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Monetary Policy Framework and "Insurance Against Deflation"

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Monetary Policy Framework
and
“Insurance Against Deflation”

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[Abstract]

Using the FRB/Global model on Japanese monetary policy in the early 1990s, Ahearne et al. (2002) argued that deflation could have been avoided in Japan if the BOJ had lowered short-term interest rates by a further 250 basis points at any time between 1991 and early-1995 as “insurance against deflation.” That study raised interesting questions on how the central bank could offer “insurance against deflation” when the inflation rate is close to zero. However, the simulation by Ahearne et al. (2002) has some drawbacks: it assumes the central bank’s commitment to *permanent downward shift* of the policy reaction function when policymakers are not sure what would happen, which is neither feasible nor credible. In this paper, we show alternative policy frameworks of “insurance against deflation” that can be feasible and credible even under uncertainty. The simulation using the Japanese Economic Model (JEM), a large-scale macroeconomic model of the Research and Statistics Department of the Bank of Japan, suggests that what is important is not large cuts in interest rates at an early stage; rather, the central bank would commit to cut interest rates aggressively in the future, if the risk of deflation increases.

Key Words: Asset Price, Collapse of Bubbles, Insurance Against Deflation, Monetary Policy, JEM (Japanese Economic Model)

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1. Introduction

Recently, the importance of "insurance against deflation" when inflation is close to zero is widely recognized. One of the rationales for this approach is found in the simulation study on the Japanese economy in the 1990s by Ahearne, Alan G., Joseph E. Gagnon, Jane Haltmaier, and Steven B. Kamin (2002)–hereafter called simply AGHK. Using the FRB/Global model, the paper argues that deflation could have been avoided in Japan if the BOJ had lowered short-term interest rates by a further 250 basis points at any time between 1991 and early-1995, as "insurance against deflation."

FOMC members have repeatedly cited the paper and argue that it is possible to avoid deflation by significantly cutting interest rates after the "asset price bubble" has burst. For example, Kohn (2006) referred to AGHK and suggested the following:

> In Japan, deflation could probably have been avoided if the initial monetary response to the slump in real estate and stock market values had been more aggressive; in addition, macroeconomic performance would have been better if the government had dealt more promptly with the structural problems of the banking sector.

Also, Mishkin (2007)[1] wrote the following:

> As pointed out in Ahearne and others (2002), the Bank of Japan did not ease monetary policy sufficiently or rapidly enough in the aftermath of the crisis. The lesson that should be drawn from Japan's experience is that the task for a central bank confronting a bubble is not to stop it but rather to respond quickly after it has burst. As long as the monetary authorities watch carefully for harmful effects stemming from the bursting bubble and respond to them in a timely fashion, then the harmful effects can probably be kept to a manageable level.

That study raised critical questions regarding how the central bank can offer "insurance against deflation" when the inflation rate is close to zero. Unfortunately, however, the analysis by AGHK has serious drawbacks, in that the simulation assumes the policy reaction function is "permanently" shifted downward as insurance against the risk of deflation.

[1] Ferguson (2002), Bernanke (2002), Mishkin (2008b) and others have also referred to AGHK.

Why does this assumption have serious drawbacks?

First, there will be a credibility issue on the commitment to unconditional long-term monetary easing when the commitment is made at a time of great uncertainty, and in which the nature of risk to the economy is still unclear.

Second, even if such a commitment could gain modest credibility, it will likely involve the risk of increasing both asset prices and economic fluctuation due to expansion of the imbalance in the financial markets,[2] since the private sector will act on the expectation that the excessively low interest rates policy will be maintained, as pointed out by Taylor (2007), for example.

With these responses considered, while the simulation by AGHK can be useful as a tool for "post mortem" examination for monetary policy during such period, it cannot be considered as a future policy framework that can be actually applied under uncertainty of similar nature.

In this paper, we examine a "risk management" approach that can actually be adopted by central banks facing some risk of deflation that involves high degree of uncertainty, considering the question raised by AGHK.

Specifically, we run simulations with the large-scale macroeconomic model "JEM," which is a forward-looking model similar to the FRB/Global model used by AGHK.

2. Simulations of Monetary Policy During the Early 1990s by AGHK

2.1. Key Discussions of AGHK

The results of the analysis of monetary policy by AGHK can be summarized as follows:

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[2] For example, White (2006) suggests the following: The core of the problem is that persistently easy monetary conditions can lead to the cumulative build-up over time of significant deviations from historical norms—whether in terms of debt levels, saving ratios, asset prices, or other indicators of "imbalances."

- Notwithstanding the severity of the collapse in asset prices and the vulnerability of the financial sector to this collapse, Japan's sustained deflationary slump was not anticipated. This was true not only of Japanese policymakers themselves, but also of private-sector and foreign observers, including Federal Reserve staff economists.
- Deflation can be very difficult to predict in advance. As a consequence, as interest rates and inflation rates move closer to zero, monetary policy perhaps should respond not only to baseline forecasts of future activity and prices, but also to special downside risks—especially the possibility of deflation—to those forecasts.
- Simulations of the staff's FRB/Global model suggest that, had the BOJ lowered short-term interest rates by a further 250 basis points at any time between 1991 and early 1995, deflation could indeed have been avoided. (The model indicates that loosening after the second quarter of 1995 would have been too late to avoid deflation, since by that time inflation had already fallen below zero.)
- Of course, policymakers in the early 1990s were not sure what would happen. There was a risk that, if the economy were to recover of its own accord, further monetary loosening would have had unwelcome consequences. Compared with the costs of entering into deflation, however, the costs of excessive monetary loosening would have been relatively limited.
- The collapse in asset prices and resultant deterioration of balance sheets—by making firms more reluctant to borrow and banks more reluctant to lend—most likely diminished the ability of monetary policy to stimulate the economy, but probably not to the point where the benefits of earlier, sharper easing would have been obviated.
- To sum up, an analysis of Japan's experience suggests that while deflationary episodes may be difficult to foresee, it should be possible to reduce the chances of their occurring through rapid and substantial policy stimulus.

According to AGHK, the growth rate of real GDP changes little in the simulation in which interest rates are lowered exogenously by 250 basis points before the first quarter of 1995 (Figure 1). In this regard, results suggest that the avoidance of deflation did not lead to the avoidance of the long-term stagnation of the Japanese economy.

However, consumer price inflation certainly does not fall into negative territory in the simulation. Consequently, it is understandable that the paper has been repeatedly cited as the basis for the assertion that "In Japan, deflation could probably have been avoided if the initial monetary response to the slump in real estate and stock market values had been more aggressive."

It should be noted, however, that "the possibility of 'financial headwinds' associated with the collapse of asset prices to hinder the ability of monetary policy to boost activity" is not incorporated into the FRB/Global model that AGHK used for the simulation. On this point, AGHK suggested, intuitively, that "The failure of the Japanese economy to revive in the 1990s, even after substantial declines in real short-term interest rates, raises concerns about whether Japanese policy might have lost its ability to influence the economy during this period. While evidence on this issue is not fully conclusive, our sense is that much of the failure of monetary loosening to support asset prices and to boost the economy owed to offsetting shocks rather than to a genuine breakdown of the monetary transmission mechanism." (p.24, underline is added)

Thus, the FRB/Global model abstracts away the impact of instability of the financial system that characterized Japanese experience after the collapse of the bubble. This point should be noted as a limitation of their analysis and our analysis, explained below.[3] Still, it is interesting to examine the monetary policy framework for risk management by using a macroeconomic model similar to the one used by AGHK.

However, even if we accept a macroeconomic model—which abstracts away the impact of instability of the financial system—as a starting point, it is necessary to change the assumptions of AGHK, i.e. a permanent lowering of the policy interest rate, to those that could actually be adopted, if a policymaker is looking for realistic guidelines for risk management. In the following section, we begin the discussion with this point.

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[3] Kato and Nishiyama (2005) also argued policy implications similar to AGHK.

2.2. Regime Shift of Monetary Policy Assumed by AGHK

AGHK explain their counterfactual simulation as follows.

> In each simulation, monetary policy in Japan and in the other major industrial countries follows a standard Taylor rule. Depending upon the simulation, the exercise consisted of permanently reducing the intercept term in the Japanese policy rule by 250 basis points in 1991 Q1 (the simulation represented by the red line), 1994 Q1 (the blue dotted line), and 1995 Q2 (the green dashed line). The policy rules respect the zero bound on nominal interest rates by specifying that the policy rate is the maximum of zero and the rate implied by a Taylor rule.

Here, we examine the implication of driving interest rates lower by 250 basis points based on the policy reaction function adopted in JEM, which we will use for the following analysis. Fujiwara et al. (2007) showed estimates on a Taylor-rule-type reaction function of the Bank of Japan using real-time data (estimation period is 10 years from the first quarter of 1986 to the fourth quarter of 1995) as

$$i_t = \underset{(12.32)}{1.60}\pi_t + \underset{(7.05)}{0.41}\left(y_t - y^*_{t|realtime}\right) + \underset{(11.22)}{2.43}, \quad \bar{R}^2 = 0.84,\ S.E. = 0.81$$

Note. The figures in ( ) indicate *t*-value.

Here, i_t indicates nominal interest rate, π_t indicates inflation rate and $\left(y_t - y^*_{t|realtime}\right)$ is the difference rate between the logarithm of real GDP and potential GDP measured in real time, i.e. the real time output gap.

The parameters for inflation rate and output gap derived from these results are 1.6 and 0.4 respectively, and are almost identical to the coefficients in the original Taylor rule (1.5, 0.5) shown in AGHK. If we incorporate the assumption of AGHK into the policy response function estimated by Fujiwara et al. (2007), their assumption should mean reducing the constant term in the estimated policy response function from +2.43 to -0.07. As the constant term in that policy response function corresponds to "equilibrium real interest rate - $0.6\times$ target inflation rate," this change in the constant term represents either an increase in target inflation rate (approximately 4%) or a decrease in natural rate of interest (2.5%).

2.2.1. Increase in the Target Inflation Rate

Let us first consider the possibility of increase in the target inflation rate. The notion of raising the target inflation rate reminds us of the suggestion made by Krugman (1998) in the late 1990s that "the Bank of Japan should commit itself to continue the inflation rate of 4% for 15 years."

However, AGHK states that

> "What if the BOJ had loosened substantially in 1994, to guard against the risk of deflation, and then unanticipated favorable shocks had lifted output gaps and inflation well into positive territory? In that scenario, based on the logic of the simulation results discussed above, inflation would have risen above desired levels for a number of years, but a tightening of monetary policy by the BOJ in response would have caused short-term interest rates to rise and inflation eventually to decline back to its original baseline (p. 22)."

Judging form this explanation, AGHK do not seem to be assuming the permanent increase in the target inflation rate.[4] Also, if a central bank *permanently* maintains a higher inflation rate as a response to the risk of deflation, economic welfare will deteriorate as its consequence, as the analysis by Fujiwara et al. (2006) has shown.[5] Consequently, it is unlikely for the central bank to maintain such a policy, and thus it is inconceivable that such a policy announcement would gain credibility.

Thus, considering both of the authors' intentions and the possibility of the policy gaining credibility, this interpretation—an increase in the target inflation rate—does not seem to hold.

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[4] Theoretically speaking, the permanent increase in the target inflation rate is not consistent with the permanent lowering of the policy interest rate in the first place, since the permanent increase in the target inflation rate will raise the steady state of policy interest rate. That is, even if the central bank lowers the constant term of the policy rule, it should raise the steady state of inflation rate, thus leading to an upward shift in the steady state of policy interest rate.

[5] Fujiwara et al. (2006) show that the social loss based on the target level of inflation set afresh results in undoubtedly larger social losses; it also suggests that any target that is substantially different from the desired level of inflation should not be credible.

2.2.2. Credibility of Permanent Downward Shift in Natural Rate of Interest

An alternative interpretation is the central bank would assume that the natural rate of interest (equilibrium real interest rate) fell *permanently* by 250 basis points in the early 1990s, and would announce a downward shift of the policy reaction function, in which market participants would place confidence and form expectations accordingly.

In this case, the central bank is convinced of negative shock to the economy, a consequence that would permanently decrease the natural rate of interest. In response to this negative shock, the central bank announces that it will permanently lower the policy interest rate. The private sector agents (those who are forward-looking), then, place confidence in the policy announcement and form their expectations accordingly.

However, according to the experience in Japan, it seems inconceivable that these assumptions are satisfied for two reasons.

First, as AGHK repeatedly pointed out, long-term deflationary stagnation of the Japanese economy in the 1990s could not be anticipated in the early 1990s by the government and the Bank of Japan or by outside observers, including the Fed and the IMF. This is evident from the economic outlook at the time, which was always biased in an optimistic direction (Figures 2 and 3). Also, given the difficulty in estimating the natural rate of interest, it should not be easy for the central bank to be convinced of permanent and significant decline in the natural rate of interest at an early stage of long-term deflationary stagnation in Japan.

Second, for the lowering of interest rates to have an effect of monetary easing, only the natural rate of interest in the policy rule has to decline, while the natural rate of interest in IS curve needs to remain the same. To satisfy such assumptions, the private sector has to have confidence in the downward revision of the central bank's perception on the natural rate of interest, while keeping its own perception on the natural rate of interest unchanged. However, it is not realistic to assume this gap in the perceptions on the natural rate of interest between the central bank and the private sector will be indefinitely preserved.[6]

Considering these, although the assumption of the simulations by AGHK is simple and clear, it cannot be, in its present form, considered as a policy option that a central bank can adopt in reality. This is true not only for Japan in the early 1990s but also for future similar cases in which the central bank still does not know exactly what is happening, but feels the need for insurance against deflation.

3. Simulations Using JEM

Focusing on policymaking under uncertainty, Fujiwara et al. (2007) analyzed the monetary policy of the Bank of Japan (BOJ) in the early 1990s, by conducting stochastic simulations with JEM.[7] However, their results are difficult to compare with those of AGHK largely due to the difference of assumptions stemming from the difference of the concern.

In this paper, by conducting stochastic simulations with JEM, we examine two approaches that respect the approach of AGHK to insure against the risk of deflation and, at the same time, change the unrealistic assumption of permanent downward shift of the constant term of the policy response function and make it more realistic.

There are two approaches: the first is that a central bank commits to depart from the Taylor rule (by reducing the intercept term of policy reaction function) for a certain period of time, but it also makes a commitment to return to the standard Taylor rule after that. The second approach is that a central bank changes the Taylor rule to respond non-linearly and aggressively to the increased risk of deflation. For either approach, a variety of options exist, depending on the following.

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[6] The gap in the perceived natural rates of interest should eventually be reflected in the rise in inflation.

[7] The JEM used in their analyses is a large-scale dynamic general equilibrium model comprising 219 equations, but one may consider its essence as being summarized in two equations: the Phillips curve and the IS curve. These are both hybrid equations combining forward-looking and backward-looking expectations of the private sector. See Fujiwara *et al.* (2005).

