IMES DISCUSSION PAPER SERIES

What Can Inflation Expectations and Core Inflation Tell Us About Monetary Policy in Japan ?

Masahiro HIGO

Discussion Paper No. 99-E-22

IMES

INSTITUTE FOR MONETARY AND ECONOMIC STUDIES

BANK OF JAPAN

C.P.O BOX 203 TOKYO
100-8630 JAPAN

IMES Discussion Paper Series 99-E-22
August 1999

What Can Inflation Expectations and Core Inflation Tell Us About Monetary Policy in Japan ?

Masahiro Higo*

Abstract

The Bank of Japan (BOJ) has stabilized measured inflation rates since the 1980s, but Japanese economy has also experienced large fluctuations in the real growth rate and asset prices. This paper will show one possible explanation that large swings in inflation expectations, which were different from the actual movement of inflation, might have caused the high volatility in real GDP and asset prices by investigating various measures for medium or long term inflation expectations. It will also show that, in order to stabilize the public's inflation expectations, it may be useful for the BOJ to introduce inflation targeting. However, if BOJ adopted inflation targeting, BOJ would face various operational difficulties in the conduct of monetary policy. To use Trimmed Mean CPI as a core inflation measure would solve some of these difficulties, because it could exclude fluctuations driven by supply shocks that should be accommodated by monetary policy, and at the same time improve the accuracy of the inflation forecasts. However, even if a device such as the Trimmed Mean CPI were effectively employed, it should be pointed out that other substantially difficult problems remain in Japan.

Keywords: Asset Price, Business Cycle, Inflation Expectation, Inflation Targeting, Monetary Policy, Real Interest Rate, Trimmed Mean CPI

JEL Classification Code: E31, E52

* Research Division 1, Institute for Monetary and Economic Studies, Bank of Japan (E-mail: masahiro.higo@boj.or.jp)

This paper was prepared for discussion at the BOE Workshop "Choice of Intermediate Monetary Policy Targets", 16-20 Nov. 1998. Views presented in this paper are those of the author, and not necessarily those of the Bank of Japan or the Institute for Monetary and Economic Studies. I would like to thank Lavan Mahadeva(Bank of England), Hasan Bakhshi (Bank of England), Ronald McKinnon (Stanford University), Shigenori Shiratsuka (Bank of Japan), Heather Montgomery (University of Michigan) and participants in the Workshop for useful and valuable comments. I am also grateful to Hitoshi Mio (Bank of Japan) and Sachiko Nakada (Bank of Japan) for the efficient technical assistance on empirical analysis.

1 Introduction

In Japan, as a primary goal of monetary policy, price stability is generally considered to include not only stability of current measured inflation rates, but also price stability in the medium to long run, which contributes to sound development of the economy. The Bank of Japan (BOJ) has never set any numerical target or target range for a specific price index as an ultimate goal of monetary policy[1], and also has never set any intermediate targets as guidelines in the pursuit of price stability. BOJ seems to have greatly succeeded in maintaining stability of measured inflation rates since the latter half of the 1980s. At the same time, however, the Japanese economy has experienced a large swing in the business cycle due to the emergence and collapse of the so-called " Asset bubble."

This paper will show that such a large swing in real growth rates and asset prices could have been caused by volatile inflation expectations. It will also show that it may be useful for BOJ to introduce an explicit policy framework, such as inflation targeting, in order to stabilize the public's inflation expectations. The paper will also investigate the operational difficulties in implementing inflation targeting which might arise if policymakers were to use conventional CPI for such a targeting approach. In this regard, the paper proposes to use the Trimmed Mean CPI that excludes fluctuations driven by supply shocks and, at the same time, improves the accuracy of the inflation forecasts.

The next section summarizes the performance of the Japanese economy and monetary policy since the latter half of the 1980s. Section 3 estimates the expected inflation rate from survey and financial data, and analyzes development of expected inflation. Section 4 investigates the operational difficulties in implementing inflation targeting for stabilizing expectations and evaluates the usefulness of the Trimmed Mean CPI for excluding fluctuations driven by supply shocks from overall inflation and improving the accuracy of forecasts of future inflation. Finally, Section 5 summarizes the discussion and comments on the remaining problems.

[1] In an announcement of recent monetary policy change (Sept. 9,1998), the policy board said " The monetary policy objective of Bank of Japan is to pursue price stability, avoiding both inflation and deflation." However the board did not comment on any specific price index targets that might be needed for practical execution of a monetary policy.

2 Japanese Economic Performance and Monetary Policy since the latter half of the 1980s

2.1 Japanese Economic Performance and Monetary Policy

From 1979 to 1980 the Japanese inflation rate rose sharply as a result of the second oil crisis, but BOJ succeeded in decreasing the inflation rate in the relatively short term by maintaining a restrictive monetary policy (Figure 1). Since the mid-1980s, the CPI inflation rate has been approximately between zero and three percent. As indicated by changes in CPI, BOJ has succeeded in maintaining price stability, at least in terms of the stability of measured inflation. In marked contrast, the Japanese economy has experienced large swings in its real growth rate since the mid-1980s. From 1987 to 1990 the real growth rate tended to be higher than the potential growth rate, and after that it sharply dropped and remained around zero percent between 1992 and 1994. Recent economic performance has deteriorated and the real growth rate has turned negative. In brief the combination of the lower inflation rate and the higher volatility in real growth rate is a conspicuous feature of the recent Japanese economy.

BOJ has responded to large fluctuations in business cycles with large swings in short-term interest rates. From 1985 to 1987 it lowered the short–term interest rate (the overnight call rate) from around 6 to 3 percent. Though the economy sharply recovered soon after that, BOJ maintained this low interest rate until the end of 1988. In 1989, it changed its policy stance to a strictly restrictive one and sharply increased the short-term interest rate to around 8 percent by the end of 1990. After the spring of 1991, it eased its policy stance again and lowered the short-term interest rate step by step. It remained at around 0.5 percent from the fall of 1995 to that of 1998 and finally reached below 0.15 percent in February of 1999. Roughly speaking, movements in the long-term interest rate (the 10-year government bond yield) have paralleled those of the short-term interest rate. From 1985 to 1987, the rate dropped from around 7 to 4 percent. Between 1987 and 1988 the long-term rate stayed around 4 percent. Since the beginning of 1989, the long-term interest rate rose sharply and reached around 8 percent in the fall of 1990. However, after 1991, it sharply dropped and recorded below one percent, the lowest rate in Japanese history, in 1998.

2.2 Volatile Movement of the Real Growth Rate in Japan

Let us compare the volatility of the real growth rate in Japan with those in the U.S., Germany and the U.K. from the first quarter of 1985 to the third quarter of 1998. The

average of the real growth rates in four countries was all around the middle of two percent, and, by contrast, the standard deviation in the growth rate in Japan was much larger than those in other countries (Table 1). Furthermore, by using a Fourier transformation, we conduct spectral analysis on the growth rates of real GDP to identify which cycle period components are included in each growth rate (Table 2). In the case of the Japanese growth rate, the power spectrum of irregularly fluctuated components of cycles of less than one year is large. At the same time the power spectrum of cycles of more than two years is also large: four times as much as that in U.S. and 1.5 times as much as those in Germany and the U.K. .

