# Japan's Deflation, Problems in the Financial System, and Monetary Policy

**Naohiko Baba, Shinichi Nishioka, Nobuyuki Oda, Masaaki Shirakawa, Kazuo Ueda, and Hiroshi Ugai**

*This paper offers three analyses of Japan's macroeconomic experience during the post-1990 period. First, we analyze various facets of deflation during the period, arguing that the deflation of general prices has by no means been a major factor for the stagnating economy. In contrast, the deflation of asset prices was closely related to the economic difficulty of the period. In particular, the negative shocks generated by sharp declines in asset prices in the early 1990s have been propagated and amplified by their interaction with the deterioration in the condition of the financial system. Some statistical evidence supports this view.*

*Second, we analyze the effects of monetary policy adopted by the Bank of Japan (BOJ) to fight deflation since the late 1990s. Given that short-term interest rates were already nearly zero in the mid-1990s, policy measures have focused on creating monetary easing effects beyond those created by zero interest rates alone. We show that the zero interest rate policy, which includes a commitment to maintain a zero interest rate for a longer period than that suggested by a baseline monetary policy rule, has produced strong effects on expected future short-term interest rates and thus the entire yield curve.*

*Third, we argue that the BOJ has successfully prevented a repetition of the 1997–98 type liquidity crisis by directing market operations at addressing the financial-sector problems. These operations have taken the form of containing risk and liquidity premiums, particularly in the money market, through proactive provision of liquidity as well as the BOJ's own risk-taking activity.*

Keywords: Zero interest rate policy; Quantitative monetary easing policy; Commitment; Deflation; Financial accelerator; Negative interest rate; Investor behavior
JEL Classification: E43, E44, E52, E58, G12

Naohiko Baba: Senior Economist and Director, Financial Markets Department, Bank of Japan (E-mail: naohiko.baba@boj.or.jp)
Shinichi Nishioka: Economist, Financial Markets Department, Bank of Japan (currently Personnel and Corporate Affairs Department)
Nobuyuki Oda: Senior Economist and Director, Monetary Affairs Department, Bank of Japan (E-mail: nobuyuki.oda@boj.or.jp)
Masaaki Shirakawa: Executive Director, Bank of Japan (E-mail: masaaki.shirakawa@boj.or.jp)
Kazuo Ueda: Member of the Policy Board, Bank of Japan (E-mail: kazuo.ueda@boj.or.jp)
Hiroshi Ugai: Deputy Director-General, Monetary Affairs Department, Bank of Japan (E-mail: hiroshi.ugai@boj.or.jp)

The authors gratefully acknowledge helpful comments by Michael Mussa and Marc Olivier Strauss-Kahn on an earlier version of the paper and research assistance by staff members of the Bank of Japan (BOJ)—in particular, Hitoshi Fuchi, Hitoshi Mio, Ichiro Muto, and Yosuke Shigemi. The views expressed here are those of the authors only and are not those of the BOJ.

## I. Introduction

In the eyes of anyone, Japan's macroeconomic experience during the last two decades has been quite extraordinary. Stock and land prices soared to peak levels in the late 1980s and early 1990s respectively, giving way subsequently to a decade-long correction process. In April 2003, the Tokyo Stock Price Index (TOPIX) reached a low of 773.1, the same level as in 1984. Declining asset prices have hit the banking system severely. Although taxpayers' money, bank earnings, and bank capital, in total amounting to about 20 percent of GDP, have been used to address the nonperforming-loan (NPL) problem, the banking system has not yet fully recovered. Business fixed investment has continued to suffer from the excesses of the late 1980s and the impaired financial system. The economy grew at a minimal 1.0 percent rate on average during 1991–2002, a period that has been called a "lost decade."[1]

The weak condition of the economy has been reflected in general prices. The GDP deflator and the consumer price index (CPI) have been declining since 1995 and 1998, respectively. The Bank of Japan (BOJ) started to ease in the summer of 1991, then lowered the call rate by almost 800 basis points in the following four years, bringing the rate to under 0.5 percent in the summer of 1995. This, however, was not enough to counteract the deflationary forces. Since 1999, the call rate has been lowered to zero with the exception of the August 2000–February 2001 period. In addition, the BOJ went still further in adopting several unconventional policy measures. At the time of the writing of this paper, deflationary forces seemed to be finally easing, but the CPI inflation rate has not yet clearly turned positive.

The purpose of this paper is threefold. First, it aims to survey various discussions of the "lost decade" from a macroeconomic perspective. Second, it reviews the sequence of how monetary policy responded to the weak economy during the decade and provides some preliminary analysis of the effects of policy measures adopted. Third, it explains how some of the monetary policy measures adopted were geared to alleviating problems in the financial system and discusses some of the unexpected consequences of such policy measures.

In our survey of Japan's macroeconomic fluctuations, we attempt to show that the deflation of general prices has not been the root cause of the stagnation of the economy, but rather just one manifestation of more fundamental problems. The basic driving force of the stagnation seems to have been the need to work off the excesses in capital, labor, and debt built up in the late 1980s and early 1990s. Sharp declines in asset prices have added to the need of adjustment by generating various negative financial accelerator effects, including the NPL problem. We will pay more attention to the description of negative financial accelerator effects, since they are less well understood aspects of the stagnation.

Next, our analysis of the effects of monetary policy focuses on the attempts to "manage expectations," under the zero interest rate policy (ZIRP) during 1999–2000 and the quantitative monetary easing policy (QMEP) adopted since March 2001.

1. The average growth rate of the Organisation for Economic Co-operation and Development (OECD) economies during the same period was 2.4 percent. Germany, however, suffering from the aftermath of reunification, registered a growth rate of only 1.3 percent.

In these periods, the scope of BOJ policy went further than simply lowering short-term interest rates to zero. We show that such attempts have had some significant effects on the term structure of interest rates. We also argue that a number of market operations conducted by the BOJ during the periods have been geared, in addition to the conventional purpose of liquidity provision, to alleviating the impaired credit intermediation function of the financial system.

In Section II, we survey the literature on Japan's macroeconomic problems during the last decade or two. We first discuss some salient features of the recent deflation in Japan, including a short overview of analyses of the causes of the recent deflation of general prices. We then briefly summarize how prices and nominal and real interest rates behaved during the late 1920s and early 1930s in Japan. We also refer to the literature on the causes of the Great Depression, paying particular attention to the so-called debt deflation theory and the role of negative financial accelerators. This discussion provides a benchmark for evaluating Japan's deflation experience since the 1990s. Section II.B turns to Japan's deflation itself, and illustrates that Japan's recent deflation experience has not been as serious as the debt deflation in either Japan or the United States during the Great Depression. Currently, there is no evidence of a sharp rise in real interest rates and thus in the real debt burden as a result of the deflation of general prices.

As stated above, it has been the deflation of asset prices, not that of general prices, that has generated serious negative effects on the net worth of borrowers and, over time, on that of lenders. This channel is considered to be a negative financial accelerator, adding to deflationary forces in the economy, which is described in the next section. We then turn to review the literature that emphasizes the role of real factors, namely declines in productivity growth, as the main cause of the stagnant economy. Against such a view, we point out the possibility that even the declines in the productivity growth rate can be understood as a manifestation of the effects of a financial accelerator. Finally, the section conducts an econometric analysis showing the importance of the financial accelerator effects.

In Section III, we turn to the analysis of monetary policy during the period. We first briefly survey the policy responses to Japan's weak economy since 1998. Then we point out the difficulties the BOJ faced in its combat against deflation. Using a combined macroeconomic model and finance theory approach, we attempt to quantitatively assess the effects of the policy measures on the economy. One particular feature of the analysis is that it explicitly provides an alternative scenario for the policy that would have been adopted in the absence of the ZIRP or the QMEP. The differences in the behavior of the economy between the two, i.e., one with the ZIRP and/or the QMEP and the alternative scenario, are estimated. Our estimation result shows that the management of market expectations under the ZIRP and the QMEP has had a significant impact on the term structure of interest rates.

Given the importance of problems in the financial system, the BOJ has naturally tried to address them through its market operations. Such aspects of the BOJ's market operations and resulting consequences are discussed in Section IV. The section argues that the BOJ has successfully contained liquidity problems of the financial institutions but has not made much progress in reviving their risk-taking ability. Moreover, the BOJ's measures to this end have caused some unusual developments in the money and capital markets. These include a lowered intermediary function of the money market, the emergence of negative interest rates in some areas of the money market, declines in credit spreads, which were already narrow prior to the ZIRP, and a lower-than-expected increase in the issue amount of corporate bonds. Such developments, along with their relation to problems of the financial system, and their implications for the transmission mechanism of monetary policy are discussed in Section IV.C.

Section V offers concluding remarks.

## II. Macroeconomics of the "Lost Decade"

Japan's anemic annual growth rate of 1 percent during the period 1991–2002 is something of a puzzle in view of its spectacular growth performance during the previous three decades. A complete analysis of this would be a topic for future research. Below, we provide a brief survey of the data and literature on this period, with a particular emphasis on the relationship between the stagnation of the economy and the various facets of deflation.

### A. Japan's Deflation since the 1990s

As a first approximation, prices of final goods and services have been fairly stable in Japan since the early 1990s.[2] Figure 1 shows movements of the CPI and the GDP deflator.[3]

**Figure 1 Rate of Inflation in Japan**

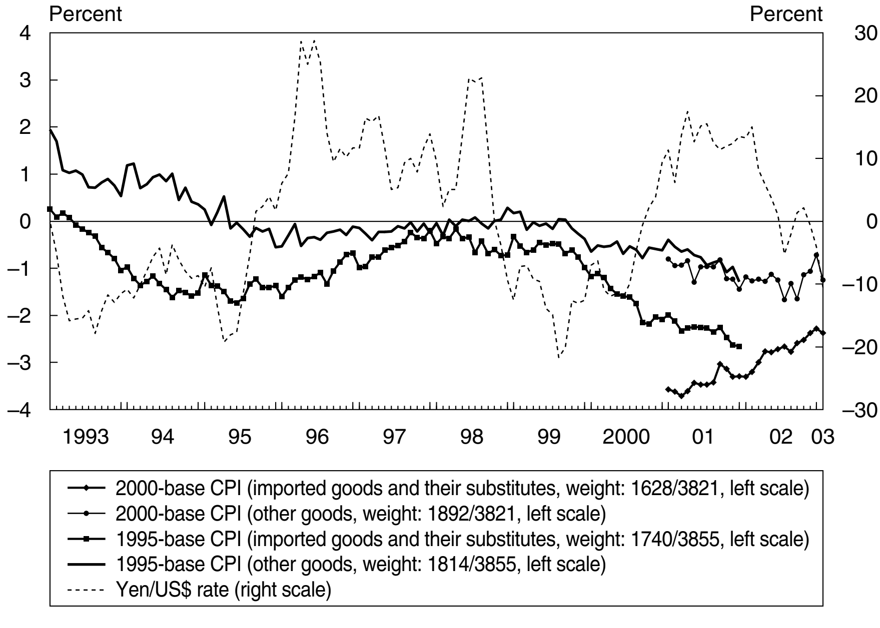

Sources: Economic and Social Research Institute, Cabinet Office; Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications.

2. Actually, prices were also stable in the 1980s, with the exception of the first two years of the decade.
3. In this paper, the CPI and GDP deflator have been adjusted for the effects of the 1997 hike in Japan's consumption tax rate. Specifically, the rate of change in the indices has been adjusted downward by 1.5 percentage points for 1997 and by 0.5 percentage point for 1998 to compensate for the effects of the tax change.

The average annual rate of change in the indices is 0.1 percent and –0.8 percent, respectively, during the period 1991–2002. The larger decline in the GDP deflator reflects the large secular decline in the investment deflator resulting from technological improvements, as well as its nature as a Paasche-type price index that tends to overstate the contribution of the deflation of goods, especially when the quality of the commodity in the basket is improving.[4] The two indices have been falling since the mid- and late 1990s, respectively. Interestingly, deflation stayed at moderate levels, –0.8 to 0.2 percent for the CPI and –1.5 to –0.6 percent for the GDP deflator, even at the bottom of the two most recent recessions, in 1998 and 2001. Since early 2003, there has been a tendency for deflation to ease, at least for the CPI.

Among the components of the CPI, the goods component has been falling faster than that for services. Among services, those sectors that have experienced significant deregulation, such as transportation and communications, have seen larger declines in the rate of inflation. Deregulation in the non-manufacturing sector has certainly been an important background factor for deflation of general prices. A closer look at the goods component of the CPI reveals that goods facing strong competition from imports have suffered larger price declines than the rest, as shown in Figure 2. Such observations lend support to the view that supply-side forces have been important.

**Figure 2 Comparison of Imported Goods and Other Goods in Terms of the CPI**




Sources: Ministry of Public Management, Home Affairs, Posts and Telecommunications; Ministry of Economy, Trade and Industry; Ministry of Finance; Bank of Japan.

4. In Japan, the estimation of the GDP deflator employs the hedonic method to adjust prices for product quality changes, resulting in sharp increases in the quantities of consumption for personal computers with quality

Turning to demand-side factors, one can immediately point out the potential existence of a large GDP gap as the dominating force behind the deflation of general prices. Most estimates of the GDP gap are very large. For example, assuming a 2 percent growth rate in trend output and the absence of a gap in the early 1990s, the GDP gap, i.e., the gap between maximum and actual levels of output, appears to exceed 10 percent in 2002.[5] This is, however, hard to reconcile with the mild deflation of about 1 percent and the absence of any apparent tendency for this deflation to accelerate further. One needs to consider the possibility that the gap is much smaller (the growth rate of trend output is much lower), or that the effect of the gap on prices has become increasingly smaller.

A rule-of-thumb Phillips curve that contains an estimate of the GDP gap term and import prices tracks well the inflation performance of the last decade or two. The response of inflation to the gap, however, is disturbingly small in such a Phillips curve; a 1 percentage point increase in inflation requires a 4 to 5 percentage point real growth above potential.[6]

It seems fair to say that more analyses and, perhaps, more data are necessary to determine the relative contributions of supply-side versus demand-side factors. The seemingly small effect of cyclical factors on inflation remains a puzzle.

In contrast to general prices, the volatility of stock and land prices during the last two decades is worth pointing out. The TOPIX rose by almost 400 percent between 1980 and 1989 and fell by about 70 percent from its peak to the low in 2003. Similarly, the price index of urban commercial land in six large cities rose by almost 500 percent between 1980 and 1992 and has declined by 85 percent.

Asset price volatility has been as high as it was during the Great Depression, but has not been accompanied by volatility of general prices. In fact, this represents a common feature of many industrialized economies with respect to their stock market booms and busts since the mid-1990s. The asymmetry between asset and general prices is surely an important topic for future study.

### B. Has Deflation Been the Major Cause of the Economic Stagnation?

Deflation of general prices, if unanticipated, creates a transfer of purchasing power from debtors to creditors by raising the real interest rate (*ex post*). Even an anticipated deflation raises the real interest rate, if nominal rates are at the zero bound and cannot be reduced further.

To the extent that debtors have higher propensities to spend out of income than creditors, such transfers reduce aggregate demand, adding to deflationary forces

---

improvements. These goods are weighed using the quantities thus calculated and prices in the base year, currently 1995, which leads to gross overestimates of the contribution of the deflation of such goods. Chain indices (the current base year is 2000) that correct for this bias have been published since December 2004. According to these indices, the GDP deflators (and hence the real interest rates calculated in Figure 4 of this paper) were biased downward by almost 1 percentage point in 2003. Given the preliminary nature and limited availability of the chain indices, however, we use the 1995 fixed-weight GDP deflator series in this paper.

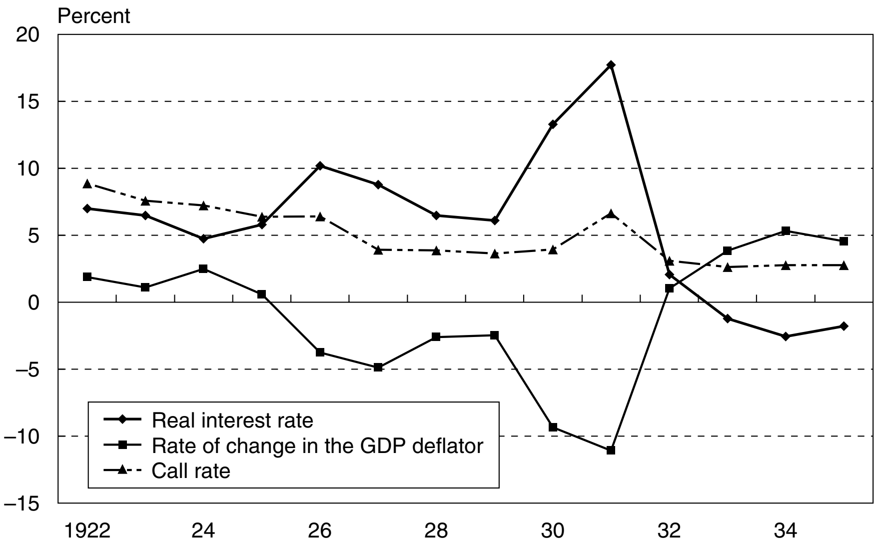
5. This measurement is zero at the maximum level of output and, unlike other gap measures that show zero at the non-accelerating inflation rate of unemployment (NAIRU), does not display positive numbers even when the inflation rate is positive.
6. For example, see Hirose and Kamada (2002). Some preliminary evidence suggests that the slope of the curve has flattened further in recent years to about half the size referred to in the text.

in the economy.[7] In addition, under asymmetric information, banks may reduce lending in response to a decline in the net worth of debtors, setting in motion a negative financial accelerator. The effects of accelerators become more serious if financial institutions' net worth declines sharply due to their exposure to the stock and/or land markets.[8]

Examples of serious debt deflation can be found in the experiences of industrialized countries during the 1920s and 1930s. Figure 3 shows Japan's call rate, the rate of change in the GDP deflator, and the real interest rate (defined as the difference between the two). Deflation exceeded 10 percent and the real interest rate 15 percent in the early 1930s. As a result, the debt burden of borrowers rose sharply. For example, net interest payments relative to cash flows rose from about 80 percent in 1929 to more than 200 percent in 1930. As is well known, a similar pattern of movement in the variables can be seen in the United States during the 1930s. In addition, as Bernanke (1983) extensively documents, the debt deflation was exacerbated by the decline in the economy's ability to carry out financial intermediation.

Post-1990s Japan is not remotely close to the United States or Japan in the 1930s in terms of the impact of general price deflation on the debt burden of borrowers. Figure 4 plots the real interest rates faced by major borrowers, i.e., nonfinancial firms and the central government. The real interest rates are calculated as gross interest payments divided by total debt minus the rate of increase in the deflator for domestic demand. It is evident that the real interest rates have declined slowly since the

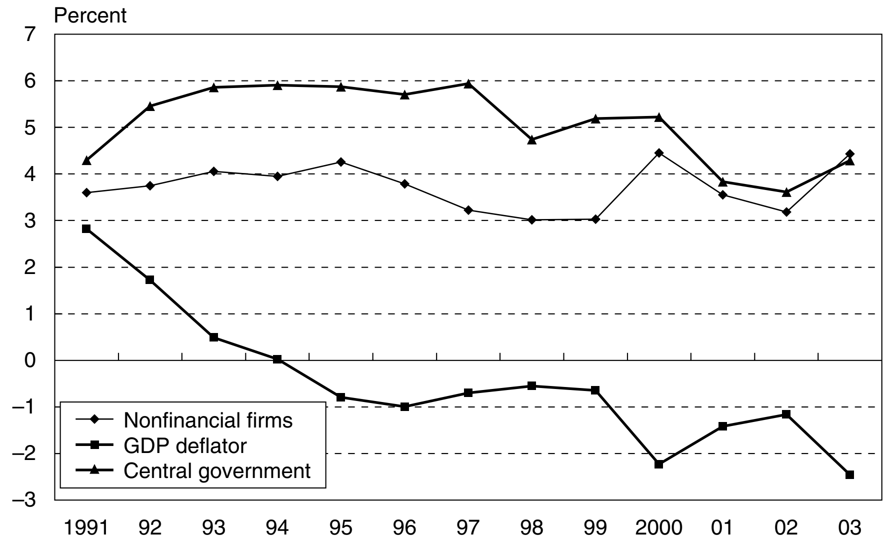
**Figure 3 Estimates of Real Interest Rate, 1922–35**




Sources: Economic and Social Research Institute, Cabinet Office; Bank of Japan.

7. See Fisher (1933) and King (1994).
8. For example, see Bernanke (1983) and Bernanke and Gertler (1990).

**Figure 4 Estimates of Real Interest Rates, 1991–2003**




Note: Real interest rates are calculated as gross interest payments divided by total debt minus the rate of increase in the deflator for domestic demand.

Source: Economic and Social Research Institute, Cabinet Office.

mid-1990s. Of course, to stimulate aggregate demand, it would have been better if real interest rates had been much lower. There is, however, no evidence that deflation has substantially increased real interest rates. Other measurement methods such as interest payments relative to cash flows tell the same story. For nonfinancial firms, this percentage ratio has been falling steadily since the early 1990s. It is now around 12 percent, a significant fall compared with a level of more than 40 percent in 1991 and 1992.[9]

**C. Asset Price Deflation and Associated Negative Financial Accelerators in Japan**

Undoubtedly, the sharp fall in asset prices has been the major reason for the recent instability in the Japanese financial system. Less clear is the causality between the financial system problems and the deflation of general prices. To shed some light on this issue, let us first look at Figure 5, where the relationship between inflation and the degree of seriousness of the NPL problem is shown by industry. The figure clearly reveals that the lower the rate of industry inflation, the less serious is the NPL problem for that industry. Although a correct interpretation of the relationship in the figure requires further research, the relationship is evidently at odds with the view that the deflation of output prices has been the main cause of NPLs.

In Figure 6, we show the relationship between land holding at the peak of the bubble period and NPLs as of March 2000, both measured as a share of total assets,

9. Of course, deflation decreases this variable by lowering nominal interest payments faster than cash flows. This effect is offset by a rise in the real value of the principal. To see the net impact, one needs to look at the real interest rate, which is what appears in Figure 4.

**Figure 5  Deflation versus NPLs**

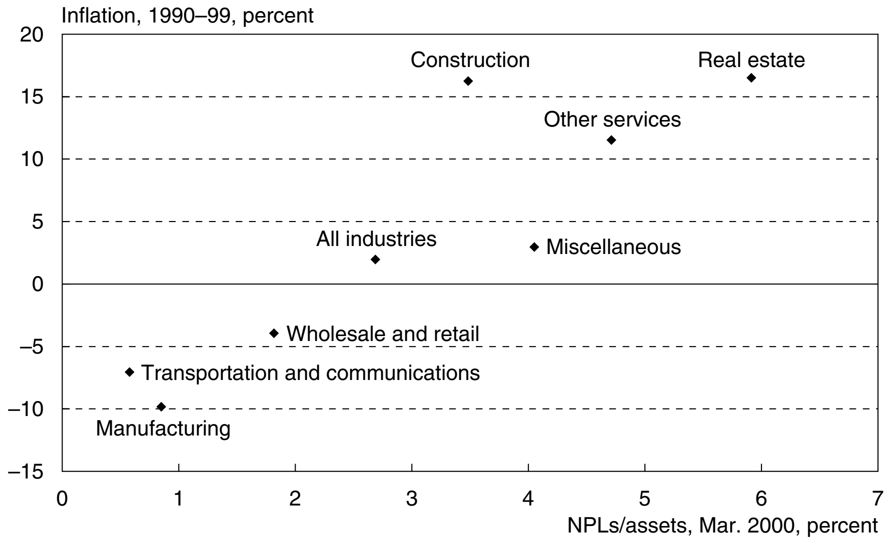
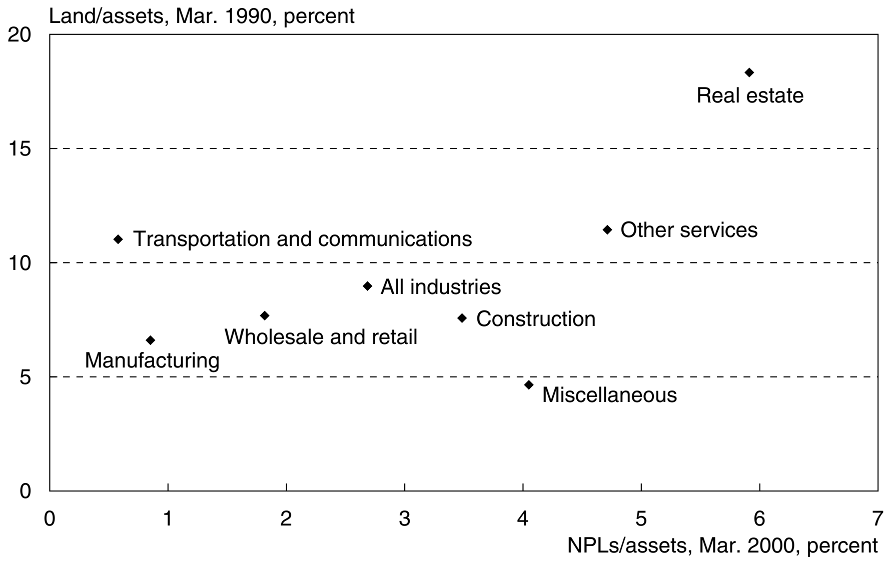



**Figure 6  NPLs versus Land Holding**




Source: Economic and Social Research Institute, Cabinet Office.

by industry. Assuming that the real estate industry observation does indeed contain significant information in this regard, there is a positive relationship between the two variables. That is, the larger the land holding, the more serious the NPL problem, providing evidence of causation running from asset price deflation to NPLs.[10]

Turning to the effects of NPLs on the real side of the economy, Nagahata and Sekine (2002) conduct an analysis of the determinants of business fixed investment using a firm-level time-series cross-section data set. Along with other determinants, their analysis examines the importance of the net worth of both borrowers and their main banks. They find that declines in the net worth of borrowers have had significant negative effects on investment. They also find that lenders' net worth has exerted significant negative effects on the investment of firms without access to the bond market. Declines in net worth can be explained mostly by declines in asset prices and by NPLs (in the case of banks). Moreover, most of the declines in bank lending since the mid-1990s can be attributed to these two factors, together with the liquidity problems of banks during 1997–98. Thus, a negative financial accelerator has clearly been at work.[11]

The negative effects of financial instability spread throughout the economy during the credit crunch in 1997–98. The Asian economic crisis, a premature tightening of fiscal policy in 1997, and the Russian crisis in 1998 were the triggers for the crunch. Several major financial institutions in Japan became insolvent. Risk premiums and the demand for liquidity rose sharply across the nation's financial system. Japanese banks, already suffering from NPLs, found themselves facing difficulties in raising funds, and began calling in their loans to nonfinancial firms. Even large companies felt the pressure of the credit crunch, and subsequently had to cut back on their investment. In retrospect, the failure to resolve the NPL problem at an early stage resulted in the credit crunch and became one of the key reasons for the ongoing stagnation of the economy.