- ✓ In the case of the first approach, how quickly and how long a central bank commits to lower interest rates, assuming that the central bank affects an insurance policy against the risk of deflation via decrease in interest rates for a certain period of time.
- ✓ In the case of the second approach, how a central bank non-linearizes the Taylor rule against the risk of deflation, and strengthens the response to the risk of deflation.

In the following section, we make several alternative assumptions on these points, and conduct counterfactual simulations on the Japanese economy using JEM.

4. Simulations Using JEM (1): The Case of the Departure from the Taylor Rule for a Certain Period of Time

4.1. Assumptions of the Simulations

We set the assumptions as listed below, for the first type of counterfactual simulations we performed, i.e. the type that corresponds to the case in which the central bank departs from the Taylor rule for a certain period of time and returns to the rule after the period. In comparison with AGHK, both assumptions can be thought of as time-limited, lowering of the constant term in the policy response function (or, the extension of the policy response function incorporating the policy shocks u_t).

Simulation 1: Enhancement of Insurance

- ✓ Lowering interest rates by 250 basis points for four years from 1990.
- ✓ Lowering interest rates by 250 basis points for three years from 1991.

Simulation 2: Lowering rates during the so called “high-yen recession”

- ✓ Lowering interest rates by 250 basis points from 1985--lowering interest rates for three years from 1985 to 1987, for four years from 1985 to 1988, and for five years from 1985 to 1989 by 250 basis points, respectively.

- ✓ Lowering interest rates by 250 basis points from 1986--lowering interest rates for two years from 1986 to 1987, for three years from 1986 to 1988, and for four years from 1986 to 1989 by 250 basis points,, respectively.
- ✓ Lowering interest rates by 250 basis points from 1987--lowering interest rates for 1 year in 1987, for two years from 1987 to 1988, and for three years from 1987 to 1989 by 250 basis points, respectively.

4.2. Results of the Simulations

4.2.1 Simulation 1: Enhancement of Insurance

In 1991, it was still recognized that vigilance against inflation was necessary due to the rise in oil prices and other factors. This is evident in the April 1991 issue of the "Quarterly Economic Outlook Report" released by the BOJ.[8] In this issue, the "Recent Developments" section cited that "Although price movements on the whole remain within a largely stable trend, both domestic wholesale and consumer prices have slightly accelerated recently owing to price increases in petroleum products and perishable foodstuffs, among other items." The "Outlook" section predicted that "[Under such conditions] vigilance is called for concerning future price developments, especially in view of pressures arising from such factors as aforementioned tight market conditions and increasing labor costs, although further acceleration could be avoided against the background of a slowing economy provided crude oil prices and foreign exchange rates remain stable and inflationary expectations subdued."

Thus, in 1991, it was still recognized that vigilance against inflation was necessary due to rise of oil prices and other factors. In addition, the rise in land prices followed that in stock prices with a significant time lag. Kohn (2006), however, argued that the initial monetary response to the slump in real estate and stock market values should be more aggressive; as stock prices were plummeting at the end of 1989—which turned out

[8] Table 1 of Fujiwara et al. (2007) shows the excerpts from the BOJ's "Quarterly Economic Outlook Report" from January 1991 to October 1995.

to be its peak—it is possible, at the least as a thought experiment, to assume a preventive interest rate cut starting in 1990 or 1991.

As shown in Figures 4(1) and 4(2), output gap swings upward in both of the simulations. CPI inflation increases in positive territory until 1992. Interest rates rise sharply as a policymaker ends the additional loosening in 1994 under the upward swing of inflation and output gap, and returns to the policy interest rate based on the Taylor rule. Still, deflation can be avoided in the 1990s, if a central bank makes substantial interest rates cut immediately after the sharp decline in stock price. In the case of Figure 4(2), where the policymaker "waits and sees" the situation for one year, the economy turns into deflation soon after 2000. Thus, in these simulations, the one year difference in an "insurance period" makes a significant difference in the economic situation.[9]

4.2.2. Simulation 2: Lowering Interest Rates During the High-Yen Recession

Inflation and the output gap during the so called "endaka-fukyo" (high-yen recession) period in 1985-86 were at almost the same level as in 1993-94 during the period of the bubble's collapse. In fact, amid the sharp appreciation of the Japanese yen after the Plaza Accord, the Japanese economy sharply deteriorated; the year-on-year rate of change in the wholesale price fell below a negative 2% at the end of 1985, while it was above zero at the beginning of 1985. Deflation continued for a long period thereafter, and CPI inflation also trended downward toward negative territory, as shown in Figure 5. Now, what would have happened if the policymaker had

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9 Miyao et al. (2008) examined the case in which the BOJ lowers nominal short-term rates by 2.5% versus historical rates from 1991 to the first half of 1994 with counterfactual simulations using JEM, as we have done in this paper. According to the study, the results suggest that deflation could be avoided and Japan would not have faced the zero bound on interest rates, as with the results of AGHK. At the same time, the study suggests that while the zero bound on interest rates could be avoided by maintaining higher inflation rates, a decline in the output gap could not be avoided, and that it is arguable if substantial monetary loosening (with considerations to the zero bound on interest rates) could be justifiable given the economic situation at the time, where the image of the bubble economy was still vivid and a decline in the natural rate of interest had not yet been confirmed. Miyao et al. (2008) also suggest that the loss of social welfare due to aggressive monetary loosening during the simulation period is very limited. While the change of social welfare is an interesting subject for discussion, this paper does not delve into the subject, as the main point of the discussion by AGHK is the avoidance of deflation (or the zero bound on interest rates).

committed to maintaining low interest rates as an insurance against the risk of deflation after the mid 1980s, when the economy began to turn toward deflation? We will examine these issues in sequence in the following section.

Case of Additional Loosening After 1985

In the case shown in Figure 6(1), in which the BOJ commits to reduce the constant term in the policy response function for three years from 1985, CPI inflation remains at almost 2% until 1988. Following the rise of CPI inflation to close to 4% and the upswing in output gap thereafter, strong monetary tightening has been conducted by 1991. The path of economic growth, however, mostly does not change and inflation path is stabilized at 1% above the historical figures.[10]

However, in the case in which we extend the commitment period to four years from 1985 through 1988 (Figure 6(2)), the CPI inflation rate and the short-term nominal interest rate exceed 5% and 11%, respectively, at their peaks. If we extend the commitment period further to five years from 1985 through 1989 (Figure 6(3)), the CPI inflation exceeds 7% and the short-term rate goes above 15% at their peak. These cases are considered to be well beyond the normal tolerance range of central banks.

In theses simulations, we ignore the negative effects of substantial fluctuations of interest rates, which would contribute toward deepening turmoil in the financial system. Thus the economy would have been further destabilized.

Case of Additional Loosening After 1986 or 1987

These are cases in which the BOJ commits to lower the constant term of the policy reaction function at a stage where deflation in terms of CPI becomes real possibility.

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[10] This case seems to correspond to the case in which AGHK suggested in their counterfactual simulations in the period of the collapse of the bubble as follows: "What if the BOJ had loosened substantially in 1994, to guard against the risk of deflation, and then unanticipated favorable shocks had lifted output gaps and inflation well into positive territory? In that scenario, based on the logic of the simulation results discussed above, inflation would have risen above desired levels for a number of years, but a tightening of monetary policy by the BOJ in response would have caused short-term interest rates to rise and inflation eventually to decline back to its original baseline".

As in the case of additional loosening after 1985, the results fall into the acceptable range if the commitment is short term. However, if the commitment period becomes longer, the results become disruptive, with a substantial rise in CPI inflation and a wide fluctuation of interest rates (Figures 7 and 8).

5. Simulations Using JEM (2): Adoption of Non-Linear Policy Reaction Function

5.1. Adoption of Non-Linear Reaction Function

An alternative approach considered to be more promising is to non-linearized the Taylor rule so that the monetary policy stance becomes more expansive than that implied by the standard Taylor rule, since the economic environment is becoming deflationary.

Our approach of modifying the Taylor rule in the face of the zero bound on interest rate is similar to the approach of Reifschneider and Williams (2000) in the sense that they both try to avoid the risk of deflation in advance by the commitment of a central bank.

Also, Adam and Billi (2006, 2007) and Oda and Nagahata (2008) are among the examples of studies that examined the effects of the non-linear reaction function as a preventive measure against deflation, a point of common interest to this paper.

Conducting calibration to the U.S. economy, Adam and Billi (2007) suggest that when the economy may face a zero lower bound of interest rates, the policymaker should reduce nominal interest rates more aggressively than suggested by a model without a lower bound. The reason is that rational agents anticipate the possibility of reaching the lower bound in the future, and this amplifies the effects of adverse shocks well before the bound is reached. They conclude that while the empirical magnitude of the U.S. mark-up shocks seems too small to entail zero nominal interest rates, shocks affecting the natural real interest rate plausibly lead to a binding lower bound. Under optimal policy, however, this occurs quite infrequently and does not require targeting a positive average rate of inflation.

Oda and Nagahata (2008) analyze the monetary policy rules that could be implemented in practice under the zero interest rate constraint. Based on the estimated small structural model for the Japanese economy, they report that the characteristics of the non-linear optimal simple rule they develop can be summarized as follows.[11]

- The nominal interest rate is set at 0% when the baseline Taylor-type rule indicates a nominal rate of 0.5% or below.
- When the baseline Taylor-type rule indicates nominal interest rates of 1.0, 1.5, and 2.0%, the optimal rule results in lower nominal rates of 0.27, 0.75, and 1.46%, respectively.
- When the baseline Taylor-type rule indicates a nominal interest rate of 3.0% or higher, the optimal rule almost corresponds to the baseline Taylor-type rule.

With these results in mind, in the following we incorporate two alternative policy response functions (monetary policy rules) into JEM and examine the results.

5.1.1. Non-Linear Rule 1

Rule 1 is that a policymaker changes the constant term of the policy rule in a non-linear fashion depending on a prevailing economic situation.

$$i_t = Max[0, \quad \psi_t^{NL}(r^* + \pi^*) + x_t]$$

$$\psi_t^{NL} = \frac{\exp(\psi_1 x_{t-1} + \psi_2 \Delta x_{t-1} + \psi_3)}{1 + \exp(\psi_1 x_{t-1} + \psi_2 \Delta x_{t-1} + \psi_3)}$$

$$x_t = 1.6(\pi_t - \pi^*) + 0.4(y_t - y_t^*), \quad \psi_1, \ \psi_3 > 0$$

where, ψ_t^{NL} is the time-varying parameter ($0 < \psi_t^{NL} < 1$) that depends on a prevailing economic situation x_t. The economic situation x_t is weighted sum of output gap and gap between inflation and its target, and corresponds to Taylor rule type policy reaction function excluding the constant term. With appropriate choice of positive parameters

[11] The optimal parameter, of course, varies depending upon such factors as a target inflation rate.

ψ_1 and ψ_3, we can set up the time-varying parameter ψ_t^{NL} in a way that 1) ψ_t^{NL} gets closer to zero when a deflation gap ($x_t < 0$) becomes larger, and 2) $\psi_t^{NL} \approx 1$ when an inflation gap ($x_t > 0$) exists. If we assume that the time-varying parameter ψ_t^{NL} has the properties described above, a central bank will determine the interest rates based on the Taylor rule when there is an inflation gap ($x_t > 0$), but a central bank can take a more aggressive policy response by driving the rates lower by reducing the constant term $\psi_t^{NL}(r^* + \pi^*)$ as a deflation gap ($x_t < 0$) becomes greater. While AGHK assumed permanent and significant reduction in the constant term in the reaction function and our simulations in the previous section assumed significant reduction in the constant term during pre-determined length of period, the non-liner rule described here assumes that the extent and the length of period of the reduction of the constant term are determined endogenously by a deflation gap.

Positive values of ψ_2 ($\psi_2 > 0$) correspond to the case in which the emphasis is on the interest rate cuts against increasing downward pressure on the economy ($\Delta x_t < 0$), while negative values for ψ_2 ($\psi_2 < 0$) correspond to the case in which the emphasis is on driving lower interests rates lower during the recovery of the economy ($\Delta x_t > 0$). Since the focus of this study is on monetary policy as an insurance against deflation, we set a positive value for ψ_2 ($\psi_2 > 0$).

While there are no specific determining factors for ψ_1, ψ_2, ψ_3, we set up these parameters as $\psi_1 = 10$ and $\psi_3 = 5$, so that 1) when the deflation gap is $x_t = -0.5$, the time-varying parameter becomes $\psi_t^{NL} \approx 0.5$ and 2) when the deflation gap is $x_t = -1.0$, the time-varying parameter becomes $\psi_t^{NL} \approx 0.0$. Also, we set up ψ_2 as $\psi_2 = 1$.

5.1.2 Non-Liner Rule 2

Alternatively, it is possible to consider a policy rule that increases responsiveness of the policy rate against the target variables when a deflation gap emerges, rather than shift the constant term upward/downward.

$$i_t = Max[0,\ r^* + \pi^* + \lambda_t^{NL} x_t],$$

$$\lambda_t^{NL} = \frac{\lambda_1 - 1}{1 + \exp\left(\lambda_2 x_{t-1} + \lambda_3 \Delta x_{t-1} + \lambda_4\right)} + 1,$$

$$x_t = 1.6(\pi_t - \pi^*) + 0.4(y_t - y_t^*),\ \ \lambda_1 > 1,\ \ \lambda_2, \lambda_4 > 0,$$

where λ_t^{NL} is the time-varying parameter ($1 < \lambda_t^{NL} < \lambda_1$) that depends on the prevailing economic situation x_t. With appropriate choice of positive parameters λ_1, λ_2 and λ_4, we can set up the time-varying parameter λ_t^{NL} in a way that 1) λ_t^{NL} gets closer to λ_1 as the deflation gap ($x_t < 0$) becomes larger, and 2) $\lambda_t^{NL} \approx 1$ when an inflation gap ($x_t > 0$) exists. This rule is identical to the Taylor rule when there is an inflation gap ($x_t > 0$), but makes the policy interest rates respond more strongly against the economic situation x_t as a deflation gap emerges ($x_t < 0$). Under this rule, policy responsiveness is multiplied by λ_1 when a deflation gap exceeds certain threshold.

Positive values of λ_3 ($\lambda_3 > 0$) correspond to the case in which the emphasis is on the preventive lowering of interest rates against downward pressure on the economy ($\Delta x_t < 0$), while negative values for λ_3 ($\lambda_3 < 0$) corresponds to the case in which the emphasis is on driving interest rates lower during the recovery of the economy ($\Delta x_t > 0$).

While there are no specific determining factors for λ_1, λ_2, λ_4, we set up these parameters as $\lambda_1 = 2.5$, $\lambda_2 = 10$ and $\lambda_4 = 3$, so that 1) when the deflation gap is $x_t = -1.0$, the time-varying parameter becomes $\lambda_t^{NL} \approx 2.5$ and 2) when the deflation gap is $x_t = 0$, the time-varying parameter becomes $\lambda_t^{NL} \approx 1.0$. Also, we set λ_3 as $\lambda_3 = 1$, to emphasize a preventive cut of interest rates.