Next let us compare the volatility of the inflation rate as measured by the CPI in Japan with those in the other three countries for the same period. The standard deviation of year on year changes of the CPI in Japan is not so small, as much as those in the U.S. and Germany (Table 1). Furthermore, we conduct spectral analysis on changes in the CPI to identify which cycle period components are included in each inflation rate (Table 2). In Japan the power spectrum of cycles of more than two years is small; about 60 percent of that in the U.S. and one fourth of that in the U.K., though that of irregularly fluctuated components of cycles of less than one year (which are caused by temporary supply shocks) is larger. Briefly, owing to business cycles, the inflation rate fluctuated less in Japan than in other three countries but on the other hand the real growth rate fluctuated more in Japan.

2.3 Why is the Real Growth Rate so Volatile in Japan? : Possible Explanation

Next let us investigate why the real growth rate has been very volatile in Japan since the middle of 1980s. We can find the possible explanations as follows.

The first explanation is that the large GDP volatility was caused by the large swing in asset prices. Uemura and Kimura[1998] showed that share prices lead both real GDP and its private-sector components by testing Granger causality using a two-variable VAR from the first quarter of 1970 to the second quarter of 1997. Positive and negative wealth effects caused by such severe fluctuations in asset prices have greatly influenced business investment and household consumption. Furthermore, because the amount of non-performing bank loans has sharply increased due to the drop in asset prices, many banks have been greatly damaged by the huge losses arising from such loans; consequently, they do not have the capacity to take the various financial risks that accompany lending and other financial activities.

The second explanation is that a permanent supply-side shock might have affected the long-run volatility of GDP in Japan since the 1980s. Sterne and Bayoumi[1993] pointed out by using structural VAR that in Japan productivity shocks dominated fluctuations in variations in real GDP, which was different from the case in the U.S. and the U.K.. From the estimated results for total factor productivity (TFP), its contribution to the real growth rate in Japan has been larger than in other countries such as the U.S. for a few decades (Inoue[1998]). This contribution of TFP increased in the latter half of 1980s and then, on the contrary, it decreased in the 1990s. It seems that this movement paralleled that of the real growth rate. However it is difficult to explain completely the large swing of real GDP only by the large fluctuation of TFP.

The third explanation to be considered is that there are important downward nominal rigidities in wages and prices. By estimating the Phillips-type inflation forecasting equation, we can calculate the long-run sacrifice ratio (the change of GDP gap/that of inflation rate). The result showed that the later the starting point of the sample period for the estimation, the larger the sacrifice ratio is (Table 3). It implies that under zero-inflation or deflation shocks affect mainly not the change of prices but the change of real GDP. However, Kimura and Ueda [1997] insisted that in Japan wages did not exhibit serious downward rigidity by analyzing industry-level panel data set from 1976 to 1995. This result demonstrates that nominal rigidities may not be the important factor that have enhanced the volatility in real growth rates during 1980s and the first half of the 1990s, at least when the inflation rate has stayed strictly positive.

Finally, we can point out the possibility of large swings in inflation expectations as a factor causing the high volatility in real GDP. As mentioned above, BOJ has maintained a discretionary policy framework without announcing any numerical policy targets. Under this kind of policy, the public has difficulty in forming expectations on monetary policy response, since there is no explicit criteria on whether current monetary policy is consistent with long-run sustained price stability. If the monetary policy is not fully credible, there is some possibility that the lack of credibility influences the formation of inflation expectations in the public. For example, if the economic boom continues for a certain time, the public tends to form the expectation that inflation will greatly accelerate in the near future because it cannot incorporate the prospect of fully strict policy action into its inflation expectations. Without sufficient credibility, BOJ has no choice but to raise the short term interest rate dramatically and keep it high over a longer term than predicted in order to control and stabilize inflation expectations. But it might also make the fluctuations of real growth rate and asset prices volatile at the same time.

To investigate this possibility, it is important for BOJ to understand how inflation

expectations have changed and what kind of relationship exists between inflation expectations and monetary policy stance in Japan.

3 What Can We Learn From Measures of Inflation Expectations?

3.1 Estimation of Inflation expectations

Unfortunately Japan has no market for indexed government bonds and little survey data on the expected rate of inflation. Therefore, there is not enough direct information on medium to long-term expectations of inflation. Alternatively, we employ the Fisher equation to decompose nominal long-term interest rates into two components, the long-term real interest rate and the expected inflation rate, as follows:

(Nominal long-term Interest Rate)

=(Real long-term interest Rate)+(Expected Inflation Rate)

More precisely, we calculate three-year real interest rates by the following three methods and then, indirectly estimate three-year expected inflation rates by subtracting the real interest rates from three-year nominal interest rate. It should be noted that the estimates of expected inflation rates contain risk premiums on future uncertainty. This is because nominal long-term interest rates include such risk premiums, and the expected real growth rates do not, thus implying that expected inflation rates, calculated as a difference between these two variables, are sure to include risk premiums. By applying this procedure, this paper calculates three-year inflation expectations and real interest rates from 1981 to 1998 on a quarterly basis (See Data Appendix for detailed information about the data).

a) Estimation by using survey data about expected real growth rates

First, as a proxy for real interest rates, let us calculate three-year expected real growth rates per capita[2] by using expected real growth rates data taken from the " Report of

[2] The following condition for maximizing household utility should be satisfied under the neoclassical growth model.

$r=\rho+\theta*\acute{y}$

where r is real interest rate, ρ is the rate of time preference, θ is the coefficient of relative risk aversion and $\acute{y}$ is the real growth rate of output (consumption) per capita. Using the expected

Survey Research Concerning Corporate Behavior" held by the Economic Planning Agency. Because this survey is conducted in January each year, such survey data is transformed into quarterly data by linear interpolation.

b) Estimation by using growth rate of potential GDP

The second method is to estimate inflation expectations by using growth rates of potential GDP per capita as proxies for real interest rates. Following the procedure in Watanabe[1997], let us (i) estimate a production function in the Cobb-Douglas formation; (ii) estimate the potential labor as well as capital inputs; and (iii) compute potential GDP by substituting the potential figures for (ii) into the production function estimated in (i). The movement in growth rate of potential GDP estimated seems to be relatively smooth and not greatly influenced by the fluctuation in business cycles. This result demonstrates that the growth rate of potential GDP per capita can serve as a proper proxy for three-year real interest rates. Let us calculate three-year inflation expectations from it.

c) Estimation by using the rate of return on capital

Theoretically the real interest rate represents the marginal product of capital. Following the approach in Kitamura and Fujiki[1997], this paper will estimate the rate of return on capital[3]. In this case, it should be noted that the fixed capital of the public sector is also added to non-residential fixed capital of the private sector as capital stock, because not only does private fixed capital contribute to the production of the business sector, but so does public fixed capital.

$$MPK_t = 100 * (SK_t * \left[\frac{Y_t}{K_t + KG_t} \right])(1-\tau) - \delta_t - RP$$

where *MPK* is the rate of return on capital; *SK* is capital share of income; *Y* is real GDP at factor cost in the calendar year 1990; *K* is real private capital stock; *KG* is real public capital stock; τ is effective corporate tax rate and δ is depreciation rate of capital stock.

