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A Theoretical and Empirical Survey

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Abstract

In this paper, I survey the existing literature and examine three related questions: (1) What inflation rate constitutes the appropriate target for the central bank?; (2) What is an operational definition of price stability for the conduct of monetary policy?; and (3) What is the policy framework for pursuing price stability in practice? In doing so, I emphasize that it is crucially important for a central bank to seek to maintain a price environment that is neither inflationary nor deflationary and is consistent with stability of the economy in the long run. I propose two definitions of price stability, 'measured price stability' and 'sustainable price stability.' I argue that 'sustainable price stability' should be the fundamental goal for monetary policy. Although, from the viewpoint of accountability, 'measured price stability' is important as a quantitative yardstick by which to evaluate policy achievement, it should not be the justification for preventing the central bank from its pursuit of 'sustainable price stability.' Since observed changes in price indices are affected by various types of external shocks and measurement errors, it is indeed quite difficult to assess whether the underlying rate of inflation is stable or not. Therefore, even if 'measured price stability' seems to be maintained, a central bank may need to alter interest rates promptly if it judges that the maintenance of 'sustainable price stability' is at risk. In this sense, it is deemed important to construct a framework for monetary policy designed to maintain policy flexibility with a high degree of transparency by properly ensuring consistency between 'measured price stability' and 'sustainable price stability.' The current policy framework adopted by the Bank of Japan can be viewed as aiming at a kind of 'constrained discretion' by restricting pure discretion under open independence in line with this direction.

Key words: Ultimate Objective of Monetary Policy; Welfare Costs of Inflation and Deflation; Measured Price Stability; Sustainable Price Stability; Constrained discretion

JEL Classification Code: E31, E41, E52, E58

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I. Introduction

Article 2 of the Bank of Japan (BOJ) Law stipulates that "Currency and monetary control shall be aimed at, through the pursuit of price stability, contributing to the sound development of the national economy." In general, the above philosophy of the BOJ Law is regarded as meaning that the BOJ "pursues price stability to achieve sound development of the national economy." More precisely, although there exists a trade-off between price stability and output (or employment) stability in the short run, such a trade-off will disappear in the long run.[1] In other words, monetary policy makes its best contribution to economic growth and employment by keeping inflation low and stable.

However, the practical interpretation of price stability, which includes items such as the scope and criterion of price stability, is not explicitly defined in the Bank of Japan Law, and, thus, a consensus has yet to be gained as to how to transform it into the practice of monetary policy. For example, in Japan, there are active debates concerning the introduction of inflation targeting. Some proponents of inflation targeting argue that a numerical definition of price stability, such as 'a specific value of a specific price index,' will improve the accountability and transparency of monetary policy.

The question of what 'price stability' is, even though it is a fundamental question for monetary policy, is not necessarily an easy one to answer clearly in practice. In fact, changes in actual price indices --- the consumer price index (CPI), the wholesale price index (WPI), and the GDP deflator --- are affected by various types of temporary shocks and measurement errors, making it quite difficult to gauge the underlying inflation trend. For example, it might be the case that statistically measured inflation appears highly volatile at a glance, while most of the effects are just temporary. On the contrary, it might also be the case that measured inflation remains stable, even though the changed underlying inflation trend is offset by temporary shocks. Furthermore, the magnitude of measurement errors in price indices is likely to vary according to the current economic conditions and the pace of technological innovation.

If one accepts that 'price stability' does not always correspond to the achievement of a specific rate of inflation in a specific price index, the question of "whether it is appropriate to express a desirable state of price development as a specific value of a specific price index" is not necessarily an easy one to answer clearly. In this sense, it

[1] See Bank of Japan, Institute for Monetary and Economic Studies (2000), for the discussion on legal interpretations of price stability in the Bank of Japan Law.

is worthwhile examining the practical way of thinking on 'price stability' in detail to improve the transparency of monetary policy. In this paper, I survey the existing literature and examine three related questions: (1) What inflation rate constitutes the appropriate target for the central bank?; (2) What is an operational definition of price stability for the conduct of monetary policy?; and (3) What is the policy framework for pursuing price stability in practice?

This paper is organized as follows. Section II summarizes the benefits of price stability and Section III provides a selective survey of the existing literature on the costs of inflation, disinflation, and deflation. Then, Section IV examines what the desirable rate of inflation is from the viewpoint of monetary policy conduct and proposes two views on price stability, i.e., 'measured price stability' and 'sustainable price stability.' Section V explores the importance of constructing a framework for monetary policy designed to ensure consistency between these two views on price stability from the viewpoints both of the accountability of monetary policy and of economic stability. Section VI concludes the paper. Appendixes provide some empirical evidence on the cost of inflation in Japan: Appendix A estimates the long run money demand function to compute 'shoe leather' cost; and Appendix B examines the relationship between relative price fluctuations and the rate of inflation.

II. Benefits of Price Stability

In the following two sections, I review the existing academic literature on the welfare cost of inflation and deflation to examine why price stability is desirable.

A. Expectation Formation and the Rate of Inflation

In the economy that the principle of 'classical dichotomy' holds, real variables do not depend on nominal variables, such as the money supply and the general price level. Thus, an increase in real labor productivity, which directly affects social welfare, is determined by capital accumulation and technological progress, and is unaffected by changes in the rate of inflation. This implies that aggregate price fluctuations are neutral with respect to social welfare.[2]

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[2] For example, Lucas (1987) states that "a society can use monetary and fiscal policy to attain any *average* inflation rate it wants," and that "[l]ong-run price stability is one of the few legitimate 'free lunches' economics has discovered in 200 years of trying." In other words, the rise and fall of the average inflation rate affects the decision-making of private agents, thereby inducing distortions of resource allocation in the economy. Thus, a society can achieve the most efficient resource allocation by guiding the average rate of inflation to a rate that is neutral with regard to the decision-making of private

Indeed, Federal Reserve Board Chairman Greenspan refers to price stability as being a state in which "economic agents no longer take account of the prospective change in the general price level in their economic decision making" (Greenspan [1996]). This definition can be interpreted as indicating the importance of attaining the state of classical dichotomy in which price fluctuations do not affect the decision making of economic agents regarding resource allocation. On more realistic basis, inflation is probably not strictly neutral, price stability, however, minimizes distortions in the economy, thereby promoting sustainable economic growth.

Then, does the impact of inflation on the decision making of economic agents vary in accordance with the rate of inflation? Figure 1 plots the relationship of people's perceptions concerning inflation to the rate of inflation itself. This figure suggests that private perceptions of inflation remain stable until the rate of inflation reaches some critical level, while such perceptions change rapidly once the rate of inflation exceeds the critical level.

B. Inflation as a Source of Welfare Loss

Why do aggregate price fluctuations affect resource allocations in the economy, and, as a result, lower social welfare? In considering this question, it is important to understand the dynamic nature of decision making. Economic activity often consists of various nominally denominated economic contracts (either explicit or implicit). Therefore, if the general price level changes, real economic values will change, resulting in unplanned redistribution of income between the parties concerned. However, at the same time, the risk of future changes in inflation, and hence in real economic values, increases.

Unanticipated inflation causes unintended redistribution of both income and risk. Moreover, the increase in unexpected inflation introduces additional uncertainty about future prices, thereby raising interest rates by increasing the risk premium. As a result, the distortion of resource allocation induces welfare loss in the economy. Even anticipated inflation, however, affects resource allocation to some extent. This is because social and economic systems are non-neutral with respect to inflation. Therefore, inflation inevitably induces some welfare costs whether it is anticipated or not, even though the magnitude and mechanism of the costs differ.

The aforementioned adverse effects of inflation-induced distortion in the economy could in principle be reduced by indexing economic contracts to offset the risk of

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agents.

fluctuations in the general price level. In practice, however, it seems unlikely that there will be a wholesale shift to indexed economic systems, and nominal contracts will continue to dominate. Thus, it is reasonable to suppose that achieving and maintaining a stable general price level is the most practical way to reduce the social costs of inflation.[3]

III. Welfare Costs of Inflation and Deflation

In this section, I summarize in turn the issues involved in the social costs of inflation, disinflation, and deflation.[4]

As aforementioned, the sources and mechanisms of the costs of inflation differ, depending on whether inflation is anticipated or not. As Blinder (1987) points out, the important point is that "the costs of inflation depend very much on whether it proceeds at a steady, predictable rate or is volatile and takes people by surprise." In the following, I examine the costs of inflation in the cases of both 'predictable' and 'surprising' rates. I then go on to explore the social costs of disinflation and deflation.[5]

A. Costs of Inflation

First, let me consider the case of anticipated inflation where the rate of inflation is moderate and stable over time, and assume that people can generally predict the future course of inflation. Under these circumstances, academic literature emphasizes 'shoe leather' cost, menu cost, and the non-neutrality of tax systems with regard to inflation.[6]

On the one hand, the former two costs ('shoe leather' cost and menu cost) arise from the allocation of scarce resources to unproductive activities, thereby lowering economic efficiency. The latter cost (tax system), on the other hand, arises because inflation induces distortion in resource allocation by affecting the decision making with

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[3] For example, Feldstein (1997) emphasizes that while a fully indexed tax system would in theory be possible, such a system design is not legislatively and administratively feasible. He then concludes that indexation cannot be a practical alternative to reducing inflation.

[4] If the desirable rate of inflation is not zero but some positive value, inflation at that desirable rate will incur social costs. In the following, these kinds of costs are included in the costs of deflation.

[5] There are a number of major survey articles on the costs of inflation, including Driffill, Mizon, and Ulph (1990), and Briault (1995). Issing (2000) also provides a useful discussion on this issue with emphasis on its implications for monetary policy.

[6] In addition to the social costs examined here, the effects of increased uncertainty are often pointed out. Kimura and Tanemura (2000b) estimate the CPI inflation rate that minimizes inflation uncertainty, i.e. inflation volatility, is around 1 percent.

regard to investments.

1. 'Shoe leather' cost and the opportunity costs of money holdings

Since nominal interest rates generally increase due to the Fisher effect as inflation rises,[7] people have a greater incentive to save cash balances that yield no interest earnings. Consequently, people try to reduce their cash holdings by making frequent trips to banks to withdraw their deposits. This cost is metaphorically called 'shoe leather' cost because frequent trips to banks make people's shoes wear down faster than would otherwise be the case.

The question we have to examine here is whether this cost will be serious even at a moderate rate of inflation. There is a large quantity of empirical literature on quantitative evaluations of 'shoe leather' cost obtained by computing the changes in consumers' surplus with a money demand function, stemming from the contribution of Bailey (1956). More concretely, Figure 2 shows the 'dead weight loss' which is produced by higher nominal short-term interest rates, as an approximation to the 'shoe leather' costs.