### D. A Real Business-Cycle Theory View

A different approach in analyzing Japan's lost decade emphasizes real factors. For example, Hayashi and Prescott (2002) observe that declines in total factor productivity (TFP) growth coupled with the reduction in the work week can roughly explain the stagnation of the economy. They also argue that the NPL problem was not the major factor behind this stagnation apart from 1997–98.

Kawamoto (2005) looks more closely at the reasons for this decline in TFP growth. He decomposes the standard Solow residuals into "true" aggregate technical changes and the terms representing the effects of increasing returns, imperfect competition, cyclical fluctuations in utilization of capital and labor, as well as resource reallocation among different sectors of the economy. He finds little evidence of a decline in the pace of technological change in the 1990s. Rather, most of the declines in measured productivity growth rates are attributed to inefficient use of inputs: a cyclical decline in input utilization rates and the failure to reallocate

10. See Ueda (2000) for a more careful analysis on this point along with discussion of other causes of the NPL problem.
11. One could say that a similar mechanism was working during the Great Depression, which was only aggravated by the deflation of general prices.

resources to more efficient sectors of the economy. His results are consistent with the view that problems in the financial system hindered an efficient reallocation of resources: banks were not extending loans to new efficient projects while continuing to finance many virtually nonviable companies. Nakakuki, Otani, and Shiratsuka (2004) also decompose changes in TFP growth into various sources including factor market distortions. They find that factor market distortions explain about one-third of the decline in TFP growth in the 1990s compared to that of the bubble period.

The analysis of the above papers suggests a mechanism by which the problems in the financial system have adversely affected the Japanese economy. This interpretation is perfectly consistent with the evidence discussed above showing that the NPL problem has had negative effects on business fixed investment.

This literature also has some interesting policy implications. If the productivity decline is mainly due to "true" declines in TFP growth, there would be little room for macroeconomic policy to reverse these developments. Even if declines in TFP growth are due to factor market distortions, the correct policy response is to address these distortions directly, for example, by measures to alleviate the NPL problem. In either case, asset prices will decrease to match the decline in the rate of profit, followed by a prolonged period of low investment and declining capital stock. This, along with the excesses built up during the bubble period, seems to be one of the reasons for the prolonged nature of the stagnation of post-1990s Japan.

### E. An Econometric Analysis of Japan's Macroeconomic Fluctuations since the Early 1990s

The foregoing informal discussion suggests the importance of the negative effect of financial accelerators in explaining Japan's macroeconomic problems during the last decade or two. This subsection offers a more formal statistical analysis in an attempt to gauge the importance of such a mechanism.

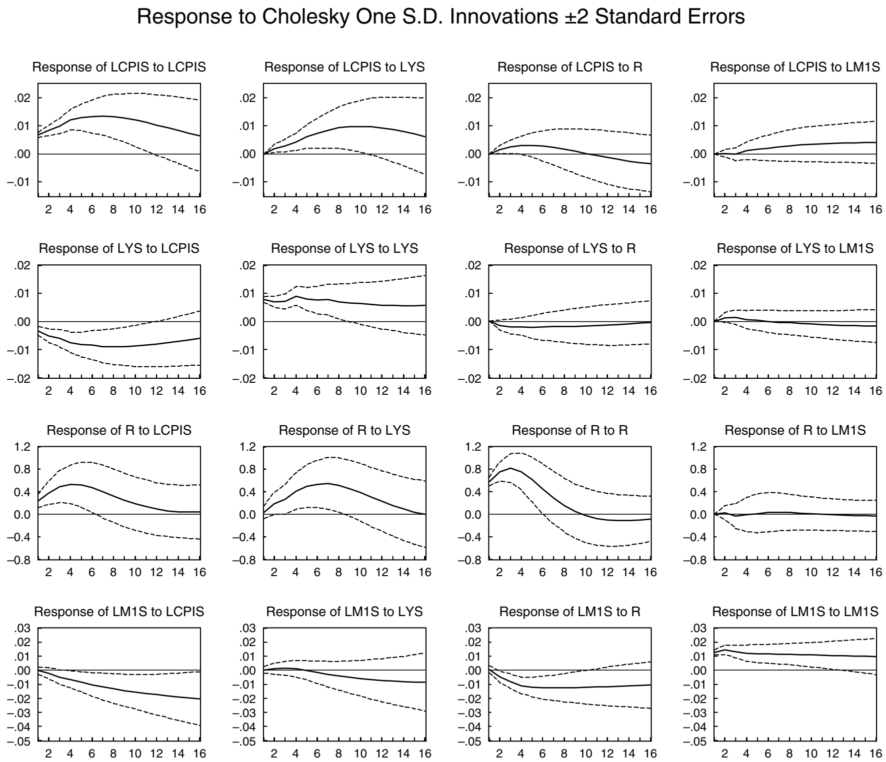
As a preliminary check, we ran vector autoregressions (VARs) similar to those employed by Leeper, Sims, and Zha (1996). We first estimated simple systems consisting of a price index, real GDP, a short-term interest rate, and the money supply. The results are similar to those estimated for the United States. We then proceed to include a variable that represents a financial accelerator effect.

Figure 7 shows impulse response functions for a four-variable model, i.e., the CPI, real GDP, the collateralized overnight call rate, and M1. All variables except for the interest rate are seasonally adjusted and used in logarithmic forms. Identification of the system is based on the assumption of a recursive ordering as in Leeper, Sims, and Zha (1996). The assumed ordering of the variables is as described above. The model is estimated over the period 1971/I–1999/I.[12] A more detailed explanation of the data and estimation method is found in the notes to Figure 7.

The impulse response functions are quite similar to those estimated for the United States. For example, the so-called liquidity and price puzzles are observed. Specifically, the interest rate R does not fall clearly in response to an M shock; the

12. The estimation period ends in 1999/I because the "nonconventional" policy measures adopted after that may have changed the relationship between the variables.

**Figure 7 Impulse Responses for Four-Variable VAR**




Notes: 1. LCPIS, LYS, R, and LM1S are the CPI, real GDP, the collateralized overnight call rate, and M1, respectively. The CPI, real GDP, and M1 are in logarithmic form and seasonally adjusted. R is in level form and non-seasonally adjusted.
2. Each panel shows the 16-quarter response of the given row variable to a shock to a given column variable. Impulse responses are orthogonalized recursively in the order shown above. Dashed lines indicate two standard error bands, calculated by the Monte Carlo method with repetition 10,000 times.
3. The estimation includes four lags and a constant.

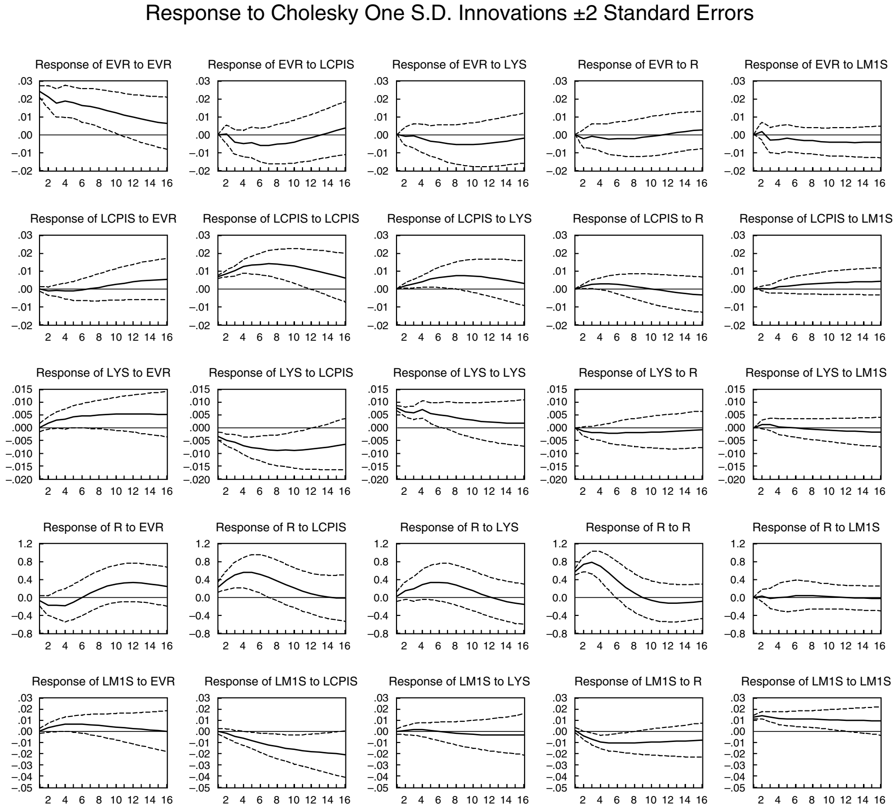
Source: Authors' VARs.

CPI rises for an extended period in response to an R shock. Also in the figure, the CPI responds positively to a Y shock, while Y responds negatively to a CPI shock. This appears to suggest the significance of supply shocks.

Figure 8[13] shows impulse response functions for the system that adds a leverage ratio variable EVR, the ratio of the market value of equity to the value of the firm. We assume that this variable represents the effect of a financial accelerator, which reflects financial market imperfections. This is a key variable in financial accelerator

13. Estimated results are robust to changes in the definition of monetary aggregates, for example, to base money or M2+CDs.

**Figure 8 Impulse Responses for Five-Variable VAR**




Notes: 1. EVR, LCPIS, LYS, R, and LM1S are the ratio of the equity value to the value of the firm, real GDP, the collateralized overnight call rate, and M1, respectively. The CPI, real GDP, and M1 are in logarithmic form and seasonally adjusted. EVR and R are in level form and non-seasonally adjusted.

2. Each panel shows the 16-quarter response of the given row variable to a shock to a given column variable. Impulse responses are orthogonalized recursively in the order shown above. Dashed lines indicate two standard error bands, calculated by the Monte Carlo method with repetition 10,000 times.

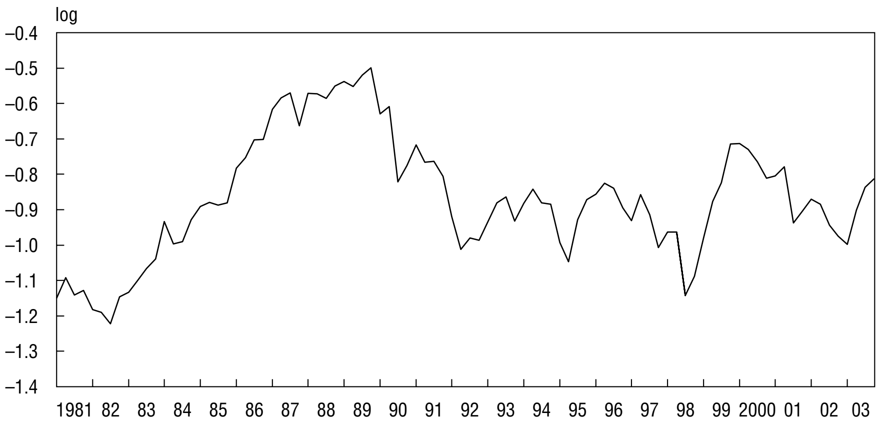
3. The estimation includes four lags and a constant.

Source: Authors' VARs.

mechanism, as in the one used in Bernanke, Gertler, and Gilchrist (1999). Figure 9 shows changes in actual EVR and estimated EVR shocks, where the latter closely follows stock prices. In Figure 8, we find that real GDP responds significantly to an EVR shock. The CPI also responds positively to the EVR shock after about seven quarters. Also, EVR impulse responses indicate that the shocks other than the shock to EVR itself do not have significant effects on EVR. The figure assumes that EVR comes first in the ordering, but it turned out that the ordering of EVR did not matter much for the results.

**Figure 9 Ratio of the Market Value of Equity to the Value of the Firm (EVR)**

[1] Actual EVR




Notes: 1. Value of equity is “shares and other equities” of “private nonfinancial corporations” in the Flow of Funds Account. Data up to 1997/III are calculated from “total market value of listed stocks (Tokyo Stock Exchange, First Section).”

2. Value of the firm is the sum of value of debt and value of equity. Value of debt is the sum of “loans” and “securities other than shares” of “private nonfinancial corporations” in the Flow of Funds Account. Data up to 1997/III are calculated from the Flow of Funds Account based on 68SNA.

[2] Changes in Equity Price and EVR Shocks

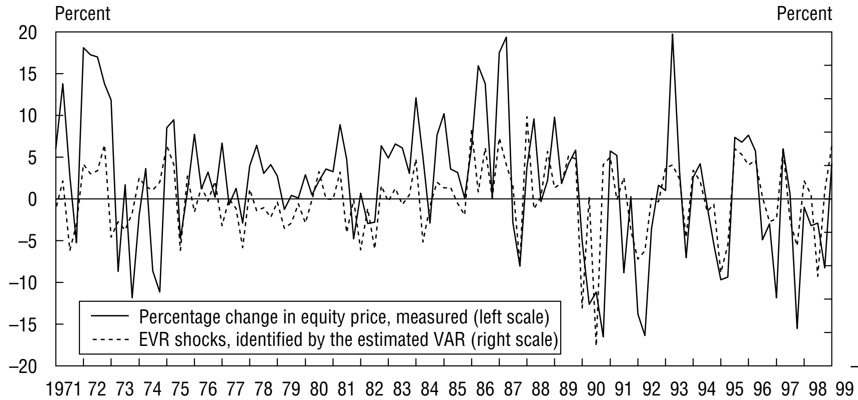
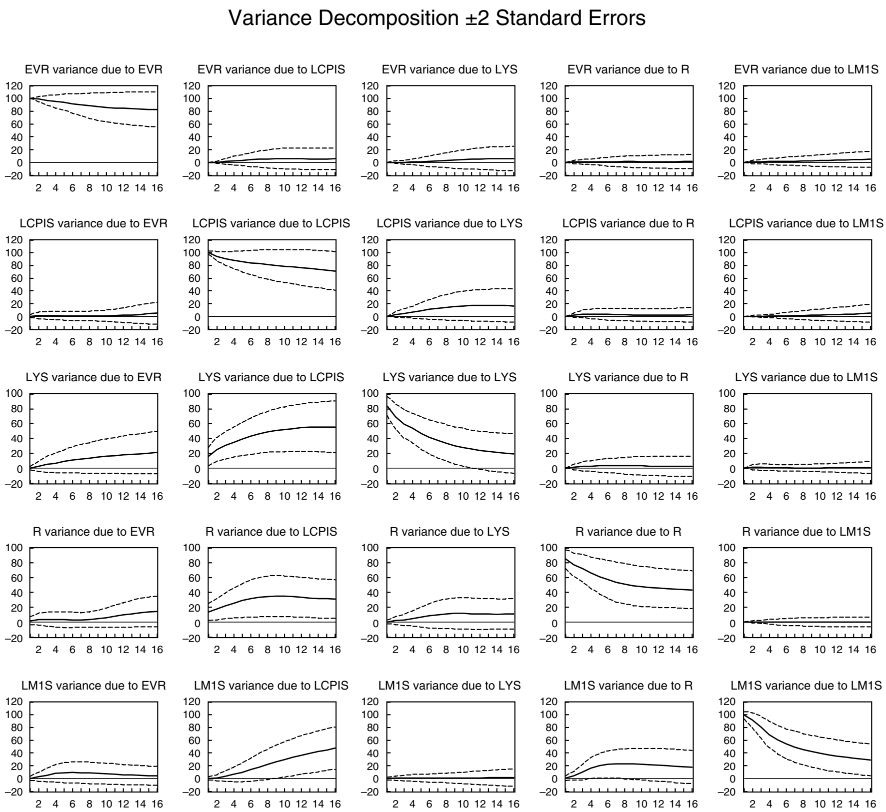


Figure 10 presents variance decomposition results for the same system. Although EVR shocks explain about 20 percent of real GDP fluctuations in point estimates, they contribute little to the CPI. The CPI variance is mostly explained by shocks to itself and real GDP shocks.

**Figure 10 Variance Decomposition of Five-Variable VAR**




Note: Each panel shows the 16-quarter forecast error variance decomposition, based on the estimation result summarized in Figure 8. Dashed lines indicate two standard error bands, calculated by the Monte Carlo method with repetition 10,000 times.

Source: Authors' VARs.

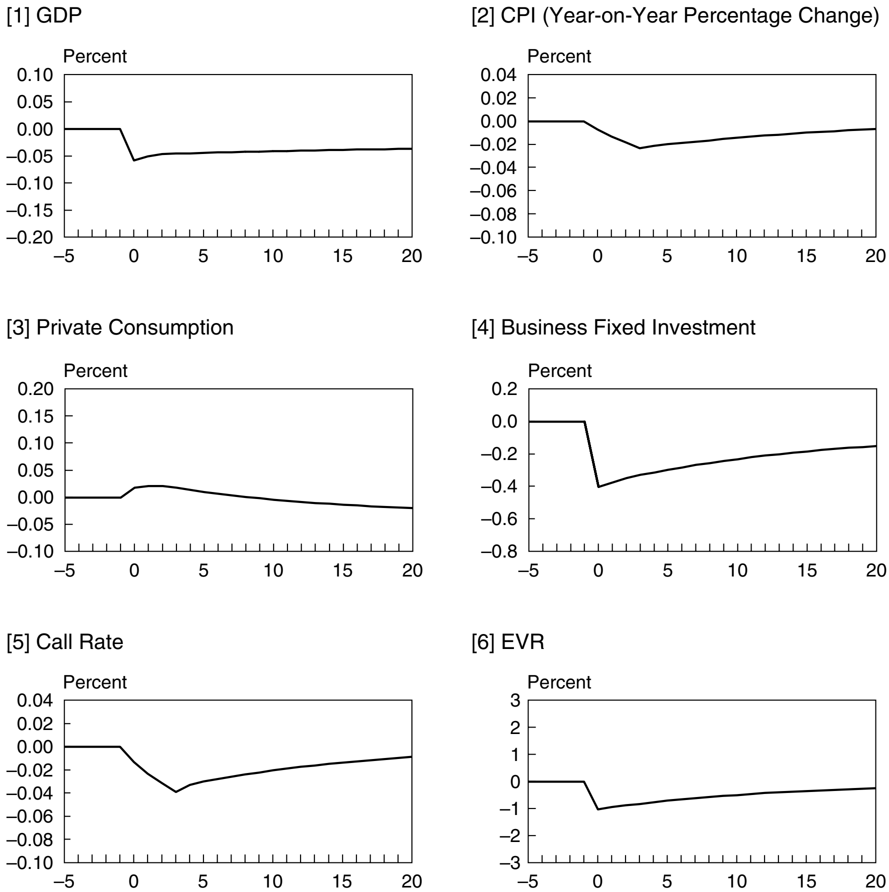
These results suggest that the stagnation of the economy may have been partially due to accelerator mechanisms that resulted from a fall in stock prices. But the deflation of general prices hardly seems to be related to asset price changes.

We next present an estimation result of financial accelerator effects based on a more structural model. The model is close to the one in Bernanke, Gertler, and Gilchrist (1999). It incorporates credit market imperfections and is designed to examine the role of the financial accelerator mechanism in the propagation of macroeconomic shocks. Households determine their consumption paths by solving the conventional intertemporal optimization problem (equation [A.2] in Appendix 1). Investment determination follows the conventional q-theory (equation [A.5]). Credit market imperfection is modeled as EVR affecting the cost of capital (equation [A.7]). Equation (A.8) describes the evolution of EVR, where capital market imperfections are assumed to make sudden large changes in EVR costly, thus forcing it to move slowly mainly in response to cash flows. The details of the model are provided in Appendix 1. The model has been estimated by the generalized method of moments (GMM) over the 1981/I–2003/I period.

Based on the estimated coefficients, we conduct simulation that gauges the impact of the financial accelerator. For this purpose, we regard the error term of equation (A.8) as a shock to the balance sheet of the representative firm and estimate the contribution of the term to macroeconomic fluctuations. This procedure requires an explanation. It turns out that the major driver of the error term of equation (A.8) is the movement of stock prices. Stock price changes, however, seem to be already included, through equation (A.3), in the return to capital term on the right-hand side of equation (A.8). But in the estimation and simulations of the model, we assume that equation (A.5) holds exactly and therefore the capital gain terms on the right-hand side of equation (A.3) are determined by movements in the investment to capital ratio. Thus, stock price movements that are not correlated with the current investment to capital ratio but affect the EVR variable are reflected in the error term of equation (A.8). The simulation considers such stock price movements exogenous and calculates their effects, through the EVR variable, on other variables in the system. Despite the rather strong assumptions, the procedure seems to be effective in identifying the magnitude of financial accelerator effects caused by asset price changes.

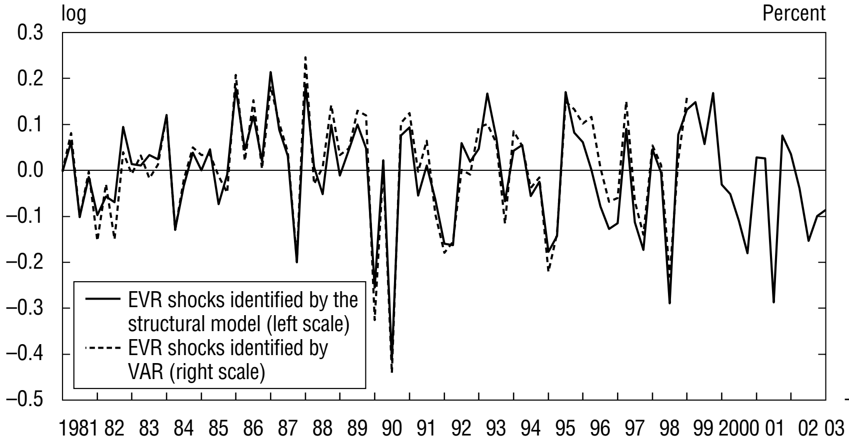
Figure 11 shows the response of major variables to a negative 1 percent permanent shock to equation (A.8). The effects are largely plausible. Fixed investment declines sharply, generating prolonged declines in GDP and the CPI. This is partially offset by the response of monetary policy and its effect on consumption. Figure 12 presents the estimated shocks to equation (A.8). The figure also shows the EVR shock derived in the VAR analysis presented above. The two estimated error series are almost identical, suggesting that the exogeneity assumption is acceptable. It also shows that large EVR shocks are observed in the bubble years of the late 1980s, the post-bubble years, and the years of financial instability during the late 1990s.