The estimated rate exceeds the risk-free real interest rate by the risk premium(*RP*).

---

real growth rate per capita as a proxy for real interest rate implies setting $\rho \rightarrow 0$ and $\theta=1$. To determine whether this assumption is justified or not additional analysis is needed.

[3] The rate of return on capital can be considered the average product of capital. If a production function is the Cobb-Douglas type, then the rate of return on capital equals the marginal rate of capital. Kitamura and Fujiki[1996] showed that whichever type is used as a production function, there are little differences among all marginal products of capital.

To adjust such premium, the difference between the average lending rate of the commercial banks and the risk free interest rate is subtracted from the rate of return on capital, yielding the risk-free rate of return on capital. The movement of the estimated rate of return seems to be smooth and independent of business cycles, though it is estimated on a quarterly basis, so that it is likely to be related to business cycles. This result demonstrates that the rate can be a proper proxy for three-year real interest rates. Next let us calculate the three-year inflation expectation from the rate of return.

3.2 Characteristics of movement in expected inflation

Figure 2 presents movement in the three-year expected inflation rates estimated by the aforementioned three methods and figure 3 presents movements in the proxies for three-year real interest rates. Comparing movements, there appear to be few differences among these estimated rates. Movement in expected inflation has three features as follows.

First, the movements in inflation expectations are volatile. All expected inflation measures rose and maintained an annual rate of around four percent from 1990 to 1991. By contrast, most of them, except those derived from survey data, stayed around zero percent from 1986 to 1988, and all have stayed below zero since 1995. During the last fifteen years the difference between maximum and minimum was five percent, much larger than that of actual inflation rate[4]. Second, the movement in expected inflation has been close to changes in actual year on year inflation rates from one year earlier. This demonstrates that the public has predicted that the present inflation rate would possibly persist for the next three years. Detailed observation reveals that there are various expectations in different situations. In the first half of the 1980s, expectations of inflation were backward-looking. In contrast they seemed to be somewhat forward-looking during the previous inflation phase between 1989 and 1991. Third, the short-term real interest rates deflated by the actual inflation rate from one year earlier continue to be positively correlated with inflation expectation. As a whole, it seems that expected inflation rates have somewhat led short-term real interest rates (Figure 4).

To check the relationship between estimated expectations of inflation and various economic variables (actual inflation rate<Trimmed Mean CPI, year on year change>, real growth rate<year on year change>, GDP gap<the difference between potential and actual

[4] This seems to contradict theoretical knowledge that the movement of expected values should be smoother than that of actual values. This implies that the expected inflation estimated here includes a risk premium under future uncertainty that may greatly change during this period.

GDP>, short-term real interest rate and the change rate of stock prices<year on year change>), let us calculate coefficients of time correlation and test Granger causality using a two-variable VAR from the first quarter of 1983 to the third quarter of 1998.

First, we would like to check time correlation (Table 4). The real growth rate leads the expected inflation rate by eleven quarters and there are the highest contemporary time correlations between expectations and actual inflation rate, short-term real interest rate and GDP gap. Expected inflation has only an obscure relationship with changes in stock prices, which in turn lead real growth rate by three quarters. Second, the result of Granger causality (Table 5) indicates that expectations of inflation determine actual inflation rate, short-term real interest rate, GDP gap and changes in stock prices. It also indicates that the causality relationship between the expectation and the real growth rate is ambiguous and almost no variables cause the expectations.

By combining above two results, we can unify the following lead/lag relationship between the inflation expectations and economic indicators during the past fifteen years. At first, the increase of the real growth rate influences the expectations of inflation with long lags. Next, the rise of inflation expectations slightly leads the movement of other economic variables. It means that the formation of inflation expectations includes a somewhat forward-looking property. Finally, the rise of expectations and actual inflation cause the downward movement of stock prices, and, moreover, it may also provoke the decline of the real growth rate. Meanwhile, changes in the short-term real interest rate, which indicates the monetary policy stance, slightly lag behind the inflation expectations.

3.3 Implications for the conduct of monetary policy

What kind of relationship do large-scale fluctuations in inflation expectations have with the conduct of monetary policy? One possible answer is that the timing of policy actions tends to be too late to keep inflation expectations stable. When policy actions were delayed, inflation expectations fluctuated greatly so that these would make the economy unstable. BOJ needed to respond to such a possibility by raising or lowering the interest rate more drastically. From figure 4 we find that it takes a long time to decrease expected inflation after BOJ increases the short-term real interest rate. For example, the expected inflation rate continued to rise for more than one year after the short-term rate was raised in the inflationary phase of 1989. This shows that there is a long lag between the conduct of monetary policy and the emergence of a policy effect on actual inflation. At that time BOJ had to raise the interest rate sharply and keep it high for a certain period in order to surely prevent inflation expectations from accelerating.

Considering this experience, BOJ needs to conduct a truly pre-emptive monetary policy with an optimal scale of policy actions. For this purpose it might be beneficial to specify the standards for policy judgement, and to clearly demonstrate policy objectives or optimal weights among the objectives. In this case whether BOJ can conduct such monetary policy depends on how early and how accurately it can forecast the acceleration or reduction of inflation in the near future.

Another possible answer is that the public possibly predicted that BOJ would not continue a restrictive monetary policy needed for enough of a reduction in inflation in the phase of accelerating inflation because BOJ usually wanted to accommodate promptly a serious recession occurring in the real economy. This interpretation implies that BOJ has not been fully credible in controlling inflation[5]. Following such predictions, the public would maintain a high level of expected inflation. Under insufficient credibility of monetary policy, BOJ had no choice but to implement an extremely restrictive monetary policy and continue it over a longer term than predicted in order to lower promptly inflation expectations and succeed perfectly in stabilizing inflation. However, it resulted in large damages to the real economy.

Considering the above experience, it could be useful for BOJ to introduce a specific policy framework that signals a well-timed policy action, enhances its credibility and makes it easier for the public to predict possible future policy actions and its effects in order to stabilize people's inflation expectations, although BOJ cannot directly control inflation expectations. Stabilizing inflation expectations is certain to be a necessary condition in stabilizing inflation and the economy.

4 Operational Use of the Trimmed Mean CPI in Implementing Inflation Targeting in Japan ?

4.1 Advantages of and Difficulties in the Implementation of Inflation Targeting

The inflation targeting approach is one of appropriate choices to increase the credibility

[5] Recently the expected inflation rate has stayed below zero, although monetary policy has already been fully eased and the short-term interest rate is now around zero percent. In this case, people possibly expect that it is very difficult for BOJ to conduct additional effective measures by decreasing the interest rate below the zero boundary for nominal interest rates in order to stimulate economic recovery and to increase inflation expectations. Therefore this situation is somewhat different from the usual case.

of monetary policy, making the policy more effective and the inflation expectations of the public fully stabilized. As Bernanke and Mishkin[1997] insisted, the inflation targeting approach has several advantages: 1) it increases the credibility by attaching an institutional commitment to the ultimate objective; 2) it increases the transparency by clearly stating the specific criteria for monetary policy actions; 3) it decreases the public's uncertainty in the future by improving various types of communication between the central bank and the public[6].