Employing the analytical framework of Lucas (2000), I estimate the 'shoe leather' cost in Japan (see Appendix I for the details). More precisely, I quantitatively evaluate the magnitude of 'shoe leather' cost by estimating the money demand function, which explains the ratio of real money balances (M1 base) to real income in terms of the nominal short-term interest rate, using long-range historical data from 1885 to 1999. The estimation results show that the welfare gain from a 10 percent decline in the rate of inflation is just 0.03 percent of real GDP, because interest rate elasticity with regard to money demand is quite low in Japan.[8] By contrast, the estimation results in Lucas (2000), which uses the US data for 1900-94, show that the welfare gain from a 10 percent reduction in inflation is equivalent to an increase in real GDP of slightly less than 1 percent. However, it should be noted that such estimation results are very sensitive to the specifications of money demand function and/or utility function.[9]

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[7] Fisher effect assumes the one-for-one influence of expected inflation on the nominal interest rate, because nominal interest rate is the sum of the real interest rate and expected inflation.

[8] I compute welfare gains when the nominal short-term interest rate was lowered from 12.5 percent to 2.5 percent by assuming that the equilibrium real short-term interest rate is equal to 2.5 percent, based on the estimation of Mori, Shiratsuka, and Taguchi (2000) based on long-term historical data for Japan. It should be noted, however, that changes in the equilibrium short-term interest rate hardly affect the magnitude of welfare gains, since welfare gain varies in an almost linear fashion with regard to the interest rate due to low interest rate elasticity in Japan.

[9] Sinn (1999) comments on the estimation results in Lucas (2000) which show that welfare costs will

2. Menu cost and relative price fluctuations

The menu cost associated with inflation refers metaphorically to the additional cost incurred by the necessity of printing and distributing new catalogues and price lists whenever price revisions take place. Since menu cost can lead to significant stickiness in nominal price adjustment, money is non-neutral to real economic activity in the short run.

As a clue to the effects of menu costs on social welfare, let me now explore empirically the relationship between relative price variability and the rate of inflation. A fundamental function of a price system is to transmit the necessary information for resource allocation in the economy efficiently. Although the relevant information in this case is not absolute prices but relative prices, it should be noted that all the information in practice is provided in the form of absolute prices.[10] However, under the existence of menu cost and positive trend inflation, as Ball and Mankiw (1994) suggest, positive shocks to firms' desired prices trigger greater adjustment than do negative shocks of the same size, thus leading to excessive fluctuations in relative prices.[11]

The upper panel of Figure 3 is a scatter diagram showing, from January 1971 to April 2000, on the horizontal axis, the CPI inflation from a year earlier, and, on the vertical axis, the weighted standard deviation of individual item inflation rates as a proxy for relative price variability.[12] This diagram shows that there is a positive

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decline markedly if one takes into account the effects of transaction costs and interest income tax. Attanasio, Guiso, and Jappelli (1998) employ individual household data in Italy regarding the usage of ATMs to estimate the welfare costs of reducing cash balances as being less than 0.1 percent of the real GDP. On the contrary, Dotsey and Ireland (1996) take a general equilibrium approach to assess the welfare costs of inflation by considering the effects on time allocation, human capital accumulation, in addition to 'shoe leather' cost. They then point out that welfare costs reach 1.08 percent of the real GDP for 4 percent inflation, and 1.73 percent for 10 percent inflation.

[10] Friedman (1977) emphasizes that although the relevant information with regard to price mechanism is relative prices, then points out that highly volatile general prices make it difficult to extract an indicator of relative prices from absolute prices, because the information is in practice transmitted in the form of absolute prices.

[11] Looking at the relationship between the rate of inflation and the shape of the cross-sectional distribution of individual price changes in the CPI, the shape of the distribution skews to the right under high inflation, while the shape of the distribution skews to the left under low inflation. There are two models to explain why the shape of the cross-sectional distribution of individual price changes is asymmetric: (1) a model which assumes the existence of menu cost and asymmetric price shocks (Ball and Mankiw, 1995), and (2) a model which assumes the accumulative influence of sectoral shocks (Balke and Wynne, 1996, 2000). For the details on these points, see Shiratsuka (1997) and Mio and Higo (1998).

[12] I use disaggregated CPI data in 88 categories, which are continuously available retroactively to 1970.

correlation between the rate of inflation and this standard deviation. However, if one divides the sample into two by setting the border rate of inflation at 3 percent, this positive correlation becomes insignificant in the sample of inflation rates below 3 percent.[13] This results suggests that there is a possibility that it becomes difficult to distinguish relative price fluctuations from changes in general price level when inflation reaches a certain rate.[14]

In this regard, the critical rate of inflation at which the correlation between relative price fluctuations and the rate of inflation become significant needs to be determined. More precisely, I thus conducted rolling regressions for the equation that explains the relationship between relative price variability and the rate of inflation, by moving up the border rate of inflation gradually within the sample period from January 1971 to April 2000 (see Appendix B for the details).

The estimation results can be summarized as follows: (1) The CPI inflation rate that corresponds to the rate at which the positive relationship between the CPI inflation rate and relative price variability becomes statistically significant is estimated at 2.7 percent. (2) The CPI inflation rate that corresponds to the rate at which the difference between higher and lower inflation samples becomes statistically insignificant is 5.9 percent. Although these estimation results vary slightly depending on the sample period chosen, the general conclusion that the former critical inflation rate is around 3 percent and the latter critical inflation rate is 5 to 6 percent remains unchanged.

3. The non-neutrality of taxation with regard to inflation

In recent years it has been emphasized that even anticipated and relatively low rates of inflation provoke substantial welfare losses to the economy, because their cumulative effects distort economic decision making and resource allocation significantly in the long run.[15] The most important source is the interaction of inflation with the tax

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The measures of overall CPI inflation and relative price variability are respectively calculated as a weighted average of individual items, and its weighted standard deviation. See Shiratsuka (1997) for details of this data.

[13] Ball and Mankiw (1994) show that the asymmetric response of relative prices to external shocks disappears when the rate of inflation becomes high.

[14] Although this analysis focuses only on the current prices of goods and services for consumers, this type of analysis should essentially cover all the relative prices in the economy, ranging from current prices of raw and intermediate materials and other factor prices, such as wages, to future prices of such products.

[15] A literature on the monetary growth model starting with Tobin (1965) explores the long-run effects of inflation on resource allocation. In this literature, the mechanism of the so-called 'Tobin effect' is examined in detail. That is, higher inflation increases the opportunity cost of holding money, inducing a portfolio shift from financial assets to real assets, thereby leading to higher economic growth in the long

system, which is non-neutral to the level of inflation, due to the absence of complete indexation.[16] In fact, the cumulative effects of past inflation erode the tax benefits, leading to tax-related distortions across taxable items and methods of taxation. As a result, even low or moderate levels of inflation produce serious distortion by reducing the optimal level of investment and incentives to work.

For example, Feldstein (1999) estimates the social gains of reducing inflation by two percentage points (from 2 percent to zero) to be 0.76-1.04 percent per year as a ratio to real GDP.[17] He also argues that such social gains are sure to outweigh the cost of reducing inflation, considering that the social gains of reducing inflation should be evaluated as the discounted present value of the permanent benefits of price stability. More precisely, Feldstein (1999) points out that just 0.16 percent of real GDP as the annual benefit of lower inflation corresponds to the upper limit of the 'one-time' cost of reducing inflation, ranging from 4 to 6 percent, with a relatively high real discount rate, which is computed as the subtraction of the average rate of real economic growth (2.5 percent) in 1970-94 from the real net-of-tax return from stock investment (5.1 percent).

4. The cost of hyperinflation

Nobody denies that hyperinflation is extremely costly to the economy, as evidenced by the recent poor economic performance in countries that have experienced hyperinflation.

Hyperinflation produces tremendous costs because economic agents start using huge amounts of resources to avoid the impact of hyperinflation, instead of more productive activities, such as production and investment. In fact, although 'shoe leather' and menu costs are not so apparent when inflation remains moderate, such costs become serious under hyperinflation. 'Shoe leather' costs become large, because cash loses its value very quickly under hyperinflation and people devote much time and effort to save cash balances. Menu costs are also serious, because maintaining the current price level automatically implies a large decline in relative prices, leading to a higher incentive to change prices more frequently.

Moreover, the costs of hyperinflation undermine the credibility of long-term

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run. However, Orphanides and Solow (1990), who provide a comprehensive survey of this issue, point out that it is difficult to assess the practical relevance of the Tobin effect because slight differences in the set-up of theoretical models yield quiet different conclusions.

[16] Feldstein (1997, 1999) emphasize the effects of capital income taxes as a mechanism by which the tax system becomes non-neutral to inflation. Since the real effective tax rate rises as inflation increases, households are motivated to consume earlier, distorting intertemporal resource allocation.

[17] To the best of my knowledge, there are no empirical studies that estimate the costs of inflation associated with tax-related distortion, which correspond to Feldstein (1999).

contracts, and adversely affect economic decision making in the long run. Higher inflation increases the uncertainty of relative prices as well as the future general price level. As a result, both risk premiums for long-term interest rate increases, and intertemporal resource allocation is misguided. In addition, the functioning of financial intermediation, which plays an important role in intertemporal resource allocation, is weakened.

The costs of inflation lower productivity growth, thereby leading to a lower rate of economic growth. Taking account of the fact that inflation is determined by the interaction of various factors, empirical evidence that links inflation with overall economic performance is not particularly robust. Still, some empirical studies are available that show that there is a negative correlation between the rate of inflation and the rate of economic growth (Fischer [1993], Judson and Orphanides [1996], and Barro [1997]). These empirical studies indicate that price stability is one of the fundamental bases for achieving favorable economic performance in the long run.

B. The cost of Disinflation

Another point that should be emphasized regarding the costs of inflation is that disinflation is highly likely to be associated with significant social costs. As the empirical literature on the 'sacrifice ratio' tells, reduction of the rate of inflation from a once increased level is costly in terms of both lost output and employment.[18] Furthermore, these costs become larger as the rate of inflation rises. Therefore, it is deemed important to sustain price stability to avoid the cost of disinflation being incurred once price stability is achieved.

C. The cost of Deflation

There is a growing consensus that deflation is potentially more costly than inflation, even though the costs of inflation are significant.[19]

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[18] Ball (1994) conducts a cross-country study on the sacrifice ratio, and points out that (1) the sacrifice ratio is decreasing in line with the speed of disinflation (the ratio of the change in trend inflation to the duration of disinflation episode, and (2) the sacrifice ratio is lower in countries with more flexible labor contracts.

[19] For example, Bernanke *et al.* (1999) state that "undershooting a zero inflation target (i.e., deflation) is potentially more costly than overshooting a zero inflation target by the same amount" (p. 30). De Long (1999) emphasizes that deflation is more fearful than inflation because (1) the nominal interest rate has a lower bound at zero; and (2) the resultant wealth transfer from debtors to creditors is likely to trigger disruption of the financial system.