**Figure 11 Responses to EVR Shocks**




Notes: 1. Responses to negative 1 percent shocks in the error term of equation (A.8).
2. Data for [1], [3], [4], and [6] are percent deviations from the steady state, and data for [2] and [5] are deviations from the steady state.

**Figure 12 EVR Shocks**




Note: The correlation coefficient of the shocks in the structural model and in VAR is 0.94.

Figure 13 then shows the effects of the estimated EVR shocks on major macroeconomic variables. The effects are considerable. The EVR shocks seem to have raised GDP and the CPI through their effects on business fixed investment in the late 1980s, while they have worked in the opposite direction since the early 1990s. Without the shocks, fixed investment would have been higher by some 30 percent in early 2003, GDP by 5 percent, and CPI inflation by about 2 percentage points, implying that deflation would have ended by now by a considerable margin.[14]

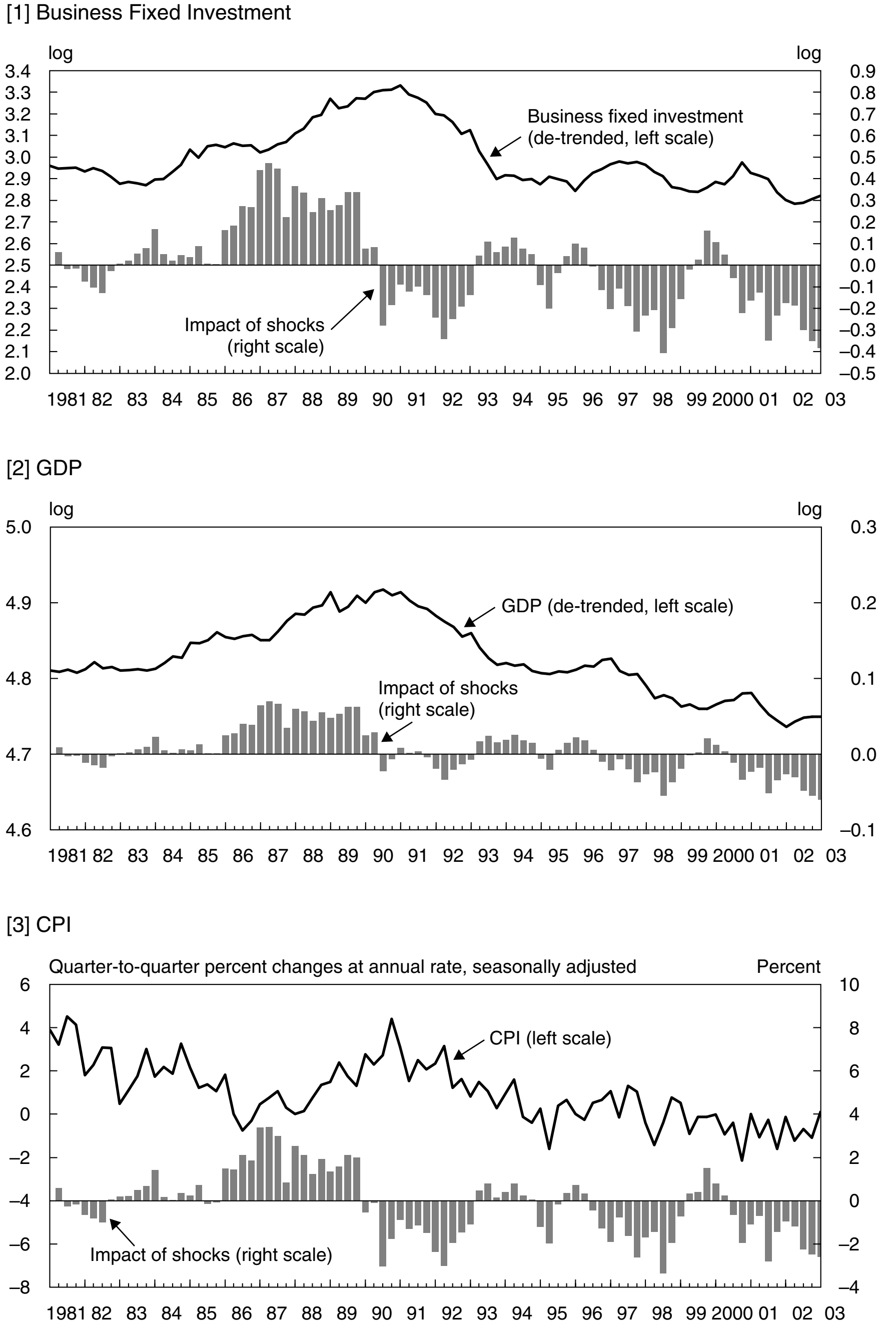
Although our analysis is not capable of fully decomposing Japan's macroeconomic fluctuations into various sources, the discussion in this section suggests the importance of asset price declines and the associated financial accelerator effect. The literature is divided concerning the causes of asset price declines. Some have attributed them to the bursting of the bubble formed in the late 1980s, and others have seen them as a natural response to underlying declines in the rate of productivity growth. But as we argued in Section II.D, even the declines in the productivity growth rate could have been partly due to the negative financial accelerator effects.[15]

It is perhaps fair to say, however, that a significant portion of EVR shocks in the above analysis remains ascribable to slowdowns in growth expectations that are unrelated to financial-sector events. These revisions in expectations must have generated significant adjustment pressure irrespective of financial-sector problems. Thus, optimistic growth expectations during the bubble period led many firms to build up

14. Ideally, the estimated effects would have to be compared with those of other types of shocks. But the forward-looking and highly nonlinear nature of the model has made this task next to impossible. Equation (A.8) happens to be of the backward-looking form, making the simulation possible.

15. The statistical analysis in this subsection does not take into account such a possibility because it uses data de-trended by observed productivity changes (see Appendix 1). Hence, it does not capture the possible covariation of stock prices and productivity changes.

**Figure 13 Impact of the Estimated EVR Shocks (Results of Simulation)**




Note: Impact of shocks shows the simulated responses of endogenous variables to the estimated EVR shocks, and is expressed in deviations from the steady state.

large production capacities financed by borrowing from banks. Firms also invested huge sums of money in land for speculation and securing of collateral for future borrowing. They also added substantially to their employment pool, as they believed that a period of labor shortage was at hand. As firms revised economic growth expectations downward, they had to reverse these activities, and the adjustment of real variables such as capital stock, employment, and land has taken a painfully long time. Financial-sector problems have added to the pain of adjustment. A precise estimation of the contribution of the latter is left as a future task.

The period since the mid- to late 1990s saw the mild deflation of general prices. The negative macroeconomic effects of price declines were also moderate during the period. Monetary policy, however, has had a difficult time stopping this mild deflation. We will discuss this aspect of Japan's experience in the next section.

## III. Policies to Deal with the Problems

The prescription for 1930s-type debt deflation has been proposed by, among others, Bernanke and Gertler (1990). The financial accelerator problem may be dealt with by transferring income to debtors with promising projects, at least to the extent that such projects exist and borrowers are identifiable. A similar kind of transfer could be applied to banks. Macroeconomic policy can take care of general price deflation.

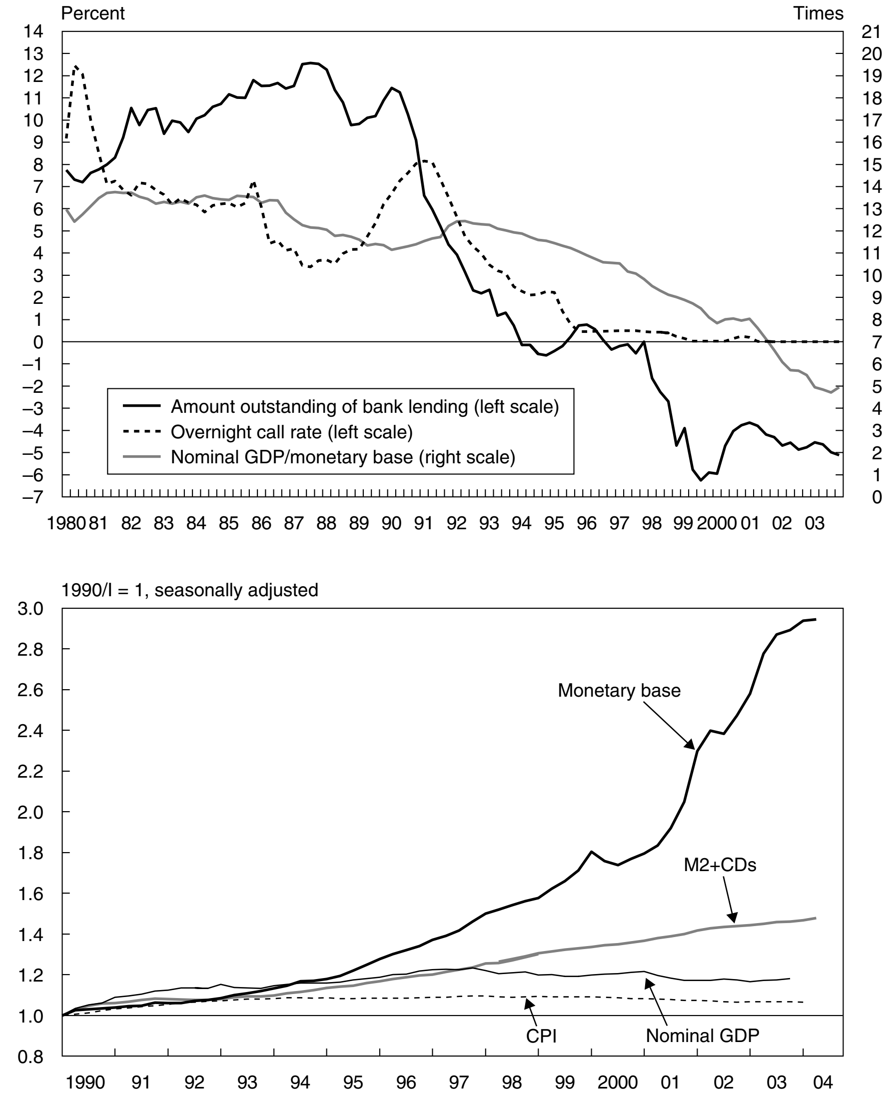
Meanwhile, the case of Japan since the 1990s has been more complicated. As we have pointed out, the deflation of general prices has not been the major cause of the economic stagnation. Instead, excesses generated during the bubble period, asset price deflation, and the cumulative effect of the interaction between the financial system and the economy have been at the center of the problem. If the condition of the economy worsened beyond a certain extent, measures to bolster asset prices might be justified. It would, however, be difficult to determine whether the economy had reached such a stage.

The role of macroeconomic policy is also not straightforward in this situation. Halting the deflation of prices for goods and services would surely mitigate the pain of economic adjustment we have just described, but it does not necessarily imply that the economy can dispense with the required adjustment itself. The ratio between asset and general prices has had to be adjusted.[16] Moreover, as we explain below in the case of monetary policy, the problems in the financial system have lowered the effectiveness of macroeconomic policies in stimulating the economy.

Let us now focus on monetary policy. Figure 14 shows the difficulty the BOJ has been facing in combating deflation. The ratio of nominal GDP to base money shown in the figure presents a sharp downward deviation from its trend prior to around 1995. Conversely, the ratio of base money to GDP has roughly doubled since then. Yet deflation has persisted, albeit at moderate rates. This is a clear case of monetarism

16. The ratio of asset prices to the GDP deflator has declined sharply since the peak around 1990 and is now back to where it was around 1983 for both stock and land prices. Thus, a fair amount of adjustment has already taken place. As pointed out above, however, it is difficult to determine whether the process is over, incomplete, or has gone too far.

**Figure 14 Monetary Indicators, Economic Activity, and Price Developments**




Source: Bank of Japan.

failing to explain the relationship between money and inflation. Possible reasons for this are also illustrated in the same figure. The rate of growth of bank loans has been either around zero or negative since 1995, in line with the problems of the financial sector.[17] As we mentioned above, this has reduced the ability of low interest rates to stimulate the economy. Moreover, as the figure makes clear, short-term interest rates

17. Correspondingly, the money supply has grown at a much lower rate than base money. That is, the money multiplier has declined sharply.

have hit the zero boundary during this period, depriving the BOJ of additional leeway for using standard monetary policy instruments.[18] As a result, the BOJ has adopted several unconventional monetary policy measures. These include efforts to generate monetary easing effects beyond those resulting from a zero short-term interest rate and to supplant the impaired ability of the financial system to carry out credit intermediation. In the remainder of this section, we focus on the monetary policy aspect of the measures the BOJ has adopted during the past several years and present some quantitative estimates of their effects. The next section describes interaction between monetary policy and financial-sector problems.

### A. The BOJ's Monetary Policy during 1998–2004: A Brief Summary of the Policy Measures Adopted

The major monetary policy actions by the BOJ during the last six years are summarized below. In response to the onset of deflation and the deterioration of the financial system, the overnight call rate was first lowered from around 0.43 percent to 0.25 percent in September 1998. Then it was lowered to near zero percent in March 1999. In April 1999, the BOJ promised to maintain a zero interest rate "until deflationary concerns are dispelled"—the so-called zero interest rate policy (ZIRP). The economy then recovered and grew at 3.3 percent between 1999/III–2000/III. Consequently, the ZIRP was abandoned in August 2000. The economy, however, went into a serious recession again led by worldwide declines in the demand for high-tech goods.

The BOJ announced the introduction of the quantitative monetary easing policy (QMEP) in March 2001. This has consisted of maintaining an ample liquidity supply by using the current account balances (CABs) at the BOJ as the operating policy target[19] and the commitment to maintain ample liquidity provision until the rate of change of the core CPI becomes zero or positive on a sustainable basis. The BOJ also announced that it was ready to increase the amount of purchases of long-term government bonds to meet the target for the CABs. The commitment regarding future liquidity provision was further clarified in October 2003 with the BOJ committing itself to continue providing ample liquidity until both actual and expected inflation becomes zero or positive.[20] The target for the CABs has been raised several times, reaching ¥30–35 trillion in January 2004 compared to the required reserves of approximately ¥6 trillion.[21] To meet such targets, the BOJ has conducted various purchasing operations for instruments such as bills and CP in addition to treasury bills (TBs) and government bonds.[22] Since 2003, the BOJ has also started buying asset-backed commercial paper (ABCP) and asset-backed securities (ABSs).

18. See Shirakawa (2001) and Ueda (2001, 2002) for more detailed accounts of monetary policy during the period.
19. Before the adoption of the QMEP, the operating target was the uncollateralized overnight call rate.
20. It was also decided that the dual condition of both actual and expected inflation turning positive was necessary but not sufficient for the termination of the QMEP. That is to say, depending on developments in the economy, the QMEP could be maintained even if the dual condition were met.
21. The policy directive contains a clause allowing the BOJ Operations Desk to increase the liquidity provision beyond the level decided by the Policy Board should there be a risk of financial market instability and an accompanying surge in liquidity demand. This clause has been applied several times toward the end of fiscal accounting years, immediately after the September 11 terrorist attacks in 2001, and on the occasion of computer system problems at financial institutions.
22. Funds-providing operations in bank bills and CP are essentially the BOJ lending to financial institutions with government securities, CP, and other eligible securities as collateral. For example, CP operations are carried out

The three building blocks of the QMEP—ensuring ample liquidity provision, commitment to continue such liquidity provision, and the use of various types of market operations, especially a purchasing operation for long-term government bonds—roughly correspond to the three mechanisms pointed out by Bernanke and Reinhart (2004) that can be effective in generating easing effects even at very low interest rates.[23] The correspondence is not an exact one. For example, the BOJ's policy to increase the CAB target may have had an announcement effect that makes the liquidity provision commitment more credible. The BOJ's long-term government bond-purchasing operation has functioned as a major tool to meet the target on the CABs. The possibility remains, however, that changes in the composition of the BOJ's balance sheet caused by its market operations have had some effects on the term structure of interest rates. Another difference is that, while Bernanke and Reinhart (2004) emphasize a fiscal aspect of the central bank's balance-sheet expansion, i.e., seigniorage revenue for the government, the BOJ has not taken into account such an aspect.

It should be noted that any one of the three building blocks is not a prerequisite for the others. For example, the liquidity provision commitment is essentially a commitment to maintain a zero short rate. In this sense, the commitment can be carried out without significantly expanding CABs beyond required reserves. Likewise, purchases of long-term government bonds can be conducted as twist operations without expanding CABs. The large increases in the CABs, however, might not have been possible without increasing the purchases of long-term government bonds.

Put differently, the QMEP has consisted of a ZIRP, expansion of the CABs above levels necessary to maintain short-term interest rates at zero (ECAB) and use of purchasing operations of long-term government bonds and other securities to meet the CAB target. We will refer to the first component, i.e., the commitment to maintain sufficiently high liquidity provision to keep the short-term interest rates at zero until the inflation rate turns zero or positive, as the revised version of the zero interest rate policy (RZIRP).[24]

Let us now take a closer look at the market operations and the behavior of interest rates under the QMEP framework. The CAB target was set at ¥5 trillion in March 2001. Right before the adoption of the QMEP, the level of CABs was around ¥4 trillion, nearly equal to the required reserves at the time. As of May 2004, the CABs had grown eightfold with an average annual growth rate of 92 percent. Figure 15 shows the evolution of the target and actual CABs and required (or excess) reserves. Of the ¥27.5 trillion increase in the CABs between the end of February

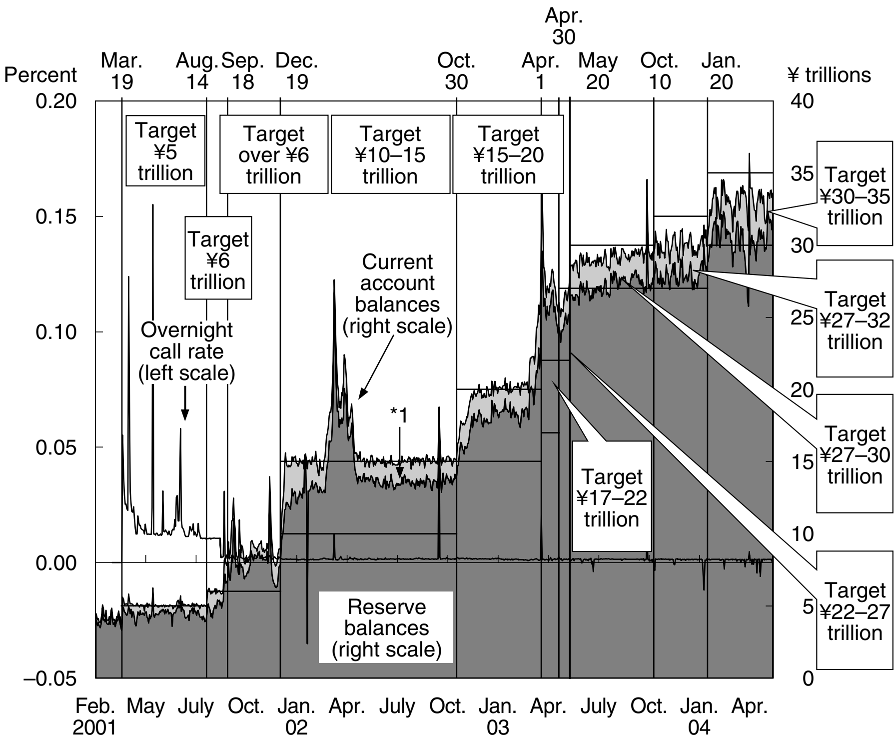
in a repo manner and thus are not outright purchases by the BOJ. In contrast, in the operations in ABCP and ABSs that began in 2003, the BOJ has bought these assets outright.

23. They called the three mechanisms shaping interest rate expectations, altering the composition of the central bank's balance sheets, and expanding the central bank's balance sheets.

24. Some authors have suggested that the BOJ buy long-term government bonds more aggressively. It is important to note the difference between such a policy on its own and when it is used together with the RZIRP. In both cases, the purchases can be used as a measure to increase liquidity. But the effects on long-term interest rates are different. When bond purchases are used in isolation, they may affect both expected short-term interest rates and risk premiums. When they are used in combination with the RZIRP, they would mainly affect the risk premiums given the strong effects of the RZIRP on expected short-term interest rates. The statistical analysis to follow will check these predictions. See the Bank of Japan (2003b, 2004) for more details on money market operations.

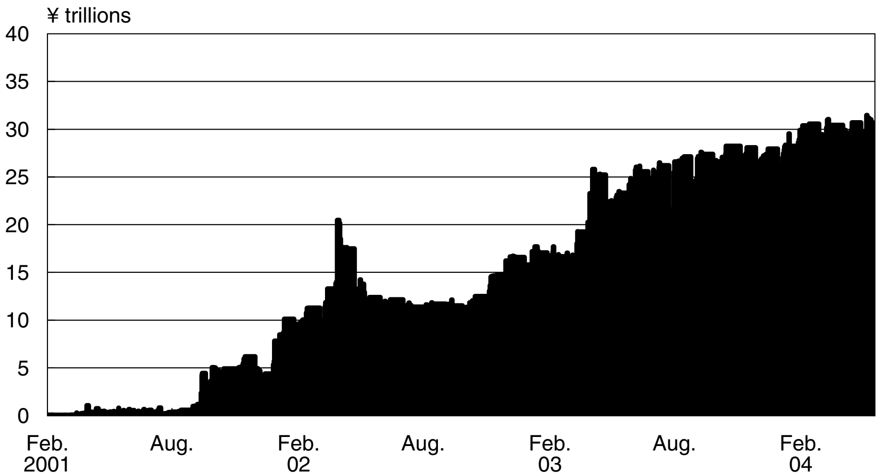
**Figure 15 Target and Excess Reserves**

[1] Target Reserve and Actual Balance




Note: *1. Current account balances held by institutions that are not subject to reserve requirements.

[2] Excess Reserves

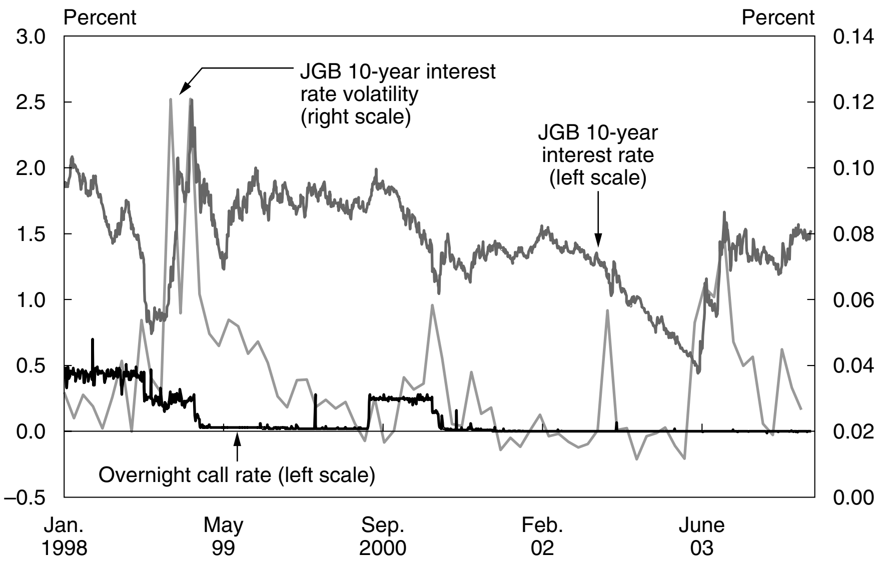



Source: Bank of Japan.

2001 and April 2004, market operations provided ¥27.7 trillion, while autonomous factors such as issuance/withdrawal of currency and government deposits subtracted ¥0.2 trillion. Among the market operations, purchases of long-term government bonds totaled ¥37.8 trillion.[25] The Ministry of Finance's (MOF's) interventions in the foreign exchange market are funded by the issuance of financing bills (FBs) and thus are neutral to the level of the CABs.[26] As a result of aggressive ECAB, the monetary base grew by 67 percent during the same period. Currency volume held by the public increased substantially as a result of the decline in interest rates. The financial system instability also stimulated currency holdings by the public.[27]

During the ZIRP period, the overnight call rate declined to at most 0.01 percent, while in the QMEP period the rate declined further to 0.001 percent. In both periods, differences in interest rates for individual financial institutions also came down to minimal levels, at least at the short-term end of the money market (Figure 16).

**Figure 16 JGB Yield and Volatility**




Note: Volatility is defined as the monthly standard deviation of daily changes in the interest rate on 10-year JGBs.

Sources: Japan Securities Dealers Association; Bank of Japan.