For the target inflation rate, since we use the model of the Japanese economy for the counterfactual simulations, we assume $\pi^* = 1\%$ for both rule 1 and rule 2, based on the BoJ's statement.[12]

[12] On March 10, 2006 the BOJ published "The Bank's Thinking on Price Stability" and explained the level of inflation rate that each Policy Board member understands as price stability from a medium- to long-term viewpoint as follows. "While there was a range of views, reflecting the

5.2. Results of the Simulations

The results of the simulations are summarized in Figures 9 and 10. Under both rules, non-linear interest rate cuts start after the second half of 1993. Monetary policy does not alter the long-term stagnation of the Japanese economy substantially, since there is little change in the growth rate and the output gap.

However, it is interesting to note that deflation can be narrowly avoided, at least until 2001. In addition, the timing of the interest rate cuts are not early, compared to the simulations of loosening at the early stages such as those in Figure 4(1), which are not feasible in reality. Also, average interest rates throughout the period do not seem to be substantially lower than the historic figures, and we can avoid wide fluctuations in interest rates, such as the sharp rise in the rates seen when the central bank returns to the Taylor rule in the simulations of time-limited cuts of interest rates.

Moreover, based on the BOJ's policy board members' thinking on price stability, the assumption on the target inflation rate is set at 1%, which is relatively low among major economies. Thus our results do not rely on a higher target inflation rate that is often recommended as an insurance against deflation. It is worth noting that even under these weak assumptions, a reasonable policy effect can be achieved in terms of mitigation of the risk of deflation.

The reasons for this seem to be that, in addition to a normal effect via interest rate channel by non-linear cuts in interest rates, there exists a strong effect via expectation channel suggested by Adam and Billi (2006) and others, i.e. an effect by which negative deflationary influence is mitigated; the behavior of economic agents

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differences in the relative weight attached to factors affecting the understanding of price stability, it was recognized that the level was somewhat lower than that in major overseas economies. It was agreed that, by making use of the rate of year-on-year change in the consumer price index to describe the understanding, an approximate range between zero and two percent was generally consistent with the distribution of each Board member's understanding of medium- to long-term price stability. Most Board members' median figures fell on both sides of one percent. Given that the understanding of medium- to long-term price stability may change gradually reflecting developments such as structural changes in the economy, as a rule, Board members will review it annually."

incorporates an expectation on an aggressive monetary policy that should make substantially larger interest rate cuts than would occur under a normal situation, before the economy gets into a zero bound on interest rates.

6. Concluding Remarks

Mishkin (2008a) raises the question that how monetary policy should respond to financial disruptions in light of risk-management considerations and argues that monetary policy needs to be timely, decisive, and flexible.

As for policy flexibility, Mishkin argues that

> *policy flexibility* is crucial throughout the evolution of a financial market disruption. During the onset of the episode, this flexibility may be evident from the decisive easing of policy that is intended to forestall the contractionary effects of the disruption and provide insurance against the downside risks to the macroeconomy. However, it is important to recognize that financial markets can also turn around quickly, thereby reducing the drag on the economy as well as the degree of tail risk. Therefore, the central bank needs to monitor credit spreads and other incoming data for signs of financial market recovery and, if necessary, take back some of the insurance; thus, at each stage of the episode, the appropriate monetary policy may exhibit much less smoothing than would be typical in other circumstances.

In light of Mishkin's argument, the assumption of permanent downward shift of Taylor rule by AGHK is too decisive, especially when central banks try to take an action against the risk of deflation under strong uncertainty. Thus it would not be a realistic guideline for future policymakers.

In this paper, we examined two approaches as alternative responses that can be considered realistic: 1) the central bank either departs from the Taylor rule for a certain period of time and returns to the rule after that, or 2) the central bank modifies the Taylor rule into a non-linear rule that creates increasingly stronger policy interest rates against the rise in the risk of deflation.

The results of the simulations of the first approach that involves time-limited commitment to low interest rates using JEM are as follows:

- ✓ In the case in which the economy actually suffers a deflationary shock subsequently, the period of departure from the Taylor rule needs to be sufficiently long; otherwise, deflation cannot be avoided.
- ✓ However, if there is a subsequent inflationary shock on the economy as the result of monetary loosening, a longer period of departure from the Taylor rule could lead to substantial destabilization of the economy.

Consequently, to make a commitment of time-limited downward shift of the Taylor rule as a risk management measure against deflation—even when forward-looking economic agents have confidence in the commitment—is not considered to be a fail-safe strategy because of the lack of flexibility.

For the second approach, which non-linearizes policy response function, it does not lead to an adoption of zero-interest rate policy at an early stage or to an unacceptable wide fluctuation of interest rates. A reasonable policy effect is observed, since deflation is avoided during the simulation periods.

These results are considered to be caused by a forward-looking expectation on aggressive monetary policy that is incorporated into the economic agents' behavior. Thus, adverse deflationary impact due to economic agent awareness of the zero bound on interest rate can be mitigated.

Of course, the extent of the loosening effect through the expectation channel could vary, depending on the proportion of economic agents that act in a forward-looking fashion. Also, such monetary policy cannot be expected to alter long-term stagnation either, at the least in the case of the Japanese economy in the 1990s, judging from the growth rate and the development of the output gap observed in the simulations. In addition, many readers might find our results inadequate, since the model does not explicitly incorporate the negative effects of disorder of the financial system that represents an essential transmission mechanism of the collapse of the asset price bubble.

However, the simulations do suggest the particular importance of "communication strategy for a deflation fighter" for central banks that face the risk of deflation, which involves substantial uncertainty. Under significant uncertainty, what is required for central banks as insurance against deflation is not necessarily to make interest rates cuts that are so significant in the early stages of disinflation and commit to maintain such significant low interest rates. Nor is it required to set a target inflation rate that is so high that it cannot possibly create confidence.

What is required is to announce the course of action that the policymaker will take at the stage where the risk of deflation becomes apparent to a certain degree. Moreover, the policymaker will return to normal rule when the risk of deflation becomes remote and as market participants gain confidence from the course of action.

The effects of the BOJ's zero interest rate policy were heavily dependent on the so-called "policy duration" effects that emerged through the commitment to the condition of lifting the zero interest rate policy, which affected expectations on the interest rate path. The results of the study here suggest that it is important to examine further how the communications of monetary policy should be conducted to keep flexibility, and to gain benefit from policy duration effects via exerting influence on expectations from the standpoint of risk management.[13]

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[13] Woodford(2008), referring to the BOJ's experience on policy duration effects, discussed the benefit of central banks showing expected future interest rate path (via fan chart with confidence interval, rather than point forecasts), as follows:

> I think that talking about the likely future course of rates can be quite valuable, at least at certain times. The economic effects of monetary policy depend almost entirely on the *anticipated future path* of the policy rate, rather than on the current level itself of a rate such as the federal funds rate; announced changes, or non-changes, in the funds rate operating target matter only to the extent that they also often imply changes in the expected path of the funds rate months or even years into the future.

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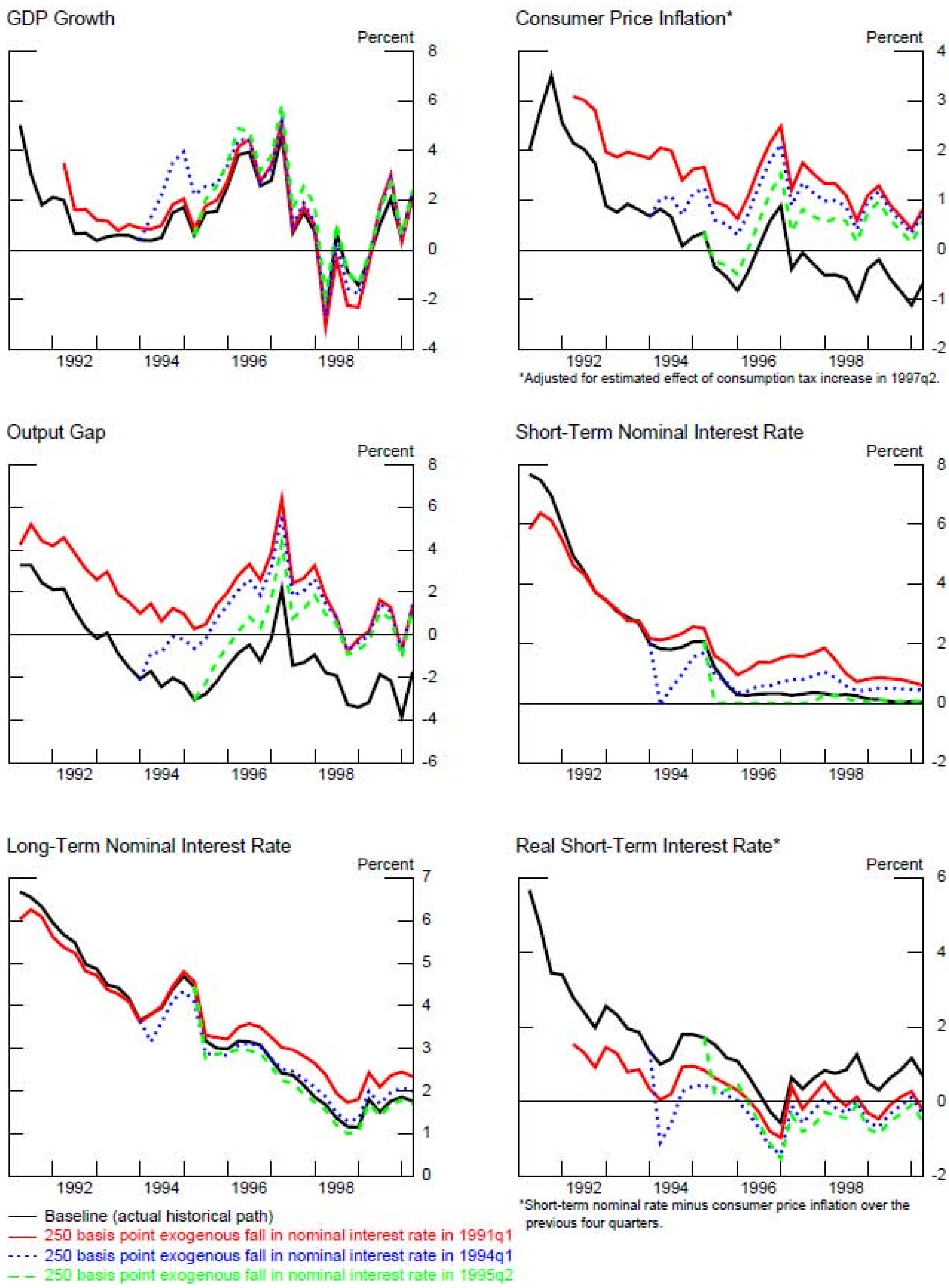
(Figure 1)

Simulation Results of Ahearne et al.(2002)

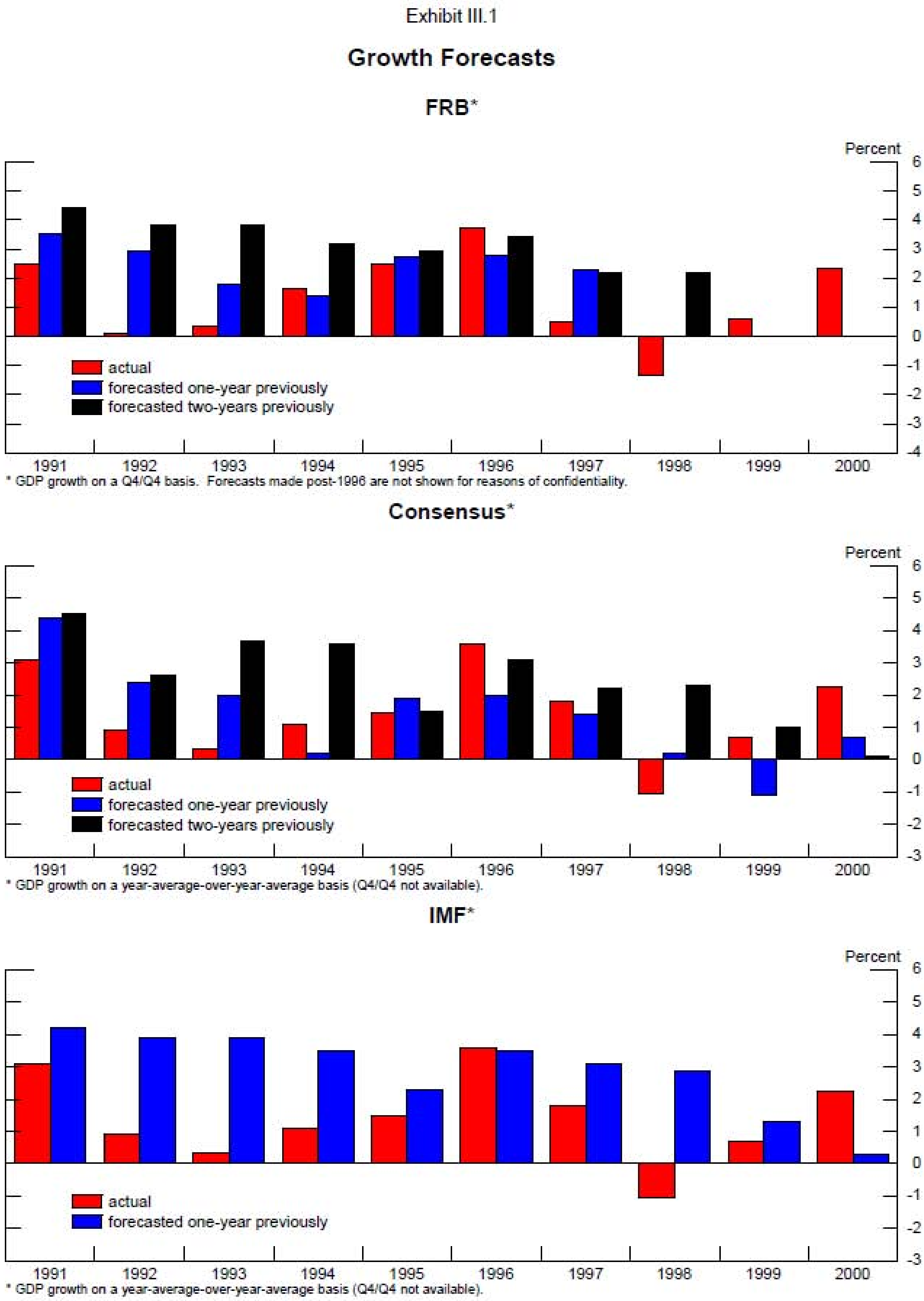
Exhibit IV.2

FRB/Global Simulations of Alternative Japanese Monetary Policies



(Figure 2)