1. Downward rigidity of nominal wages

Akerlof, Dickens, and Perry (1996) point out that downward rigidity in nominal wages may prevent the smooth adjustment of real wages under a very low rate of inflation. This impediment to real wage adjustment is likely to hamper re-allocation of labor force across sectors and areas, thereby leading to an increased equilibrium unemployment rate.

Looking at the empirical studies conducted in Japan, Kimura (1999), for example, shows that the hypothesis of downward rigidity of nominal wages is rejected with data up to 1998, while the hypothesis is not rejected with data up to 1997. He then suggests two alternative interpretations of this result. The first is the possibility of the permanent disappearance of downward rigidity as a result of the fact that the Japanese employment system, which is characterized by seniority payments and lifetime commitments, started changing fundamentally, as a result of the introduction of performance-based payment schemes. The second is the temporary disappearance of downward rigidity resulting from the fact that an extremely large adverse shock to the economy induced a temporary reduction in nominal wages as an emergent measure. However, since no country has experienced a situation in which near-zero inflation has continued for a long period of time, it is certainly still too soon to come to any definite conclusion. We have to wait at least for several more years for accumulation of longer time-series before conducting an additional estimation to find a definite answer.

2. Adverse effects on the financial system

Deflation undermines both the soundness of the financial system and the stability of the economy. Unexpected deflation initiates the malfunctioning of financial intermediation through the adverse mechanisms of debt deflation and credit crunch.[20] The former mechanism is an income transfer from debtors to creditors as a result of an increase in the real value of debt due to unexpected deflation. Debtors have higher expenditure propensity than creditors, resulting in a decline in aggregate demand. The latter mechanism of credit crunch raises balance sheet adjustments in response to declining net worth for economic agents, leading to an increase in non-performing loans within the financial system. Under such circumstances, economic agents whose capital base had been eroded became cautious in taking on risks and also in doing business with counterparties whose capital base has been eroded, leading to a decline in economic activity.

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[20] For the discussions on debt-deflation and credit crunch, Fisher (1933) and Bernanke (1983) respectively comprise the basic literature in these two issues.

3. Upward bias in price indices

An upward bias in price indices is provoked because current price indices fail to account for the dynamic nature of economic activity such as the changes in consumers' behavior in choosing between goods in response to relative price fluctuations, the introduction of new goods, and the disappearance of old goods.

Straightforwardly, an upward bias in price indices has a direct implication for price stability. Because of this upward bias, even if a central bank decided that its target for the 'true' rate of inflation should be zero, the implied target for measured inflation would have to be greater than zero. The existence of an upward bias in the CPI thus means that pursuing a zero measured inflation rate means that it is necessary to conduct a deflationary policy, thereby possibly resulting in a loss of economic welfare.

Shiratsuka (1999) estimates upward bias in the Japanese CPI at 0.9 percentage points.[21] As shown in Table 1, however, the effects of upward bias in major industrial countries ranges from 0.5 percentage points to 1.1 percentage points per year. Although the accuracy of the estimate is not necessarily high due to the lack of existing studies in this field in Japan, it is reasonable to suppose that there exists some positive upward bias in Japan.

It should be noted that the magnitude of measurement error is deemed to change according to economic conditions. For example, Shiratsuka (1999) demonstrates a positive correlation between the rate of inflation and the impact of upper substitution bias, indicating that the impact of the problems in price index formula construction increase during high inflation periods. In addition, the speed of technological progress could vary over time. Thus, to accept a certain inflation rate as an upward bias does not necessarily ensure welfare maximization in the economy, and could lead to a loss of economic welfare. Bearing this point in mind, how measurement errors in the price index change over time in relation to the business cycle is an important issue awaiting solution.

4. Non-negativity constraints on nominal interest rates

Non-negativity constraints on nominal interest rates become increasingly important in a very low inflation environment.

Monetary policy generally controls short-term nominal interest rates, while it is the

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[21] Shiratsuka (1999) updates the estimation results of the upward bias in the Japanese CPI in Shiratsuka (1998). The point estimate remains unchanged, while the upper limit is lowered from 2.35 percentage points per year to 2 percentage points, based on the revised estimation results on the substitution bias.

real rate that matters in terms of its effects on inflation and real economic activity. Even if nominal short-term interest rates are kept constant, the effects of monetary easing or tightening on economic activity will vary depending on the rise and fall of the rate of inflation. Therefore, it is crucially important for monetary policy to adjust the nominal interest rate in accordance with fluctuations in the rate of inflation, so as to guide real interest rates consistently with the financial and economic conditions.

Since the nominal interest rate cannot be negative, a low level of nominal interest rates leaves a central bank with very little room to lower interest rates when the economy faces deflationary pressure. In this case, it is highly possible that increased deflationary pressure would rather result in an increase in real expected interest rates, thereby leading to greater economic instability.

Looking at the Japan's experience of the so-called zero interest rate policy, however, it is evident that monetary policy maintains its effectiveness by working on expectations. More precisely, a zero interest rate policy can be regarded as an automatic stabilizer that functions by promoting the smoother formation of market expectations regarding the future course of monetary policy by announcing that it will persist "until deflationary concerns are dispelled." In this regard, if the economy is on a downward trend, market participants believe that the termination of the zero interest rate policy should be put off, thus bringing longer-term interest rates down to flatten the yield curve. On the contrary, if the economy is on an upward trend, market participants believe that the termination should get closer, thus raising longer-term interest rates to steepen the yield curve rise, acting as a brake on the monetary easing effect.[22]

IV. Price Stability as an Objective of Monetary Policy

In this section, based on the discussion so far, I examine next what the desirable rate of inflation is. I then discuss how this rate of inflation can be related to the practical definition of price stability for monetary policy.

A. Monetary Policy and the Desirable Rate of Inflation

As to the desirable rate of inflation, there are a lot of debates on whether it corresponds

[22] Fujiki, Okina, and Shiratsuka (2000) examine the Japan's experience of monetary policy under zero interest rates as well as additional measures for monetary easing beyond the so-called zero interest rate policy. Goodfriend (1999) also investigates the policy options for a central bank under the non-negativity constraint on nominal interest rates.

to exactly zero measured inflation or to a small but positive rate of inflation.[23]

1. Level of the desirable rate of inflation

There is growing attention to the debate over precisely what numerical value should be targeted in an inflation-targeting regime.[24] The general consensus on this point in academic circles is that an inflation target should be some small but positive rate of measured inflation, obtained by adding a 'margin for safety against the risk of deflation' to 'a true inflation of zero adjusted for the upward bias in price index' (see, for example, Bernanke *et al*., 1999).

With respect to the risk of deflation, there is a perception that monetary policy should be conducted so as to prevent deflation from happening, taking into account the fact that deflation is more difficult to deal with than inflation.

As summarized in the previous section, it should be noted that there is a substantial risk that deflationary pressure will be amplified in a low inflation environment due to difficulties of real wage adjustment and the adverse effects of debt deflation and credit crunch. In addition, considering that nominal interest rates can not be negative, low nominal interest rates leave very little room for a central bank to lower interest rates to fend off a tremendous deflationary shock. This suggests the greater possibility of rising real expected interest rates in the event of recession, thereby leading to a higher risk of instability in the economy.

However, it is necessary to examine the validity of the above argument in a disinflationary environment against the backdrop of productivity improvement. It is often pointed out that worldwide price declines, including those in Japan, are induced by the improvement in productivity against the backdrop of revolution in information

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[23] Friedman's rule, proposed by Friedman (1969), postulates that (1) efficient resource allocation requires that there be a zero opportunity cost of holding money, i.e. zero nominal interest rates, implying price deflation at the equivalent rate of the real interest rate in absolute terms; and (2) an optimal monetary policy to achieve efficient resource allocation should steadily contract the money supply at a rate sufficient to bring the nominal interest rate down to zero. See Woodford (1991) for a detailed survey of this issue. In contrast, Summers (1991) argues that 2 or 3 percent inflation is desirable because of (1) the non-negativity constraint of nominal interest rates; (2) downward rigidity in nominal wage rates; and (3) the high possibility of equalizing the marginal costs and benefits of inflation at a positive rate of inflation. Furthermore, Fischer (1996) emphasizes that it is best to target a rate of inflation in the range of 1 to 3 percent by pointing out the effects of upward bias in price indices in addition to the first and second reasons suggested by Summers (1991).

[24] For details of the policy framework of inflation targeting, see, for example, Bernanke *et al*. (1999), and Bank of Japan, Policy Planning Office (2000).

and telecommunications technology.[25]

As examined in the previous section, quality changes and/or new product bias, which stem largely from technological progress, are identified as constituting the largest source of the upward bias in the CPI in major industrial countries (see Table 1). An overestimation of 'true' inflation is, to put it differently, an underestimation of productivity growth or economic growth. For example, if a price decline is brought about by a downward shift of the aggregate supply curve as a result of an increase in productivity, it is possible to argue that this downward pressure on the general price level is acceptable (Figure 4). Even if the price index incorporates an upward bias of the same magnitude, the implication for monetary policy will differ according to the source of such bias.

Therefore, the question of what the desirable rate of inflation is, is not necessarily an easy one for which one can find a clear answer in conditions of ongoing structural change in the economy. In the next subsection, I examine this issue further, taking account of its relationship with 'sustainable price stability.'

2. The desirable rate of inflation and policy rules

The aforementioned discussions on the desirable rate of inflation do not have sufficient theoretical and empirical bases. However, the most important point in these discussions is that regarding the rate of inflation that enables monetary policy to respond effectively to various external shocks, thereby realizing a more efficient combination of inflation and output variabilities in practice.

Recent literature on monetary policy rule frequently employs the 'policy frontier,' shown in Figure 5, as a criterion by which to evaluate the performance of monetary policy rules (for example, see Taylor, 1994).[26] Changes in the weightings of the output

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[25] Fischer (1996) points out that the price development in 1820-96 was stable with steady economic growth and called it 'Victorian equilibrium,' as it approximately corresponds to the lifetime of Queen Victoria (1819-1901). Looking at the GDP statistics in Mitchell (1988), it is clear that the average rate of real GDP growth in 1830-96 remained at 2 percent per year, while nominal GDP growth was 1.8 percent per year, implying that GDP deflator declined annually by -0.2 percent. This indicates that zero inflation is not necessarily inconsistent with the sustainable economic growth.