However, if BOJ adopts inflation targeting as the framework for Japanese monetary policy, BOJ will face several operational difficulties. One of the important problems is how large the target range width should be set. This specific range width is needed to accommodate fluctuations in inflation caused by supply shocks and also to provide room for changes in the relationship between inflation and output because BOJ is required to give some consideration to the maintenance of well balanced and sustainable growth. However, if the target range for the overall CPI (the year-on-year change) had been set between one and three percent, we would find that since 1985 the actual inflation rate had stayed within the assumed target range in most periods. As a result such a target range cannot provide useful signals for policy decisions. Considering the above observations, BOJ needs a newly-devised inflation targeting framework. For example, it should exclude from the original movement of inflation caused by supply shocks to be accommodated and target the remaining variations of inflation relevant to macroeconomic fluctuations. In this case, BOJ would need to narrow the target range width to provide useful policy guidance.

Another important problem is how accurately BOJ can forecast future inflation as an operational target indicator. The movement of inflation rates tends to lag behind real economic variables by at least one year, i.e. monetary policy has a large time lag before affecting inflation. Svensson[1997] insisted that forecast inflation is the ideal intermediate variable for an inflation targeting regime because both the public and the central bank can observe the forecast inflation rate contemporaneously and a rationally formed forecast for inflation incorporates all information currently available[7].

---

[6] BOJ has published a great deal of information for the public in its various announcements, in the minutes of the Monetary Policy Meetings, in speeches by the Governor at press conferences, in various publications and so on. The level of public information about monetary policy is comparable to that of other central banks However, information about the bank's future prospects or its policy actions cannot always be accurately transmitted to the public because BOJ has never published the explicit forecast inflation rate and real GDP growth rate.

[7] By contrast, Bernanke and Woodford[1997] asserted that the central bank should not target the forecast for inflation as an intermediate variable because targeting the forecast for

Following this approach, BOJ would need to obtain a forecast inflation rate one or two years ahead as accurately as possible in order to conduct more effective policy actions operationally using the inflation targeting approach.

4.2 How successfully does the Trimmed Mean CPI exclude temporary supply shocks ?

We will next investigate how much better the Trimmed Mean CPI is as a target indicator[8]. The Trimmed Mean CPI is a price index that excludes outliers in a cross-sectional distribution of individual price changes for each period. Bryan and Cecchetti[1994], Shiratsuka[1997] and Mio and Higo[1999] indicate that this estimator shows moderate fluctuations in line with relevant macroeconomic variations by excluding the components related to temporary shocks.

Figure 5 represents movements in the Trimmed Mean CPI (TM-CPI) calculated on a year-on-year change basis that excludes 30 percent outliers (15 percent on each side) since 1985. It can be seen that the TM-CPI successfully excludes inflation changes related to temporary and external shocks that lasted no more than one or two years. To explain this, it helps to see which components are excluded from the overall CPI. These components frequently include fresh foods and energy items. They sometimes also include clothes and household electrical appliances influenced by changes in the exchange rate or the import ratio. Thus, it is judged that it successfully excludes variations caused by temporary and external supply shocks, including extreme weather, changes in energy prices such as oil shocks, and changes in exchange rates, so that the TM-CPI is relevant to fluctuations caused by macroeconomic factors. In brief, the TM-CPI can be a more suitable core price index that should be controlled by monetary policy. Moreover, its movement is smoother than that of the overall CPI because the TM-CPI omitted the fluctuations. Should BOJ adopt the TM-CPI, it could narrow the width of the target range, rendering inflation targeting more effective in its operational aspects and at the same time increasing the credibility of the monetary policy.

---

inflation might make actual inflation and output unstable through the existence of indeterminacy of rational expectations equilibria, and also because there is no incentive for anyone to gather information and so every forecast inflation rate becomes uninformative as perfect stabilization of the inflation forecast is approached.

[8] In New Zealand the Trimmed Mean CPI has been used as one of indicators of underlying inflation. See Roger[1994].

4.3 Improvement of the accuracy of inflation forecasting by the Trimmed Mean CPI

Next, we will investigate whether the forecast of future inflation can be improved by using the TM-CPI. First, we will concretely estimate forecasting functions[9] by using lag terms of inflation rates and GDP gaps[10] for inflation rates one quarter ahead (the estimated equations are shown in Table 6). For an inflation rate, we use the overall CPI, the CPI excluding fresh foods or the TM-CPI. Table 6 indicates that when using the TM-CPI, all coefficients of explanatory variables are significant and the coefficient of determination (R^2) is the largest of the three. Second, we recursively estimate forecast values for future inflation two, three, ·····and nine quarters ahead by using the forecast function and the estimated value, assuming that the future path of GDP gap is accurately forecast. Table 7 shows the results of the standard deviation of prediction errors in the out-of-sample forecast exercise. When forecasting one quarter ahead, the standard deviation of prediction error obtained by the TM-CPI (0.24 percent) is less than half of that obtained by the overall CPI (0.54 percent) and also one-tenth smaller than that by the CPI ex-fresh foods (0.27 percent). As the forecasting period is extended, the difference between the deviation by the TM-CPI and the CPI ex-fresh food also increases. In forecasting five quarters ahead, the deviation obtained by the TM-CPI (0.75 percent) is two-tenths smaller than that obtained by the CPI ex-fresh foods (0.89 percent). This is thought to be the result because the share of various supply shocks except for fresh foods increases with the change of CPI. The prediction error for the TM-CPI is especially smaller than that for other price indexes between 1986 and 1987 during the period of the sharp drop in oil prices. As mentioned above, accuracy in forecasting inflation is greatly improved by using the TM-CPI. This result is very beneficial in using forecast inflation as an operational target for inflation targeting.

5 Concluding Remarks

This paper pointed out that BOJ has successfully stabilized measured inflation since

---

[9] This type of forecasting function presupposes a Phillips type trade-off. However, it is generally believed that this trade-off relationship exists only in the short run, and not in the long run. Higo and Nakada[1999] investigate how long the trade-off relationship holds true, by testing the sum of the parameters of lag terms of the inflation if the number of these terms increases. They indicate that the trade-off is maintained for three-year at least.

[10] The gap is calculated by the procedure of Watanabe[1997].

the 1980s, but that it might have failed to stabilize inflation expectations. As a result, large fluctuations in expected inflation might have amplified swing in the real economy and asset prices. Adopting inflation targeting is thought to help in stabilizing inflation expectations. However, if BOJ were to adopt inflation targeting as the framework of its monetary policy, it would face the following operational difficulties; a) Choice of the target range width, b) Accuracy of forecasting the target indicator. A key point for solving these problems is the effective decomposition of inflation movements into a trend component related to macroeconomic fluctuations that should be controlled by monetary policy and a component caused by supply shocks, and also forecasting future inflation rates one or two years ahead more accurately. Utilization of the Trimmed Mean CPI would benefit these purposes.