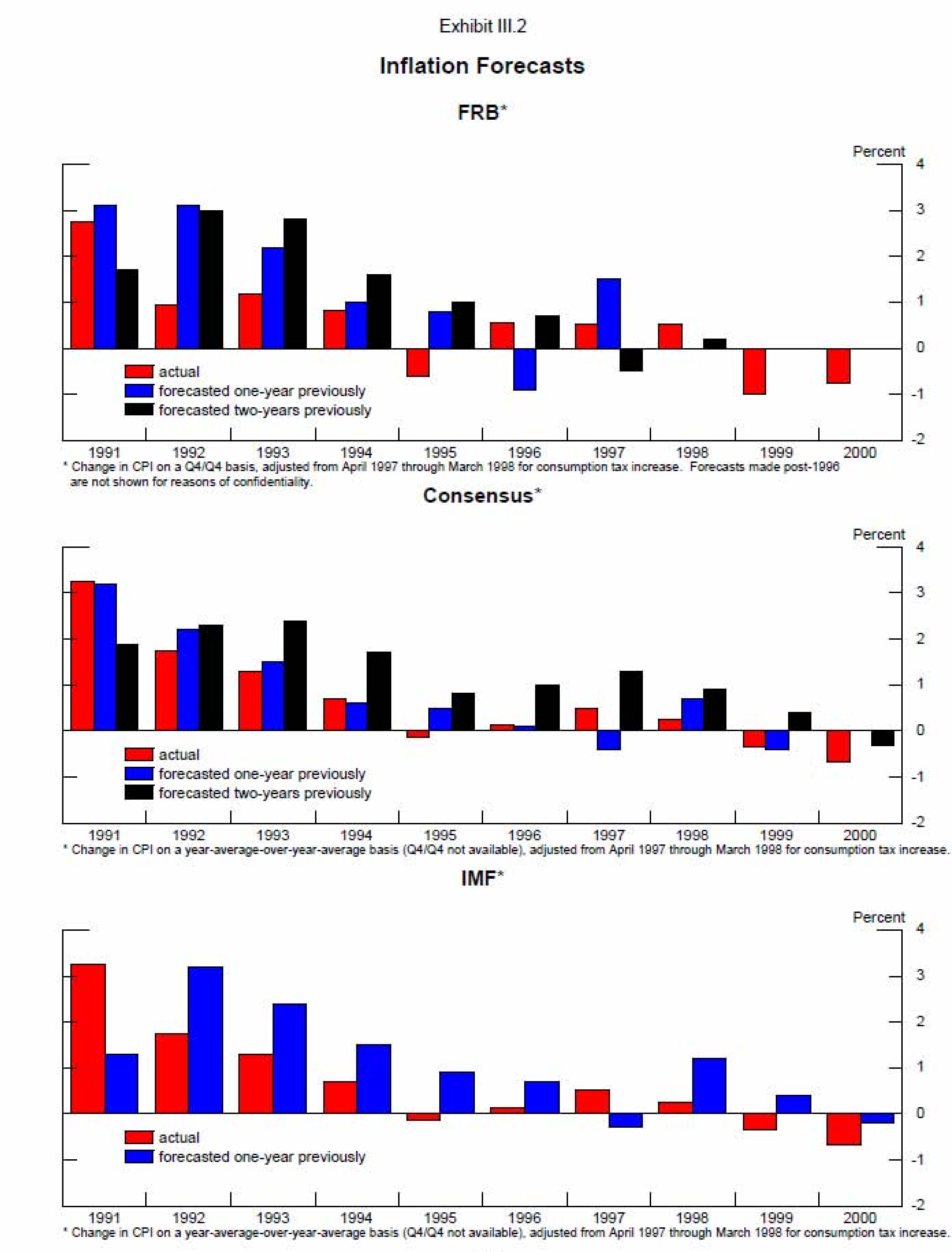
Outlook of Japanese Growth Rate During the 1990s



Source: Ahearne et al.(2002)

(Figure 3)

Outlook of Japanese Inflation Rate During the 1990s

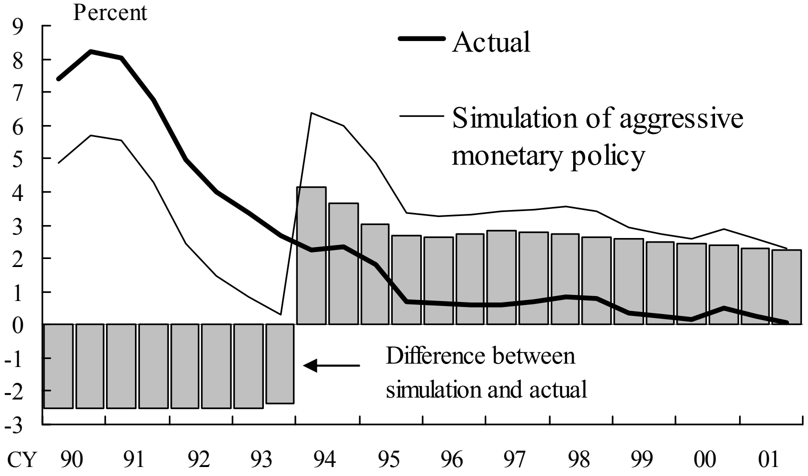


Source: Ahearne et al.(2002)

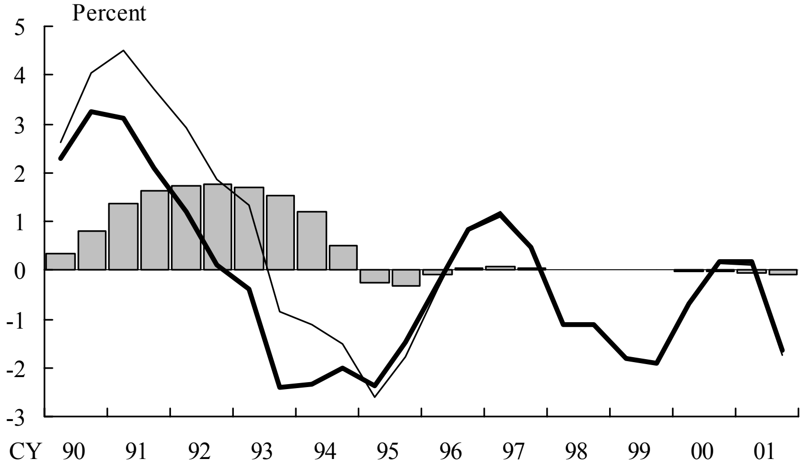
(Figure 4(1))

Simulation 1: Lowering Interest Rates by 250 bp. for Four years from 1990

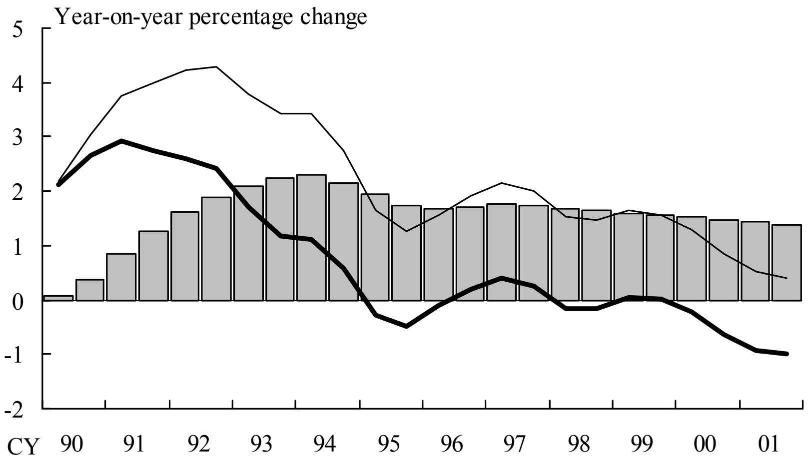
(1) Nominal short-term interest rate (3-month)



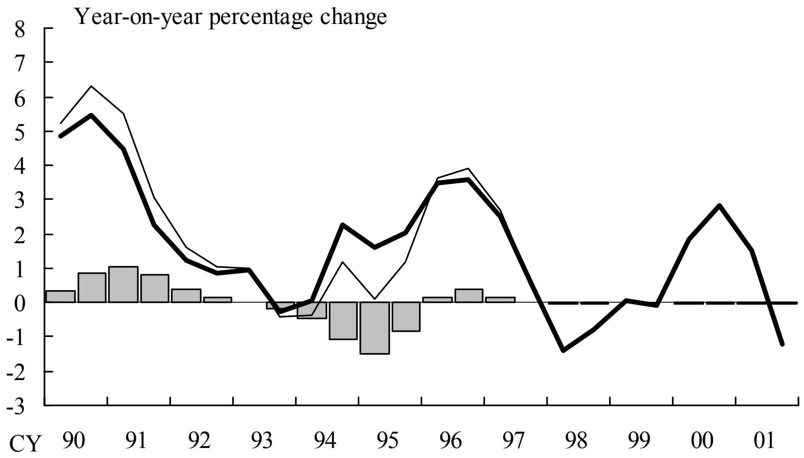
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)



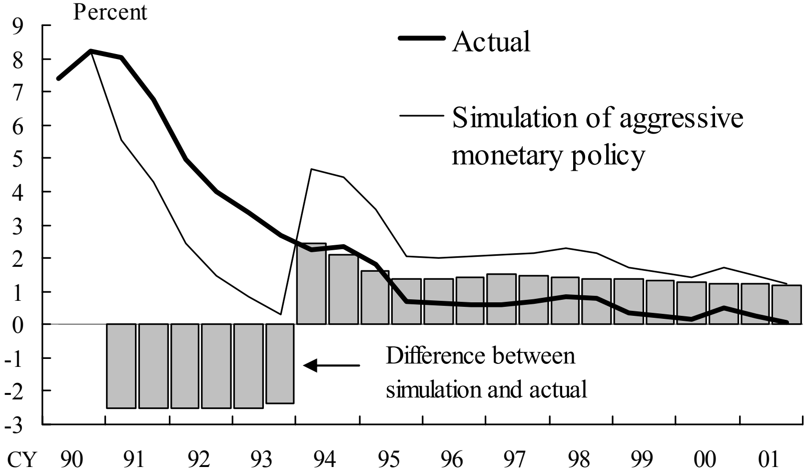
(4) GDP growth rate



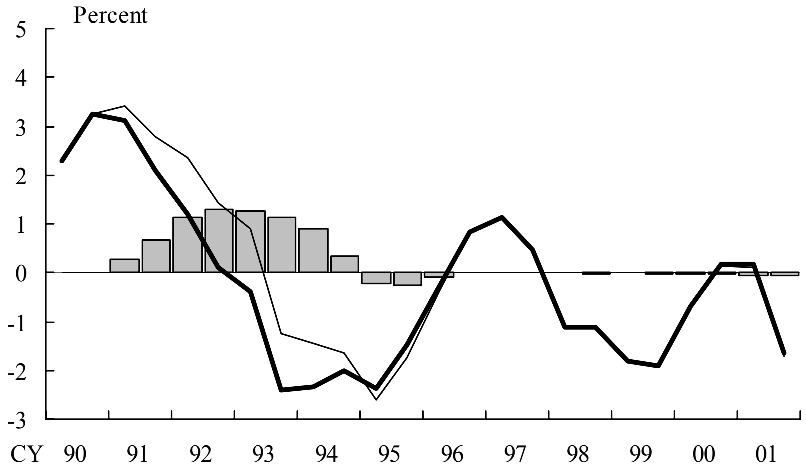
(Figure 4(2))

Simulation 1: Lowering Interest Rates by 250 bp. for Three Years from 1991

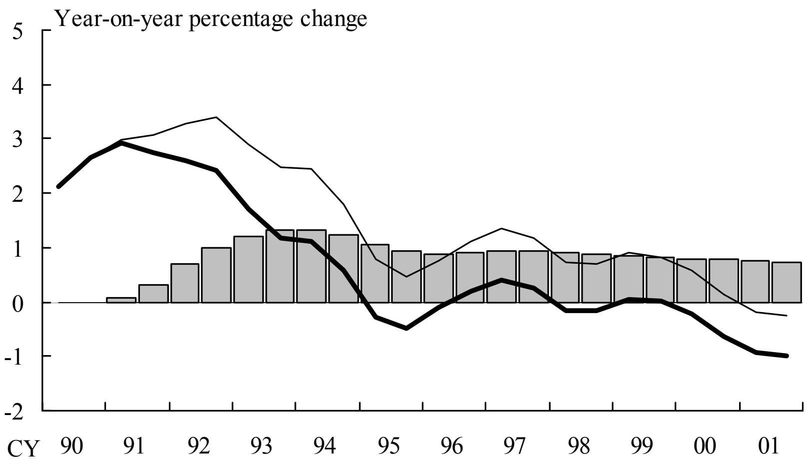
(1) Nominal short-term interest rate (3-month)



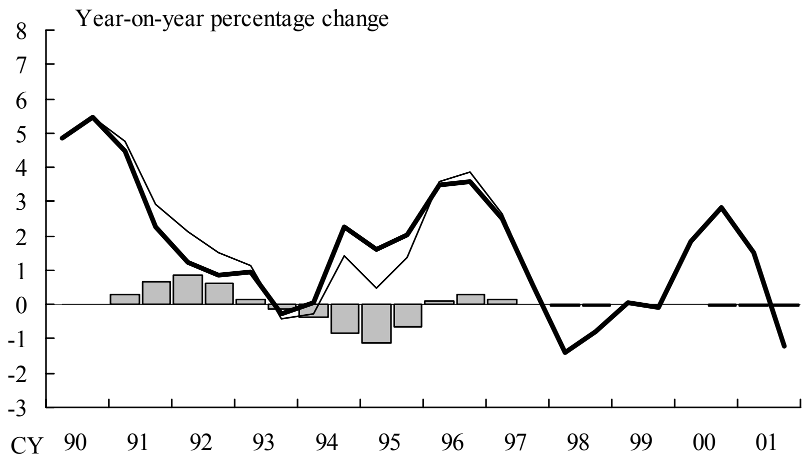
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)