[26] The policy frontier is generally defined as the 'variance trade-off' between the GDP gap and the inflation rate, which is downward sloping and convex to the origin. However, for ease of discussion relating to 'price stability,' I plot output stability on the horizontal axis and inflation stability on the vertical axis, so that the trade-off curve is reversed. Recent empirical analyses of monetary policy rules employ forward-looking econometric models to evaluate the efficiency of monetary policy rules with deviations from the policy frontier. See Kamada and Muto (2000) and Kimura and Tanemura (2000) for empirical research in Japan. It should be noted that the policy frontier is generally discussed in closed economic models, because effects stemming from the economic policy of other countries are marginal

gap and inflation in the policy reaction function affect the dynamic paths of the output gap and inflation in relation to the long-run equilibrium values and thus the variances of these two variables (the inverse of the degree of stability). The policy frontier is the locus of the most efficient pair of the degrees of stability in output gap and inflation, which is convex to the top-right direction. This implies that a central bank faces a policy tradeoff in the sense that if the central bank wants to increase inflation stability it has to tolerate a decline in output stability.

In the economic model in which the assumption of classical dichotomy holds, the target inflation rate does not affect the performance of economy, thus leaving the shape of the policy frontier unchanged. As examined in the previous section, however, inflation is not neutral to economic fluctuations in the short run, and persistent inflation, even though it is moderate, produces considerable costs in the form of an accumulation of distorted resource allocations. In addition, the risk of economic instability varies as the target rate of inflation changes because of the non-negativity constraint on nominal interest rates and downward rigidity of nominal wages. Therefore, the desirable rate of inflation in the short run can be regarded as the rate of inflation that leads the economy to achieve the most efficient combination of output and inflation stabilities on the policy frontier.[27]

Furthermore, as pointed out in the previous section, inflation reduces mid- to long-term economic growth. This implies that reducing the rate of inflation and stabilizing the macroeconomic environment improve macroeconomic performance in the medium to long run. In this sense, a desirable rate of inflation in the medium to long run can be considered as the rate of inflation that enables the economy to expand the policy frontier as much as possible, thus leading to more stability in both output and inflation. The solid and upward-sloping arrow in Figure 5 illustrates this point.[28]

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compared with those of one's own, as shown in Taylor (1993).

[27] The existing empirical literature on the evaluation of policy rules assumes that the classical dichotomy holds in the long run, thus the shape of the policy frontier is independent of the inflation rate. In order to examine the possibility that the policy frontier varies in accordance with the inflation rate, it is necessary to incorporate the nonlinear response of real variables against the rate of inflation in the model. However, such an extension seems to make the econometric model too complex and difficult to handle.

[28] In terms of the long-run Phillips curve and the natural rate of unemployment, this argument can be interpreted to mean that the long-run Phillips curve is not necessarily vertical but, rather, upward-sloping by comparison with the short-run Phillips curve. More precisely, although the unemployment rate will decline when inflation declines and the economic environment becomes more stabilized, the unemployment rate will, on the contrary, increase when inflation rises and macroeconomic conditions becomes unstable.

B. Two Definitions of Price Stability

Given that there is a consensus that small but positive rate of inflation is desirable, how can we relate this idea to a practical definition of price stability as the objective of monetary policy? Although a consensus has yet to be gained as to how we should define price stability in the context of monetary policy operations, it seems reasonable to classify the views on price stability into two.

The first definition enables one to specify price stability numerically so as to set a tolerable target range for the inflation rate, such that "price stability corresponds to a rate of inflation from zero to 2 percent." Let me call this approach to price stability 'measured price stability.'

This approach can be interpreted as assuming that a central bank has a lexicographic ordering among policy objectives, among which price stability has primary importance, and considers other objectives only when the inflation rate remains within the target range. Monetary policy is regarded as a failure when the first priority objective (price stability) is off target, even though at the same time other objectives (e.g. economic growth, employment) show good performance. This approach emphasizes transparency in the sense that the goal of monetary policy is clear, simple, and understandable. Accountability of a central bank is assured by its obligation to give a convincing rationale for its policy conduct, especially in the case of missing a previously announced target.

The second definition considers price stability to be an important basis for sustainable economic growth. This approach emphasizes the importance of achieving a stable macroeconomic environment as a fundamental condition for sustainable growth, rather than merely pursuing measured inflation using a particular price index. Let me call this approach 'sustainable price stability.'[29]

This approach is deemed to be similar to setting a goal for avoiding large fluctuations in real economic activity and the general price level in the long run.[30] It can be interpreted as emphasizing the importance of stabilizing public expectations regarding inflation, as a necessary condition for maximizing economic stability and

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[29] Since the notion of 'sustainable price stability' refers to the importance of the sustained stability of inflation that is compatible with sustained economic growth, it does not necessarily correspond to the mere stability of measured inflation at a particular level. In this sense, 'sustained price stability' implies not only stability of the rate of inflation but also the stability of inflation variability.

[30] Mieno (1994), the former Governor of the Bank of Japan, stated during his lecture at the Kisaragi-kai in May 1994 that "Price stability does not mean the stability of price indices. Real price stability can be achieved when such stability is backed by medium- to long-term, well-balanced, and sustainable economic growth."

efficiency.[31] Price stability in itself is, however, a necessary but not a sufficient condition for sustainable economic growth. Furthermore, an important question is still left open. That is, coupled with the fact that an operational definition of the inflation rate necessary for sustainable economic growth is quite difficult to come up with, "the price index that should be stabilized" still remains a relevant question even as the central bank focuses on sustainable economic growth.

C. The Practical Interpretation of Price Stability

In order to obtain a clearer picture of the aforementioned two views on 'price stability,' I examine the relationship with the policy frontier and, then, carry out a case study to determine how these two views on price stability can be interpreted in the context of price development during the bubble period.

1. The relationship with the policy frontier

First, let me summarize the two views on price stability in relation to the policy frontier.

From the viewpoint of single-minded targeting on inflation to pursue 'measured price stability' at any cost under conditions of lexicographic preference, there is no trade-off between price stability and output stability. Or, even more realistic to permit the trade-off between price stability and output stability, the policy frontier is extremely flat because the opportunity cost of improved output stability to compensate inflation stability is very large. However, inflation-targeting countries do not assume such an extreme preference in the trade-off between inflation stability and output stability. On the contrary, inflation-targeting countries must be considered as employing 'measured price stability' as an indicator to help them to achieve 'sustainable price stability.'

For example, Batini and Haldane (1999) point out that inflation-forecast-based policy rules, which guide short-term interest rates in response to the inflation forecasts for three to six quarters ahead, help improve not only price stability but also output stability.[32] This result is viewed as supporting evidence for the current framework of the Bank of England to employ inflation forecasts for about two years ahead as an

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[31] For example, in an introductory speech at the August 1996 Federal Reserve Bank of Kansas City Symposium entitled "Achieving Price Stability," Greenspan (1996), Chairman of Federal Reserve Board, referred to an operational definition of price stability from a central bankers' point of reference: "Price stability obtains when economic agents no longer take account of the prospective change in the general price level in their economic decision making."

[32] Kimura and Tanemura (2000a) show the possibility that an inflation-forecast-based policy rule that responds to the inflation forecast for six quarters ahead can stabilize both inflation and the output gap simultaneously.

intermediate target. If this interpretation is appropriate, it is the case that there is no trade-off between price stability and output stability in the long run, and that, in this case, two years is long enough to be considered as the long run in practice.

The recent analyses of monetary policy rules conduct stochastic simulations on the various parameter sets of policy reaction functions. In this case, stochastic simulations give random shocks for a certain period of time that can be used to compute variances of time series of simulated output gaps and inflation rates. Then, the simulations are repeated several hundred times and a pair of average of computed variances calculated for each simulation. The procedure of stochastic simulations implies that the performance of policy reaction functions is evaluated on the policy frontier in terms of 'sustainable price stability,' rather than 'measured price stability.'

This point is relevant to extracting a practical implication from the relationship between 'measured price stability' and 'sustainable price stability.' This is because the above empirical analysis casts some light on how effectively various policy reaction functions stabilize macroeconomic performance in the medium to long run, and provides a clue to understanding how long the "medium to long run" is in practice.

Although two views share an emphasis on the importance of pursuing sustainable economic growth in the long run, their proponents think differently from each other concerning the practical way to achieve it, thus putting different relative weights on 'measured price stability' and 'sustainable price stability'. More concretely, from the viewpoint of 'measured price stability,' even though the central bank is expected to pursue price stability that is consistent with sustainable economic growth in the medium to long run, it is necessary to establish a track record of maintaining stable inflation in the short run by committing to the previously announced target for the inflation rate. On the contrary, from the viewpoint of 'sustainable price stability,' stabilization of the inflation rate around the target rate using a specific price index at a particular point in time is not sufficient to achieve price stability that supports sustainable economic growth in the long run.

The above interpretation of the two views on price stability seems consistent with the following historical fact. That is, inflation targeting was initially introduced in countries where macroeconomic performance had deteriorated and, as a result, the central bank was required to establish a credible commitment to price stability.

2. Japan's experience of the bubble era

In order to put the difference between the two views on 'price stability' into perspective, it may be useful to conduct a case study regarding how such views are interpreted in

regard to price development in the second half of the 1980s, based on the discussion of Okina, Shirakawa, and Shiratsuka (2000).

At the time of the bubble period,[33] the CPI had been extremely stable until around 1987, started to rise gradually in 1988, and the year-on-year increase was still 1.1% in March 1989, immediately before the introduction of the consumption tax (Figure 6). The year-on-year increase in the CPI, adjusted for the impact of consumption tax, continued to rise after April 1989, and it reached 2% in April 1990 and 3% in November 1990.

First, looking at this price development from the viewpoint of 'measured price stability,' two evaluations are possible: (1) prices eventually rose substantially toward the end of the bubble period, compared with the recent level of inflation; and (2) price stability had not been undermined in comparison with the figure before the bubble period. The difference between the two evaluations, so to speak, boils down to the question of what can be regarded as a tolerable rate of inflation, and there can be a variety of answers to this question.

However, if one look back at Japan's experience since the bubble period from the viewpoint of 'sustainable price stability,' it can be seen that Japan's economy experienced a decline in inflation and faced the risk of tumbling into a deflationary spiral. Thus, it is crucial to determine a way of evaluating the fact that such deflation occurred as a result of the emergence of the bubble economy in the second half of 1980s. In this context, as Okina, Shirakawa, and Shiratsuka (2000) point out, it could be safely evaluated that "it seems more important to consider whether price stability is sustainable over the long run, instead of discussing whether prices had been stable during the bubble period. According to this view, it might be possible to assess that Japan's economy did not succeed in sustaining price stability after the bubble period." In other words, it suggests the importance of evaluating the sustainability of price stability over a fairly long period.

So how can above summary of economic performance since the second half of the 1980s be evaluated from the viewpoint of output stability and price stability? Figure 7 is a scatter diagram showing the root mean squared deviations[34] of CPI inflation

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[33] Okina, Shirakawa, and Shiratsuka (2000) define the bubble period as the period from 1987 to 1990, from the viewpoint of coexistence of three factors of bubble economy, that is, a marked increase in asset prices, an expansion of monetary aggregates and credit, and an over-heating of economic activity.