However, even if a device such as the Trimmed Mean CPI were effectively employed, it should be pointed out that other substantially difficult problems remain in Japan if BOJ were to adopt an inflation targeting approach. First, adopting inflation targeting does not necessarily stabilize the real growth rate enough. BOJ is required to pursue price stability that contributes to sound development of the economy. Recently in Japan, it seems that the sacrifice ratio has become increasingly larger and at the same time the relationships among economic indicators have been unstable for various reasons. In this kind of situation, it may be difficult to attain such objectives by adopting inflation targeting alone. If BOJ tries to control inflation strictly, there is a high possibility that the real GDP growth rate will fluctuate more widely. Not only does Japan face this problem, but so do all other countries that have a zero-inflation objective and whose inflation rates are approaching zero.

The second problem involves how BOJ should deal with fluctuations in asset prices that cannot be eliminated merely through stabilizing expected inflation. As asserted above, if BOJ introduces inflation targeting, its credibility regarding monetary policy is expected to increase, which stabilizes inflation expectations. However, large variations in asset prices are sure to be not only the result of changes in expected inflation, but also the result of other factors, such as changes in investor preferences, changes in the age composition of the Japanese population and changes in regulations and tax systems. Accordingly, we should offset the inflation or deflation of asset prices by directly reshaping the above-mentioned factors, by means other than monetary policy. However, it usually takes a long time to reshape these factors, while long-lasting inflation or deflation of asset prices possibly accelerates fluctuations in the real growth rate, and damages financial systems. Considering these conditions, BOJ may need to conduct

pre-emptive policy actions even if the bank does not forecast that a target indicator will change and overshoot or undershoot the target range[11].

Data Appendix

This appendix fully describes the data used in this paper.

1) Nominal long term interest rate(three-year)
From 1 Q in 1981 to 4 Q in 1994: yield of interest bearing bank debentures (three-year)
From 1 Q in 1995 to 4 Q in 1998: yield of interest-bearing government bonds (three-year)
The former yield is the average of the yield at the end of each month among each quarter. The latter yield is the average of the yield for all trading days among each quarter. The main reason why the yield of bank debentures by the end of 1994 is used is because of the availability of data on the basis of compound interest. By the end of 1994, the banks that issued bank debentures maintained high rank ratings so that the yield of the bank debentures was almost the same as that of government bonds.

2) Capital share of income (*SK*)
By using National Account Statistics, the share of compensation of employees and that of operating surplus and consumption of fixed capital of owner-occupied dwellings in GDP at factor cost are excluded from one as a capital share of income.

3) Real private capital stock (*K*)
The paper uses the statistics " Gross Capital Stock of Private Enterprises " from the Economic Planning Agency. This is an estimate of market prices for the 1990 calendar year. This value does not include residential stock.

[11] Regarding the possibility of explicitly incorporating the information inherent in asset price fluctuations, Shiratsuka [1999] discusses as follows. Asset prices can be explicitly incorporated into inflation measures by extending the price index into a dynamic framework so as to trace intertemporal changes in the cost of living. Although such a dynamic inflation measure is highly valued from the viewpoint of theoretical consistency, it is difficult to expect its role to be anything more than a supplementary indicator of inflation pressures. This is because that (i) asset price changes do not necessarily imply future price changes since there are a lot of sources for asset price fluctuations apart from public expectations of future price inflation; and (ii) the reliability of asset price statistics is quite low, compared with existing price indexes.

4) Real public capital stock (*KG*)

The paper uses statistics estimated by the Economic Planning Agency[1998]. These are estimates of market prices for the 1990 calendar year. These statistics are only given at the end of every fiscal year, so the data is transformed into quarterly data through linear interpolation. Also, these statistics only cover the period up to the end of the 1993 fiscal year, therefore the data from 1994 to 1998 are estimated by using the data of gross capital formation by public sector from National Accounts Statistics.

5) Effective corporate tax rate (τ)

The effective corporate tax rate is defined as the direct tax on income of private corporations divided by the sum of the operating surplus and consumption of fixed capital of private corporations.

6) Risk premium of private sector (*RP*)

As a proxy for risk premium, we use the average difference between the average lending rate of commercial banks and the risk free interest rate from the beginning of 1985 to the end of 1998. The estimated value is 1.21 percent. The average lending rate is the average contracted interest rate on loans and discounts (total: the average of city banks, regional banks and regional banks II). The risk free interest rate is the subscriber's yield for the 3-month Treasury bill (after 1989) or the 3-month yield for government bonds with repurchase agreements (before 1988).

(References)

Bernanke, Ben S., and Fredric S. Mishkin, " Inflation Targeting: A New Framework for Monetary Policy?," *Journal of Economic Perspectives*, 11, 1997, pp.97-116

————————, and Michael Woodford, " Inflation Forecasts and Monetary Policy ," *Journal of Money, Credit and Banking*, 29(4), 1997, pp.653-684

Bryan, Michael F., and Stephen G. Cecchetti, " Measuring Core Inflation," in N.G. Mankiw eds. *Monetary Policy*, University of Chicago Press, 1994, pp.195-215

Economic Planning Agency, *Nippon no Shakai Shihon (Public Capital Stock in Japan)*, Toyokeizai Inc.,1998 (in Japanese)

Higo, Masahiro and Sachiko Kuroda Nakada, " What Determines the Relation Between Output Gap and Inflation? — International Comparison of Inflation Expectation and Staggered Wage Adjustment — ," *IMES Discussion Paper Series, forthcoming*, Institute for Monetary and Economic Studies, Bank of Japan,1999

Inoue, Tetsuya, " Impact of Information Technology and Implications for Monetary Policy," *Monetary and Economic Studies 16(2)*, Institute for Monetary and Economic Studies, Bank of Japan, 1998, pp. 29-60

Kimura, Takeshi and Kazuo Ueda, " Downward Nominal Wage Rigidity in Japan: Is Price Stability Costly?," *Bank of Japan Research and Statistics Department Working Paper* 97-1, 1997

Kitamura, Yukinobu, and Hiroshi Fujiki, " Keizaiseichoka no Jisshitsukinri no Sokutei (Estimation for Real Interest Rate)," *mimeo*,1996 (in Japanese)

————, and ————— " Supply Side Jouhou wo Riyoushita Shohini Motozuku Shihonshisankakaku Moderu no Suikei (Estimation for C-CAPM by the real interest rate derived from supply-side information)," *Kin'yu Kenkyu* 16(4), Institute for Monetary and Economic Studies, Bank of Japan, 1997, pp. 137-154 (in Japanese)

Mio, Hitoshi and Masahiro Higo, " Underlying Inflation and the Distribution of Price Change: Evidence from the Japanese Trimmed-Mean CPI," *Monetary and Economic Studies 17(1)*, Institute for Monetary and Economic Studies, Bank of Japan, 1999, pp.103-132

Mishkin, Frederic S., and Adam S. Posen, " Inflation Targeting: Lessons from Four Countries," *Federal Reserve Bank of New York Economic Policy Review*, 3, 1997, pp.9-96

