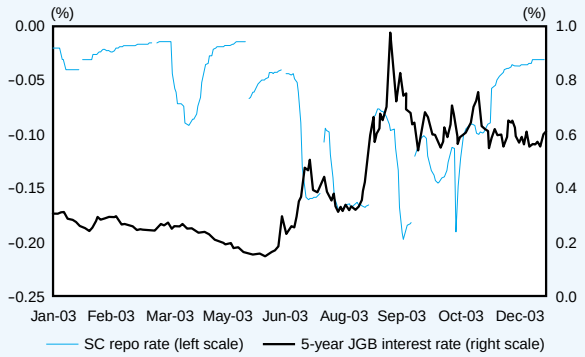


Chart 12: SC Repo Rate



Note: The contract term of the SC repo here is one week.
The interest rate is on a newly issued JGB with 5-year remaining maturity.
Sources: Japan Bond Trading Co., Ltd.; and the Bank of Japan.

Concluding Remarks

In 2003, JGB interest rates fluctuated widely. They were influenced by several factors: changes in the outlook for Japan's economy, interest-rate developments in the US, changes in the expected duration of quantitative monetary easing, and the hedging strategy employed by Japan's leading banks. In certain periods, these factors collectively influenced interest rates. To properly understand how interest rates are formed, we need to carefully monitor various aspects of related markets and activities of market participants.

[1] Alan Greenspan, Chairman of the Federal Reserve Bank, testified that substantial further disinflation would be an unwelcome development in the Committee on Financial Services, US House of Representative, April 30, 2003.

[2] According to the Japan Dealers Association, the monthly average of net purchases of JGBs excluding short-term government securities by city banks, financial institutions for agriculture and forestry, investment trusts, and insurance companies totaled 1.53 trillion yen for the first half of 2003. It was 1.57 trillion yen for 2002, and 1.38 trillion yen for 2001.

[3] On March 2001, the BOJ changed its main operating target for money market operations from the uncollateralized overnight call rate to the outstanding balance of the current accounts at the BOJ. This new procedure is called the quantitative monetary easing policy.

[4] CPI here stands for the year-on-year rate of the Consumer Price Index excluding perishables, with 2000 as the base year.

[5] We classify JGBs in terms of remaining maturity as follows: short-term, less than 1 year; medium-term, 1 to 7 years; long-term, 7 to 10 years; and super-long, longer than 10 years.

[6] The rise in CPI is likely to be attributable to the following temporary factors: (i) rise in medical treatment charges reflecting medical insurance reform in April; (ii) rise in tobacco tax in July; and (iii) rise in rice prices in October due to a cool summer.

[7] A euro-yen futures is a derivative that promises to lend or borrow funds on a certain date at the price determined in advance. The underlying asset of euro-yen futures, which is listed on the Tokyo International Financial Futures Exchange, is the 3-month TIBOR (Tokyo Inter-Bank Offered Rate). Thus, euro-yen futures should reflect the outlook for future short-term interest rates.

[8] The newly-specified conditions for discontinuing the quantitative easing policy are as follows: (i) it requires not only that the most recently published core CPI should register a zero percent or above, but also that such tendency should be confirmed over a few months; (ii) the BOJ needs to be convinced that the prospective CPI will not be expected to register below a zero percent; and (iii) the above conditions are just necessary conditions, not sufficient ones.

[9] Although Japan's leading banks had appraisal gains on total portfolios due to a rise in stock prices after April, their JGB portfolios suffered appraisal losses. Most of the banks employed almost the same method of assessing risk based on historical volatility, and thus uniformly tried to reduce their interest-rate risk exposure.

[10] A bond futures is a derivative that determines the price of a certain bond on a certain date in advance. It enables investors to avoid capital losses on bonds. For example, those who sell bond futures can make a profit from the futures when interest rates rise in the future.

[11] Investors who sell euro-yen futures make a profit when interest rates rise in the future.

[12] An interest-rate swap is a derivative in which a fixed interest rate and a floating interest rate are exchanged. When a swap interest rate is 0.5%, the fixed rate of 0.5% and six-month floating LIBOR (London Inter-Bank Offered Rate) are exchanged every 6 months.

[13] A bond option is a right to buy or sell a certain bond at a price determined in advance. The holder of the option can execute it for a certain period or on a certain date. If investors buy put options on bonds, they can hedge the losses caused by a future rise in interest rates.

[14] Japan's leading banks try to match their duration between their assets and liabilities to reduce interest-rate risk exposure. Thus, they prefer to hold medium-term JGBs since their liabilities consist mainly of deposits.

[15] Another form of repo transaction is the general collateral (GC) repo. In GC repos, bonds as collateral are not specified.

Market Review is edited and published by the Financial Markets Department of the Bank of Japan in order to stimulate comments and discussion from a wide audience. This report, 2004-E-2, is a translation of the original Japanese issue, 2004-J-1, published in January 2004. The views expressed in the Review are those of the authors and do not necessarily represent those of the Bank of Japan. Comments and questions as well as requests for hard copies should be addressed to Naohiko Baba, Senior Economist, Financial Markets Department (naohiko.baba@boj.or.jp). *Market Review E-series and Bank of Japan Working Paper E-series* can be obtained through the Bank of Japan's Web site (http://www.boj.or.jp).