[34] The root mean squared deviation is computed as follows: compute the first mean value of squared deviations of the inflation rate from its target rate, and then take the root value. This corresponds to the root-mean-square-error around the target value of inflation.

(vertical axis) and real GDP growth (horizontal axis) from their target values (CPI inflation for 1.5 percent and real GDP growth for 2.5 percent) for the 5-year and 15-year subsample periods[35] from 1980. This picture shows Japan's realized economic performance on the policy frontier. The plot of the 15-year subsample period is relatively stable, compared with large fluctuations in the plot of 5-year subsample period. Moreover, the plot of the 5-year subsample period shifts inside the plot of the 15-year subsample period in the second half of 1990, while it is located outside it before then, implying that there was a significant deterioration in macroeconomic stability. This deteriorating economic performance can be also seen in the plot of the 15-year subsample period.

A closer look at this figure also offers the following observations. First, observations for the period from late 1980 to early 1990, which largely covers the bubble period, are concentrated in the upper left area, implying that resultant economic performance was poor due to the remarkable swing in business conditions. Second, the plots of both root mean squared deviations and standard deviations for the 15-year sample period exhibit lower output stability than inflation stability, while both show similar shapes. These observations support the argument in Okina, Shirakawa, and Shiratsuka (2000) that Japan's economy did not sufficiently succeed in sustaining price stability after the bubble period.

The experience of the bubble period seems to suggest the importance of "the sustainability of price stability over a fairly long period." This contrasts with the aforementioned empirical results in the United Kingdom that indicate that the inflation-forecast-based policy rule, which adjusts short-term interest rates in response to the inflation forecasts for three to six quarters ahead, helps improve not only price stability but also output stability.

V. Price Stability and the Framework for Monetary Policy Conduct

As a next step, I examine the issues regarding the practical framework for the conduct of monetary policy, based on the above summary of ideas about price stability.

A. The relationship between the Two Views on Price Stability

Under the new Bank of Japan Law, the BOJ is required to pursue sound development of the national economy by maintaining price stability. This can be taken to mean that,

[35] In this analysis, 5-year and 15-year sample periods illustrate the duration of a business cycle and the period from emergence to collapse of the asset price bubble, respectively.

on the one hand, the BOJ is required to pursue price stability, an aim which is in itself based on certain criteria from the viewpoint of understandability, and, on the other hand, it is also required to ensure stability of the economy as a prerequisite for the basis for medium- to long-term economic growth.

Of course, as the notion of 'sustainable price stability' keeps future price developments strongly in mind, it is not necessarily equivalent to a low measured inflation rate at a particular point in time. In this context, the relevant question in practice is how to relate 'measured price stability' to 'sustainable price stability.'[36]

1. Difficulties in interpreting 'measured price stability'

'Measured price stability' is defined by observed movements in various inflation indicators, such as the consumer price index (CPI), the wholesale price index (WPI), and the GDP deflator. However, since movements of such indicators are affected by various temporary shocks and measurement errors, it is indeed quite difficult to gauge the underlying inflation trend. For example, it might be the case that statistically measured inflation appears highly volatile at a glance, while most of the effects are just temporary. On the contrary, it might also be the case that measured inflation remains stable, even though the changed underlying inflation trend is offset by temporary shocks.[37] Furthermore, the magnitude of measurement errors in price indices is likely to vary according to the current economic conditions and the pace of technological innovation.

Consequently, since it is indeed quite a difficult issue to assess whether the basis for price stability is maintained solely by observing the movement in inflation indicators, it is not easy to specify numerically the desirable inflation rate. In other words, if one wishes to set a numerical target in pursuing 'measured price stability,' one should be ready to answer questions concerning the consistency of this numerical target with 'sustainable price stability,' which is considered as the ultimate goal for monetary policy.

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[36] It should be noted that the notion of 'sustainable price stability' could vary, reflecting public perceptions on inflation at the time. Therefore, during the transitional period of such sentiment, it might become increasingly difficult for a central bank to transmit its intentions to the markets.

[37] For example, the price development during which the prices of fresh food fluctuate up and down markedly due to bad weather corresponds to the former case in which "statistically measured inflation is highly volatile at a glance, while most of the effects are just temporary." On the contrary, the price development during which the upward pressure on the price level is offset by the so-called 'safety valve effects,' such that declining prices for imported raw materials and expanded production capacity due to yen appreciation and increased imports corresponds to the latter case in which "measured inflation remains stable, even though the changed underlying inflation trend is offset by temporary shocks."

2. Analysis intended to promote a more appropriate interpretation of 'measured price stability'

In this regard, it is important to adjust the impact of temporary or transitory shocks to extract the cycle and trend components of underlying inflation movements.

Regarding the former component of cyclical one, Shiratsuka (1997), and Mio and Higo (1999) empirically show that the trimmed mean estimator, which excludes the impacts of items located on the both tails of cross-sectional distribution of inflation, adequately adjusts for the impact of temporary shocks, and could well be a quite useful and powerful indicator with which to gauge the changes in underlying inflation fluctuations.[38]

For example, Shiratsuka (1997) suggests that the trimmed mean estimator is useful in adjusting for the effects of various temporary shocks and in gauging the underlying inflation fluctuations. In particular, the level and direction of the underlying inflation fluctuations become more evident when the trimmed mean estimator is used in combination with the overall CPI (or the overall CPI excluding fresh food). As shown in Figure 8, if one focuses on the four points of time that correspond to the first oil crisis, the second oil crisis, the yen appreciation phase after the Plaza accord, and the yen appreciation in 1995, a comparison of the headline CPI and the trimmed mean estimator clearly indicates those occasions on which large external shocks affected a very limited range of goods and services (the second oil crisis and the yen appreciation after the Plaza accord) and those occasions on which they affected a fairly wide range of goods and services (the first oil crisis and the yen appreciation in 1995).

As to the latter component of trend movements, the important point to be examined is how to evaluate the inflationary pressure or the potential output level by taking account of structural changes of uncertain magnitude and timing.

A typical question in this line is how to evaluate the impact of an upward shift in the potential growth rate, as evidenced in the argument surrounding the 'New Economy.' Oliner and Sichel (2000) apply the analytical framework of growth accounting to quantify the impacts of information and telecommunication evolution in recent years, and show that two thirds of the increase in labor productivity between the 1991-95 to 1995-99 periods is attributable to capital accumulation in the form of personal computers and information networks as well as increased productivity in the manufacture of intermediate goods such as semiconductors.

Some caution, however, is in order when interpreting the above estimation results.

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[38] For the empirical research in the US, see, for example, Bryan and Cecchetti (1994).

It is hard to deny that the estimated increase in the productivity trend growth is likely to be affected by cyclical factors, because the US economy in the latter half of the 1990s enjoyed a long-lasting expansion. In this sense, it is indeed difficult to identify adequately how the structural changes are ongoing on a real time basis.[39]

3. Consistency between 'measured price stability' and 'sustainable price stability'

The above discussion indicates that 'measured price stability' does not necessarily contribute to 'sustainable price stability,' even though a central bank may be able to accomplish 'measured price stability' for a while. More precisely, if a central bank attempts to constrain measured inflation into too narrow a range, the economy may be pushed towards a boom-bust cycle.

A case in point is New Zealand in 1995-96, which was the first country to announce a strict commitment to 'measured price stability' through inflation targeting (Figure 9). Even though monetary policy in New Zealand was tight throughout 1995 and 1996, inflation remained slightly above the previously announced upper limit of 2 percent in 1996. This tight policy lead to high real interest rates and a rising real exchange rate, causing harm to the real economy. As a result, on December 10, 1996, the target range of inflation was widened from 0-2 percent to 0-3 percent (see, for example, Brash, 2000, and Bernanke *et al*., 1999).

Furthermore, as mentioned above, looking at Japan's economic development since the second half of the 1980s, it might well be a case of serious conflict between 'measured price stability' and 'sustainable price stability.' On the one hand, the general price level showed a stable movement and 'measured price stability' seemed to be maintained during this period. However, on the other hand, as an aftermath of the asset price bubble at a time of stable price development, asset prices declined remarkably and the business cycle was amplified in the 1990s. In particular, Japan's economy has been brought to the verge of a deflationary spiral.

Taking account of these experiences, it is important to note the possibility that the simultaneous requirement of achieving 'sustainable price stability' and strictly committing to 'measured price stability' might become difficult at times.

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[39] It should be noted that one important assumption for the Taylor rule to apply is that the potential growth rate remains unchanged, and this assumption might not always hold. In fact, Orphanides *et al*. (1999) pointed out that measurement errors in the GDP gap, stemming from *ex post* revision of the statistics, are so large that policy judgments could be different if real-time data were used instead of *ex post* revised data. See also Kamada and Masuda (2000) for the case in Japan on this issue.

B. A framework for Ensuring Consistency between the Two Definitions of Price Stability

The above episodes clearly show that consistency between 'measured price stability' and 'sustainable price stability' is not automatically assured in practice. It should be stressed, however, that 'sustainable price stability' is the primary goal for monetary policy and should never be hampered by pursuit of 'measured price stability.' To this end, a central bank is required to accomplish 'sustainable price stability' in the first place, and, at the same time, is also required to maintain policy credibility that is based on committing itself to 'measured price stability' according to certain criteria. Therefore, a desirable framework for the conduct of monetary policy is deemed to balance 'sustainable price stability' with 'measured price stability' so as to achieve compatibility between flexible policy responses and a high degree of transparency.

1. The conduct of monetary policy under conditions of structural change

Compatibility between 'sustainable price stability' and 'measured price stability' becomes a critical problem when fundamental structural changes in the economy are under way.

For example, Meyer (2000) states that a major challenge for US monetary policy at the moment is "to allow the economy to realize the full benefits of the new possibilities while avoiding an overheated economy." He also emphasizes the importance of possible changes in aggregate supply and in trend growth in the evaluation of inflationary pressure. More precisely, taking account of the recent development in monetary policy rules under uncertainty, he emphasizes the following three points: (1) the estimate of the GDP gap should be updated on the basis of all available data; (2) the aggressiveness of response to the output gaps should be adjusted in light of the uncertainty about their measurement; and (3) policy becomes less pre-emptive and more aggressively reactive as the degree of uncertainty about the GDP gap rises.