Roger, Scott, " Alternative Measure of Underlying Inflation," *Reserve Bank Bulletin*, 57(2), Reserve Bank of New Zealand, 1994, pp.109-129

Shiratsuka, Shigenori, " Asset Price Fluctuation and Price Indices ", *IMES Discussion*

Paper Series 99-E-21, Institute for Monetary and Economic Studies, Bank of Japan, 1999

————,“ Inflation Measures for Monetary Policy: Measuring the Underlying Inflation Trend and Its Implication for Monetary Policy Implementation,” *Monetary and Economic Studies*, 15(2), Institute for Monetary and Economic Studies, Bank of Japan, 1997, pp. 1-26

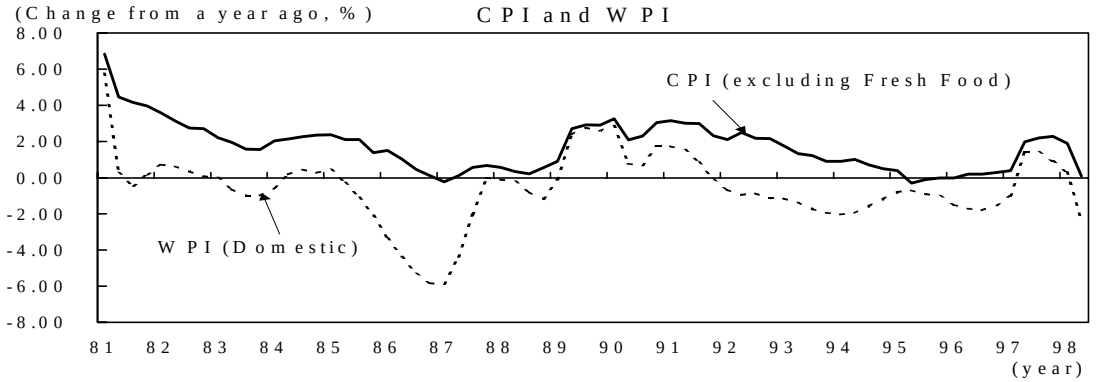
Sterne, Gabriel and Tamim Bayoumi, “ Temporary Cycles or Volatile Trends? Economic Fluctuations in 21 OECD countries,” *Working Paper Series,*13,Bank of England, 1993

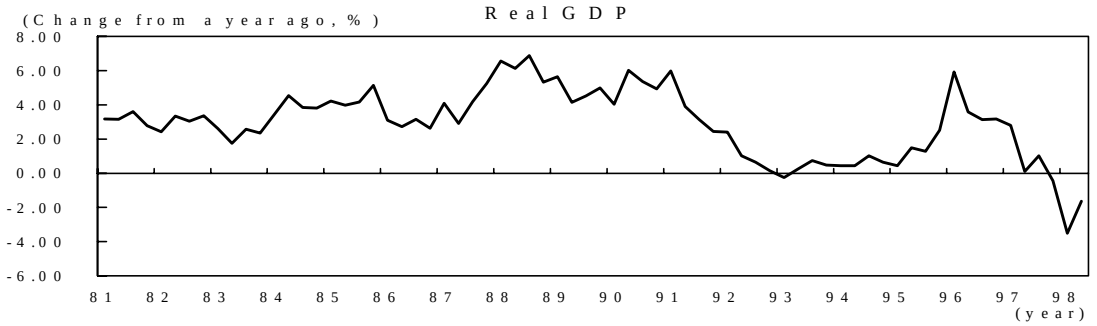
Svensson, Lars E.O., “ Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets,” *European Economic Review*, 41, 1997, pp.1111-1146

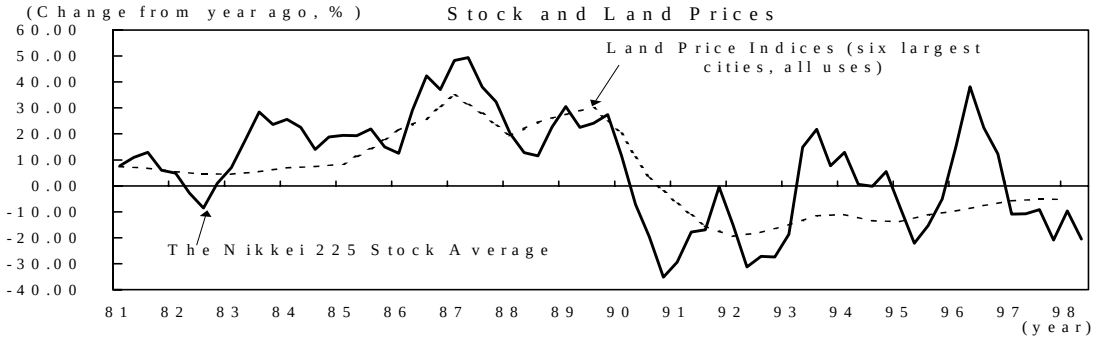
Uemura, Shuichi, and Takeshi Kimura, “ Japanese Share Prices,“ *The Role of Asset Prices in the Formulation of Monetary Policy , Conference Papers,* Vol.5, Bank for International Settlements, 1998

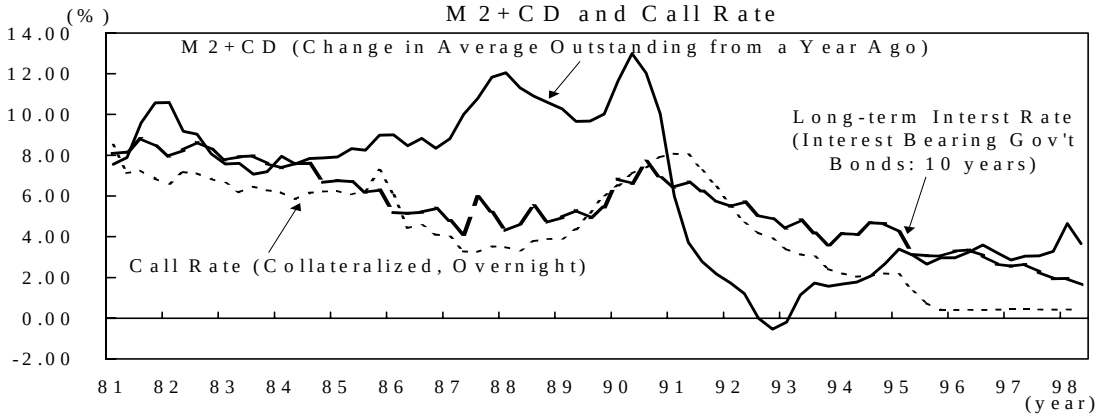
Watanabe, Tsutomu, “ Output Gap and Inflation: the case of Japan,” *Monetary Policy and the Inflation Process, Conference Papers,* Vol. 4, Bank for International Settlements, 1997

(Figure 1) Movement of economic and monetary indicators in Japan









(Table 1) Average and variability of real growth rate and CPI inflation rate in selected countries 1985/1Q-1998/3Q

< Real growth rate > percent, year on year changes

	Japan	United States	Germany	United Kingdom
Average	2.85	2.80	2.34	2.67
Standard deviation	2.57	1.39	2.04	1.39

< Inflation rate > percent, year on year changes

	Japan	United States	Germany	United Kingdom
Average	1.09	3.28	2.05	4.45
Standard deviation	1.06	1.15	1.29	2.27

Note: All data are on quarterly basis.