25. The amount of monthly purchases of long-term government bonds is set and pre-announced by the BOJ. It was ¥0.4 trillion per month in March 2001 and was gradually increased to ¥1.2 trillion by May 2004.
26. It is possible for the MOF to sell the bills to the BOJ, in which case interventions, other things equal, affect the CABs. There is, however, a MOF-BOJ agreement under which the MOF issues bills in the market as soon as possible and retires the debt held by the BOJ.
27. The growth rate of currency outstanding has slowed since the second half of 2003, reflecting improvements in the soundness of the banking system. It may decline further in the future in the event that interest rates start to rise significantly.

**B. Analysis of the Effectiveness of Monetary Policy**

At the core of the policy measures common to both the ZIRP and the QMEP is the commitment to maintain a zero short-term interest rate until, roughly speaking, the inflation rate turns zero or positive.[28] This enables a stronger monetary easing effect than a zero interest rate alone. A similar notion has appeared in economic literature for some time. Perhaps Krugman (1998) was the first to note the effectiveness of the approach. He argued that a permanent increase in the money supply has the potential to raise inflation expectations and current expenditures. In a liquidity trap, a temporary increase in the money supply is not effective, because it cannot lower interest rates. But if there is a possibility that an increase in the future natural interest rate would be high enough to move the economy out of the liquidity trap, then the expected increase in the money supply does affect the expected future price level today. Needless to say, a commitment to maintain low interest rates until the natural interest rate rises generates a similar effect. In a similar vein, using a New Keynesian type model, Eggertsson and Woodford (2003) presented a version of price level targeting that could be considered an optimal policy in the face of a liquidity trap. In their case, the optimal policy is the commitment to maintain a zero rate until the price level is restored to a pre-committed path.

While there exist differences between the policies these authors propose and those adopted by the BOJ, the basic ideas are the same. Even at a zero short-term interest rate, it is possible to pursue further monetary easing that affects expected future short-term interest rates and thus current long-term interest rates through a commitment to appropriate future monetary policy paths. In fact, since the adoption of the ZIRP in 1999, both the level and volatility of long-term interest rates have remained at very low levels, as Figure 16 shows. As discussed in Section II.B above, low nominal interest rates have been one of the reasons for the contained deflation within certain levels during this period.

Whether the ZIRP and/or the RZIRP have affected expected future short-term interest rates, however, is a more subtle question than is initially apparent. Even without any commitment by the central bank, the market normally forms expectations about the future monetary policy stance, i.e., the path of short-term interest rates. An expectation of continuing stagnation in the economy naturally leads to lower expected future short-term interest rates. Thus, it is important to show that the ZIRP and/or the RZIRP have affected the market's expectations over and above such a natural response of the market to the economy. Below, we present one provisional analysis of this issue, building on Oda and Kobayashi (2003). As a by-product, the analysis allows us to test for the existence of the effects of the two other aspects of the QMEP framework besides the RZIRP, i.e., ECAB and purchases of long-term government bonds.

28. Even under the QMEP, liquidity provision well above required reserves has meant a near-zero short-term interest rate. That is, the QMEP has included the RZIRP, as pointed out above.

We use a macro-finance model that combines a small macroeconomic model with a finance theory approach to determine risk premiums on long-term government bonds. More specifically, the model consists of aggregate demand and supply equations and a monetary policy rule. The policy rule determines the short-term interest rate, while aggregate demand is dependent on the long-term interest rate.[29] Aggregate demand and supply curves contain error terms that represent demand and supply shocks to the economy. These shocks generate uncertainties concerning future short-term interest rate movements through the policy rule. The size of the resulting risk premiums on government bonds is a function of the parameters of the model. Parameters of the model are estimated so that the term structure of interest rates thus theoretically derived matches the data.

The default monetary policy rule is set as an augmented Taylor rule that incorporates slow policy adjustment and the zero bound constraint on interest rates (equations [A.3] and [A.4] in Appendix 2). That is, the short-term interest rate is explicitly assumed to be non-negative. The BOJ's commitment to maintain the short-term interest rate at zero percent until consumer price inflation becomes zero or positive (the ZIRP or the RZIRP) is modeled as maintenance of a zero interest rate until the inflation rate exceeds a small positive number (henceforth, the threshold rate). We assume that the threshold rate is variable over time and allow the data to determine its time path.[30]

Such a formulation of the policy rule allows us to estimate the effects of the ZIRP and/or the RZIRP on interest rates.[31] We can also estimate the policies' effects on the expectations theory and the risk premium components separately.[32] This enables us to evaluate subtle questions about this period's monetary policy. As discussed above, the QMEP framework consists of three components. We may therefore attempt to estimate the effects on the economy of each of the three components separately.

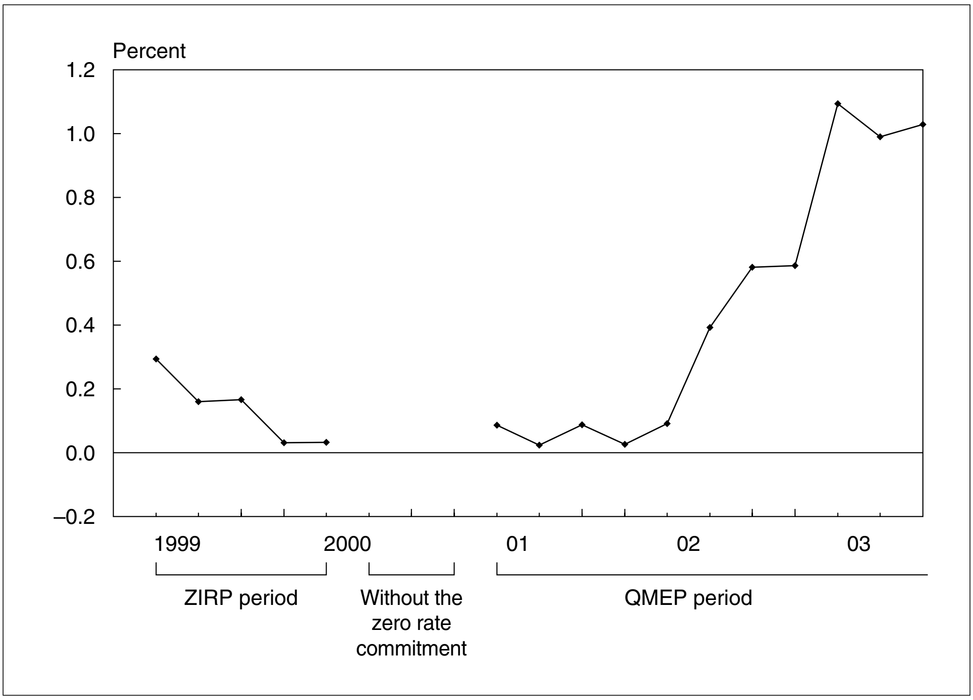
29. Actually, it is a weighted average of past short-term interest rates.
30. An alternative would be to assume that the threshold rate is fixed. This is probably closer to what the BOJ has been saying. Given that the ZIRP was the first implementation of such a policy framework, however, the market's perception of the precise nature of the framework seems to have evolved over time. Under the RZIRP, the nature of the commitment has become more concrete. The commitment to maintain ample liquidity supply until inflation becomes positive on a sustained basis must mean that the threshold rate is positive rather than strictly zero. The October 2003 change in the commitment to include a reference to expected inflation may have raised the threshold rate, although explicit formulation of the policy framework since then requires slightly different modeling. Needless to say, what is estimated as a change in the threshold rate may reflect a change in other parameters of the model that are treated as fixed in this analysis.
31. The assumption of the Taylor rule as the default policy rule may be too strong, given that the BOJ had not announced the use of any explicit policy rule before the adoption of the ZIRP. Nonetheless, there seems to be no reasonable alternative.
32. By the former, we mean the component of long-term rates that corresponds to the expectations theory of term structure, i.e., the weighted average of expected future short-term interest rates.

We first estimate the model for the maximum likelihood method using data for 1980/I–1999/I. The choice of the estimation period reflects the adoption of the ZIRP in 1999/II. In the simulations reported below, we assume that the parameters of the model remained the same after 1999/II.[33] The details of the model and estimation procedure are explained in Appendix 2.

We then proceed to the estimation of the effects of the ZIRP and the RZIRP. Since we need to estimate the effects of the policies on expected future short rates, we need estimates of the breakdown of long-term interest rates into the expected future short-term interest rate and the risk premium components. Given the market prices of risk associated with demand and supply shocks to the goods market and the value of the threshold rate, we can calculate the distribution of long-term interest rates using Monte Carlo simulations.[34] The resulting theoretical term structure of interest rates is matched with the actual value to derive estimates of the market prices of risk and the threshold rate during the period of the ZIRP and the RZIRP.

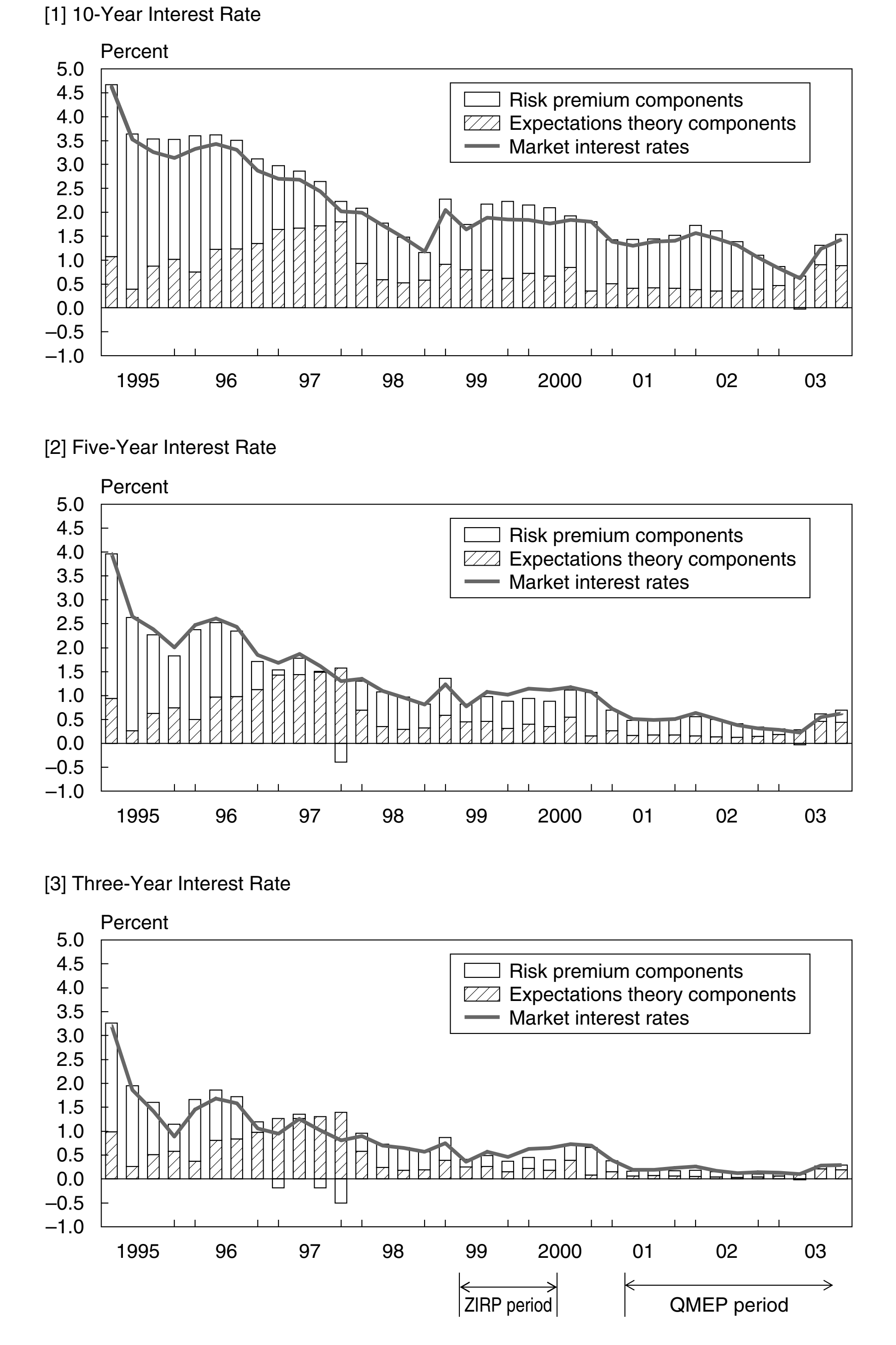
Figure 17 presents such an estimate of the threshold rate. Figure 18 shows the estimated expectations theory and risk premium components of medium- and

**Figure 17 Estimated Value of the Threshold Inflation Rate**




33. Thus, the monetary policy rule is set to be the modified Taylor rule during the estimation period. An alternative procedure would be to use the entire sample in the estimation, but with the policy rule switched to the commitment rule used as the policy rule for 1999/II–2000/II and 2001/II–present. This would require a fairly complicated estimation method. Hence, we have opted for the simpler approach.
34. This is done by calculating the risk-neutral measure of supply-demand shocks and associated levels of GDP, inflation, and interest rates.

**Figure 18 Estimation of Expectations Theory and Risk Premium Components of Medium-/Long-Term Interest Rates**



long-term interest rates. Figures 19 and 20 compare the estimated levels of interest rates with and without the zero interest rate commitment. The two figures present the results for the expectations theory and risk premium components separately.

Let us first look at Figures 19 and 20. We find evidence of the effects of the ZIRP and the RZIRP on expected future short-term interest rates in Figure 19. The estimated expectations component of the interest rates at all maturities declined with the commitment policy case. The differences between the two cases increased from 2002/III. In 2003, expected future short-term interest rates without the zero interest rate commitment went up sharply, probably in response to improving economic conditions. But the commitment seemed to have contained the increases to a large extent. In general, the ZIRP and the RZIRP imply a promise to maintain a zero interest rate even after the interest rate under the modified Taylor rule turns positive. Thus, the difference in expected three-year interest rates, say, between the modified Taylor rule and the ZIRP or the RZIRP is small if the interest rate under the Taylor rule is expected to remain negative for three years or more. The difference becomes larger as investors start to consider the possibility that the interest rate under the Taylor rule will turn positive within three years. If the commitment is credible enough to produce a temporary period of higher inflation rates in the future, then the difference in rates on the 10-year horizon could be less than on the three-year horizon. This may have been the situation in 2003, as can be seen in Figure 19.

Figure 20 shows that the effects of the commitment on the risk premium component of interest rates have been limited with the exception of the period after 2003/II for the three-year interest rate. The effects are almost nil for the 10-year interest rate. This seems reasonable if the expected duration of a zero interest rate is relatively short. The commitment reduces uncertainties about the duration of a zero interest rate, hence it affects the risk premiums on bonds of relatively short maturities. Sharp reductions in the risk premiums are observed during 2002/III–2003/I, either with or without the commitment. This may have been due to the stabilization of the inflation rate at low levels in late 2002 and 2003. The sudden emergence of the difference between the two cases in 2003/II, however, requires some other explanation.

The estimate of the threshold rate in Figure 17 exhibits some interesting features. During the ZIRP period, the value of the threshold rate decreased over time until the policy was terminated in 2000/III. This is consistent with comments made by some BOJ Policy Board members in the first half of 2000 about the desirability of discontinuing the ZIRP in the near future. During the QMEP period, the estimate of the threshold rate jumped sharply upward in 2002/III and continued to increase until 2003/II. As we saw above in relation to the discussion of Figure 19, this was a period of gradual economic recovery, and expected future short-term interest rates would have gone up without the RZIRP. In reality, however, the rises in medium- and long-term interest rates were largely contained and interest rates continued to fall until the spring of 2003. Hence, the simulation results in higher values of the threshold rate. There is more than one interpretation of this increase in the threshold rate. While no explicit statements were made during this period to enhance the effectiveness of the commitment, the BOJ had been increasing the target on bank reserves, which might have had some signaling effects. An alternative interpretation is

**Figure 19 Expectations Theory Components of Medium-/Long-Term Interest Rates (Effects of the Zero Rate Commitment)**

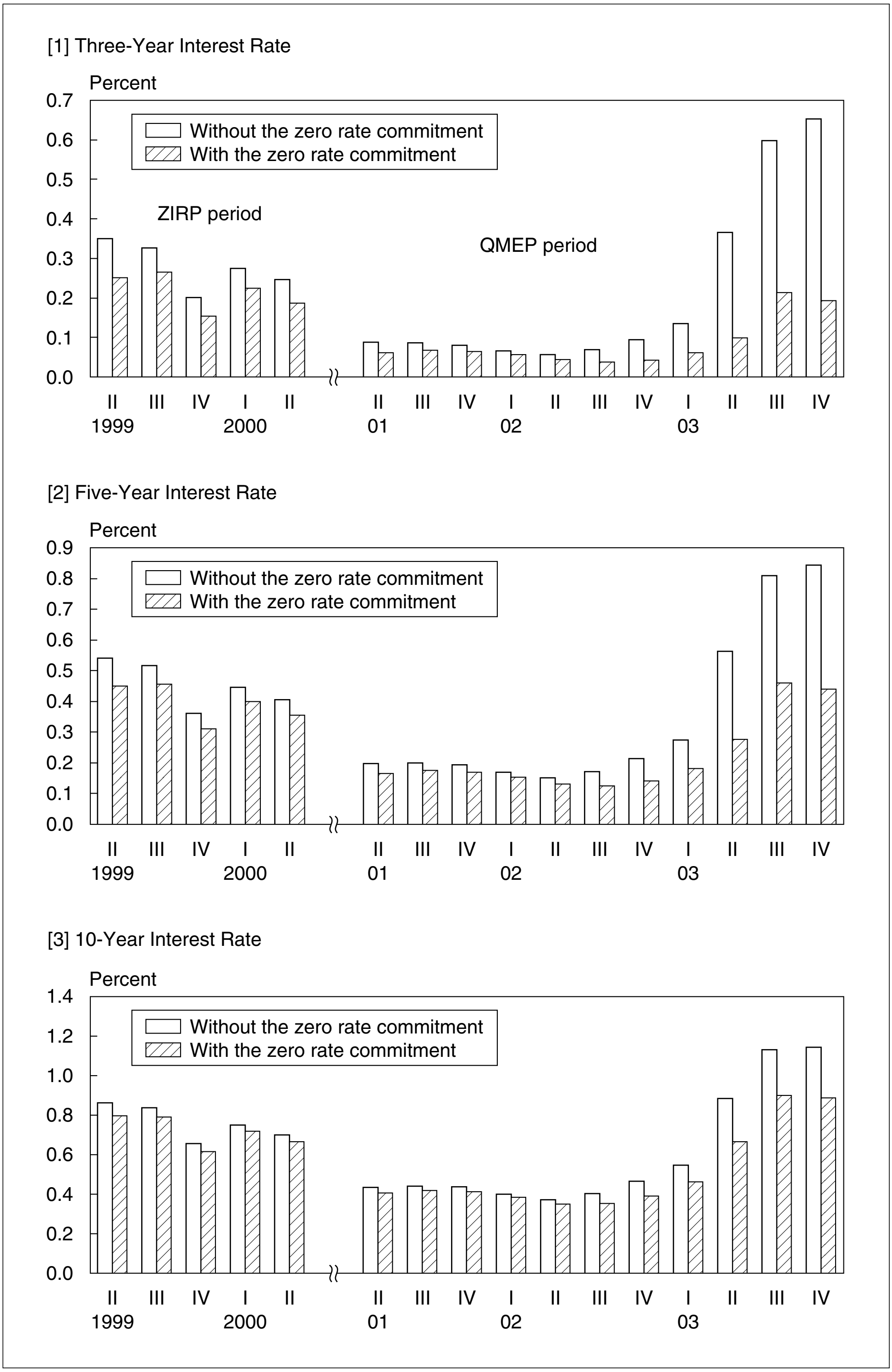
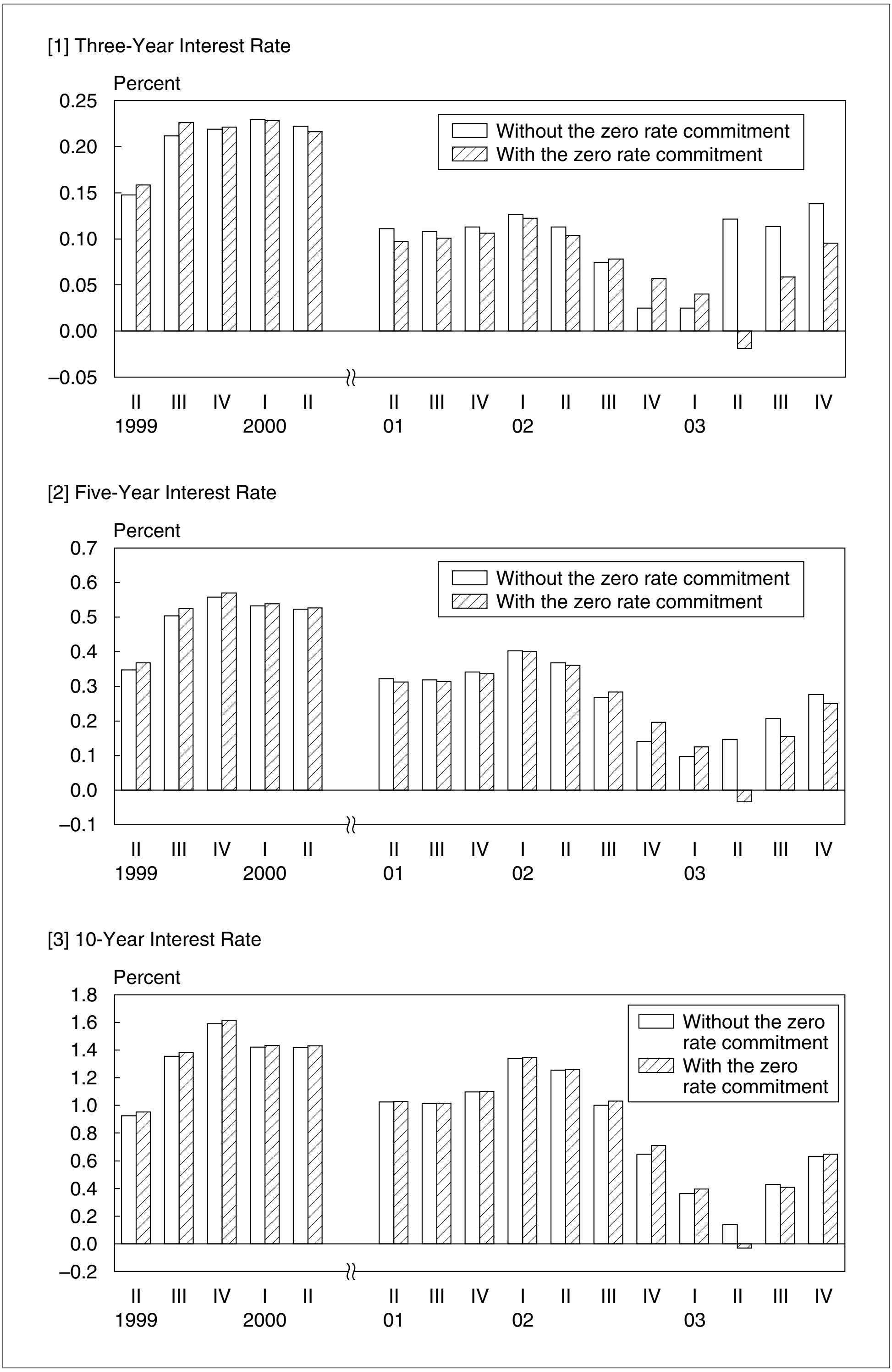


**Figure 20 Risk Premium Components of Medium-/Long-Term Interest Rates (Effects of the Zero Rate Commitment)**



that the market's perception of the economy's outlook may have been weaker than assumed in the simulation.[35] This may have resulted in higher estimates of the threshold rate than the market really had anticipated.

However, it is not easy to explain why the estimate of the threshold rate remained at around 1 percent in the second half of 2003. Casual observation suggests that the market became uneasy about the BOJ's intention to continue the RZIRP and pushed up long-term interest rates in the summer of that year. Alternatively, it could be argued that even the seemingly sharp rise in interest rates at the time was mild relative to improvements in market expectations and thus could be consistent with a higher threshold rate. In addition, the BOJ counteracted by clarifying the commitment in October as described above. These forces may have canceled each other, resulting in minor movement in the threshold rate. Still, the estimate of the threshold rate at around 1 percent seems disproportionately high in light of the current commitment and requires an explanation.

In any case, it is at least clear that the ZIRP and the RZIRP have produced stronger effects on the expectations theory component of interest rates than the effects expected from the combination of the modified Taylor rule and the stagnant economic conditions. The effects of the commitment on the risk premium component are much smaller, although our estimates suggest three- to five-year interest rates were affected to some extent.