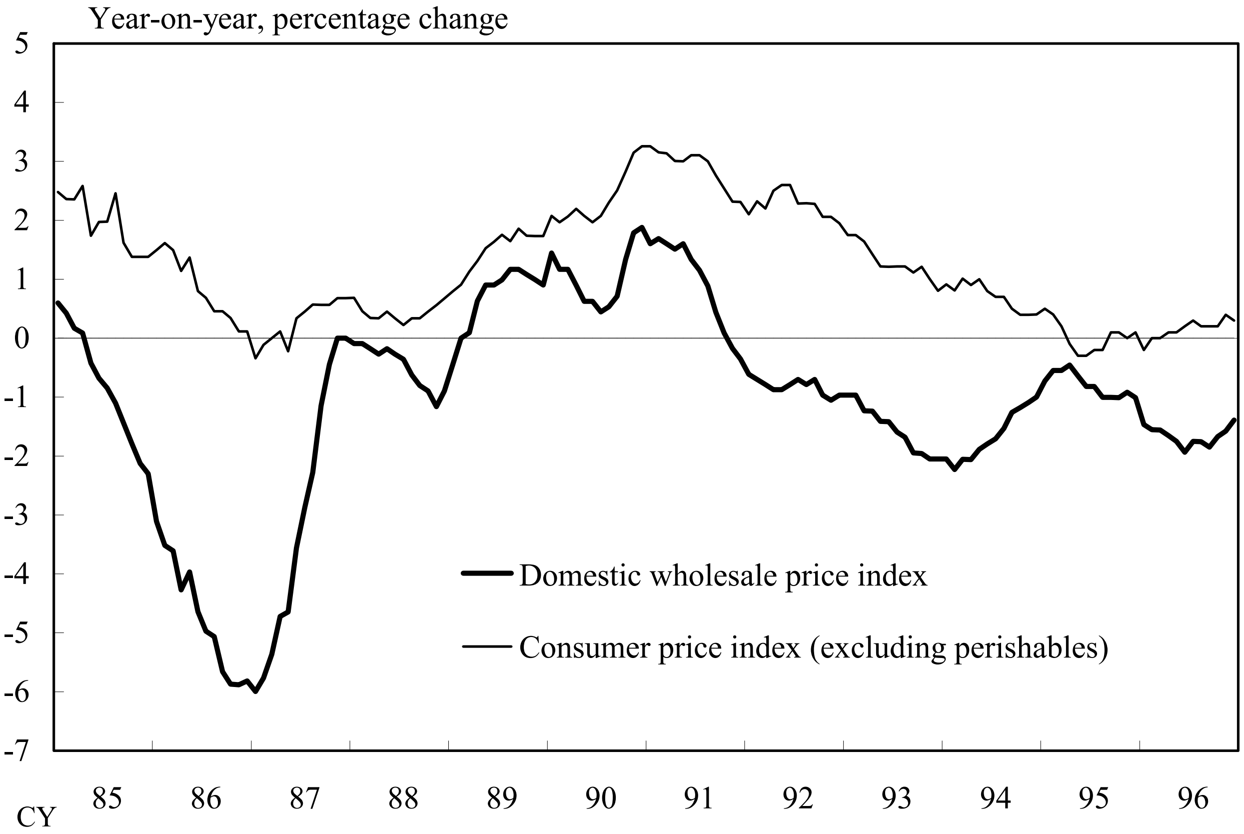


(4) GDP growth rate



(Figure 5)

WPI and CPI in Japan

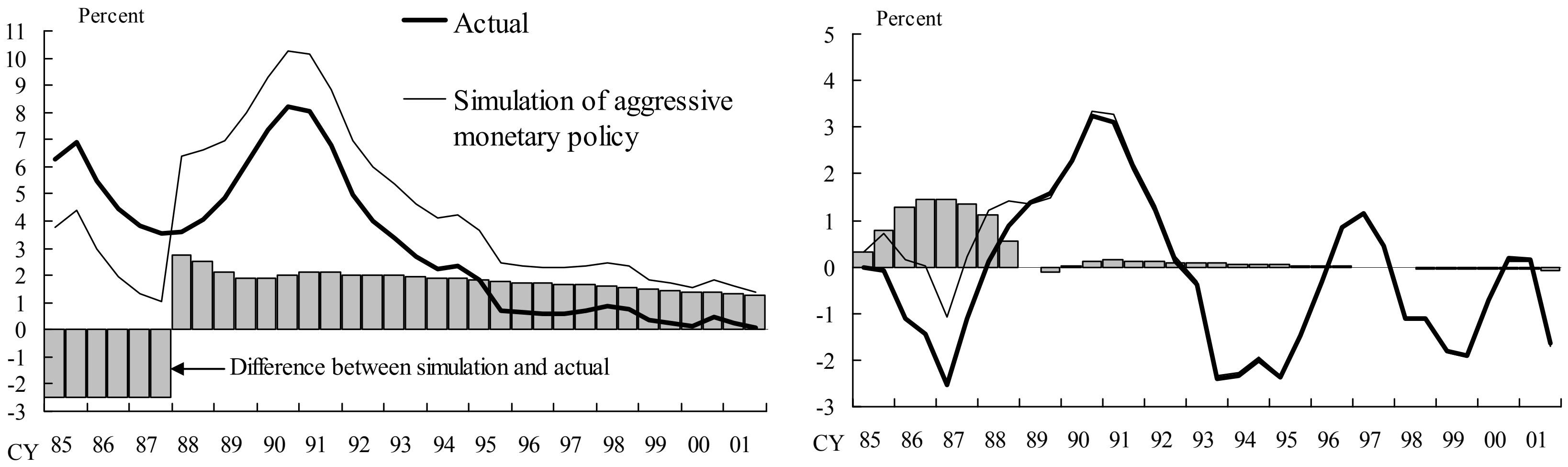


Note: Figures are adjusted to exclude the effects of the consumption tax hike in April 1989.
Sources: Bank of Japan, Ministry of Internal Affairs and Communications.

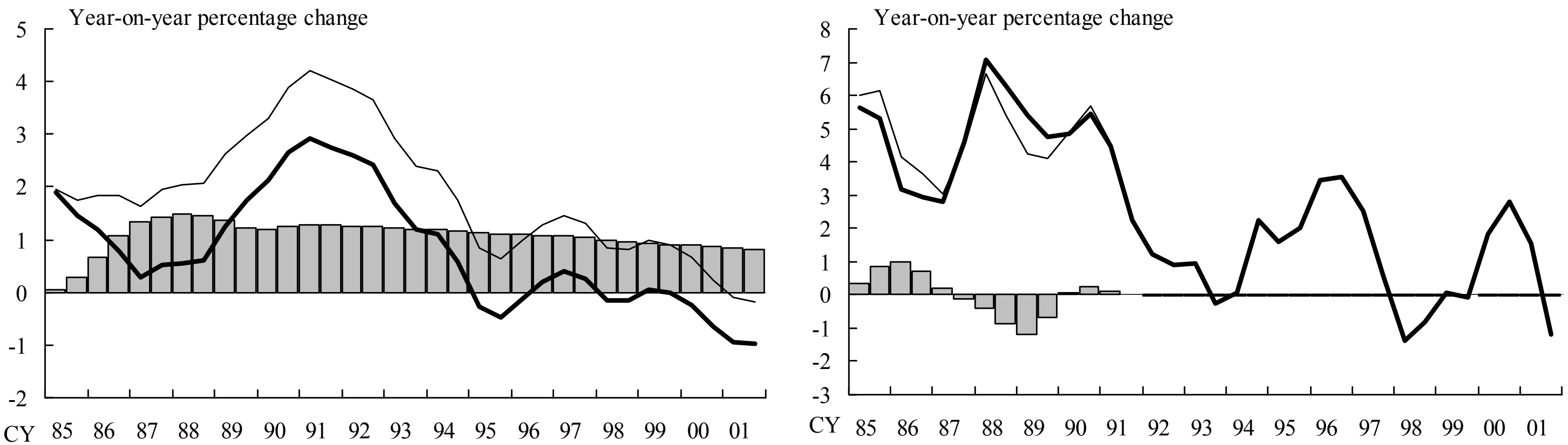
(Figure 6(1))

Simulation 2: Lowering Interest Rates by 250 bp. for Three Years from 1985

(1) Nominal short-term interest rate (3-month) (2) Output gap



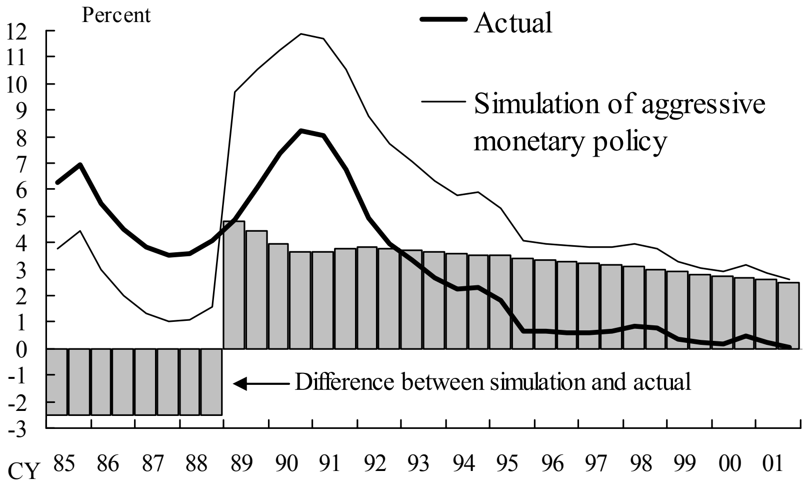
(3) CPI (excluding perishables and public utilities charge) (4) GDP growth rate



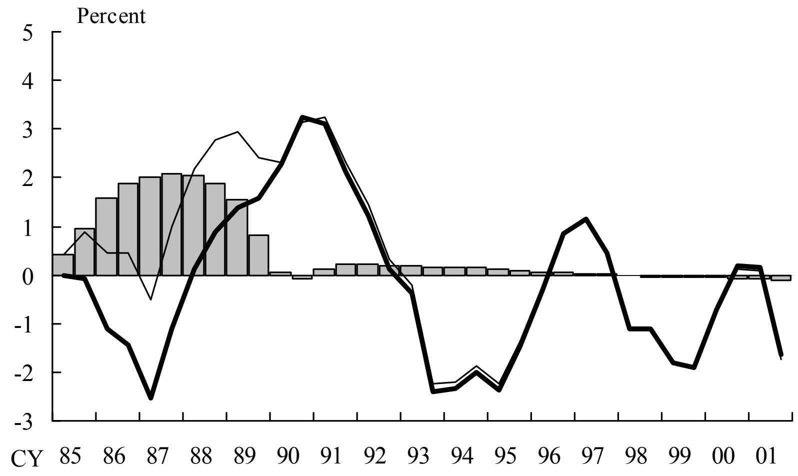
(Figure 6(2))

Simulation 2: Lowering Interest Rates by 250 bp. for Four years from 1985

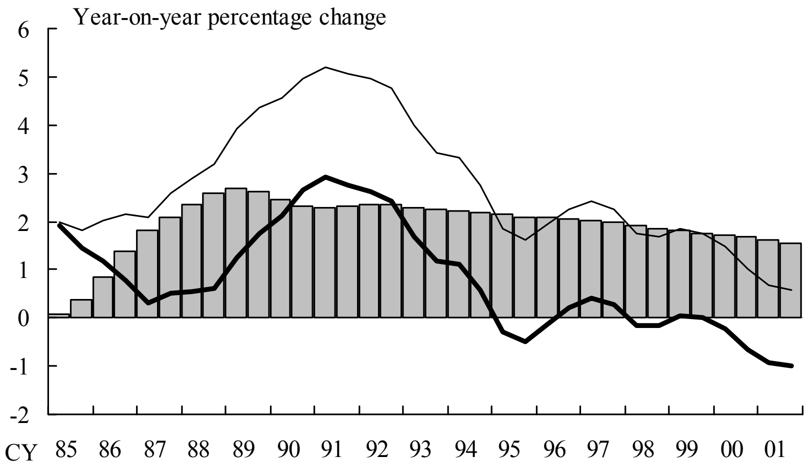
(1) Nominal short-term interest rate (3-month)



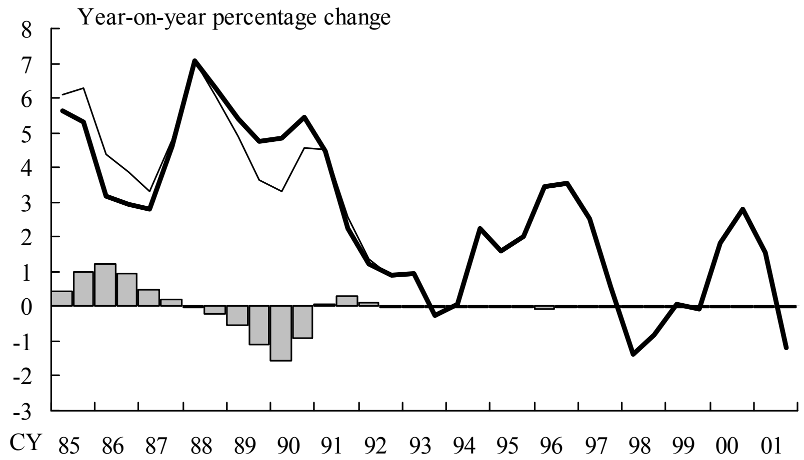
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)



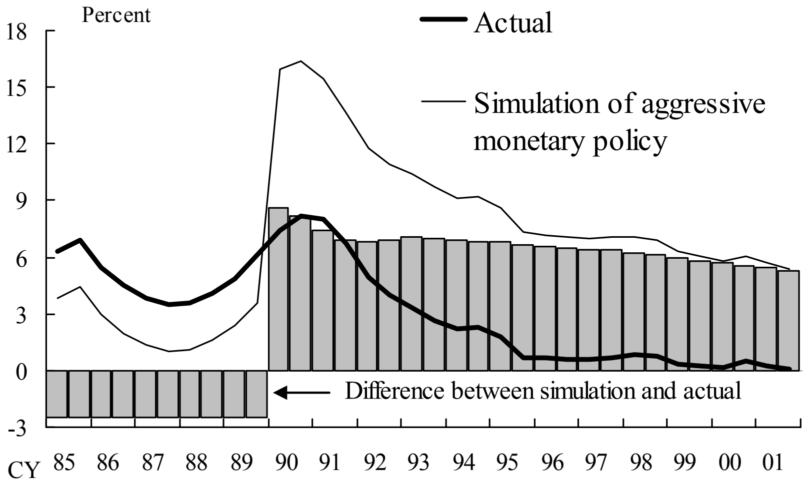
(4) GDP growth rate



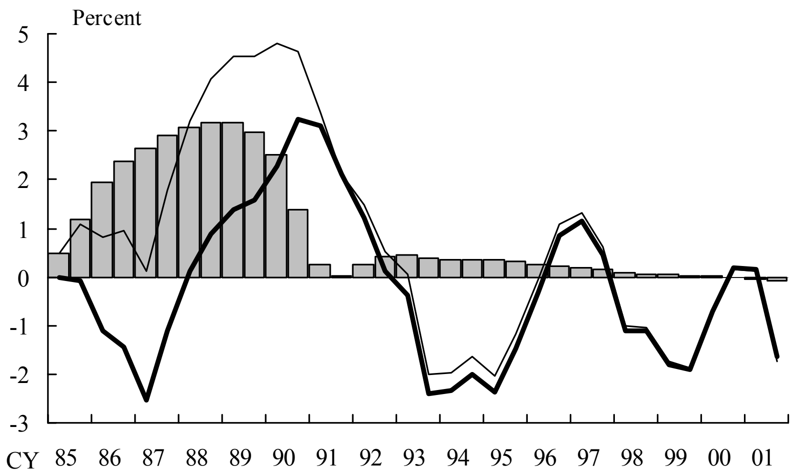
(Figure 6(3))