(Table 2) Contribution to the total variability of real growth rate and CPI inflation rate by cycle period

< Real growth rate > 1985/1Q-1998/3Q quarter on quarter changes

	Japan	United States	Germany	United Kingdom
Total Variability	100	24	88	41
More than 2 years	26	8	17	22
More than 1 years	11	3	7	5
Less than 1 years	37	12	63	14

Note: Total variability in Japan=100. All data are seasonally adjusted.

< Inflation rate > 1985/Jan.-1997/Mar. month on month changes

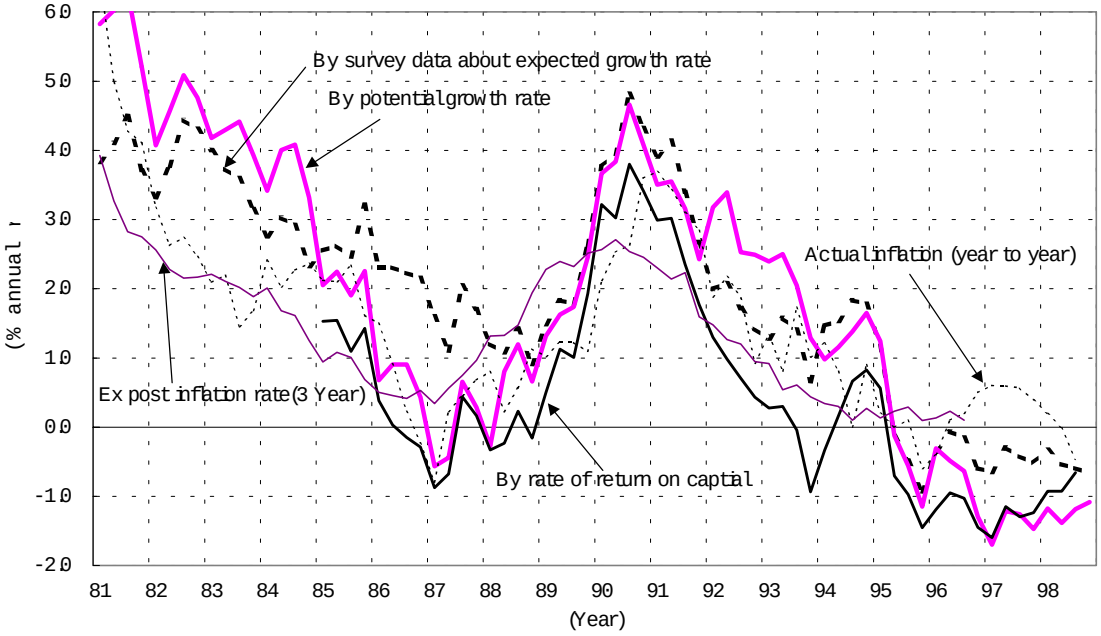
	Japan	United States	Germany	United Kingdom
Total Variability	100	59	73	166
2 years -	18	19	25	85
1 – 2 years	4	7	3	16
- 1 years	78	33	45	65

Note: Total variability in Japan=100. All data are seasonally adjusted.

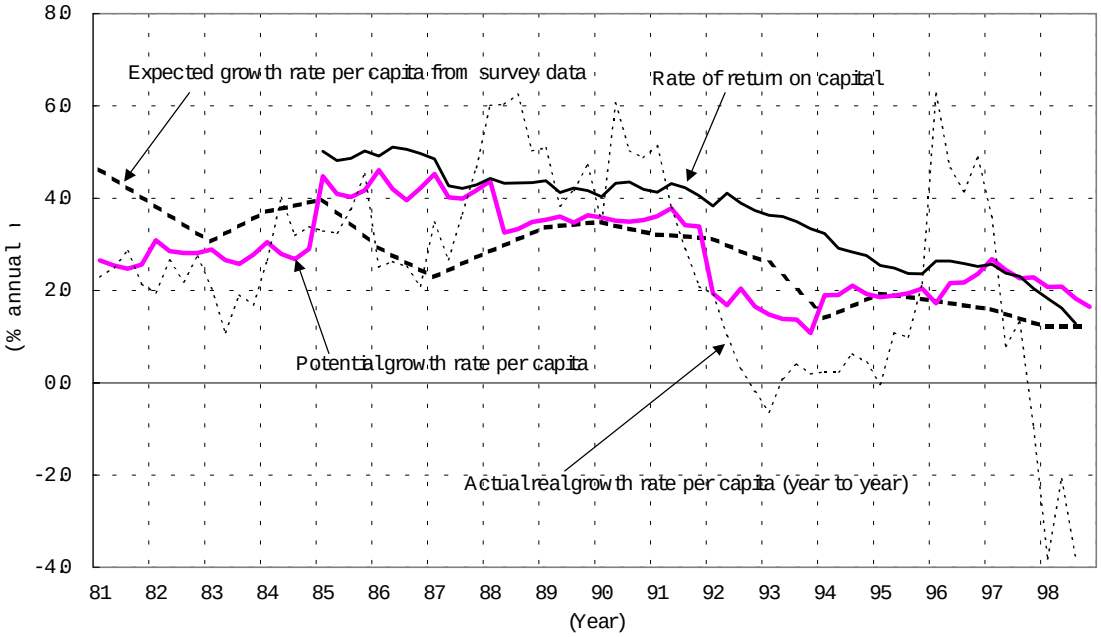
(Table 3) Long-run sacrifice ratio (the change of GDPgap / the change of CPI inflation rate)

Sample period	1980/1Q-1998/3Q	1987/1Q-1998/3Q	1991/1Q-1998/3Q
Sacrifice ratio	1.93	2.14	3.22