Furthermore, Meyer (2000) points out that the current strategy can be viewed as 'a nonlinear Taylor rule under uncertainty,' which is illustrated in Figure 10. That is, although the response to the GDP gap is attenuated in a region around the best estimate of potential GDP, the policy response should become more aggressive once the GDP gap moves sufficiently below or above the best estimate of the neutral level. The non-linear Taylor rule can be regarded as an application of the 'opportunistic approach'[40] to

[40] The opportunistic approach is the notion that, while maintaining price stability as the ultimate goal of monetary policy, monetary authorities should refrain from taking rough-and-ready policy responses

policy evaluation of the GDP gap, which is a preemptive component in a Taylor-type policy reaction function.[41]

In this context, in a speech in September 1997 Chairman Greenspan said that the conduct of monetary policy might naturally be discretionary in circumstances in which economic restructuring has been drastically effected (Greenspan [1997]). We cannot forecast the future course of the economy precisely if we just apply the historical relationships among various economic factors, because they are highly likely to have been altered as a consequence of structural change. In pursuing the policy objective of sustainable growth by maintaining price stability, it is not sufficient to follow any one mechanical rule based on previous relationships. Ad hoc or discretionary policy based on tentative decisions without any coherent criteria are problematic because such a policy is vulnerable to political pressure.

2. A framework for monetary policy with constrained discretion

The next question we have to ask is what kind of approach exists regarding the future framework for implementing monetary policy in Japan, which constrains discretion and is based on coherent criteria for policy judgment. In the following, we will examine this issue, by focusing on the idea of 'constrained discretion.'

For example, a policy regime of inflation targeting is regarded as a typical practice of 'constrained discretion.' In order to achieve consistency between the two views regarding price stability, the inflation-targeting regime commits to the previously announced inflation target, as well as permitting short-run deviations from inflation targets in response to large external shocks. More concretely, short-run policy flexibility is maintained by predetermined escape clauses and *ex-post* explanation to the public.[42] In this sense, the introduction of inflation targeting is not equivalent to a mere announcement of a commitment to the numerical inflation target. Therefore, inflation targeting is one of the policy frameworks designed to maintain policy flexibility with a high degree of transparency by properly ensuring consistency between 'measured price stability' and 'sustainable price stability'.

It should be stressed that inflation targeting is not the only way to produce a

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considering the possibility of favorable external shocks on inflation if and when inflation rate is at the level not so divergent from the long-term objective level, or is not likely to diverge from the current level. For details, see Orphanides and Wilcox (1996).

[41] It should be noted that the range of attenuation should be updated asymmetrically, reflecting subjective risk assessment on upward and downward risks in economic forecasting.

[42] For measures designed to deal with the situation when inflation breaches a target threshold, see, for example, Bank of Japan, Policy Planning Office (2000), and Bernanke *et al.* (1999).

desirable policy framework. A desirable policy framework would vary, depending on what kinds of communication measures are important in assuring accountability by showing a quantitative assessment of 'measured price stability,' while pursuing the 'sustainable price stability' as the primary objective for monetary policy.[43]

From this viewpoint, the question as to what is a desirable style for the BOJ's monetary policy does not boil down to a question of whether inflation targeting should be adopted or not.[44] The current policy framework adopted by the BOJ can be viewed as aiming at 'constrained discretion' by restricting complete discretion under open independence. In other words, this process is expected to lead to the achievement of consistency between 'measured price stability' and 'sustainable price stability,' by taking account of the characteristics of Japan's social and economic systems.[45]

VI. Conclusion

This paper first summarized the academic knowledge on the benefits of price stability, then examined the desirable rate of inflation in practice. The paper also proposed two views on price stability, i.e., 'measured price stability' and 'sustainable price stability,' and discussed their policy implications.

What needs to be emphasized concerning the relationship between two views on price stability is that the central banks should pursue 'sustainable price stability' in the first place as the fundamental and primary goal for monetary policy. It should be noted at the same time, from the viewpoint of accountability, that 'measured price stability' is also important as a quantitative yardstick with which to evaluate policy achievement. However, 'sustainable price stability' must not be undermined in the pursuit of 'measured price stability,' because the former is essential to the economy.

In this regard, the BOJ presently tries to establish a framework for implementing

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[43] It should be noted that the idea exists that while publication of all information regarding monetary policy is not undesirable, enhancing the transparency of economic policy by conveying information is needed. For example, Noyer (2000) stated, in reply to the criticism that the ECB lacks policy transparency, that "It is [therefore] important to judge carefully the contribution which the various elements of communication can make to the fulfillment of the primary objective of monetary policy." She also pointed out that "publishing forecasts might finally increase uncertainty and even complicate the maintenance of price stability," since economic forecasts should be evaluated appropriately in consideration of internal risks and uncertainty under structural reform.

[44] See Fujiki, Okina, and Shiratsuka (2000) for details regarding this point.

[45] Blinder (1998), Former Vice Chairman of FRB, states that "when people suggested to me that the Fed should be content with 3% inflation, I answered that the Federal Reserve Act calls for 'stable prices,' not 'pretty low inflation.' If citizens think that's wrong, they should get the law changed" (p. 67)

monetary policy in the middle of two extreme approaches of 'strict rule' and 'pure discretion' by restricting discretion under open independence. Such a policy framework can be viewed as 'constraint discretion,' which is in line with the basic philosophy of inflation targeting. In doing so, it is crucially important to consider proper consistency between 'measured price stability' and 'sustainable price stability,' based on the social and economic environment in Japan.

Appendix A. Money Demand and Cost of Inflation

In Appendix A, I quantitatively evaluate the magnitude of 'shoe leather' cost by estimating the money demand function using long-run historical data, which is a classical question stemming from the contribution of Bailey (1956). More precisely, provided that the observed nominal short-term interest rate contains the expected inflation rate due to the Fisher effect, I estimate the increment of consumer surplus when expected inflation is zero and nominal short-term interest rate is equal to equilibrium real short-term interest rates.

First, let $m(r)$ be the ratio of M1 to nominal GDP, m, expressed as a function of nominal short-term interest rate r. In this case, 'shoe leather' cost $w(r)$ measured as the dead weight loss of money demand function, shown in Figure 2 in the text, is written as follows:

$$w(r) = \int_0^r m(x)dx - rm(r)\,. \tag{A-1}$$

Let me assume that the money demand function is a log-log type as follows:

$$m(r) = Ar^{-\eta}\,. \tag{A-2}$$

then, equation (A-1) can be simplified as the following equation:[46]

$$w(r) = A\frac{\eta}{1-\eta}r^{1-\eta}\,. \tag{A-3}$$

Next, Figure A-1 is a scatter diagram showing the ratio of real balances to real

[46] Lucas (2000) employs the semi-log functional form as well as the log-log one expressed as equation (A-1). However, the semi-log functional form does not fit Japanese data well, exhibiting an almost

income (vertical axis) and the nominal short-term interest rate (horizontal axis). In this figure, I use M1 as currency outstanding and the call rate as the short-term nominal interest rate (I use the official discount rate before 1969).[47]

Table A-1 summarizes the estimation results of money demand function in equation (A-2).[48] Looking at the elasticity of the interest rate η across the different sample periods, it is estimated at -0.11 in the full sample period, -0.25 in the sample before World War II (pre-WWII), and -0.10 in the sample after Word War II (post-WWII). In the post-WWII sample, elasticity slightly declines to -0.09, if the samples after 1996, when the nominal short-term interest rate was below 1 percent are excluded. Although interest rate elasticity varies depending on the sample periods chosen, estimated interest rate elasticities are very similar in the post-WWII sample, regardless of the inclusion of recent samples of virtually zero nominal short-term interest rates.[49]

The upper panel of Figure A-2 displays the relation between the short-term interest rate and the welfare cost, estimated by equation (A-3) with the estimated parameters shown in Table A-1. The lower panel plots welfare changes relative to the 2.5% interest rate that I use as equilibrium real short-term interest rate. These estimation results indicate that 'shoe leather' cost is very small, that is, that the gain from reducing the annual inflation rate from 10 percent to zero is equivalent to an increase in real income of 0.3 percent, since the interest rate elasticity of the money demand function is the very small value of –0.1. However, even if one assumes interest rate elasticity to be –0.25, which corresponds to the estimate for the pre-WWII period, the welfare loss is

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linear shape. Therefore, I do not use that formula in this paper.

[47] The details of the data used in this estimation are as follows:

(i) As the outstanding amount of nominal money, the current M1 series is used since 1955. Before 1954, the estimate of Fujino (1994), which is consistent with the current series, is used except for the missing period of 1941-50. For 1941-50, I interpolate missing values based on the estimate of Asakura and Nishiyama (1974).

(ii) Nominal GDP is a current series since 1955, and Ohkawa (1974) is used up to 1954.

(iii) The nominal short-term interest rate is a concatenation of the following series: the overnight uncollateralized call rate from 1986 to1999; the overnight collateralized call rate from 1970 to 1985; and the official discount rate before 1969.

[48] Lucas (2000) assumes some plausible values for interest rate elasticity of the money demand function, and estimates the constant term so that the money demand function passes through the geometric means of the data pairs of the ratio of M1 to nominal GDP ratio and nominal short-term interest rates.

[49] Equation (A-2) implies that the money demand function is estimated by restricting income elasticity to one. In order to check the impact of this restriction, I employ the 3LS procedure, proposed in Hsiao and Fujiki (1998), to estimate the money demand function for 1950-99. The long-run interest rate and income elasticity is estimated at -0.135 and 0.922 respectively, showing a very close value to the estimation results shown in Table A-1.

limited to 0.7 percent of real GDP.

Appendix B. Relative Price Fluctuations and the Rate of Inflation

In Appendix B, I empirically examine the relationship between relative price fluctuations and rate of inflation.

As we showed in Figure 3 in the main text, a positive correlation was observed between relative price fluctuations and the rate of inflation.[50] However, this correlation is significant for the higher inflation sample, while it becomes insignificant for the lower inflation sample. As pointed out in the text, this relationship suggests the following possibility: relative price fluctuations work well as a signal for resource allocation when inflation is low, while it is increasingly difficult to distinguish relative price fluctuations from changes in the general price level as inflation becomes high.

In this regard, the critical rate of inflation at which the correlation between relative price fluctuations and the rate of inflation become significant needs to be determined. I thus conducted rolling regressions for the following equation by moving up the border rate of inflation for the sample period from January 1971 to April 2000:

$$RPV = \alpha_1 + \alpha_2 * DUM + \beta_1 * INF + \beta_2 * DUM * INF + \varepsilon \,, \qquad \text{(A-4)}$$

where *RPV* is relative price fluctuations measured by the standard deviations of CPI item inflation rate, *INF* is the CPI inflation rate, *DUM* is the dummy variable for higher inflation sample, ε is error term.

Then, by focusing on the estimated parameter on CPI inflation, the following two points are examined: (1) how high is the CPI inflation rate when the deviation from zero of the estimated parameter β_1, which captures the relation between relative price variability and CPI inflation in lower inflation sample, is at a statistically significant level?; (2) how high is the CPI inflation rate when the estimated parameter $\beta_1+\beta_2$ is statistically indifferent from β_1, or β_2 becomes statistically insignificant?[51]

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[50] For details of the data, see footnote 12. The overall CPI inflation rate here is defined as the weighted arithmetic mean of the inflation rate of 88 items, thus corresponding approximately to the geometric mean of item CPIs at the index level. Therefore, it should be noted that overall CPI inflation is lower than the official index by the amounts of upward bias in the consumer price index caused by the index formula problem.