The next question is a somewhat delicate one regarding the QMEP period. As we summarized above, the BOJ has been raising the target on the CABs and increasing purchases of government bonds on top of its commitment to continue ample liquidity provision. Therefore, an additional test is needed to clarify whether these measures have had their own effects on either of the two components of interest rates apart from the effect induced by the commitment.

Specifically, Figure 19 shows regression results whereby we run the difference between the two estimates of the expectations theory component of interest rates on the level of the CABs at the BOJ and the amount of government bonds purchased. We also show the results with the risk premium component as the dependent variable in Figure 20.[36] The results are presented in Appendix 2. To summarize briefly, the only variable that was statistically significant was the level of the CABs in the equation for the expectations theory component of interest rates. The interpretation of this result is not straightforward. One interpretation would be that increases in the target on the CABs provided a signaling effect as to the willingness of the BOJ to make a stronger commitment to a zero interest rate. Another interpretation is that other communication channels such as the BOJ Governor's comments at press conferences made at the same time as the announcement of the changes in the target have been the driver of the effects found. Or indicators suggesting economic weakness may have led the market to raise the threshold rate, on the one hand, and the BOJ to increase the target on the CABs. Unless the first interpretation is correct, the correlation we have found could be a spurious one.

35. We may note that this was a period when deflation or disinflation was a worldwide threat.

36. Ideally, we need to model the mechanism by which these measures affect the economy more explicitly and test for the existence of their effects jointly with the commitment effects.

We may tentatively conclude that the BOJ's monetary policy has worked mainly through the commitment channel since 1999. The commitments made by the BOJ have affected expected future short rates and, in turn, current medium- to long-term rates on government bonds.[37] The direct effects of liquidity expansion or purchases of long-term government bonds on the risk premiums on government bonds have not been found to be significant. There is some evidence that raising the target on the CABs has enhanced the effects of the commitment, although this interpretation is subject to various qualifications.

## IV. Monetary Policy, the Money Market, and the Financial System

### A. Overview

Given the nature of the difficulties of the period under discussion, the BOJ has naturally tried to alleviate financial-sector problems through its monetary policy. Below, we discuss such aspects of the policy measures the BOJ has adopted. Many of the BOJ's market operations during this period have had the dual role of providing liquidity and addressing problems in financial intermediation. In the process, the BOJ has assumed a certain amount of credit risk. Such attempts indeed have successfully avoided a repetition of the 1997–98 type credit crunch. In fact, risk premiums in the money and corporate bond markets have declined to minimum levels. Such declines in risk premiums, however, have not led to increased risk taking elsewhere, i.e., to increased bank lending to the borrowers who have not had access to the open money and capital markets.[38] Thus, the liquidity provided by the BOJ has not flowed into the most damaged part of the financial system. Instead, funds that have shifted outside the Japanese money market have been invested in relatively safe instruments such as Japanese government bonds (JGBs) and U.S. treasury bonds, with the currency position hedged in the latter case. The shortage of funds in the money market has had to be filled by more and longer funds-providing operations by the BOJ. The chain of events reveals a feature of the QMEP that was not foreseen at the time of its introduction. The QMEP, which has been partially directed toward alleviation of liquidity problems of financial institutions, has led to a decreased intermediation function by private banks in the money market and created strong reliance on the BOJ's market operations. This increase in the "demand" for the BOJ's funds-providing operations has made it easier for the BOJ to hit higher targets on the CABs. To the extent that provided liquidity is absorbed by the increased demand, it has not had significant monetary easing effects.

37. In principle, the model can be used to calculate the effects of the commitment channel on real GDP and inflation. However, as currently formulated, the IS equation contains the lagged values of short-term interest rates and not expected future short-term interest rates or the current long-term interest rate. Hence, the model does not allow us to capture the effects of forward-looking investor expectations on the real side of the economy. In this sense, the model is not fully general equilibrium in nature. So far, we have not succeeded in improving the model on this point.

38. The negative effects of financial-sector problems on these borrowers were discussed in Section II.C.

In Section IV.B below, we briefly discuss measures adopted by the BOJ to address problems in the financial system. In Section IV.C, we turn to the discussion of some of the "unexpected effects" of such measures.

**B. Prudential Policy Aspects of the BOJ's Market Operations**

Many of the BOJ's recent market operations have aimed at "soft spots" in the channels of financial intermediation. Thus, since the credit crunch of 1998, the BOJ has extensively used CP operations as part of its funds-providing operations. Financial institutions holding CP have been able to use it as collateral to obtain funds from the BOJ. This has added liquidity to the CP market and, in turn, led to declines in issuing costs. In addition, the BOJ has started to accept ABSs as collateral since October 1999.

In the spring of 2003, the BOJ went further with its decision to purchase ABCP and ABSs outright. This reflected the BOJ's perception that the markets for these instruments were still in their infancy and that their development could be stimulated by the BOJ's risk taking. The development of the market would allow a wider range of investors to participate in the market and ultimately result in declines in fund-raising costs for borrowers and, at the same time, in easier unloading of loans by financial institutions.[39]

In some instances, the BOJ provided explicit incentives for banks to extend loans. For example, in the fall of 1998 the BOJ introduced a scheme whereby banks that increased their lending were eligible to receive back-financing from the BOJ at the official discount rate. For many banks, the discount rate was lower than the market rate they paid.[40]

More generally, the BOJ has expanded the supply of liquidity whenever there were any serious signs of financial market instability since late 1998. The BOJ has tried to counteract this pressure by providing longer-term funds to banks.[41] During the QMEP period, such operations have been associated with either a rise in the target on the CABs or activation of the contingency clause in the policy directive (see Footnote 21). In addition, in some of its operations the BOJ has assumed, to varying degrees, the credit risk of counterparties or of issuers of instruments traded, as explained above. These have successfully contained the emergence of large risk premiums in the money market.[42] The BOJ was successful at least in preventing the repetition of the 1997–98 type credit crunch. At the same time, the distinction between monetary and prudential policies has become less pronounced.

Separately, in December 2002 the BOJ established a standby facility that allows banks to sell equities they hold to the BOJ. This was also one of the measures to

39. In retrospect, the introduction of these operations coincided with turnarounds in the stock market and the economy. Thus, banks have felt less need to sell loans they hold. As a result, the amount of the instruments the BOJ has bought has remained small.
40. The discount rate at 0.5 percent was slightly higher than the overnight call rate, which was between 0.4–0.5 percent. For many financial institutions, however, three- to six- month funding costs were higher than 0.5 percent due to term and credit premiums. This scheme was not extensively used, because the ZIRP adopted early in the following year had lowered most banks' funding costs to minimum levels.
41. Many funds-providing operations had terms of three to six months. In some instances, even nine-month funds were offered.
42. Here, we mean horizons of a few months rather than a few days. Under the QMEP, the CABs have far exceeded required reserves. Consequently, the overnight rate has seldom showed signs of rising. This has not been the case with term rates because of the decline in the risk-taking ability of banks.

target a soft spot in the financial system, i.e., banks' vulnerability to declines in stock prices.[43] Although banks could sell stocks in the market, given the low liquidity of the market at that time, banks might have been reluctant to do so, since such selling would lower stock prices. Also, banks were reportedly hesitant to sell stocks they owned on a large scale, taking into account the possibility that the stock issuers might consider such actions as facilitating unfriendly mergers or acquisitions. The BOJ's equity purchases were initiated at the request of banks; hence, these purchases have not been used as a measure for providing liquidity by the BOJ.[44]

### C. Financial Markets in a Very Low Interest Rate Environment: Some Interesting Developments and Their Implications

As stated above, market operations under the ZIRP and the subsequent QMEP regime have directly or indirectly led to various interesting developments in the money and financial markets. Some of them were the natural consequences of monetary easing, but others were not necessarily anticipated at the time the ZIRP/QMEP was introduced. In either case, they shed light on the transmission mechanism of monetary policy in a very low interest rate environment. In what follows, we first present these developments. When necessary, we refer to comparisons between the current Japanese situation and the U.S. situation in the 1930s, which was also a period of extremely low interest rates.[45] Then, we examine the significance of these and their implications for the effectiveness of monetary policy.

#### 1. "Discoveries" in financial markets

##### *a. Virtually zero money market rates*

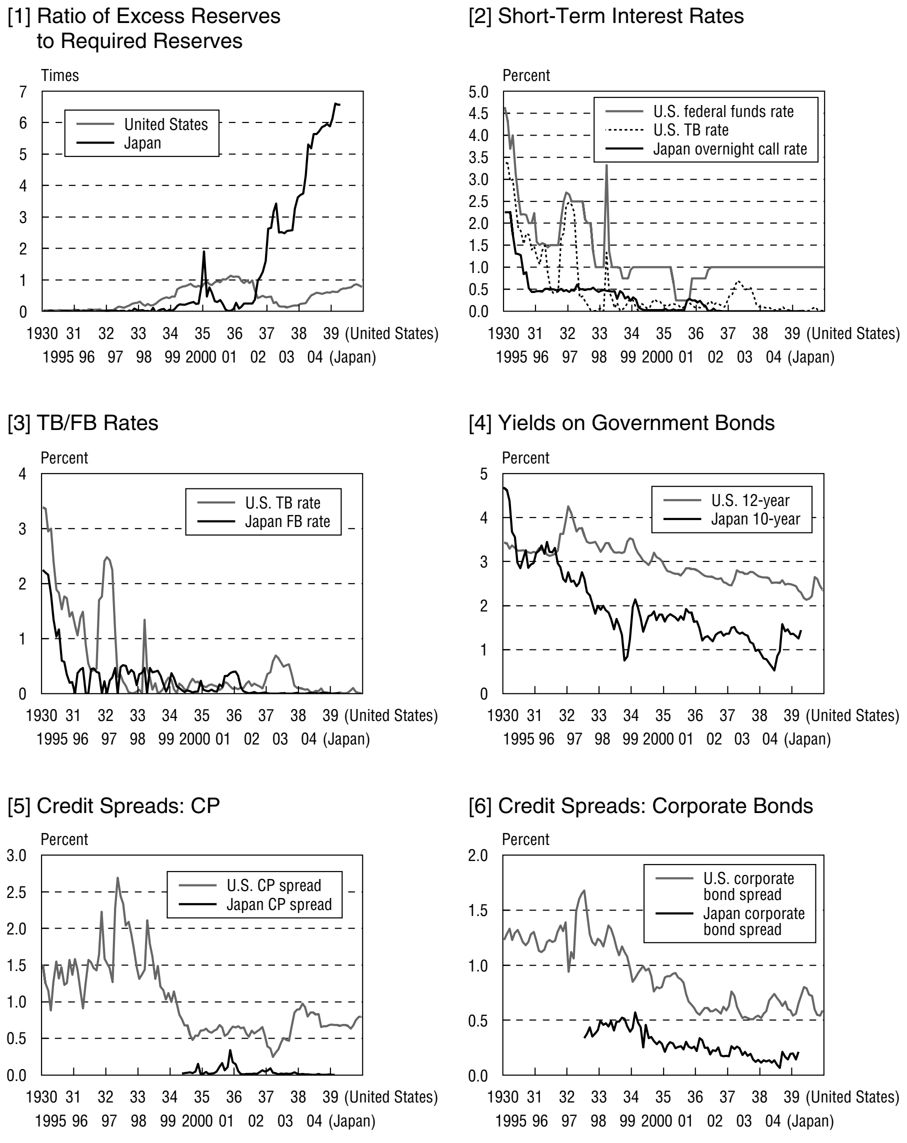
The current Japanese call rate, at which financial institutions lend and borrow short-term funds, hardly reflects credit risks, as it has been lowered to 0.01 percent under the ZIRP and to 0.001 percent under the QMEP.[46] This becomes clear if we compare it with the U.S. situation in the 1930s. During that period, the risk-free TB rate declined to approximately zero percent. But the federal funds rate, at which financial institutions lend and borrow short-term funds, declined only to 0.25 percent (Figure 21).[47]

##### *b. Marked decline in JGB yields*

Compared with U.S. financial institutions in the 1930s, Japanese financial institutions today face much lower returns on investment in long-term government bonds and larger risks of reversal in long-term interest rates in the future. In Japan, the yield on short-term government securities with maturities of less than one year has declined to levels close to that of the overnight call rate. At several points in time they reached 0.001 percent, equivalent to the level of the overnight call rate. During the same period, the average yield on 10-year JGBs was 1.20 percent, hitting the lowest yield at 0.44 percent in June 2003. In comparison, in the United States during the 1930s, the

43. Japanese banks have undertaken a fair amount of risk by holding equities. As of September 2002, the top 15 banks' holdings of equities totaled ¥19.8 trillion against Tier 1 capital of ¥15.9 trillion. The government has enacted a law requiring banks to reduce equity holdings to below Tier 1 capital by September 2006 (the Shareholdings Restriction Law).
44. At the end of September 2004, the BOJ wound up its stock purchasing program. In total, the BOJ bought about ¥2 trillion of equities from the banks.
45. See Orphanides (2004) for U.S. monetary policy in the 1930s.
46. See Borio, English, and Filardo (2003) for the U.S. experience in the 1930s.
47. The source of the U.S. data is the National Bureau of Economic Research (NBER) Macrohistory Database.

**Figure 21 Comparison between the United States and Japan**




Notes: 1. Excess reserves = total reserves – required reserves.
2. U.S. CP spread = yields on primary-rated CP (four- to six-month) – yields on TBs (three-month).
3. U.S. corporate bond spread = yields on AAA-rated bonds (40–50 year) – yields on government bonds (12-year).
4. Japan CP spread = yields on A-1+ rated CP – yields on FBs (three-month).
5. Japan corporate bond spread = yields on Aa-rated corporate bonds – yields on government bonds (five-year).
6. The indicated ratings are of Moody's (except Japan's CP).

Sources: National Bureau of Economic Research Macrohistory Database; Bank of Japan; Japan Securities Dealers Association; Bloomberg.

average yields on both short- and long-term government securities were significantly higher than those on the current JGBs, 0.54 percent and 2.98 percent, respectively.

***c. Increased dependence on the BOJ's money market operations and under-subscription***

Under the QMEP, financial institutions have increased their dependence on the BOJ's money market operations as a means of adjusting their reserve balances. The financial institutions with a funds shortage have become more dependent on the BOJ's funds-providing operations, while those with a funds surplus have come to use the BOJ's funds-absorbing operations as a means of investing funds. Put differently, the BOJ has come to play the role of a money broker. This is the mechanism that has enabled the BOJ to provide ample liquidity. When concerns over the financial system stability have receded and the precautionary demand for liquidity has declined, however, the BOJ has often faced difficulties in its attempt to supply liquidity. Specifically, it has experienced under-subscriptions in funds-providing operations: the total amount of bids has fallen short of the amount offered by the BOJ even at the lowest bidding interest rate of 0.001 percent.[48]

***d. Reduction in the size of the call market***

As financial institutions have become more dependent on the BOJ's money market operations, the size of the call market, which had already shrunk under the ZIRP, has contracted further since the adoption of the QMEP (Figure 22). The daily trading volume in the uncollateralized call market was about ¥7.4 trillion before the QMEP was adopted in March 2001. Since then, it has gradually declined, reaching ¥1.3 trillion in April 2004. The amount outstanding also declined, from ¥17.9 trillion to ¥5.0 trillion during the same period. This reduction in the size of the call market reflects lowered trading incentives for two reasons. First, the returns on investment in the call market have declined to a level that cannot cover trading costs. Specifically, when the overnight call rate is 0.001 percent, the return on investment of ¥10 billion in the overnight call market is only ¥273, which falls short of the total trading costs.[49] Second, credit spreads have narrowed substantially. A call rate of 0.001 percent means that the average of all borrowing rates is 0.001 percent, leaving little room for differences in rates between individual borrowers.

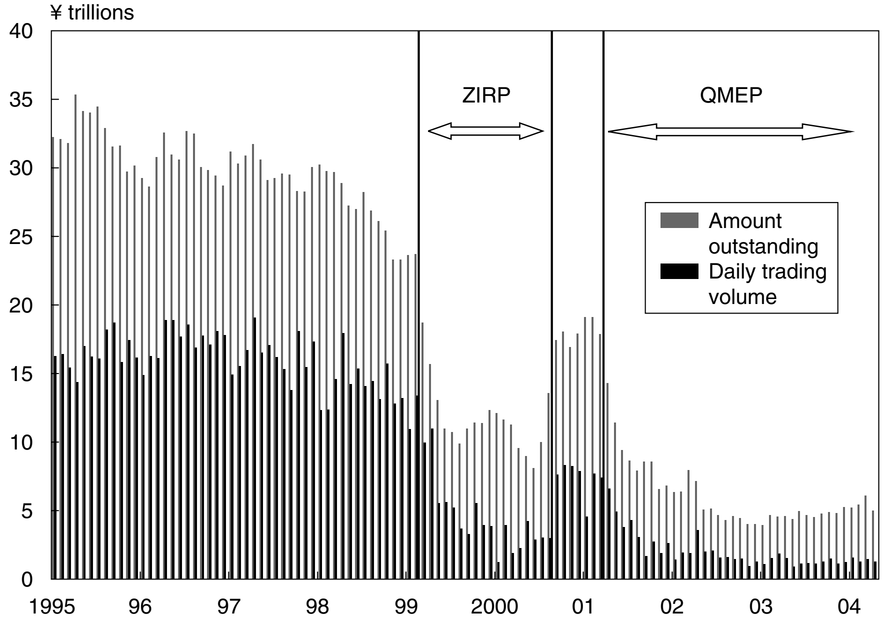
***e. Negative interest rates***

Despite the near disappearance of credit spreads in the Japanese money market, differences in the credit standing between Japanese and foreign banks have remained. This has led to the emergence of negative interest rates in some parts of the financial system. Since the adoption of the QMEP, the foreign exchange (FX) swap market has almost continually seen negative interest rates when foreign banks raise yen in exchange for U.S. dollars. Foreign banks have invested the yen funds thus raised in the CABs at the BOJ (Table 1).

48. For example, the outright purchase of short-term government securities on September 13, 2002 resulted in an aggregate bid of ¥145.6 billion against an offer of ¥800 billion with the contracted rate of 0.001 percent. Fiscal 2003 recorded 75 cases of under-subscription.

49. The trading costs, excluding excise taxes, include the commission fee for brokers (¥137), the charge for using the Bank of Japan Financial Network System (BOJ-NET) (¥40), and the contract confirmation fee (¥200).

**Figure 22 Amount Outstanding and Trading Volume in the Uncollateralized Overnight Call Market**




Source: Bank of Japan.

**Table 1 Current Account Balances at the Bank of Japan**

¥ trillions

| | Domestically licensed banks | Foreign banks in Japan | Other banks | Others | Total |
|---|---|---|---|---|---|
| End of 1997 | 3.3 | 0.1 | 0.1 | 0.0 | 3.5 |
| End of 2000 | 5.1 | 0.2 | 0.1 | 1.4 | 6.8 |
| End of 2003 | 18.0 | 5.7 | 1.9 | 4.5 | 30.0 |

Note: "Other banks" refers to financial institutions for agriculture, forestry, and fisheries and those for small businesses.

Source: Bank of Japan, "Flow of Funds Accounts."

The mechanism through which the yen funding costs turn negative is summarized as follows. An FX swap transaction is a contract in which Japanese banks borrow U.S. dollars from, and lend yen to, foreign banks simultaneously. Currently, the interest rate at which Japanese banks lend yen to foreign banks is almost zero. As the credit standing of Japanese banks is lower than that of foreign banks, the yen funding costs for foreign banks have become negative. With zero returns on the yen funds under the ZIRP and the QMEP, the negative yen funding costs have served to "sweeten the pie" for foreign banks to become counterparties of Japanese banks.[50]

50. See Nishioka and Baba (2004b) for a more detailed explanation about the mechanism of negative yen funding costs for foreign banks in the FX swap market.

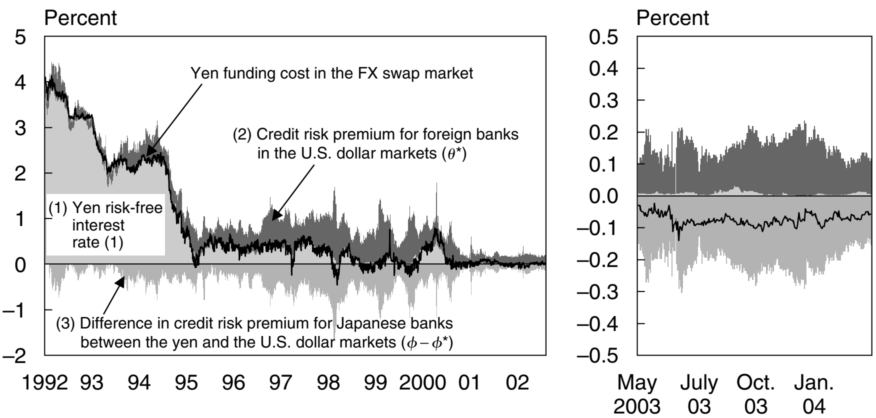
Foreign banks have profited from the spread between the negative yen funding costs and zero returns on the BOJ's risk-free CABs.

Against this background, the CABs of foreign banks amounted to ¥5.7 trillion as of the end of December 2003, which was approximately one-quarter of the excess reserves held by all financial institutions. The ratio of the CABs of foreign banks to their total assets went as high as 13.1 percent. Foreign banks invested the yen funds with negative funding costs in the call and short-term government securities markets, which occasionally led to negative interest rates in these markets as well.[51]

The yen funding costs in the FX swap market can be decomposed into three factors: (1) the yen risk-free interest rate; (2) the credit risk premium for foreign banks in the U.S. dollar market; and (3) the difference in credit risk premium for Japanese banks between the yen and the dollar markets.[52] Of these, the third factor has contributed most to the recent negative yen funding costs. That is to say, the credit risk premium for Japanese banks has been smaller in the yen market than in the dollar market. Nishioka and Baba (2004b) show how this can lead to negative yen funding costs for foreign banks.

Furthermore, a closer look at the movement of the above-mentioned decomposition of the yen funding costs reveals something interesting (Figure 23). The difference

**Figure 23 Factor Decomposition of Yen Funding Costs of Foreign Banks**




Notes: 1. Credit risk premiums are defined as the spread between the U.S. dollar/yen interest rates and TB rates. Maturity of interest rates is three months.
2. Before March 2003, the following proxies are used: yen rates for domestic banks: yen Tokyo Interbank Offered Rate (TIBOR); yen rates for foreign banks: yen London Interbank Offered Rate (LIBOR); U.S. dollar rates for domestic banks: U.S. dollar TIBOR rates; U.S. dollar rates for foreign banks: U.S. dollar LIBOR rates.

51. Due to the credit lines set on the dealings with the BOJ, some foreign banks place only limited amounts of funds in the BOJ's CABs. Thus, they lend excess funds to other banks, within the credit limit against these banks, at negative interest rates, or purchase short-term government securities. The number of Japanese banks that have been able to borrow at negative rates in this way, however, has been very small.

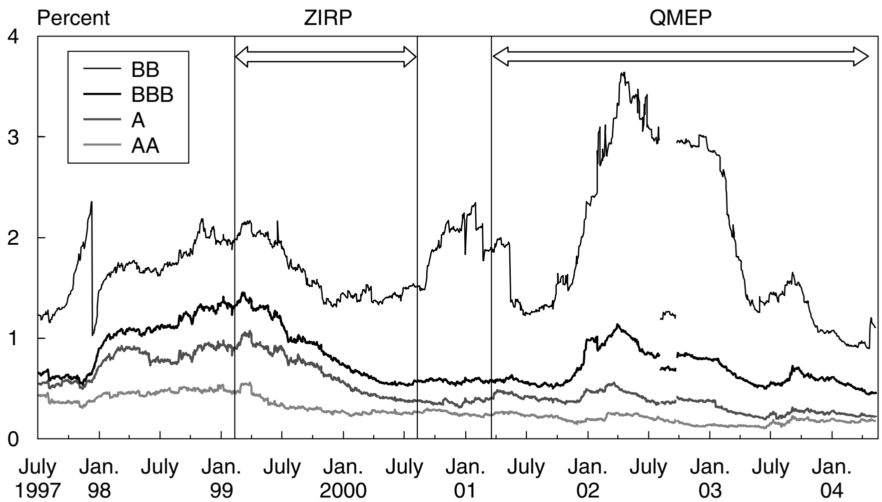
52. Foreign banks can raise yen either in the Japanese money market or through FX swap transactions. Thus, in equilibrium their yen funding cost equals the forward discount rate plus their U.S. dollar funding cost. The same

in credit risk premium for Japanese banks between the yen and the U.S. dollar markets existed even before the ZIRP was adopted. When the yen risk-free interest rate was significantly above zero percent, the yen funding costs were positive. Thus, foreign banks did not increase their CABs at the BOJ. Later on, as the yen risk-free interest rate declined to almost zero percent, the difference in credit risk premium for Japanese banks between the yen and the dollar markets exceeded the sum of the domestic risk-free interest rate and the credit risk premium for foreign banks in the dollar market, turning the yen funding costs negative.[53]

***f. Narrowing of credit spreads***

Credit spreads of corporate bonds and CP have narrowed as short-term interest rates have declined since the adoption of the ZIRP (Figure 24). The narrowing of credit spreads has extended to corporate bonds with a BBB rating. Recently, credit spreads

**Figure 24 Spreads between Corporate Bond and Government Bond Yields**




Notes: 1. Yields on bonds with five-year maturity.
2. The indicated ratings are of Moody's.