Simulation 2: Lowering Interest Rates by 250 bp. for Five Years from 1985

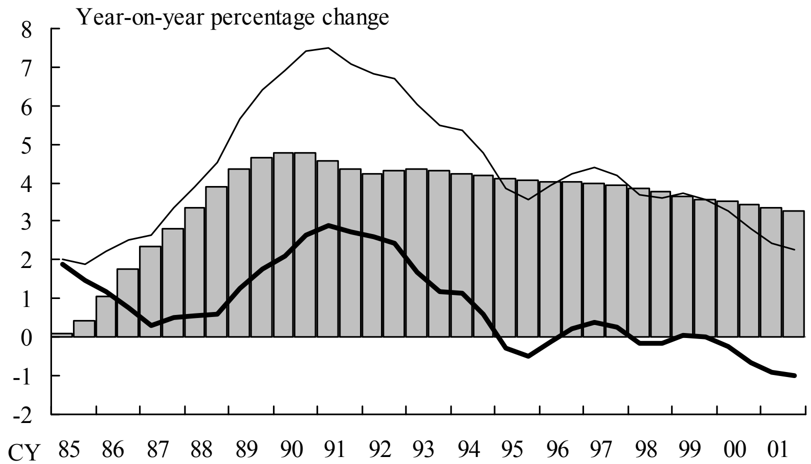
(1) Nominal short-term interest rate (3-month)



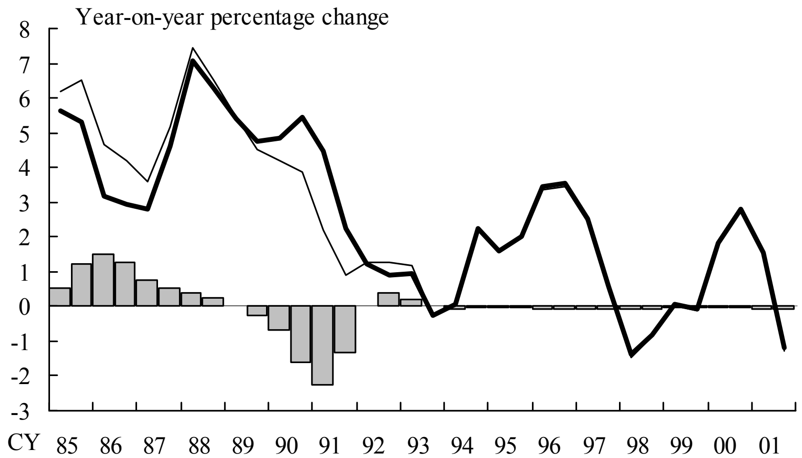
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)



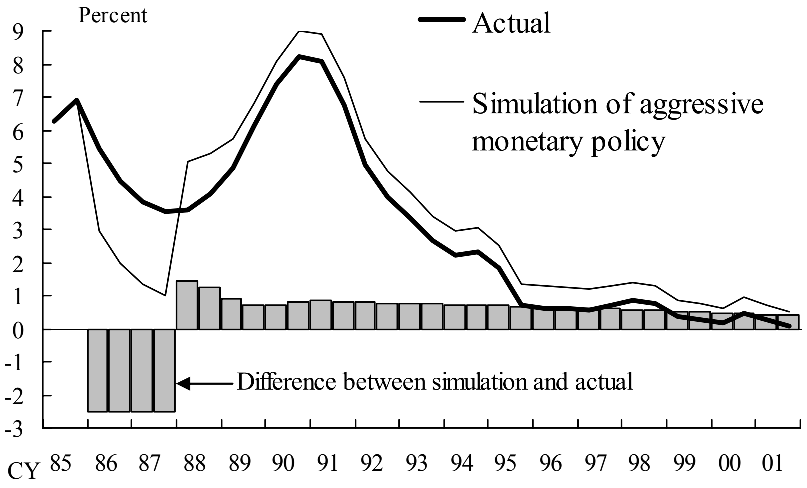
(4) GDP growth rate



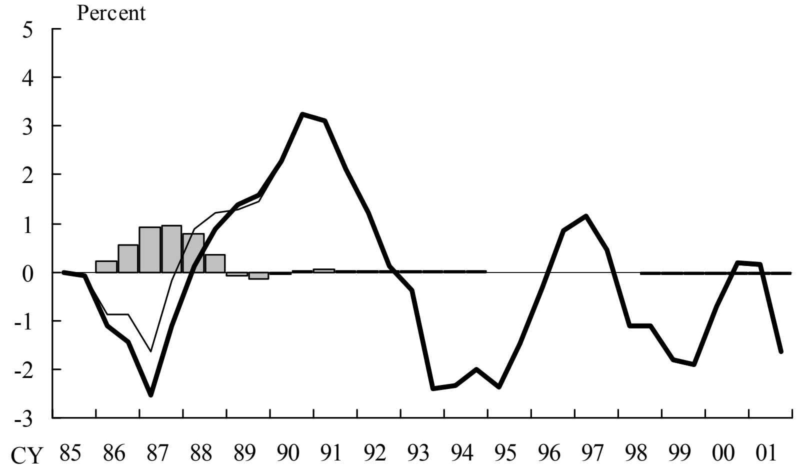
(Figure 7(1))

Simulation 2: Lowering Interest Rates by 250 bp. for Two Years from 1986

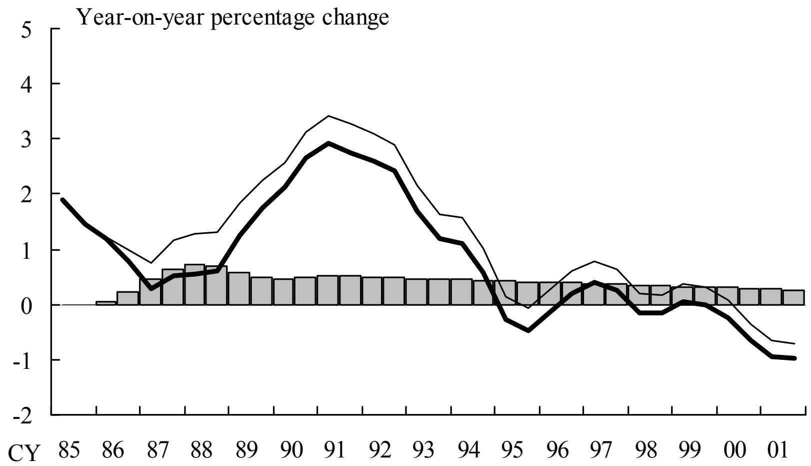
(1) Nominal short-term interest rate (3-month)



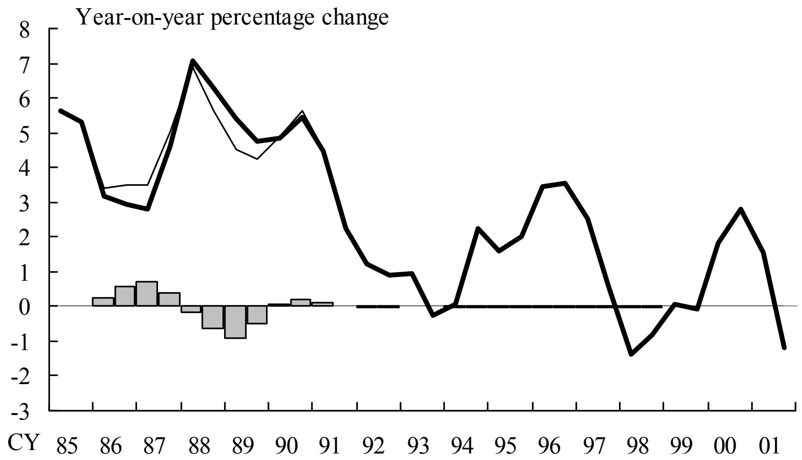
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)



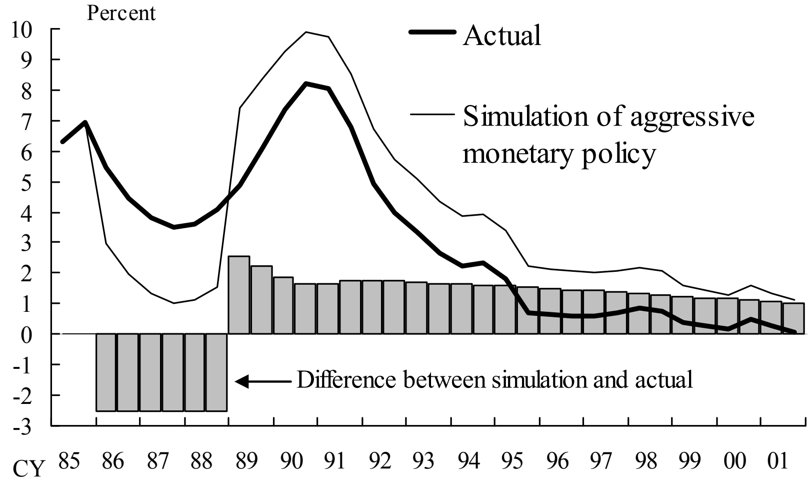
(4) GDP growth rate



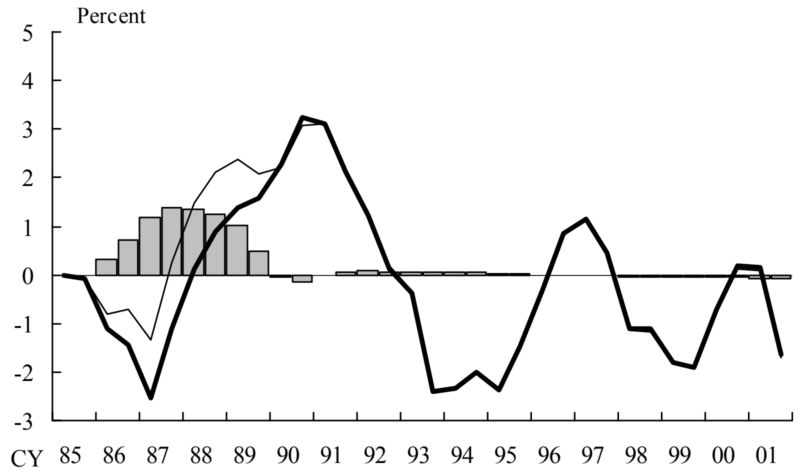
(Figure 7(2))

Simulation 2: Lowering Interest Rates by 250 bp. for Three Years from 1986

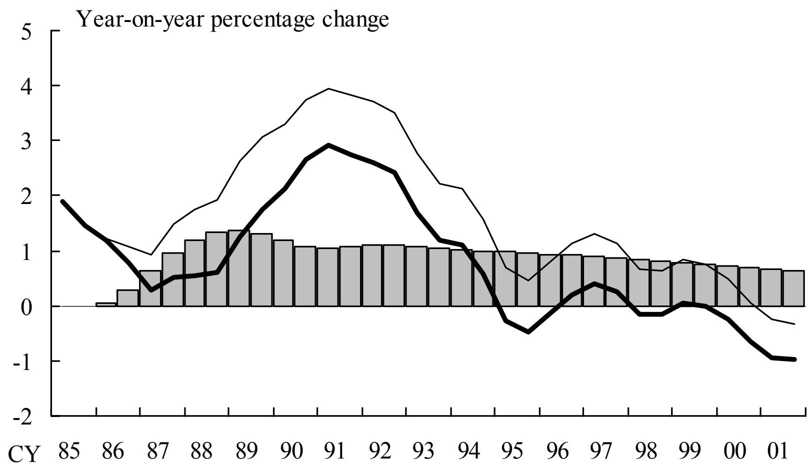
(1) Nominal short-term interest rate (3-month)



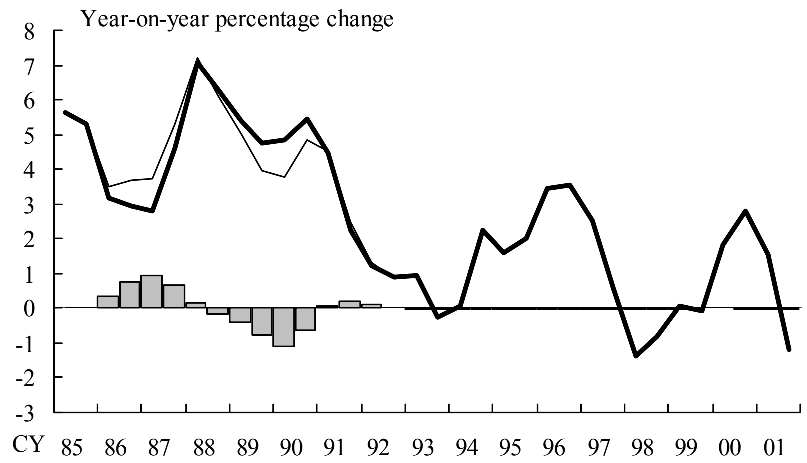
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)



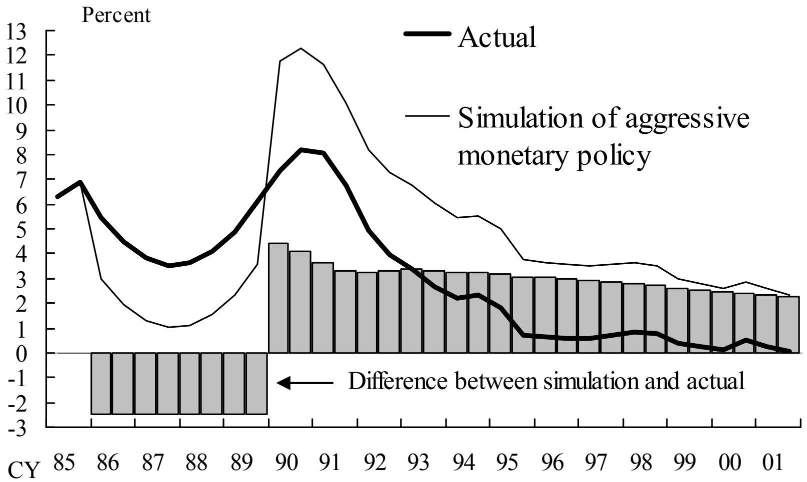
(4) GDP growth rate



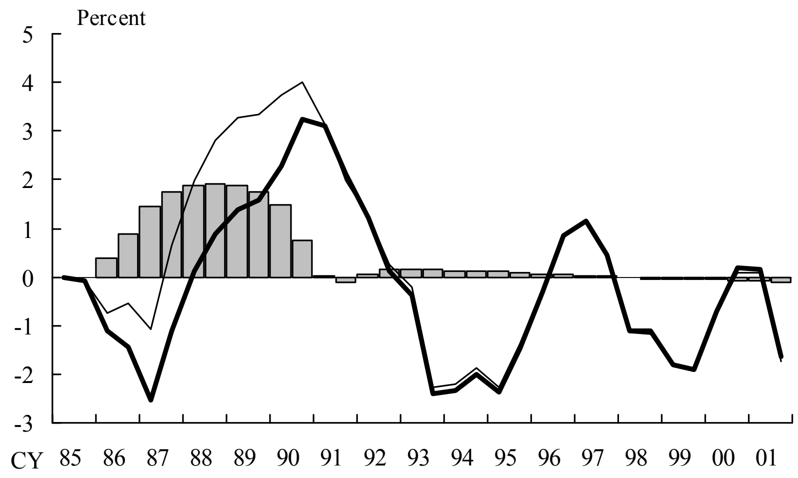
(Figure 7(3))