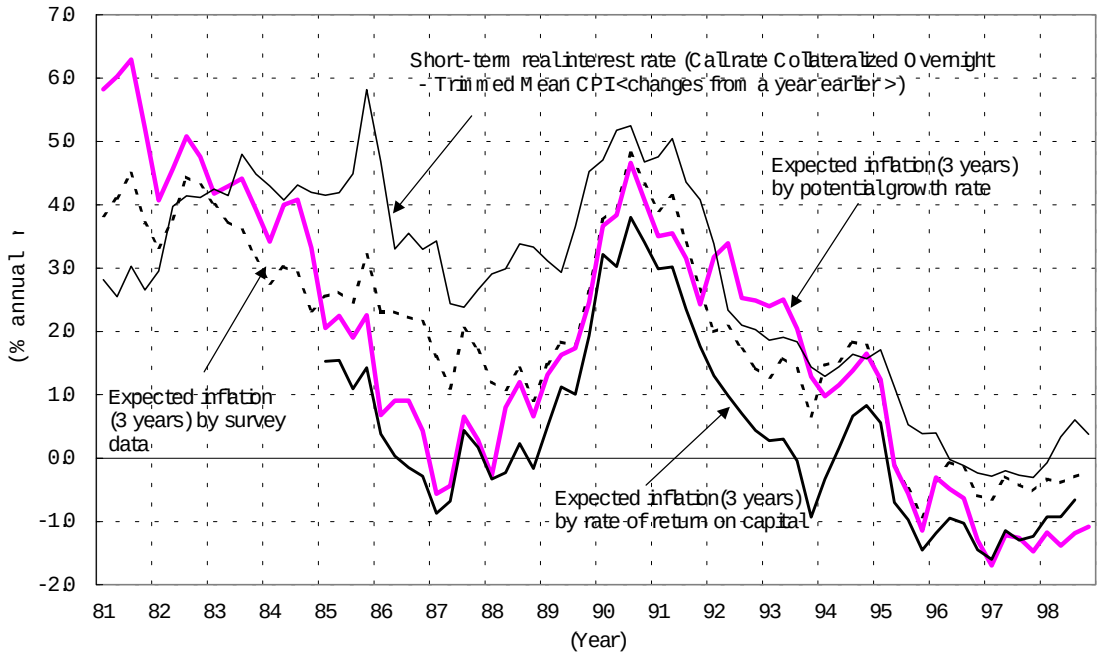
(Figure 2) Expected Inflation Rate Estimated (3 years)



(Figure 3) Real Interest Rate Estimated (3 years)



(Figure 4) Expected Inflation and Short-term Real Interest Rate



(Table 4) Coefficients of time correlation between expected inflation and economic variables 1983/1Q-1998/3Q

	Expected Inflation (3 years)		
	Survey data	Potential growth	Rate of return
Change of Trimmed CPI	0.822 (0)	0.828 (0)	0.859 (- 1)
Real growth rate	0.470 (+11)	0.450 (+11)	0.477 (+11)
GDPgap	0.658 (0)	0.651 (0)	0.680 (0)
Short term real interest rate	0.920 (0)	0.800 (0)	0.842 (0)
Change of stock price	Ambiguous	-0.106 (- 2)	-0.259 (- 2)

Note: 1. Figures indicate the largest cross correlation coefficient within twelve quarters before and after the quarter concerned. Figures in parentheses are time lags, and negative figures represent the lead of expected inflation.

2.The change of Trimmed CPI, real GDP and stock price is based on annual changes of quarterly data.

(Table 5) Results of Granger tests between expected inflation and economic variables 1983/1Q-1998/3Q (F value), Lag length = 4 quarter

(1) Expected Inflation >> Economic variables

	Expected Inflation (3 years)		
	Survey data	Potential growth	Rate of return
Change of Trimmed CPI	2.75**	2.39**	1.80*
Real growth rate	0.99	0.84	0.42
GDPgap	1.86*	2.19**	1.30
Short term real interest rate	1.29	1.88*	2.80**
Change of stock price	1.89*	4.14***	3.18***

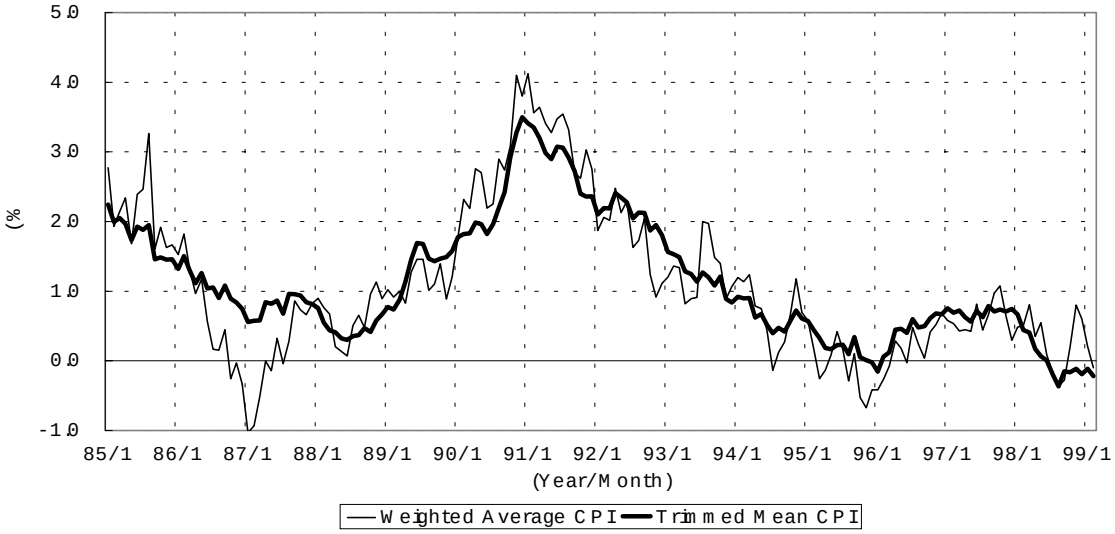
(2) Economic variables >>Expected Inflation

	Expected Inflation (3 years)		
	Survey data	Potential growth	Rate of return
Change of Trimmed CPI	0.52	0.60	0.65
Real growth rate	1.14	0.76	0.82
GDPgap	0.45	0.28	0.17
Short term real interest rate	1.23	0.78	0.60
Change of stock price	1.26	0.86	1.67*

Note: 1. *indicate significance at the level of 10%; **indicate significance at 5%; ***indicate significance at 1%

2. The change of Trimmed CPI, real GDP and stock price is based on annual changes of quarterly data.

(Figure 5) Weighted Average and Trimmed Mean CPI (year on year)



(Table 6) Estimation for Inflation Forecasting Function

< Models for Forecasting Inflation 1Q ahead >

$$\pi_{t+1} = \alpha_0 + \alpha_1\pi_t + \alpha_2\pi_{t-1} + \alpha_3\pi_{t-2} + \beta_1 GDPGAP_t$$

where π_t = CPI-Overall, CPI-ex fresh food, Trimmed Mean CPI

(Result)

	α_0	α_1	α_2	α_3	β_1	Durbin-h	Adj-R^2
CPI overall	0.273+	1.286***	-0.363**	0.025	0.053+	0.004	0.952
CPI ex food	0.213+	1.318***	-0.427***	0.075	0.048+	-0.323	0.963
CPI Trimmed	0.215**	1.511***	-0.717***	0.164*	0.046**	-1.487	0.977

Significance level ***=1% **=5% *=10% +=20%

(Table 7) Standard Deviation of Prediction Error (Out of Sample Test)

---percent per year

Forecasting time	CPI Overall	CPI excluding food	CPI Trimmed Mean
1Q ahead	0.535	0.270	0.243
2Q ahead	0.685	0.441	0.405
3Q ahead	0.829	0.602	0.507
4Q ahead	1.061	0.774	0.647
5Q ahead	1.179	0.889	0.745
6Q ahead	1.297	0.994	0.809
7Q ahead	1.386	1.101	0.886
8Q ahead	1.447	1.183	0.962
9Q ahead	1.455	1.253	1.023