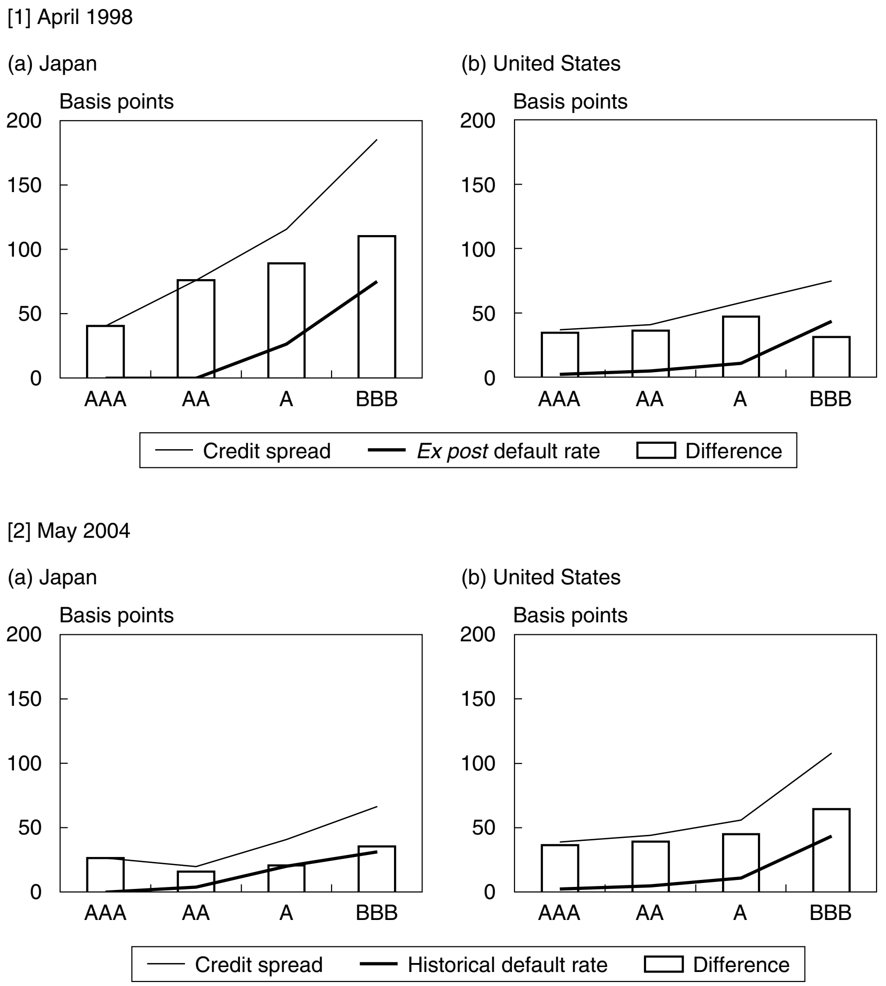
Sources: Japan Securities Dealers Association, "Over-the-Counter Standard Bond Quotations," "Reference Price (Yields) Table for OTC Bond Transactions."

arbitrage condition for Japanese banks implies that the forward discount rate equals Japanese banks' yen funding cost minus their dollar funding cost. Taken together, foreign banks' yen funding cost equals their dollar funding cost plus Japanese banks' yen funding cost minus Japanese banks' dollar funding cost, which in turn must equal the risk-free yen rate plus foreign banks' risk premium in the dollar market plus the difference in Japanese banks' risk premium between the yen and the dollar markets.

53. The United States has seen a similar phenomenon. In the U.S. repo market from early August to mid-November 2003, special collateral (SC) repo rates became negative. An SC repo rate is defined as the difference between the interest rate on cash loans and the premium for a specified collateral bond determined by its supply and demand balance. As long as the interest rate on cash loans was sufficiently high, the premium was covered so that the SC repo rate stayed positive. When the interest rate on cash loans declined, however, the SC repo rate also declined, and became negative in 2003. In Japan, the interest rate decline was earlier in timing and larger in magnitude, and the SC repo rate became negative around April 2001. For more details, see Fleming and Garbade (2004) and Baba and Inamura (2004).

have barely covered *ex post* default risks (Figure 25). Despite such favorable conditions for issuers, the issue amounts of corporate bonds and CP have not increased. In contrast, the credit spreads of corporate bonds and CP in the United States were

**Figure 25 Credit Spreads and Default Rates**




Notes: 1. Credit spread is the spread between corporate bond and government bond yields.
2. The indicated ratings of Japan are of R&I, and those of the United States are of Moody's and S&P.
3. *Ex post* default rate is the annualized actual default rate computed by the cumulative default rates of corporate bonds from 1998 to 2003.
4. Historical default rate is the annualized cumulative default rate computed by all issues in the last 21 years (Japan) and 29 years (United States).
5. Recovery rate is assumed to be zero. The default rates in the U.S. charts cover also defaults of non-U.S. corporations.

Sources: Japan Securities Dealers Association; Merrill Lynch; R&I; Moody's.

much higher in the 1930s: the credit spread of corporate bonds with an AAA rating was 0.92 percent, and that of prime-rated CP was 1.01 percent.

So far, we have described several interesting developments in the recent Japanese money and financial markets. These have important bearings on the BOJ's attempts to stimulate the economy. First, the demand for the BOJ's CABs increased as a result of the BOJ's attempts to supply additional liquidity. An increase in the CABs of foreign banks with negative yen funding costs is such an example. Increased dependency on the BOJ's funds-providing operations in the money market is another example. In other words, the BOJ's attempts to push the liquidity supply curve outward has also induced an outward shift of the demand curve for liquidity, making the net effect of the provided liquidity much smaller than it appears.[54]

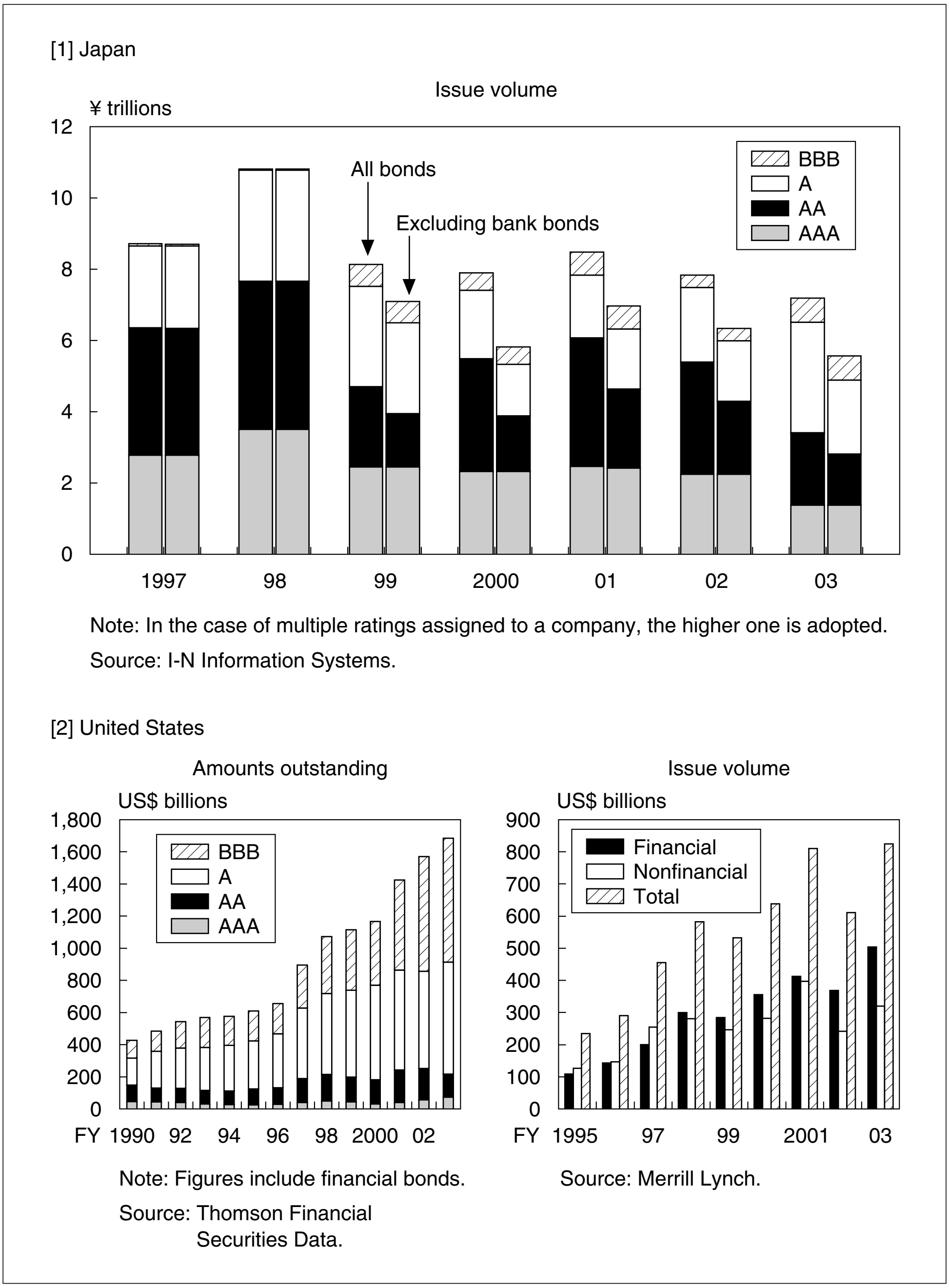
Second, despite declines in credit spreads of corporate bonds and CP, the issuing amounts of corporate bonds and CP have not increased so far (Figure 26). This is in marked contrast to the U.S. experience of monetary easing since 2001; the issuance of corporate bonds with low credit ratings has increased dramatically in response to the reduction in credit spreads.

**2. Preliminary analysis of investor behavior**

Before discussing more fully in Section IV.C.3 the implications of the developments we have ascertained, we present below a microeconomic analysis of Japanese investor behavior in a low interest rate environment. The key factor is to pay attention to the changes in the nature of investor types in response to changes in the risk-return profile of financial assets. We observe that declines in returns beyond certain levels caused risk-conscious investors to exit from markets, lowering the market's ability to price risks properly.

54. Negative interest rates themselves are expansionary. As stated in Footnote 51, however, only a small number of Japanese banks have been able to borrow at negative rates. Moreover, the amounts borrowed at negative rates have been miniscule. Foreign banks have not taken advantage of negative rates to expand loans to Japanese companies.

**Figure 26 Issue Volume of Corporate Bonds by Credit Rating**




Note: In the case of multiple ratings assigned to a company, the higher one is adopted.
Source: I-N Information Systems.

Note: Figures include financial bonds.
Source: Thomson Financial Securities Data.

Source: Merrill Lynch.

### *a. Changes in risk-return profile*

Let us briefly review the risk-return profile of financial assets after the ZIRP was adopted (Table 2). First, average returns have declined substantially. As a result, the call market has become inactive because investors cannot cover their trading costs.

**Table 2 Changes in the Distribution of the Returns on Government Bonds and Corporate Bonds**

[1] From January 4, 1996 to March 31, 1999

| | Government bonds | Corporate bonds | | | |
|---|---|---|---|---|---|
| | | AAA | AA | A | BBB |
| Mean | 0.056 | 0.073 | 0.042 | 0.034 | –0.003 |
| Variance | 0.008 | 0.015 | 0.007 | 0.008 | 0.021 |
| Skewness | –0.936 | –0.447 | –0.265 | –0.198 | –1.184 |

[2] From April 1, 1999 to January 9, 2004

| | Government bonds | Corporate bonds | | | |
|---|---|---|---|---|---|
| | | AAA | AA | A | BBB |
| Mean | 0.019 | 0.030 | 0.025 | 0.027 | 0.031 |
| Variance | 0.002 | 0.003 | 0.002 | 0.002 | 0.006 |
| Skewness | –0.975 | –0.513 | –0.883 | –0.488 | –0.719 |

Source: Nikko Securities Co., Ltd., "Nikko Performance Index."

Second, volatility has declined, weakening incentives to trade. Third, the negative skewness of the distribution of returns has expanded. To elaborate on this point, declines in short-term interest rates have forced Japanese investors to look for higher returns by taking various risks in other markets. They have taken the duration risk by investing their funds in long-term government bonds. With the decline in long-term interest rates, however, they expect large potential capital losses in the event of a reversal of interest rates movements and this, in turn, has caused the negative skewness to expand.

In such circumstances, Japanese investors have turned to credit instruments such as corporate bonds. Their active investment in these instruments has narrowed credit spreads. Due to the possibility of default, the distribution of returns on corporate bonds has a *long-tail* in the negative territory. Thus, narrowing of credit spreads has expanded the negative skewness of the distribution.[55] Similarly, in the call market, the negative skewness of returns on call loans has expanded because of the decline in interest rates to near-zero levels.

***b. Changes in investor types***[56]

Investors may be categorized into three types depending on the way they evaluate the risk-return profile of financial assets in their investment decisions. The first type are risk-cautious investors who take the skewness as well as the mean and the variance of returns into account.[57] The second type are traditional investors who care about the

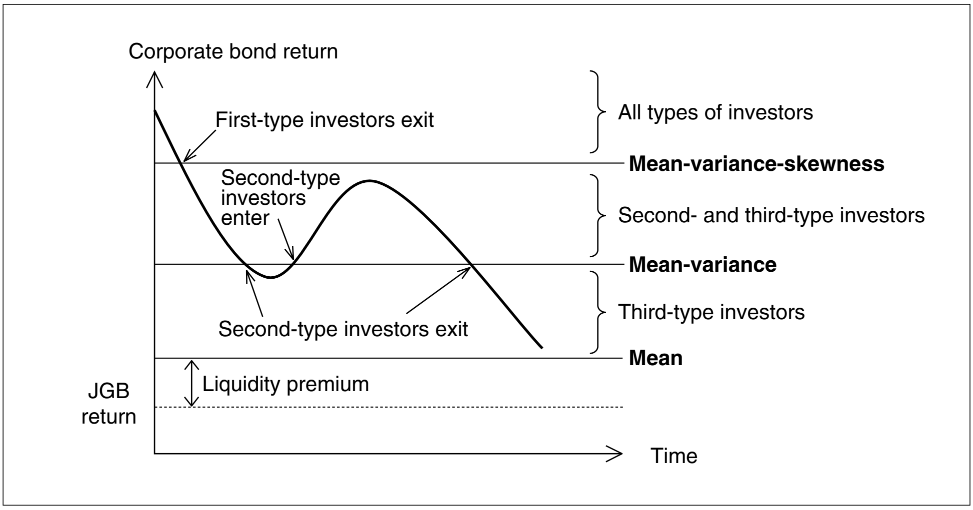
55. Amato and Remolona (2003) point out that, in the United States, credit spreads tend to be much wider than would be explained by the expected losses given the default probabilities, which they call a "credit spread puzzle." They show that the skewness in the distribution of returns on corporate bonds calls for an extraordinarily large portfolio to achieve the diversification of risks of unexpected large losses even with small probabilities.
56. See Nishioka and Baba (2004a) for a more detailed analysis of the issue. Appendix 3 provides a summary of the results.
57. Mathematically, the first type are investors who care about third moments of the distribution of returns. This would be the case if they looked at the second-order, not just the first-order, terms in the Taylor approximation of the first-order condition for maximization. The risk premium they would demand of an asset then rises with the negative skewness of the distribution of returns. See Nishioka and Baba (2004a) for details.

mean and the variance, but not the skewness. The third type are those who focus on absolute return and are solely interested in the mean of returns. The conventional Capital Asset Pricing Model (CAPM) assumes second-type investors. However, in an environment in which interest rates are very low and the risk-tolerance level of investors is affected by their capital position, investors may become more sensitive to the skewness of returns, especially for credit instruments. If expected returns on financial assets are large, the first-type investors will be able to participate in the market (Figure 27). If expected returns fall, the first-type investors will exit from the market and only the second- and third-type investors will remain. If returns decline further, the second-type investors will also exit and only the third-type investors will remain.[58] As the negative skewness of returns on credit instruments has expanded in line with the decline in returns, investors will be crowded out from the market in order of the degree of their risk aversion.

The third-type investors have an incentive to take large credit risks in a very low interest rate environment. Of course, they have been present since long before the ZIRP was adopted. The ZIRP and the QMEP, however, have lessened the number of active first- and second-type investors, making it possible for third-type investors to become more influential. As a result, bond yields seem to be no longer reflecting underlying risks of borrowers properly.

This last point is borne out in the results explained in Appendix 3, especially in Appendix Table 5. It shows that the estimated average degree of risk aversion of Japanese bond investors is generally lower when the sample includes BBB-rated

**Figure 27 Entry and Exit of Investors**




58. Overseas investors, typically categorized as first-type investors, have not entered the Japanese corporate bond market to begin with, since the returns have not covered the high risk premiums that they demand. Domestic institutional investors such as pension funds, life insurance companies, and investment trusts, categorized as both first- and second-type investors depending on their degree of risk aversion, have turned to foreign bonds with the currency position hedged as well as government bonds. Since their liabilities are denominated in yen, they prefer to hedge against FX fluctuations. Their hedging strategy is to roll over short-term hedges, typically over a three-month period. As a result, the Japanese corporate bond market has been dominated by regional financial institutions, investment trusts with active strategies, and retail investors, who may be categorized as third-type investors.

bonds than when it does not. Also, there is little evidence that investors care about the negative skewness of returns. These results do not hold for the U.S. bond market. Thus, although narrowing of credit spreads is a favorable development in a stagnant economy, there seems to be a grain of unhealthiness in it. In addition, as we pointed out, issuance of bonds has not increased much.

**3. Implications for monetary policy**

The above discussion on credit risk premiums suggests the existence of what might be called a "risk premium puzzle" concerning Japan's experience with the impaired financial system since the mid-1990s. Here, the puzzle is twofold: first, risk premiums in many areas of the impaired financial system declined rather than increased; second, declines in risk premiums have not produced significant monetary easing effects.

To solve this puzzle, it seems useful to divide credit markets into two segments. Generally, firms with relatively high credit ratings (equal to an A rating or higher) have not faced severe difficulties in raising funds from banks as well as capital markets during the ZIRP and the subsequent QMEP periods. The narrow credit spreads in the corporate bond market have been described in the above subsections. Since lending to high-rated firms has been favorable to banks due to the small risk of damaging their capital position, credit spreads on loans have been narrow as well. Firms in this segment, however, have been undergoing a significant de-leveraging process. Cash flows have stayed higher than investment since around 1999. Thus, issuance of corporate bonds has not increased substantially. Bank loans have continued to decline. The only recent exception was the period of financial instability from 1997 to 1998, in which major banks and securities companies went bankrupt, particularly in the aftermath of the Russian crisis and the failure of Long-Term Capital Management (LTCM). It was only during this period that the issuance of corporate bonds by firms in this segment increased significantly (Figure 26).

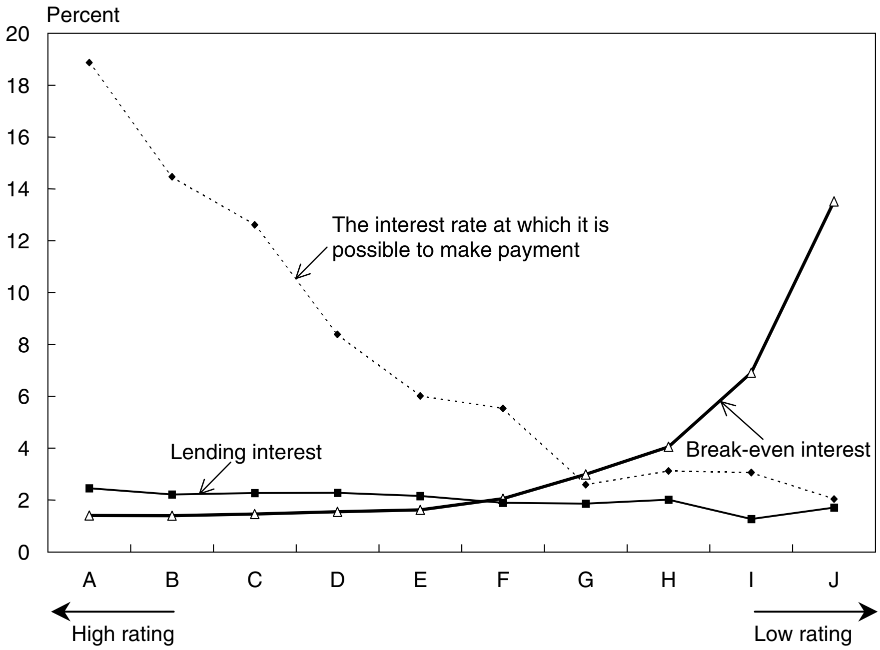
The situation has been quite different in the case of firms with lower credit standings. Many firms in this segment have faced severe credit constraints. They have had only limited access to the corporate bond market. There has been some bond issuance by firms rated BBB, but not by those with lower ratings. In fact, corporate bonds rated BB or lower are those of firms that had entered the market with BBB or higher ratings and been subsequently downgraded as a result of deteriorating financial conditions. Consequently, bank borrowing has been a major channel of fund-raising for these firms. As we referred to in Section II.C, Nagahata and Sekine (2002) show that firms without access to the corporate bond market have faced significant credit constraints when their main banks experienced financial problems. Given that these firms have had only limited access to the bond market, however, we have not been able to observe "high risk premiums" charged against these borrowers.[59]

Due to capital limitations, banks have been reluctant to extend new loans to this class of borrower. In many cases, however, they continued to roll over existing loans

59. It is possible to observe some evidence of high risk premiums on these firms. As shown in Figure 24, spreads on BB-rated bonds rose until the middle of 2002, unlike those for other classes of bonds. The amount of such bonds, however, is a very small fraction of the market (0.02 percent of the amount outstanding of corporate bonds) and a negligible fraction of the funding needs of firms in this second-tier segment of the credit market.

without raising lending rates much. Figure 28 shows that lending rates to lower-rated borrowers have been well below those that cover expenses and default risks. Demanding higher lending rates would have made many borrowers insolvent, forcing banks to realize losses; banks, however, lacked capital for such an action. As a result,

**Figure 28 Probability and Credit Ratings**




Notes:
Lending interest = (borrower's) interest payment/(borrower's) liability with interest.

Break-even interest = rate of credit cost* + short-term prime rate**.
* The ratings below J are defined as a default. The recovery rate is assumed uniformly to be 50 percent.
** A short-term prime rate is substitution of fund-raising costs and expenses.

The interest rate at which it is possible to make payment = cash flow before interest payment/liability with interest.

- The figure was created from the financial data on about 120,000 borrowers held by the Credit Risk Database (CRD) in Japan (what was offered from member financial institutions). Ratings were assigned by the BOJ based on the marks of the CRD.
- In a strict sense, differences between lending interest rates and break-even interest rates show a larger profit than the actual ones for normal borrowers, because there are differences of duration, and banks take greater interest risk. Therefore, it is necessary to take into account this factor. However, it has little impact under the present yield curve.
- Break-even interest does not include costs for allocated capital, which covers unexpected credit risks.

Source: Bank of Japan (2003a).

"high risk premiums" have not been observed here, either. The same reasoning explains the underdeveloped nature of the distressed asset market.

The near absence of the bond and distressed asset markets for, and the unwillingness on the part of banks to extend new loans to, firms in this segment largely prevented them from enjoying the easing effects of monetary policy. The BOJ's monetary easing as we have reviewed in this paper did have the effect of lowering, or stopping the rise in, risk premiums in relatively sound parts of the financial system. Resultant declines in risk premiums, however, have gone a bit too far in some areas, for example, in the money market and corporate bond market. In the case of the money market, which has actually experienced serious credit problems, the BOJ has had to act as an intermediary. In the case of the corporate bond market, some risk-sensitive investors have left the market but have not taken larger risks elsewhere, perhaps partly because they have been constrained by capital and partly because the corporate bond market as well as the secondary market for bank loans for low-credit borrowers have not been sufficiently developed for the reasons discussed above.