[51] It should be noted that the empirical exercise in this appendix is not intended to examine the causal relation between the rate of inflation and relative price variability. In this regard, Mio and Higo (1999) examine changes in the cross-sectional distribution of price changes, and point out that the changes in

Figure A-3 plots the estimated parameters β_1 and $\beta_1+\beta_2$, and their 95 percent confidence intervals as well as the bordered CPI inflation between high and low inflation samples.[52] The former CPI inflation, which corresponds to the rate when positive relation between the CPI inflation and relative price variability becomes statistically significant, is estimated at 2.7 percent. The latter CPI inflation, which corresponds to the rate when the difference between higher and lower inflation samples becomes statistically insignificant, is 5.9 percent. Although these estimation results vary slightly, depending on sample periods, the general conclusions that the former critical inflation rate is around 3 percent and the latter critical inflation rate is 5 to 6 percent remain unchanged.

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relative prices are mainly caused by idiosyncratic and temporary relative price shocks.

[52] The confidence interval for the estimated parameter is computed from heteroscedasticity-robust standard errors adjusted by White's (1980) procedure.

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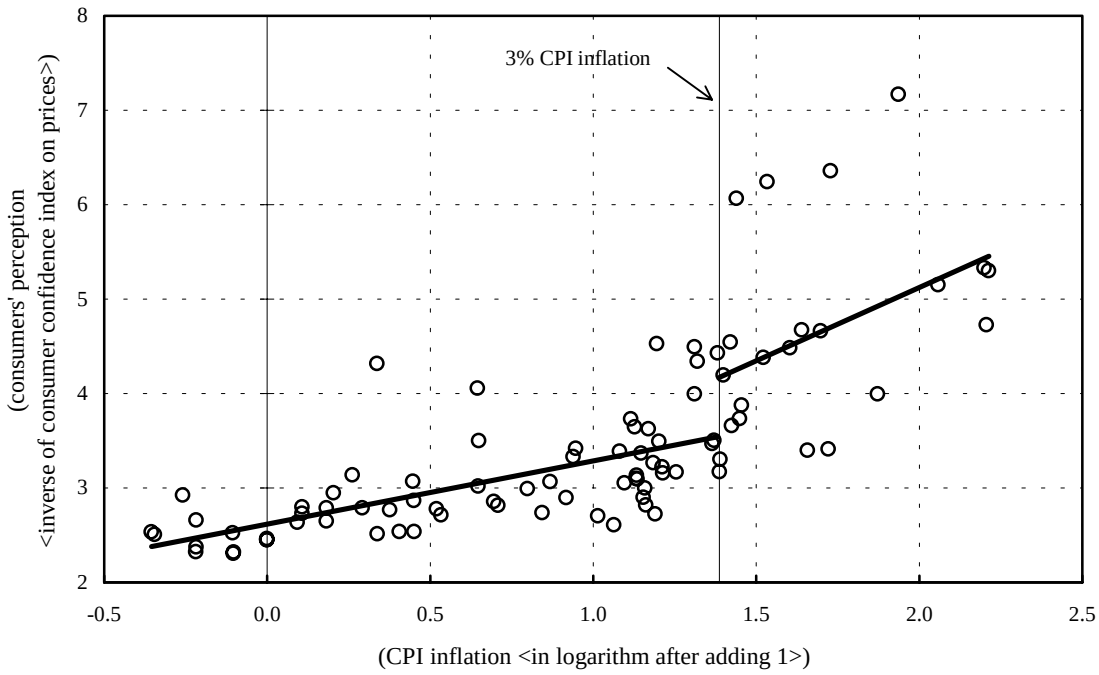
Table 1: Bias in the Consumer Price Index in Major Countries

Source of Measurement error	US	Japan	Germany	UK	Canada
Upper level substitution	0.15	0.00	0.10	0.05-0.10	0.10
Lower level substitution	0.25	0.10			
New products/quality change	**0.60**	**0.70**	**< 0.60**	**0.20-0.45**	**0.30**
New outlets	0.10	0.10	< 0.10	0.10-0.25	0.07
Total	1.10	0.90	0.75	n. a.	0.50
	(0.80 - 1.60)	(0.35 – 2.00)	(0.50 - 1.50)	(0.35 - 0.80)	

Sources: Advisory Commission to Study the Consumer Price Index (1996), Shiratsuka (1999), Hoffmann (1998), Cunningham (1996), Crawford (1998).

Notes: '<' indicates estimated bias is lower than the figure in the Table.

Figure 1: Rate of Inflation and Consumers' Perception



Sources: Economic Planning Agency, *Consumer Confidence Survey*; Management and Coordination Agency, *Consumer Price Index*.

Notes: 1. The sample period is from 1978/I to 2000/I.
2. Figures for the vertical axis are an inverse of consumer confidence index on prices, since the index is designed to increase, as inflation becomes lower.

Figure 2: Estimation of 'Shoe Leather' Cost

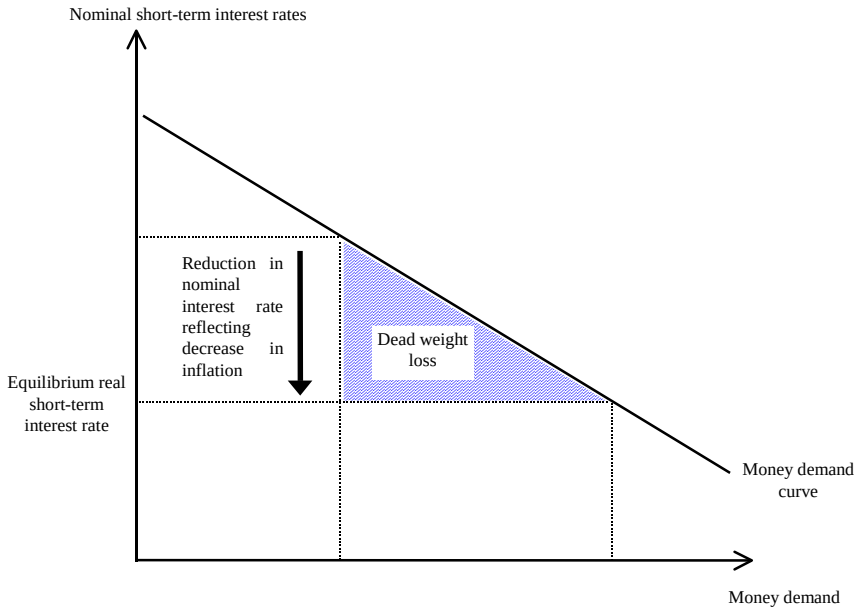
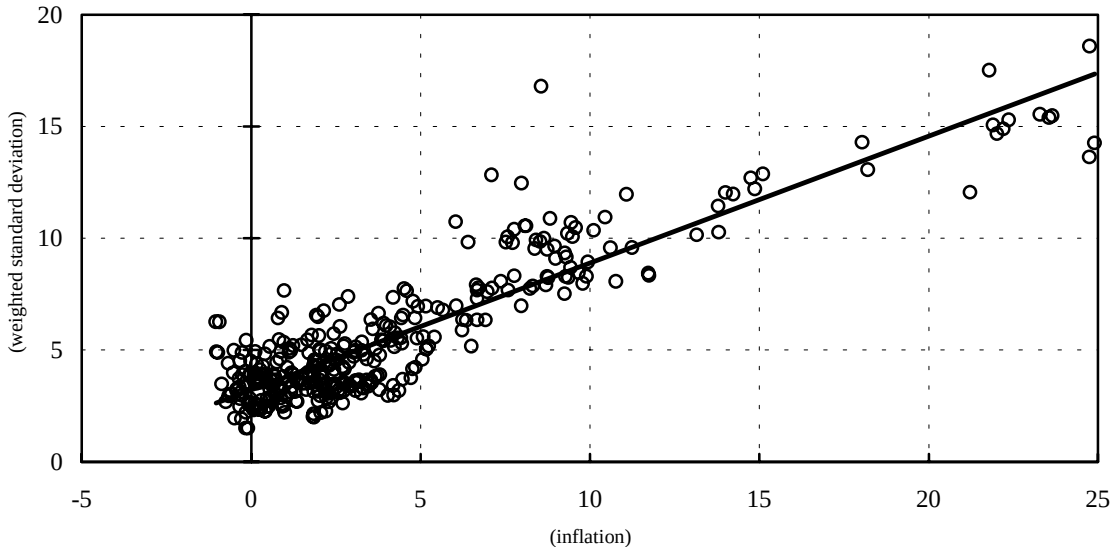
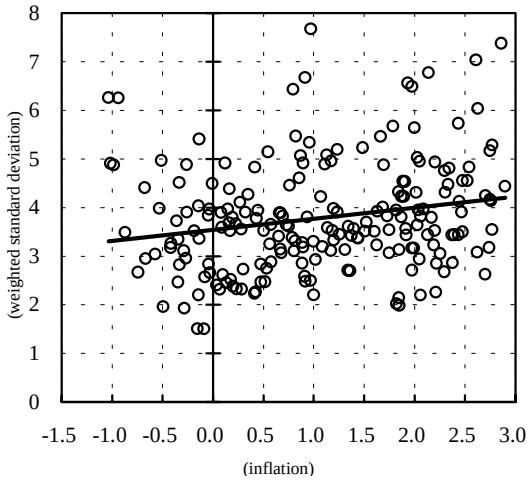