Simulation 2: Lowering Interest Rates by 250 bp. for Four Years from 1986

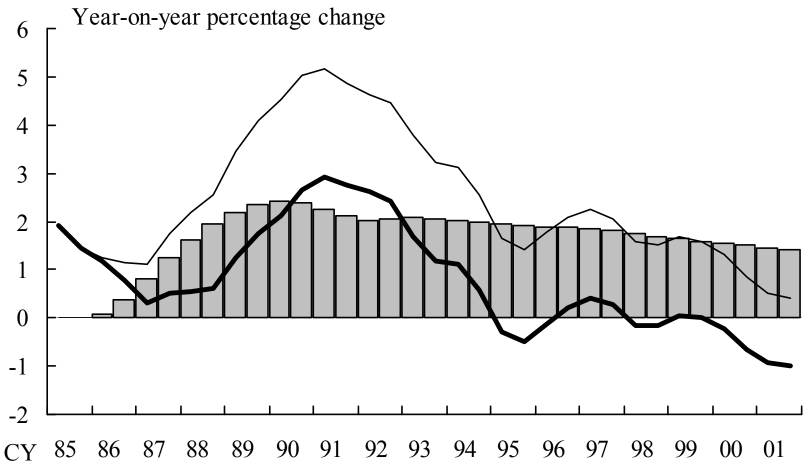
(1) Nominal short-term interest rate (3-month)



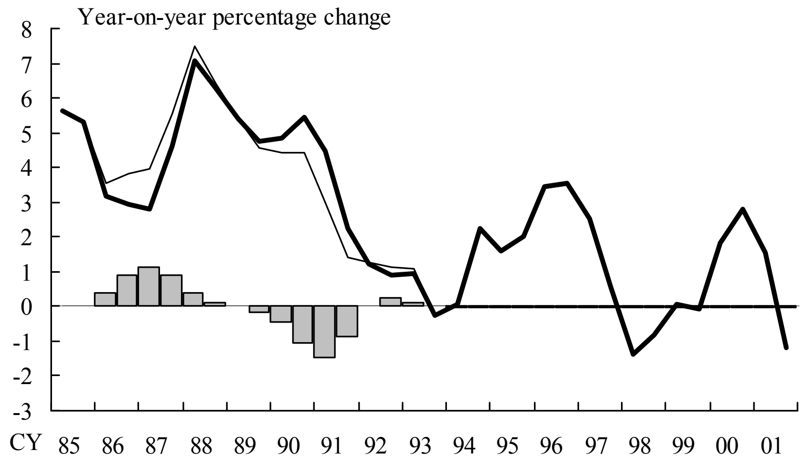
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)



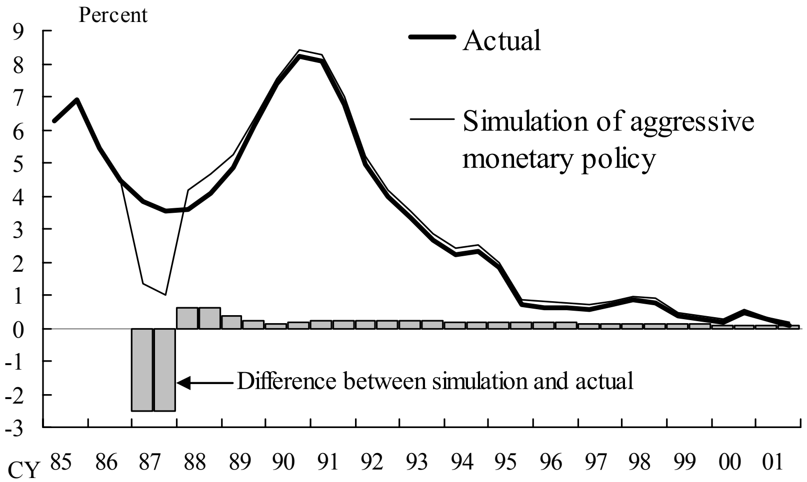
(4) GDP growth rate



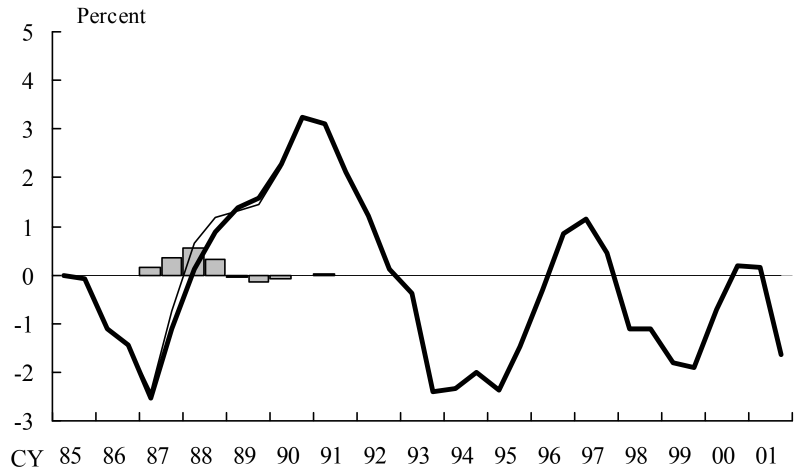
(Figure 8(1))

Simulation 2: Lowering Interest Rates by 250 bp. for One year from 1987

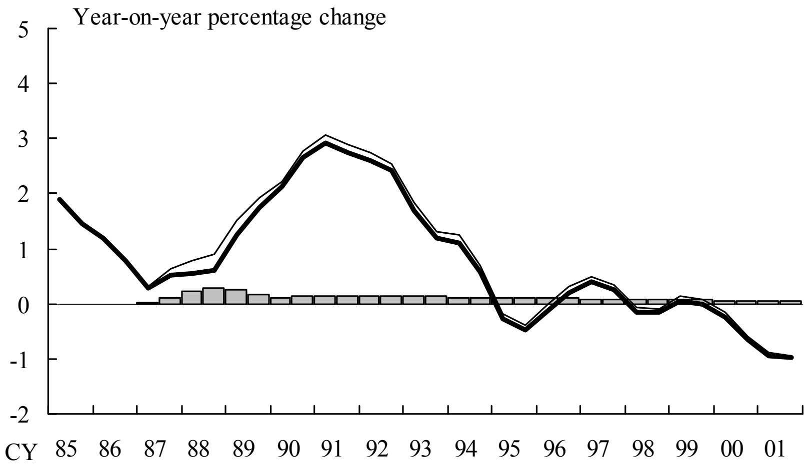
(1) Nominal short-term interest rate (3-month)



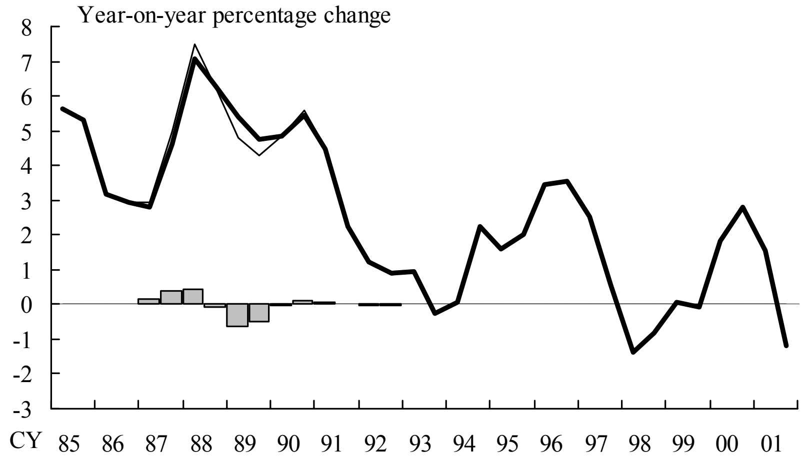
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)



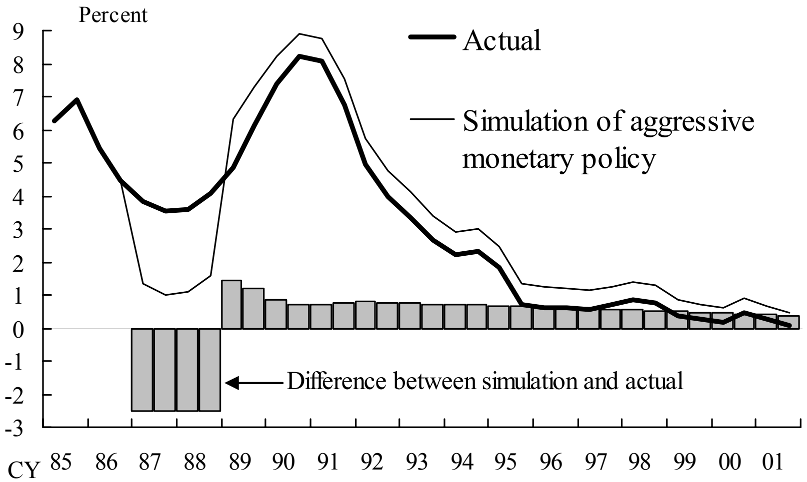
(4) GDP growth rate



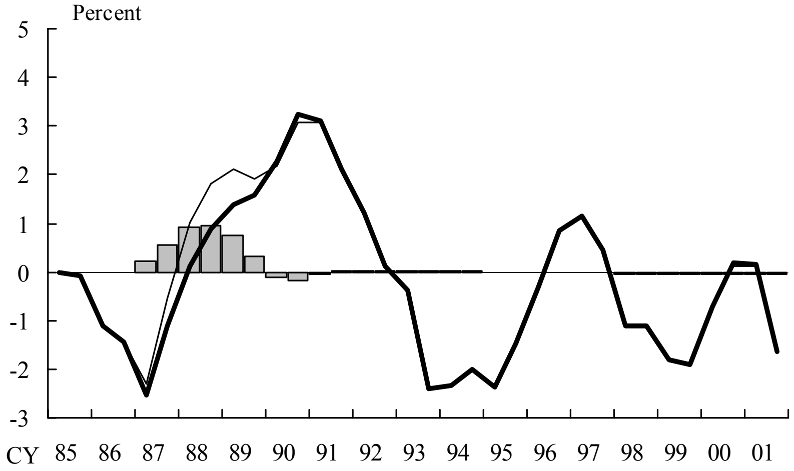
(Figure 8(2))

Simulation 2: Lowering Interest Rates by 250 bp. for Two Years from 1987

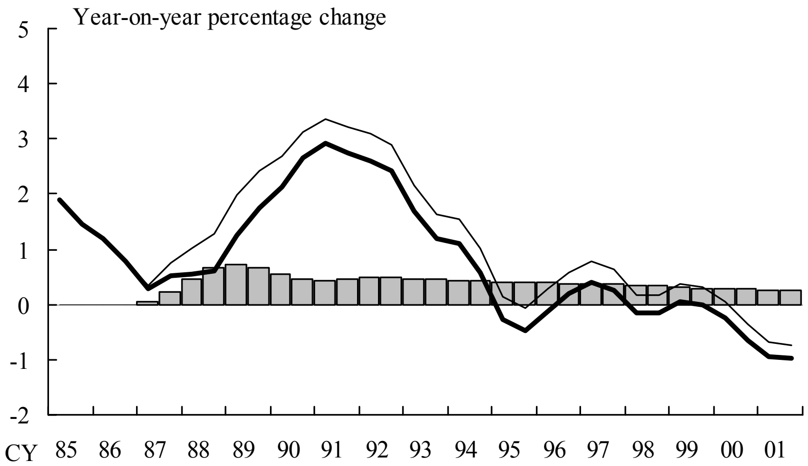
(1) Nominal short-term interest rate (3-month)



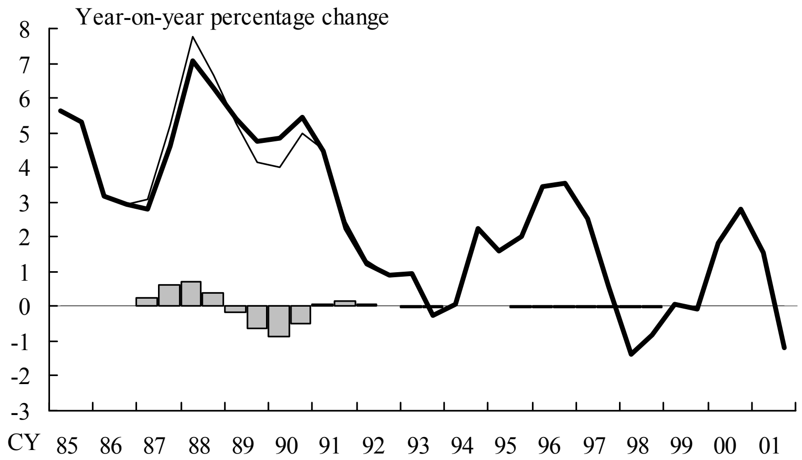
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)



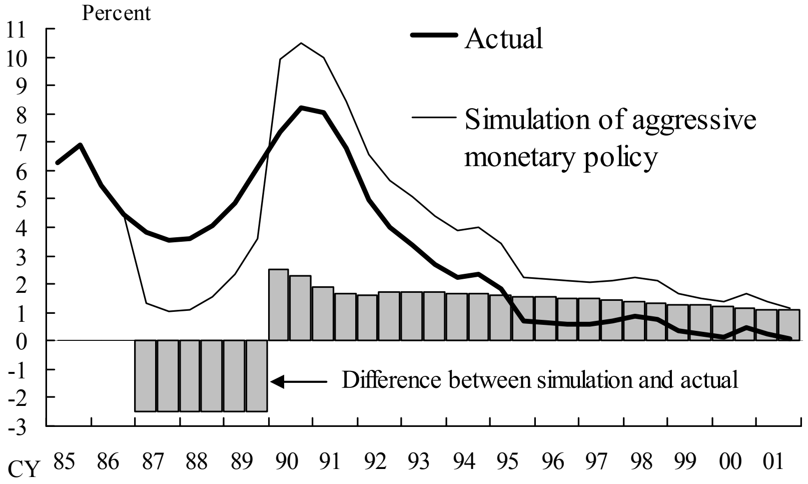
(4) GDP growth rate



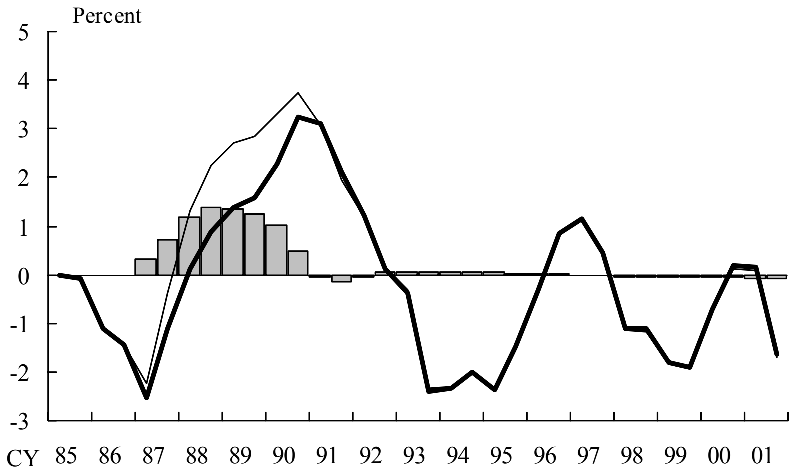
(Figure 8(3))