In this sense, the BOJ's market operations have not been able to fully address the problems in the weakest parts of the financial system. In other words, a smoothly functioning banking sector and capital markets are a prerequisite for effective monetary policy.

## V. Concluding Remarks

We have offered three analyses of Japan's macroeconomic experience during the post-1990 period. First, we analyzed various facets of deflation during the period. We argued that the deflation of general prices, although it is a serious issue, has by no means been a major factor for the stagnating economy. In contrast, the deflation of asset prices—land and stock prices—was closely related to the economic difficulty of the period. Among others, the negative shocks generated by sharp declines in asset prices in the early 1990s have been propagated and amplified by their interaction with the deterioration in the condition of the financial system. Some statistical evidence supporting this view was presented.

Second, we have reviewed and analyzed the effects of monetary policy adopted to fight deflation since the late 1990s. Given that short-term interest rates were already nearly zero in the mid-1990s, policy measures adopted have focused on creating monetary easing effects beyond a mere zero short-term interest rate policy. We have shown that the ZIRP/RZIRP, which involved a commitment to maintain a zero interest rate for a longer period than that for a baseline monetary policy rule, has produced strong effects on expected future short-term interest rates, and thus on the entire yield curve under such a framework. We conjecture, however, that the effects of such a favorable shift in the yield curve on prices and output have been limited. This is because the reduced net worth of both lenders and borrowers as well as the associated negative financial accelerator effects offset the effect of low interest rates, and therefore an increase in lending and fixed investment was not realized.

Third, we have argued that the BOJ's market operations have been directed partly at addressing the above-mentioned financial-sector problems, in addition to their conventional objective of implementing monetary policy. These operations have taken the form of containing risk and liquidity premiums, particularly in the money market, by proactively providing liquidity as well as the BOJ's own risk-taking activity. As a result, the BOJ has successfully prevented a repetition of the 1997–98 type liquidity crisis. The risk-taking ability of private financial institutions, however, has not fully recovered. That is, reductions in risk premiums in the money and corporate bond markets have not spread into other markets where credit constraints have been strict, for example, bank loans to firms without access to the bond market. Other interesting developments have also been observed. Where reductions in the premiums have been large, for example, in the money market, the BOJ has found itself acting as a major player. The risk premium for Japanese banks in the U.S. dollar market has not declined much, resulting in negative yen funding costs for foreign banks as they have entered into yen-dollar swap transactions with Japanese banks. Ironically, these unexpected events have made the provision of large liquidity easier for the BOJ, but at the same time made the effects of liquidity provision not as large as they seemed on the surface.

One unexplored area of macroeconomic policy to get around the zero rate constraint is coordination between monetary and fiscal authorities. Aggressive fiscal policy supported by aggressive monetary expansion could function as a powerful weapon to fight deflation. In a sense, the BOJ has partially provided such a framework by maintaining a near-zero short-term interest rate for almost 10 years. The fiscal authority, however, has stopped short of exploiting this environment, as can be seen by sharp reductions in public investment since 1996.[60] The degree of commitment by the BOJ beyond a zero inflation rate regarding maintenance of the pro-fiscal authority environment has been unclear. The following points, however, need to be considered. First, the increase in seigniorage revenue created by a 1 or 2 percentage point permanent increase in the inflation rate in the neighborhood of reasonable inflation rates is quite limited. Second, a sharp but temporary rise in inflation may produce a large effect on the real value of existing government debt. However, the question is whether the public is willing to tolerate such inflation. Also, it is unclear as to what the burden for the economy would be after the temporary rise in the inflation rate. Such questions are matters for further study.

60. Public investment has declined by about 40 percent from its peak in 1995.

## APPENDIX 1: A MACRO MODEL OF THE JAPANESE ECONOMY WITH A FINANCIAL ACCELERATOR

In this appendix, we provide a dynamic general equilibrium model of the Japanese economy incorporating credit market imperfections, based on the approach of Bernanke, Gertler, and Gilchrist (1999). The model contains a financial accelerator mechanism that propagates and amplifies a shock to the financial condition of borrowers.

### A. Model

We start with a description of the details of the entire log-linearized system. All data are divided by productivity multiplied by population, and are shown as percentage deviations from the steady state.

**1. Aggregate demand**

$$\hat{y}_t = \varpi^c \hat{c}_t + \varpi^i \hat{i}_t + (1 - \varpi^c - \varpi^i)\hat{g}_t, \tag{A.1}$$

$$\hat{c}_t = E_t \hat{c}_{t+1} - (\hat{r}_t^f - E_t \hat{\pi}_{t+1}^c) + E_t \hat{a}_{t+1}^c, \tag{A.2}$$

$$\hat{r}_t^k = (1 - \beta^k)(\hat{y}_t - \hat{k}_t + \hat{x}_t^i) + \hat{\pi}_t^i + \frac{\beta^k}{1 - \delta}\hat{q}_t - \hat{q}_{t-1}, \tag{A.3}$$

$$E_t \hat{r}_{t+1}^k = \hat{r}_t^{cc}, \tag{A.4}$$

$$\hat{q}_t = \varphi(\hat{i}_t - \hat{k}_t), \tag{A.5}$$

where $\hat{y}_t$, $\hat{c}_t$, $\hat{i}_t$, and $\hat{g}_t$ are output, consumption, business fixed investment, and exogenous demand. $\hat{r}_t^f$ is the nominal short-term interest rate, $\hat{\pi}_t^c$ is the CPI inflation rate, and $\hat{a}_t^c$ is the productivity growth of consumption goods. $\hat{r}_t^k$, $\hat{k}_t$, $\hat{x}_t^i$, $\hat{\pi}_t^i$, and $\hat{q}_t$ are the return on capital, capital stock, ratio of marginal cost to the price of investment goods, inflation rate for investment goods, and ratio of the value of the firm to the capital stock (real), respectively.

Business fixed investment is determined so that the expected return on capital, equation (A.3), is equal to the cost of capital, equation (A.4). Given equations (A.3), (A.4), and (A.5), business fixed investment can be expressed as follows.

$$\hat{i}_t = -\varphi^{-1}(\hat{r}_t^{cc} - E_t \hat{\pi}_{t+1}^i) + \hat{k}_t + E_t \left\{ \varphi^{-1}(1 - \beta^k)(\hat{y}_{t+1} - \hat{k}_{t+1} + \hat{x}_{t+1}^i) + \frac{\beta^k}{1 - \delta}(\hat{i}_{t+1} - \hat{k}_{t+1}) \right\},$$

$$\hat{k}_t = \delta \hat{i}_{t-1} + (1 - \delta)\hat{k}_{t-1} - \hat{a}_t^i - \hat{n}_t, \tag{A.6}$$

$$\hat{r}_t^{cc} = \hat{r}_t^f + u_t - \upsilon \hat{s}_t, \tag{A.7}$$

$$s_t = \beta^s s_{t-1} + \frac{1}{\varpi^s}\hat{r}^k_t - \frac{1-\varpi^s}{\varpi^s}\hat{r}^f_{t-1} - \hat{\pi}^i_t - (\hat{q}_t - \hat{q}_{t-1}) + \epsilon^s_t, \tag{A.8}$$

where $\hat{a}^i_t$ and $\hat{n}_t$ are the growth rate of productivity in the investment goods industry and the growth rate of the population. The cost of capital, $\hat{r}^{cc}_t$, consists of the risk-free rate and a risk premium, which in turn is the sum of an exogenous component, $\hat{u}_t$, and a term that represents the effect of credit market imperfections, $\upsilon\hat{s}_t$, where $\hat{s}_t$ is the ratio of the market value of equity to the value of the firm (EVR) and $\upsilon$ is a positive parameter. A rise in leverage caused by a decline in the stock price is assumed to increase the cost of capital under credit market imperfections. Equation (A.8) states that EVR is influenced by itself in period $t-1$ and improves gradually when the cash flow of the firm increases. The error term of equation (A.8), $\epsilon^s_t$, is an exogenous shock to the ratio of the market value of equity to the value of the firm:

$$\hat{z}_t = \beta^z\hat{z}_{t+1} + (1-\beta^z)(\hat{c}_t - \hat{r}^f_t + E_t(\hat{\pi}^c_{t+1} + \hat{a}^c_{t+1} + \hat{n}_{t+1})), \tag{A.9}$$

where $\hat{z}_t$ is real land price.[61]

**2. Aggregate supply**

$$\hat{y}_t = \varpi^h\hat{h}_t + (1-\varpi^h)\hat{k}_t, \tag{A.10}$$

$$\hat{w}^h_t = \hat{c}_t - \hat{l}_t,\ \hat{h}_t + \eta\hat{l}_t = 0, \tag{A.11}$$

$$\hat{w}^h_t - \hat{x}^c_t = \hat{y}_t - \hat{h}_t, \tag{A.12}$$

where $\hat{h}_t$ and $\hat{l}_t$ are labor and leisure. $\hat{x}^c_t$ is the ratio of marginal cost to the CPI. Equations (A.10) to (A.12) can be rewritten as follows.

$$\hat{x}^c_t = \frac{\eta^{-1} + 1 - \varpi^h}{\varpi^h}\hat{y}_t + \hat{c}_t - \frac{(1+\eta^{-1})(1-\varpi^h)}{\varpi^h}\hat{k}_t.$$

Thus, the ratio of marginal cost to the CPI increases when output increases, and decreases when the supply capacity (capital stock) increases.

$$\hat{\pi}^c_t = \beta E_t\hat{\pi}^c_{t+1} + \frac{(1-\alpha^c)(1-\alpha^c\beta)}{\alpha^c}\hat{x}^c_t,$$

$$\hat{\pi}^i_t = \beta E_t\hat{\pi}^i_{t+1} + \frac{(1-\alpha^i)(1-\alpha^i\beta)}{\alpha^i}\hat{x}^i_t. \tag{A.13}$$

61. Changes in land price can affect the ability of the firm to borrow through the constraint of the collateral, theoretically. However, as the EVR is already modeled to affect the cost of capital, land price is set not to affect other variables.

The time paths of both the CPI and the price of investment goods follow Phillips curve type equations. They consist of the expected inflation rate and the ratio of marginal cost to the price of goods in question. Among them, the ratio of marginal cost to the price of investment goods can be derived from the following definition of relative price:

$$\hat{p}^i_t - \hat{p}^i_{t-1} = \hat{\pi}^i_t - \hat{\pi}^c_t + \hat{a}^i_t - \hat{a}^c_t,$$

$$\hat{x}^i_t = \hat{x}^c_t - \hat{p}^i_t, \qquad \text{(A.14)}$$

where $\hat{p}^i_t$ is the ratio of the price of investment goods to the CPI.

**3. Monetary policy rule**

$$\hat{r}^f_t = \hat{a}^c_t + \phi^\pi \tilde{\pi}^c_t,$$

$$\tilde{\pi}^c_t = (\hat{\pi}^c_t + \hat{\pi}^c_{t-1} + \hat{\pi}^c_{t-2} + \hat{\pi}^c_{t-3})/4. \qquad \text{(A.15)}$$

This policy rule simply assumes that the short rate is a function of the moving average of past CPI inflation rates.[62]

### B. Data

This model assumes that a balanced growth path exists and that production depends on capital and labor multiplied by the state of technology. In that sense, productivity should have the same trend as the ratio of the nominal wage rate to either the CPI or the price of investment goods. We used the Hodrick-Prescott (HP) trend of the ratio of the nominal wage rate to the CPI as a proxy for productivity. Output, consumption, business fixed investment, exogenous demand, and capital stock are divided by labor in efficiency units, i.e., the HP-trended population aged 15 and above multiplied by productivity mentioned above.

All variables are shown as percentage deviations from the steady state. As the steady-state value of each variable is not necessarily known, the average trend of the sample period is used except for the steady-state value of inflation. The steady-state value of CPI inflation is equal to the target rate of the CPI and is calculated from the constant term of the estimated policy rule equation.

### C. Estimation Results

Appendix Table 1 shows results of GMM estimation of the model using quarterly data over the period 1981/I–2003/I.

62. In the estimation, the monetary policy rule is modified as $\hat{r}^f_t - \phi^{ca} ca_t = \hat{a}^c_t + \phi^\pi \tilde{\pi}^c_t$, where $ca_t$ is excess reserves. This is because the sample includes periods of zero rates when the short rate ceased to respond to inflation rates. Instead, bank reserves have become the operational target of the BOJ. While the BOJ has never stated that excess reserves respond to inflation, it has sometimes raised the reserve target in response to deteriorating economic conditions. Thus, the modification seems to capture the BOJ's behavior through the sample period as a rough first approximation. The excess reserve variable, however, does not appear in any other part of the model.

**Appendix Table 1 Estimation Results**

[1] System Estimation of Equations Based on Behaviors of Economic Agents

| Parameter | Estimate | Standard error |
|---|---|---|
| $\beta$ | 0.997 | 0.000 |
| $\nu$ | 0.038 | 0.019 |
| $\beta^k$ | 0.987 | 0.005 |
| $\delta$ | 0.019 | 0.000 |
| $\alpha^c$ | 0.742 | 0.049 |
| $\alpha^i$ | 0.824 | 0.319 |
| $\varphi$ | 0.866 | 0.053 |
| $\varpi^s$ | 0.497 | 0.016 |
| $\beta^s$ | 0.942 | 0.011 |
| $\phi^{CA}$ | 0.001 | 0.000 |
| $\overline{\pi}^c$ | 0.004 | 0.001 |
| $\phi^{\pi}$ | 1.448 | 0.073 |
| $\beta^z$ | 0.979 | 0.003 |

Test of overidentifying restrictions = 28.963 [$p$-value 0.571].

Note: Instruments used include one lag of the variables of each equation. A two-lag Newey-West (1987) estimation of the covariance matrix is used.

[2] System Estimation of Other Equations

| Parameter | Estimate | Standard error |
|---|---|---|
| $\eta$ | 6.353 | 0.018 |
| $\varpi^c$ | 0.564 | 0.002 |
| $\varpi^i$ | 0.168 | 0.001 |
| $\varpi^h$ | 0.661 | 0.003 |

Test of overidentifying restrictions = 37.415 [$p$-value 0.136].

Note: Instruments used include two lags of the variables of all equations. A one-lag Newey-West (1987) estimation of the covariance matrix is used.

# APPENDIX 2: TESTING THE EFFECTS OF THE ZIRP AND THE QMEP WITH A MACRO-FINANCE MODEL

This appendix presents the details of the analysis reported in Section III.B. We use a macro-finance model,[63] building on Oda and Kobayashi (2003), that combines a small macroeconomic model with a finance theory approach.

## A. Model of the Economy

We assume a small backward-looking model consisting of aggregate demand and supply equations and a monetary policy rule. The model is estimated by the maximum likelihood method using data from 1980/I–1999/I. The choice of the estimation period reflects the adoption of the ZIRP in 1999/II. In the simulations reported below, to calculate expected future short rates and risk premiums for the period after 1999/II

63. Examples of the application of the macro-finance approach to studies of the effects of monetary policy are Rudebusch and Wu (2003) and Hördahl, Tristani, and Vestin (2003). The analysis in this appendix differs from them in its explicit recognition of the nonlinearity of the monetary policy rule, i.e., the zero bound on nominal interest rates and the zero rate commitment by the BOJ.

we assume that the parameters of the model remained the same. The equations are

$$\text{(AD)}\quad \underset{}{y_t} = \underset{(0.102)}{0.735}y_{t-1} + \underset{(0.117)}{0.108}y_{t-2} - \underset{(0.126)}{0.159}\left(\frac{i_{t-1}+i_{t-2}}{2} - \frac{\pi_{t-1}+\pi_{t-2}}{2} - \frac{r^n_{t-1}+r^n_{t-2}}{2}\right) + \epsilon^d_t, \tag{A.16}$$

$$\text{(AS)}\quad \pi_t = \underset{(0.048)}{1.552}\pi_{t-1} - \underset{(0.048)}{0.552}\pi_{t-2} + \underset{(0.042)}{0.008}y_{t-1} + \epsilon^s_t. \tag{A.17}$$

(Monetary policy)
Type 1: The rule without the zero rate commitment (up through 1999/I and 2000/III–2001/I)

$$i^*_t = \underset{(0.079)}{0.723}i^*_{t-1} + (1 - \underset{(0.079)}{0.723})[(r^n_t + \pi_t) + \underset{(0.134)}{0.139}(\pi_t - \pi^*) + \underset{(0.305)}{0.251}y_t], \tag{A.18}$$

$$i_t = \max[i^*_t, 0]. \tag{A.19}$$

Type 2: The rule with the zero rate commitment (1999/II–2000/II and 2001/II–2003/IV)

$$i^*_t = 0.723i^*_{t-1} + (1 - 0.723)[(r^n_t + \pi_t) + 0.139(\pi_t - \pi^*) + 0.251y_t], \tag{A.20}$$

$$i_t = \begin{cases} 0 & \text{if } i^*_t < 0 \text{ or } \bar{\pi}_t < x \text{ percent,} \\ i^*_t & \text{if } i^*_t \geq 0 \text{ and } \bar{\pi}_t \geq x \text{ percent.} \end{cases} \tag{A.21}$$

(Disturbances)
Demand shock:

$$\epsilon^d_{t+1} = \underset{(0.105)}{-0.003}\epsilon^d_t + u^d_t, \quad u^d_t \sim N(0, 0.722). \tag{A.22}$$

Supply shock:

$$\epsilon^s_{t+1} = \underset{(0.055)}{0.060}\epsilon^s_t + u^s_t, \quad u^s_t \sim N(0, 0.417), \quad \text{corr}(u^d_t, u^s_t) = -0.08, \tag{A.23}$$

where
$y_n$ = output gap: deviation from the HP-filtered real GDP (seasonally adjusted),
$\pi_t$ = inflation rate: the growth rate of the core CPI,
$r^n_t$ = natural rate of output: $r^n_t = (y^*_t - y^*_{t-1}) + const,$
$y^*_t$ = potential output: the HP-filtered real GDP (seasonally adjusted),

$i_t$ = nominal short-term interest rate: defined as an overnight call rate,
$i_t^*$ = nominal short-term interest rate without the nominal zero bound or the zero rate commitment,
$\pi_t^*$ = targeted inflation rate set at 1.81 percent, which is the average of the realized rate during the estimation period,
$\bar{\pi}_t$ = two-quarter backward-moving average of the inflation rate,
$x$ = threshold rate of inflation for the zero rate commitment.

The default monetary policy rule (type 1) is set to be a modified Taylor rule that incorporates slow policy adjustment and the zero bound constraint on nominal interest rates. The BOJ's commitment to maintain a zero short rate until consumer price inflation becomes positive (the ZIRP/RZIRP) is modeled as maintenance of a zero rate until inflation exceeds the threshold rate ($x$) in the type 2 rule.

**B. Decomposition of the Long-Term Interest Rates into Expectations Theory and Risk Premium Components by Monte Carlo Simulation**

We combine the macro model, estimated above, with the no-arbitrage asset pricing theory in finance to derive the model-based yield curve, or medium- and long-term interest rates. We assume that the threshold rate of inflation in the monetary policy rule as well as the market prices of risk regarding the aggregate demand and supply shocks to the goods market are time-variant and are estimated simultaneously from the yield curve observed in the market at each point in time.

Given the threshold rate and the market prices of risks, the model-based yield curve $R_t^T$, i.e., the interest rate at $t$ on a bond maturing at $T$, can be described as follows.

$$R_t^T \equiv -\frac{1}{T-t}\ln P(t,\, T), \qquad \text{(A.24)}$$

where $P(t,\, T) = E_t^Q \exp\left[-\int_t^T \hat{i}_s ds\right]$ is the price at $t$ of a discount bond maturing at $T$. Here, $\hat{i}_t$ denotes the path of the short-term interest rate in the future and $E_t^Q$ is the expectations operator under the Martingale measure (that is, the risk-neutral measure). The stochastic process for $\hat{i}_t$ is determined by the macro model, which is driven by the demand and supply shocks. The shocks can be written as stochastic processes by simply transforming equations (A.22) and (A.23).

$$d\epsilon_t^d = -(1-\rho_d)\epsilon_t^d dt + \sigma_d dB_t^d, \quad \rho_d = -0.003, \quad \sigma_d = 0.722, \qquad \text{(A.25)}$$

$$d\epsilon_t^s = -(1-\rho_s)\epsilon_t^s dt + \sigma_s dB_t^s, \quad \rho_s = 0.060, \quad \sigma_s = 0.417, \qquad \text{(A.26)}$$

where $dB_t^d$ and $dB_t^s$ denote the increments of a standard Brownian motion. Based on the no-arbitrage pricing theory,[64] these stochastic processes must be transformed into risk-neutral processes, as below, to calculate expectations in equation (A.24).

$$d\hat{\epsilon}_t^d = [-(1-\rho_d)\hat{\epsilon}_t^d - \lambda^d\sigma_d]dt + \sigma_d d\hat{B}_t^d, \tag{A.27}$$

$$d\hat{\epsilon}_t^s = [-(1-\rho_s)\hat{\epsilon}_t^s - \lambda^s\sigma_s]dt + \sigma_s d\hat{B}_t^s, \tag{A.28}$$

where $\lambda^d$ and $\lambda^s$ denote the market prices of risk regarding the demand and supply shock, respectively, and the hats (ˆ) on the stochastic variables mean that they are defined under the Martingale measure. Given the threshold rate and the market prices of risks, we can calculate equation (A.24) numerically. That is, we conduct Monte Carlo simulations to derive the future paths of the output gap, inflation, and the short-term interest rate under the Martingale measure, starting from the initial value of the endogenous variables at observation time.[65] This leads to the model-based yield curve.

We then estimate the threshold rate and the market prices of risk in such a way that the model-based yield curve best fits the yield curve observed in the market. Specifically, we search for the values that minimize the sum of the square errors at 20 grid points, set at every sixth month on the yield curve, between the two curves. The observed yield curve is derived by McCulloch's (1971) method from the price data of all JGBs outstanding.

Figure 17 shows the estimated value of the threshold inflation rate. Figure 18 shows the model-based interest rates, expectations theory components and risk premium components at 10-, five-, and three-year horizons. Specifically, by conducting the Monte Carlo simulation mentioned above with both the market prices of risk and the threshold rate set at the estimated value, we obtain the model-based interest rates. On the other hand, by conducting the simulation with both the market prices of risk set at zero and with the threshold rate at the estimated value, we obtain the expectations theory components of the interest rates. The risk premium components are defined as the former minus the latter.

In addition, we can calculate the hypothetical long-term interest rates, and their components, that should be realized in the case without the zero rate commitment. These are derived by the Monte Carlo simulation with the type 1 policy rule (the version without the commitment) for the ZIRP/RZIRP periods. The results are shown in Figures 19 and 20. Discussions of the results in Figures 17–20 are provided in the main text.

64. Examples of standard literature on this issue are Duffie (2001) and Hull (2001).

65. We cannot calculate this analytically, since the policy rule includes nonlinearity due to the zero rate commitment and the nominal zero bound.

**C. Regression Analysis on Monetary Policy Effects**

Hypothesis testing regarding the effects of various aspects of the QMEP can be done by simple regressions using the results of the above subsection. Specifically, we have already examined the effects of the RZIRP on interest rates. Below, we analyze the effects on interest rates of ECAB, the expansion of the CAB target, and purchases of long-term government bonds. This is done by regressing the commitment effect, i.e., the differences in the expectations theory component of interest rates between the cases with and without the commitment, and the risk premium on the CAB target and the amount of government bond purchases. While there is no obvious mechanism by which ECAB or purchases of government bonds affect expected future short rates, we may interpret findings of the existence of such effects as signaling effects. That is, these moves may have been interpreted by the market as indicating greater willingness on the part of the BOJ to carry out the RZIRP, thus a rise in the threshold rate. ECAB has been accompanied by increases in various funds-providing operations including purchases of government bonds. It is quite possible that these operations affected the risk premium components of interest rates.

The results of such regressions are as follows. Appendix Table 2 contains estimation results of the effects of ECAB. We first regressed the effects of the zero rate commitment (Figures 19 and 20) on the CABs assuming that the disturbance term is AR(1). The upper table in Appendix Table 2 shows that for each of the 10-, five-, and three-year interest rates the CAB is statistically significant, although the estimated coefficients are not large.[66] This result may imply the existence of signaling effects, or it may just be a finding of a spurious correlation as discussed in the text.

We then regressed the risk premium components (Figure 18) of the long-term interest rates on the CAB along with two other variables, assuming again AR(1) structure for the disturbance term. The variables included are the turnover rate of JGBs, as a measure of the liquidity premium, and the spread between TB and banks' CD rates, as a proxy of "flight to quality" effects. The lower table in Appendix Table 2 presents the results. At all maturities, the relationship is statistically insignificant.