Simulation 2: Lowering Interest Rates by 250 bp. for Three Years from 1987

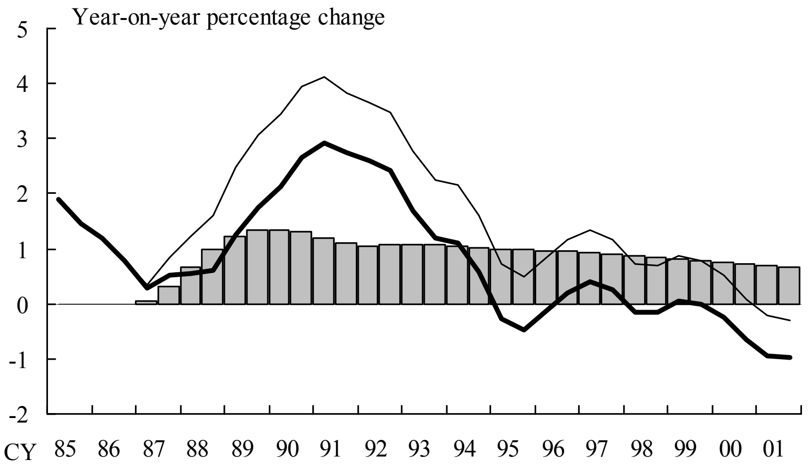
(1) Nominal short-term interest rate (3-month)



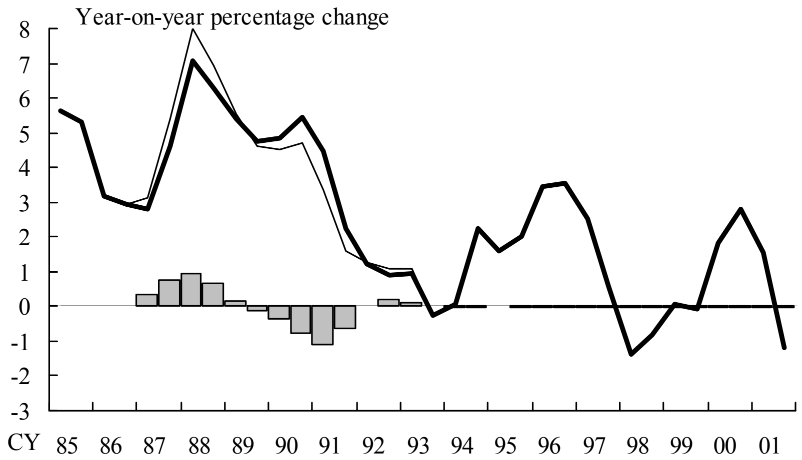
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)



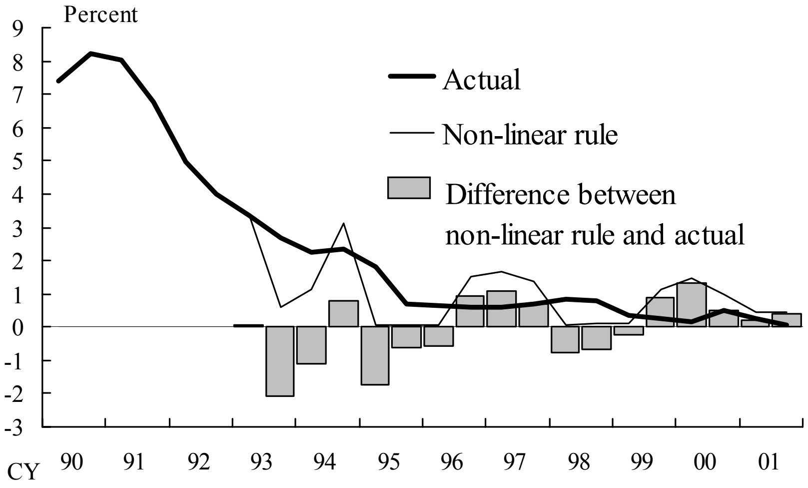
(4) GDP growth rate



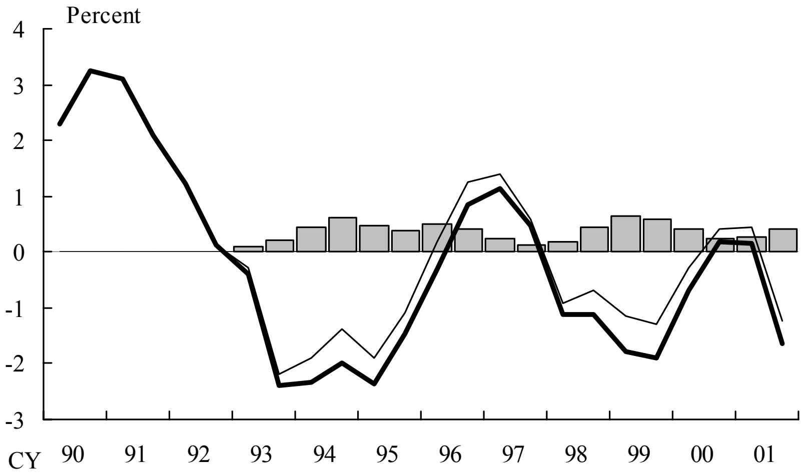
(Figure 9(1))

Simulation Based on Non-Linear Rule 1: Main Results

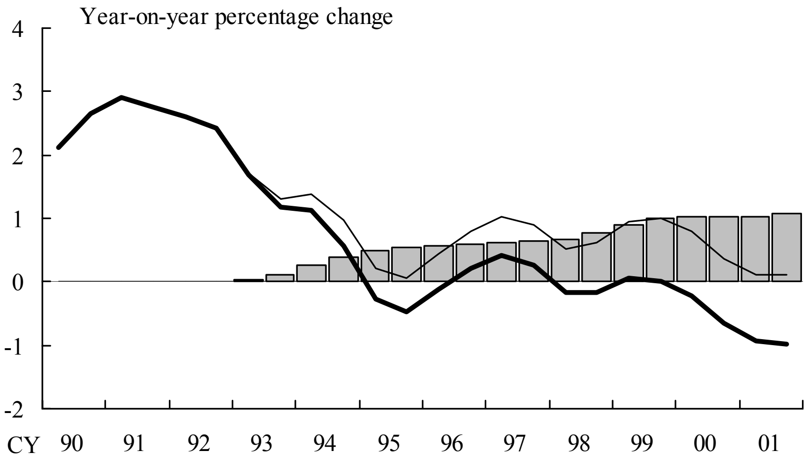
(1) Nominal short-term interest rate (3-month)



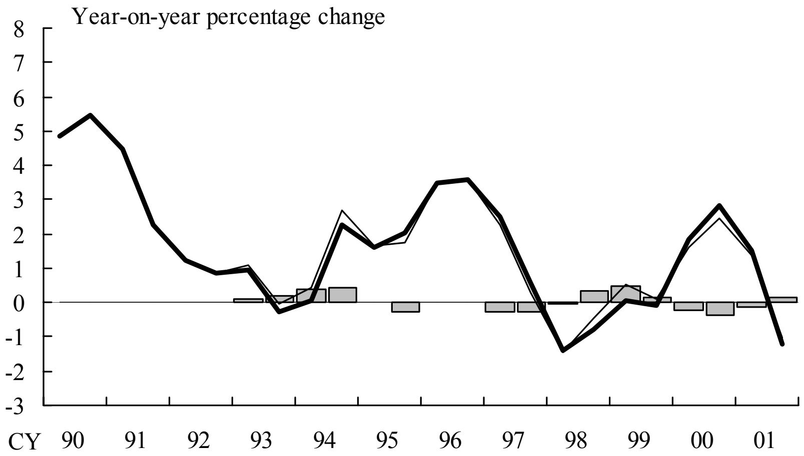
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)

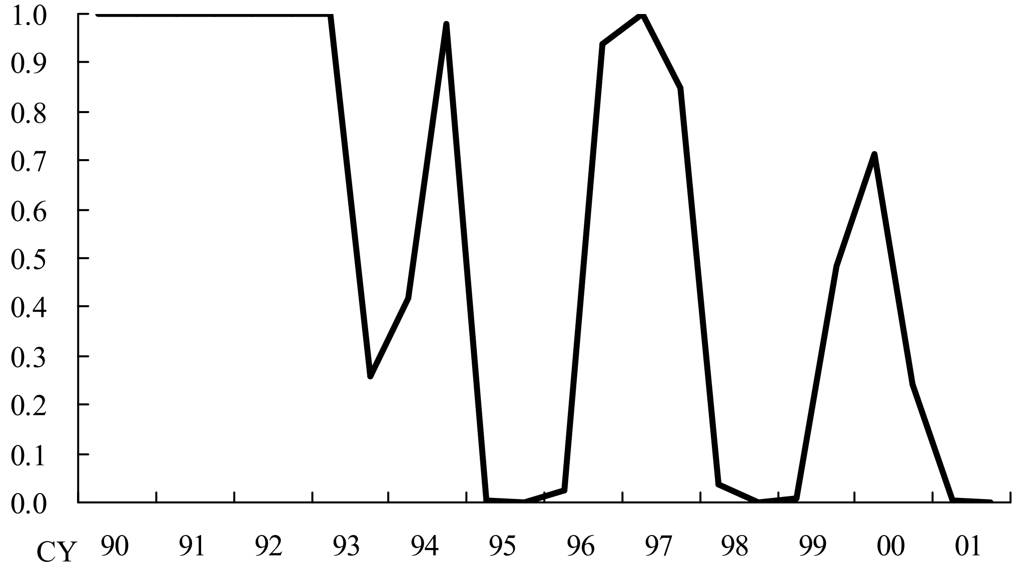


(4) GDP growth rate



Simulation Based on Non-Linear Rule 1: Parameter Dynamics

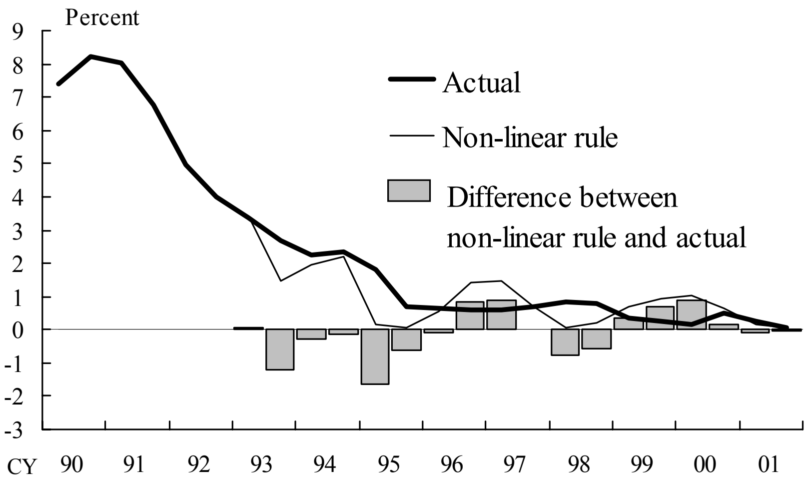
(5) Weight on equilibrium nominal interest rate ψ_t^{NL}



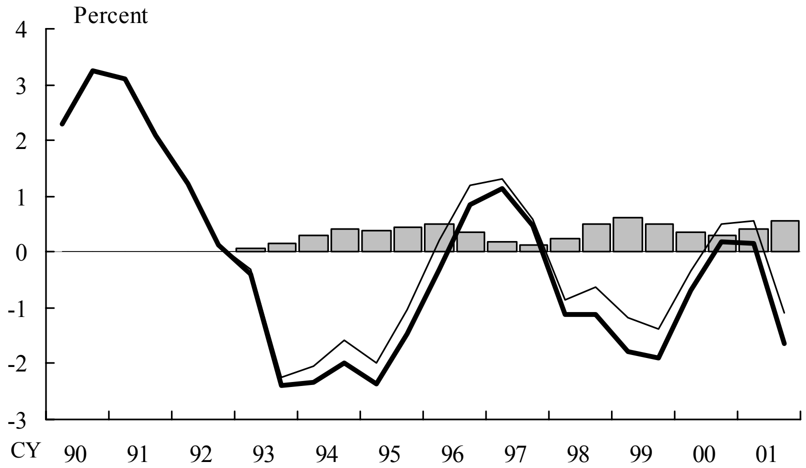
(Figure 10(1))

Simulation Based on Non-Linear Rule 2: Main Results

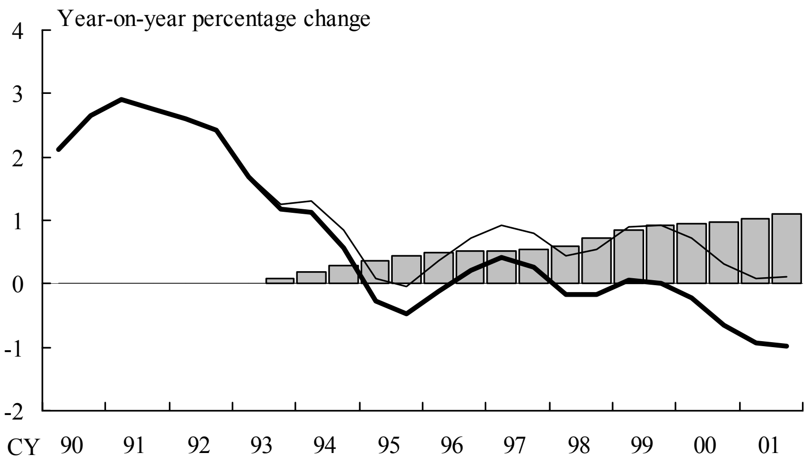
(1) Nominal short-term interest rate (3-month)



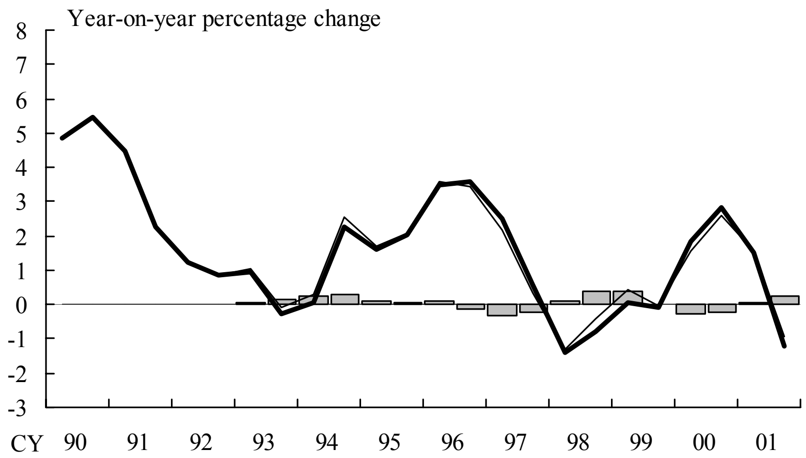
(2) Output gap



(3) CPI (excluding perishables and public utilities charge)



(4) GDP growth rate



Simulation Based on Non-Linear Rule 2: Parameter Dynamics

(5) Weight on the responsiveness of policy rate λ_t^{NL}