Next, we conduct regressions similar to the ones above, with the amount of the BOJ's purchases of long-term JGBs replacing the CAB. The effects on the expectations theory component of interest rates are shown in the upper table of Appendix Table 3. At all maturities, the relationship is statistically insignificant.

We finally estimate two sets of equations regarding the possible effects of the BOJ's purchases of long-term JGBs on the risk premium. First, we regressed the risk premium components of the long-term interest rates on the share of JGBs held by the BOJ in total JGBs outstanding. As the lower left table in Appendix Table 3 shows, the variable is statistically insignificant at all maturities. Second, we regressed the risk premium components on the flow amount of the BOJ's purchases of JGBs in each quarter. As shown in the lower right table in Appendix Table 3, this variable was also statistically insignificant at all maturities.

66. For example, an increase in the current account balance by ¥10 trillion is likely to lower the 10-year interest rate by 0.09 percentage point.

**Appendix Table 2 Regression Analysis of the Effects of the Expansion of the BOJ's Current Account Balances**

Regression method: maximum likelihood with AR(1)
Period: 1995/I–2003/IV

| | Effects of the zero rate commitment in the expectations theory components[1] | | |
|---|---|---|---|
| | 10-year | Five-year | Three-year |
| BOJ current account | 0.009 | 0.015 | 0.016 |
| Std. err. | 0.00 | 0.00 | 0.00 |
| *p*-value | 0.00 | 0.00 | 0.00 |
| Const. | –0.04 | –0.07 | –0.08 |
| Std. err. | 0.02 | 0.06 | 0.07 |
| *p*-value | 0.11 | 0.21 | 0.29 |
| AR(1) | 0.78 | 0.86 | 0.88 |
| Std. err. | 0.14 | 0.13 | 0.13 |
| *p*-value | 0.00 | 0.00 | 0.00 |
| Adjusted R-squared | 0.91 | 0.90 | 0.89 |
| Std. err. of equation | 0.02 | 0.31 | 0.04 |
| D.W. | 1.85 | 1.50 | 1.21 |

| | Risk premium components[2] | | |
|---|---|---|---|
| | 10-year | Five-year | Three-year |
| BOJ current account | –0.012 | –0.002 | 0.001 |
| Std. err. | 0.02 | 0.02 | 0.01 |
| *p*-value | 0.60 | 0.92 | 0.95 |
| Turnover rate of JGBs | –0.19 | –0.20 | –0.16 |
| Std. err. | 0.07 | 0.07 | 0.06 |
| *p*-value | 0.01 | 0.01 | 0.01 |
| TB – CD spread | 0.53 | 0.57 | 0.45 |
| Std. err | 0.56 | 0.53 | 0.46 |
| *p*-value | 0.35 | 0.29 | 0.34 |
| Const. | 2.28 | 1.65 | 1.17 |
| Std. err. | 0.56 | 0.46 | 0.39 |
| *p*-value | 0.00 | 0.00 | 0.01 |
| AR(1) | 0.80 | 0.73 | 0.71 |
| Std. err. | 0.07 | 0.07 | 0.07 |
| *p*-value | 0.00 | 0.00 | 0.00 |
| Adjusted R-squared | 0.83 | 0.75 | 0.69 |
| Std. err. of equation | 0.31 | 0.28 | 0.24 |
| D.W. | 2.59 | 2.22 | 2.05 |

Notes: 1. Defined as the difference between the expectations theory components with and without the zero rate commitment.
2. Regression results are not largely influenced by excluding the turnover rate or the TB – CD spread.

**Appendix Table 3 Regression Analysis on the Effects of the Increase in the BOJ's Purchase of Long-Term JGBs**

Regression method: maximum likelihood with AR(1)
Period: 1995/I–2003/IV

| | Effects of the zero rate commitment in the expectations theory components | | |
|---|---|---|---|
| | 10-year | Five-year | Three-year |
| BOJ's purchase of JGBs | 0.00 | –0.01 | –0.04 |
| Std. err. | 0.02 | 0.03 | 0.03 |
| *p*-value | 0.85 | 0.74 | 0.19 |
| Const. | 1.7E2 | 2.9E2 | 0.03 |
| Std. err. | 2.9E5 | 5.6E5 | 0.05 |
| *p*-value | 0.99 | 0.99 | 0.53 |
| AR(1) | 0.99 | 0.99 | 1.22 |
| Std. err. | 0.10 | 0.10 | 0.09 |
| *p*-value | 0.00 | 0.00 | 0.00 |
| Adjusted R-squared | 0.81 | 0.81 | 0.86 |
| Std. err. of equation | 0.03 | 0.05 | 0.04 |
| D.W. | 1.90 | 1.50 | 2.03 |

| | Risk premium components[1] | | |
|---|---|---|---|
| | 10-year | Five-year | Three-year |
| BOJ's share of JGBs | 0.06 | 0.06 | 0.04 |
| Std. err. | 0.07 | 0.04 | 0.04 |
| *p*-value | 0.40 | 0.13 | 0.24 |
| Turnover rate of JGBs | –0.23 | –0.16 | –0.12 |
| Std. err. | 0.07 | 0.05 | 0.05 |
| *p*-value | 0.00 | 0.00 | 0.02 |
| TB – CD spread | 0.54 | 0.12 | 0.00 |
| Std. err. | 0.58 | 0.42 | 0.38 |
| *p*-value | 0.36 | 0.78 | 1.00 |
| Const. | 1.37 | 0.24 | 0.04 |
| Std. err. | 1.28 | 0.76 | 0.71 |
| *p*-value | 0.30 | 0.75 | 0.95 |
| AR(1) | 0.49 | 0.25 | 0.29 |
| Std. err. | 0.13 | 0.14 | 0.16 |
| *p*-value | 0.00 | 0.10 | 0.08 |
| Adjusted R-squared | 0.54 | 0.42 | 0.32 |
| Std. err. of equation | 0.28 | 0.21 | 0.19 |
| D.W. | 2.46 | 2.09 | 1.72 |

| | Risk premium components[2] | | |
|---|---|---|---|
| | 10-year | Five-year | Three-year |
| BOJ's purchase of JGBs | –0.15 | –0.01 | 0.03 |
| Std. err. | 0.09 | 0.06 | 0.06 |
| *p*-value | 0.11 | 0.86 | 0.60 |
| Turnover rate of JGBs | –0.20 | –0.17 | -0.13 |
| Std. err. | 0.07 | 0.06 | 0.05 |
| *p*-value | 0.01 | 0.01 | 0.01 |
| TB – CD spread | 0.47 | –0.14 | 0.23 |
| Std. err. | 0.53 | 0.40 | 0.36 |
| *p*-value | 0.39 | 0.74 | 0.53 |
| Const. | 2.54 | 1.35 | 0.83 |
| Std. err. | 0.42 | 0.32 | 0.29 |
| *p*-value | 0.00 | 0.00 | 0.01 |
| AR(1) | 0.39 | 0.29 | 0.33 |
| Std. err. | 0.15 | 0.16 | 0.16 |
| *p*-value | 0.02 | 0.08 | 0.05 |
| Adjusted R-squared | 0.57 | 0.36 | 0.29 |
| Std. err. of equation | 0.27 | 0.22 | 0.19 |
| D.W. | 2.35 | 2.00 | 1.74 |

Notes: 1. Regression results are not largely influenced by excluding the turnover rate or the TB – CD spread.
2. Regression results for five- and three-year rates remain insignificant, not largely influenced by excluding the turnover rate or the TB – CD spread. There is an exception for the 10-year rate, however, in that the result of regression without the turnover rate shows the statistically significant coefficient (*p*-value = 0.04) for the BOJ's purchase of JGBs.

## APPENDIX 3: ASSET PRICING MODEL WITH SKEWNESS RISK[67]

### A. Model

We derive the asset pricing model with skewness risk under consideration. First, a representative investor has the following constant relative risk aversion (CRRA) utility function:

$$u(W_{t+1}) = \frac{1}{1-\alpha} W_{t+1}^{1-\alpha} \quad (\alpha > 0), \tag{A.29}$$

where $\alpha$ denotes the degree of relative risk aversion, and $W_{t+1}$ denotes the amount of the investor's total asset holdings at $t + 1$. The optimization problem of the investor is specified as follows:

$$\text{Max} \quad E_t[u(W_{t+1})],$$

$$\text{s.t.} \quad W_{t+1} = W_t + \left[ r_f + \sum_{i=1}^{N} w_{i,t}(r_{i,t+1} - r_f) \right] W_t,$$

where $r_f$ and $r_{i,t+1}$ denote the return on the risk-free asset and the $i$-th risky asset at $t + 1$, respectively, and $w_{i,t}$ denotes the capitalization weight of the $i$-th asset holdings at $t$. The first-order conditions can be written as follows:

$$E_t[u'(W_{t+1})(r_{i,t+1} - r_f)] = 0. \quad i = 1, \ldots, N. \tag{A.30}$$

Then, we can derive the following pricing model:[68]

$$E_t[r_{i,t+1}] - r_f = [w\beta_{im} + (1-w)\gamma_{im}](E_t[r_{m,t+1}] - r_f), \tag{A.31}$$

where

$$\beta_{im} \equiv \frac{\text{cov}(r_{i,t+1}, r_{m,t+1})}{\sigma_m^2}, \quad \gamma_{im} \equiv \frac{\text{cov}(r_{i,t+1}, \sigma_m^2)}{\sigma_m^3 skew_m}, \quad w \equiv \frac{1}{1 - (1/2)(1+\alpha)\sigma_m skew_m}.$$

$r_{m,t+1}$ denotes the market return, and $\sigma_m^2$ and $skew_m$ denote the variance and the skewness of the market return, respectively. $\beta_{im}$ is referred to as the "beta risk" stemming from the covariance with the market return, as in the conventional CAPM, while we call $\gamma_{im}$ the "gamma risk," which expresses the risk from the co-skewness with the market return. Negative values of $skew_m$ ensure $0 < w < 1$, meaning that the risk premium of a risky asset can be expressed as a weighted average of $\beta$-risk and $\gamma$-risk.

67. See Nishioka and Baba (2004a) for more details.

68. We can derive equation (A.31) from the risk premiums of the $i$-th asset and the market portfolio. The risk premiums are derived by approximating equation (A.30) by the Taylor expansion centered around $E_t[W_{t+1}]$ up to the second order. See Nishioka and Baba (2004a) for more details.

### B. Empirical Analysis

#### 1. Estimation method and data

Using the Japanese and the U.S. data, we estimate equation (A.31) by the GMM proposed by Hansen (1982). For the Japanese data, we use the Nikko Performance Index with the government bonds and corporate bonds (AAA, AA, A, and BBB) as individual asset classes. The sample period is from January 4, 1996 to April 6, 2004. For the U.S. data, we use the BIG Bond Index of the Citi Group with treasury and government supported and corporate bonds (AAA/AA, A, and BBB) as individual asset classes. The sample period is from January 2, 1995 to April 20, 2004. Data frequency is daily, and the return period is 20, 60, and 120 business days. Appendix Table 4 shows the summary statistics in the case of 60 business days.[69]

#### 2. Estimation results

Appendix Table 5 shows the estimated values of the degree of relative risk aversion, $\alpha$, and the risk weight, $w$, in equation (A.31). We estimated the model with or without the BBB corporate bonds. Also, for the Japanese case, we estimated the model using two sample periods: (1) full sample [from January 4, 1996 onward], and (2) subsample [from April 1, 1999 onward], which corresponds to the period after the BOJ adopted the ZIRP.

First, most estimated values of $\alpha$ are significantly positive in Japan, although when the BBB corporate bonds are included in the subsample estimation, $\alpha$ takes on a significantly negative value in the case of 20 and 60 business days. This result might suggest that Japanese investors have taken large credit risks with the BBB corporate bonds during this period. In fact, most Japanese institutional investors such as life insurance companies and pension funds set an internal limit on investment in low-credit bonds including the BBB corporate bonds for risk management purposes. Thus, low-credit bondholders in Japan are almost limited to investment trusts with active strategies, regional financial institutions, and retail investors, who are known as active risk-takers in credit instruments. On the other hand, the estimated values of $\alpha$ are significantly positive and much higher in the United States than in Japan.

Second, in Japan, the average risk weight of $\gamma$-risk, $1 - w$, is 3.2 percent, while in the United States it is 10.7 percent. This means that the corporate bond pricing in the United States reflects $\gamma$-risk much more than that in Japan. Specifically, although the $\gamma$-risk is significantly priced in Japanese corporate bonds in a statistical sense, the weight of the $\gamma$-risk is almost negligible in its magnitude; investors in the Japanese

**Appendix Table 4 Summary Statistics**

| | Japan (Jan. 4, 1996 to Jan. 9, 2004) | | | | | | United States (Jan. 2, 1995 to Jan. 27, 2004) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $r_m$ | $r_{gov}$ | $r_{aaa}$ | $r_{aa}$ | $r_a$ | $r_{bbb}$ | $r_m$ | $r_{gov}$ | $r_{aaa}$ | $r_a$ | $r_{bbb}$ |
| Mean | 0.0328 | 0.0341 | 0.0472 | 0.0321 | 0.0300 | 0.0169 | 0.0781 | 0.0775 | 0.0830 | 0.0873 | 0.0869 |
| Variance | 0.0040 | 0.0048 | 0.0083 | 0.0041 | 0.0041 | 0.0126 | 0.0063 | 0.0086 | 0.0086 | 0.0099 | 0.0125 |
| Skewness | –0.4300 | –0.5415 | –0.0255 | –0.1706 | –0.1685 | –1.4826 | –0.1448 | –0.1228 | –0.1941 | –0.1482 | 0.3307 |

Notes: 1. $r_i$ denotes the return on the $i$-th asset. *m*: bond market portfolio; *gov*: government bonds; *aaa/aa*: AAA/AA corporate bonds; *aaa*: AAA corporate bonds; *aa*: AA corporate bonds; *a*: A corporate bonds; *bbb*: BBB corporate bonds.
2. The return period is 60 business days. For the statistics of 20 and 120 days, see Nishioka and Baba (2004a).

69. Table 2 in the text shows that $\gamma$-risk in the returns on JGBs and corporate bonds rose under the ZIRP.

corporate bond market seem to care little about the $\gamma$-risk. On the other hand, investors in the U.S. corporate bond market care greatly about $\gamma$-risk as well as $\beta$-risk. This result indicates that overseas investors have a more cautious attitude toward skewness risk than Japanese investors.

**Appendix Table 5 Risk Weight of $\beta$ and $\gamma$ Implied by Estimation Results**

| | Return period | Sample period | Assets | $\sigma_m$ | $skew_m$ | $\alpha$ | $w$: risk weight of $\beta$ (percent) | $1 - w$: risk weight of $\gamma$ (percent) |
|---|---|---|---|---|---|---|---|---|
| Japan | 20 business days | Full sample: Jan. 4, 1996 to Mar. 9, 2004 | All assets | 0.104 | −0.232 | 0.009 | 98.8 | 1.2 |
| | | | Excluding the BBB corporate bonds | | | 0.802*** | 97.9 | 2.1 |
| | | Subsample: Apr. 1, 1999 to Mar. 9, 2004 | All assets | 0.082 | −0.643 | −3.456*** | 109.8 | −9.8 |
| | | | Excluding the BBB corporate bonds | | | −2.780*** | 106.9 | −6.9 |
| | 60 business days | Full sample: Jan. 4, 1996 to Jan. 9, 2004 | All assets | 0.063 | −0.430 | 0.930*** | 97.4 | 2.6 |
| | | | Excluding the BBB corporate bonds | | | 0.569*** | 97.9 | 2.1 |
| | | Subsample: Apr. 1, 1999 to Jan. 9, 2004 | All assets | 0.046 | −1.012 | −1.870*** | 102.2 | −2.2 |
| | | | Excluding the BBB corporate bonds | | | 1.596*** | 94.0 | 6.0 |
| | 120 business days | Full sample: Jan. 4, 1996 to Oct. 8, 2003 | All assets | 0.038 | −0.098 | 1.422*** | 99.5 | 0.5 |
| | | | Excluding the BBB corporate bonds | | | 1.520*** | 99.5 | 0.5 |
| | | Subsample: Apr. 1, 1999 to Oct. 8, 2003 | All assets | 0.033 | −0.441 | 3.495*** | 96.4 | 3.6 |
| | | | Excluding the BBB corporate bonds | | | 10.050*** | 91.5 | 8.5 |
| United States | 20 business days | Jan. 2, 1995 to Mar. 23, 2004 | All assets | 0.141 | −0.183 | 6.451*** | 91.2 | 8.8 |
| | | | Excluding the BBB corporate bonds | | | 7.220*** | 90.4 | 9.6 |
| | 60 business days | Jan. 2, 1995 to Jan. 27, 2004 | All assets | 0.079 | −0.145 | 23.994*** | 87.5 | 12.5 |
| | | | Excluding the BBB corporate bonds | | | 13.247*** | 92.4 | 7.6 |
| | 120 business days | Jan. 2, 1995 to Oct. 31, 2003 | All assets | 0.056 | −0.207 | 41.994*** | 80.2 | 19.8 |
| | | | Excluding the BBB corporate bonds | | | 10.093*** | 94.0 | 6.0 |

Notes: 1. The shadowed portions indicate that $\alpha$ is significantly positive.
2. *** denotes significance at the 1 percent level.

References


Amato, Jeffery D., and Eli M. Remolona, "The Credit Spread Puzzle," *Quarterly Review*, Bank for International Settlements, December, 2003, pp. 51–63.

Baba, Naohiko, and Yasunari Inamura, "The Japanese Repo Market: Theory and Evidence," *Monetary and Economic Studies*, 22 (1), Institute for Monetary and Economic Studies, 2004, pp. 65–90.

Bank of Japan, "Evaluating the Economic Value of Loans and the Implications: Toward Transformation of the Business Model of Banks and Nonbank Firms," *Bank of Japan Quarterly Bulletin*, 11 (3), 2003a, pp. 187–215.

———, "Money Market Operations in Fiscal 2002," *Bank of Japan Quarterly Bulletin*, 11 (4), 2003b, pp. 155–172.

———, "Money Market Operations in Fiscal 2003 (Summary)," *Bank of Japan Quarterly Bulletin*, 12 (3), 2004, pp. 83–86.

Bernanke, Ben S., "Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression," *American Economic Review*, 73, 1983, pp. 257–276.

———, and Mark Gertler, "Financial Fragility and Economic Performance," *Quarterly Journal of Economics*, 105, 1990, pp. 87–114.

———, ———, and Simon Gilchrist, "The Financial Accelerator in a Quantitative Business Cycle Framework," in John Taylor and Michael Woodford, eds. *Handbook of Macroeconomics*, Vol. 1, Amsterdam: North Holland, 1999, pp. 1341–1393.

———, and Vincent R. Reinhart, "Conducting Monetary Policy at Very Low Short-Term Interest Rates," presented at the Meeting of the American Economic Association, San Diego, California, January, 2004.

Borio, Claudio, William English, and Andrew Filardo, "A Tale of Two Perspectives: Old or New Challenges for Monetary Policy?" BIS Working Paper No. 127, Bank for International Settlements, 2003.

Duffie, Darrell, *Dynamic Asset Pricing Theory*, 3rd edition, Prentice Hall, 2001.

Eggertsson, Gauti B., and Michael Woodford, "The Zero Bound on Interest Rates and Optimal Monetary Policy," *Brookings Papers on Economic Activity*, 1, 2003, pp. 139–211.

Fisher, Irving, "The Debt-Deflation Theory of Great Depressions," *Econometrica*, 1, 1933, pp. 337–357.

Fleming, Michael J., and Kenneth D. Garbade, "Repurchase Agreements with Negative Interest Rates," *Current Issues in Economics and Finance*, 10 (5), Federal Reserve Bank of New York, 2004.

Hansen, Lars Peter, "Large Sample Properties of Generalized Method of Moments Estimators," *Econometrica*, 50, 1982, pp. 1029–1054.

Hayashi, Fumio, and Edward C. Prescott, "The 1990s in Japan: A Lost Decade," *Review of Economic Dynamics,* 5, 2002, pp. 206–235.

Hirose, Yasuo, and Koichiro Kamada, "Time-Varying NAIRU and Potential Growth in Japan," Bank of Japan Research and Statistics Department Working Paper No. 02-8, Bank of Japan, 2002.

Hördahl, Peter, Oreste Tristani, and David Vestin, "A Joint Econometric Model of Macroeconomic and Term Structure Dynamics," mimeo, European Central Bank, 2003.

Hull, John C., *Options, Futures, and Other Derivative Securities*, 4th edition, Prentice Hall, 2001.

Kawamoto, Takuji, "What Do the Purified Solow Residuals Tell Us about Japan's Lost Decade?" *Monetary and Economic Studies*, 23 (1), Institute for Monetary and Economic Studies, Bank of Japan, 2005, pp. 113–148 (this issue).

King, Mervyn, "Debt Deflation: Theory and Evidence," *European Economic Review*, 38, 1994, pp. 419–445.

Krugman, Paul R., "It's Baaack: Japan's Slump and the Return of the Liquidity Trap," *Brookings Papers on Economic Activity*, 2, 1998, pp. 137–187.

Leeper, Eric, Christopher Sims, and Tao Zha, "What Does Monetary Policy Do?" *Brookings Papers on Economic Activity*, 2, 1996, pp. 1–78.

McCulloch, J. Huston, "Measuring the Term Structure of Interest Rates," *Journal of Business*, 44, 1971, pp. 19–31.

Nagahata, Takashi, and Toshitaka Sekine, "The Effects of Monetary Policy on Firm Investment after the Collapse of the Asset Price Bubble: An Investigation Using Japanese Micro Data," Bank of Japan Working Paper No. 02-3, Bank of Japan, 2002.

Nakakuki, Masayuki, Akira Otani, and Shigenori Shiratsuka, "Distortions in Factor Markets and Structural Adjustments in the Economy," *Monetary and Economic Studies*, 22 (2), Institute for Monetary and Economic Studies, 2004, pp. 71–100.

Newey, Whitney K., and Kenneth D. West, "A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, 55, 1987, pp. 703–787.

Nishioka, Shinichi, and Naohiko Baba, "Credit Risk Taking by Japanese Investors: Is Skewness Risk Priced in Japanese Corporate Bond Market?" Bank of Japan Working Paper No. 04-E-7, Bank of Japan, 2004a.

———, and ———, "Negative Interest Rates under the Quantitative Monetary Easing Policy in Japan: The Mechanism of Negative Yen Funding Costs in the FX Swap Market," Bank of Japan Working Paper No.04-E-8, Bank of Japan, 2004b.

Oda, Nobuyuki, and Hiroshi Kobayashi, "Choki Kinri no Hendo o Do Rikaisuruka? Makuro Keizai Moderu o Riyoshita Kitai Tanki Kinri Seibun to Risuku 'Puremiamu' Seibun he no Bunkai (How Can We Understand the Recent Development of the Long-Term Interest Rates in Japan? Decomposition into Expectations Theory and Risk Premium Components by a Macro-Finance Model)," Bank of Japan Working Paper No. 03-J-4, Bank of Japan, 2003 (in Japanese).

Orphanides, Athanasios, "Monetary Policy in Deflation: The Liquidity Trap in History and Practice," Federal Reserve Board, Division of Monetary Affairs Working Paper No. 2004-01, Federal Reserve Board, 2004.

Rudebusch, Glenn D., and Tao Wu, "A Macro-Finance Model of the Term Structure, Monetary Policy, and the Economy," Federal Reserve Bank of San Francisco Working Paper No. 2003-17, Federal Reserve Bank of San Francisco, 2003.

Shirakawa, Masaaki, "Monetary Policy under the Zero Interest Rate Constraint and Balance Sheet Adjustment," *International Finance*, 4 (3), 2001.

Ueda, Kazuo, "Causes of Japan's Banking Problems in the 1990s," in Takeo Hoshi and Hugh T. Patrick, eds. *Crisis and Change in the Japanese Financial System*, Boston: Kluwer Academic Publishers, 2000.

———, "Japan's Liquidity Trap and Monetary Policy," speech given at the meeting of the Japan Society of Monetary Economics, 2001 (http://www.boj.or.jp/en/press/koen072.htm).

———, "The Transmission Mechanism of Monetary Policy near Zero Interest Rates: The Japanese Experience, 1998–2000," in Laran Mahadeva and Patrick Sinclair, eds. *Monetary Transmission in Diverse Economies*, Cambridge, England: Cambridge University Press, 2002 (also available at http:// www.boj.or.jp/en/press/03/press_f.htm).