Figure 3: Inflation and Relative Price Variability

(1) Full sample



(2) Inflation rate below 3% per year



(3) Inflation rate above 3% per year

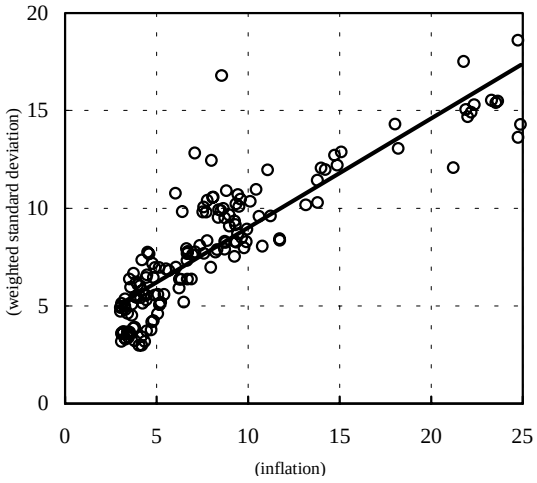


Figure 4: Impact of Productivity Increase Caused by Technological Innovation

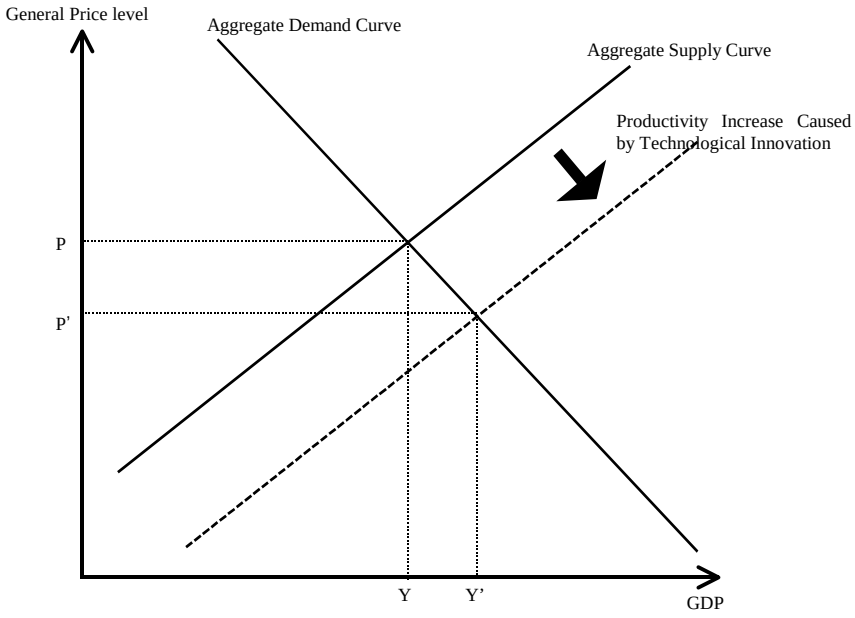


Figure 5: Policy Frontier

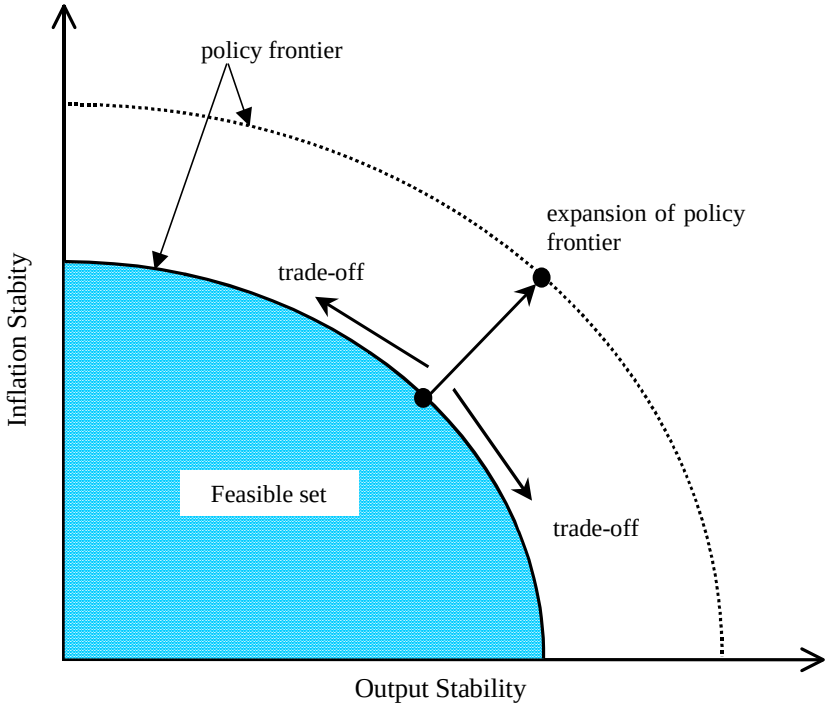
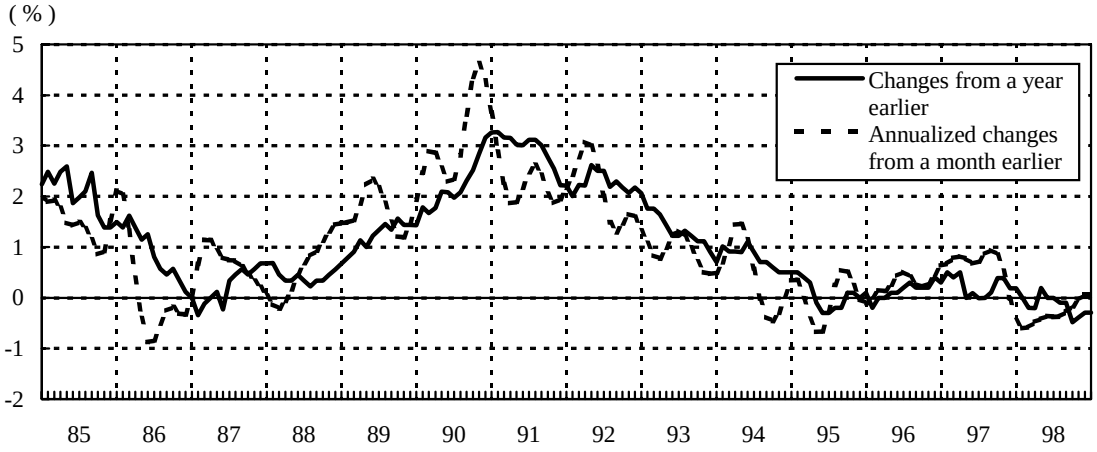


Figure 6: Price Development



Sources: Management and Coordination Agency, *Consumer Price Index*.

Notes: 1. Figures are adjusted for the impact of consumption tax.

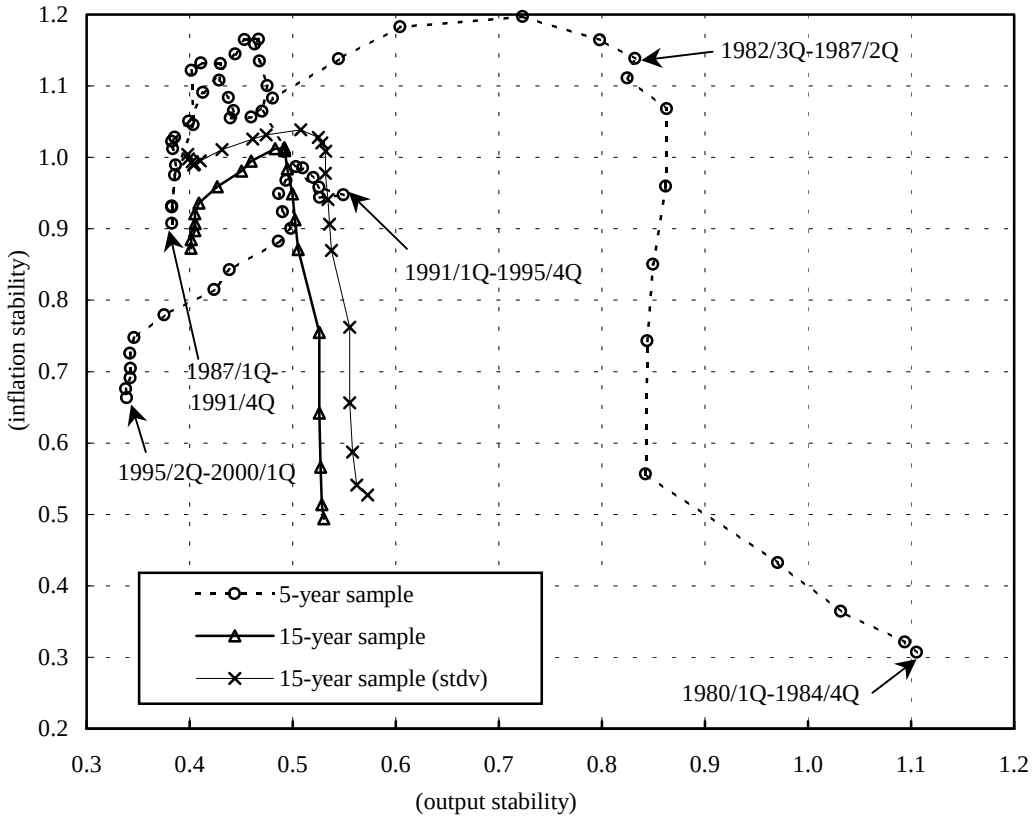
2. Regarding the CPI, annualized changes from a month earlier are computed from a seasonally adjusted series applied by the X-12-ARIMA with the options as follows:

Estimation period: From January 1980 to December 1998

ARIMA Model: $(0\ 1\ 1)(0\ 1\ 1)_{12}$

Level Adjustment: April 1989 (introduction of consumption tax) and April 1997 (consumption tax hike)

Figure 7: Economic Performance since the 1980s



Sources: Management and Coordination Agency, *Consumer Price Index*, Economic Planning Agency, *Annual Report on System of National Accounts*.

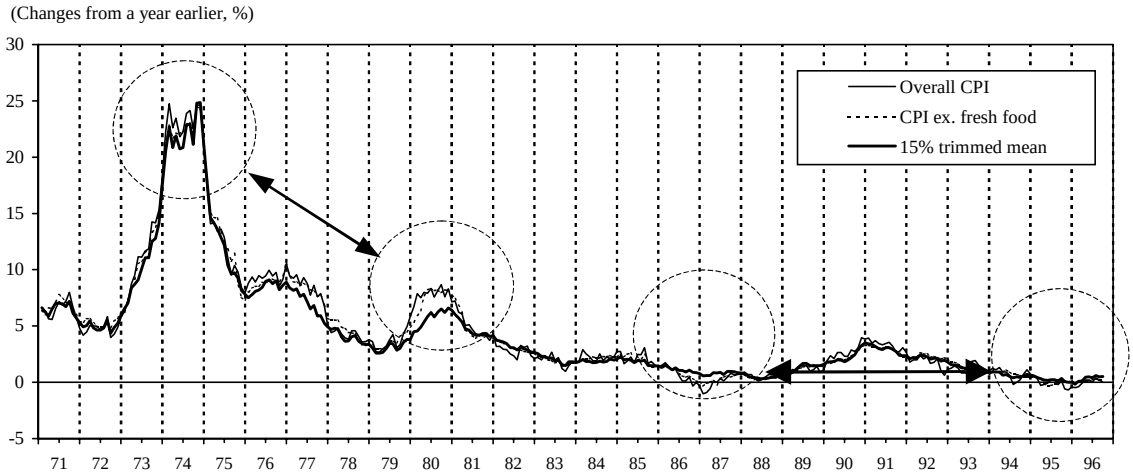
Notes: Measures for output stability and inflation stability are computed as follows:

5-year sample: Inverse of root mean squared deviation from target values (2.5 percent for real GDP growth and 1.5 percent for CPI inflation) for the 5-year sample period.

15-year sample: Inverse of root mean squared deviation from target values (2.5 percent for real GDP growth and 1.5 percent for CPI inflation) for the 15-year sample period.

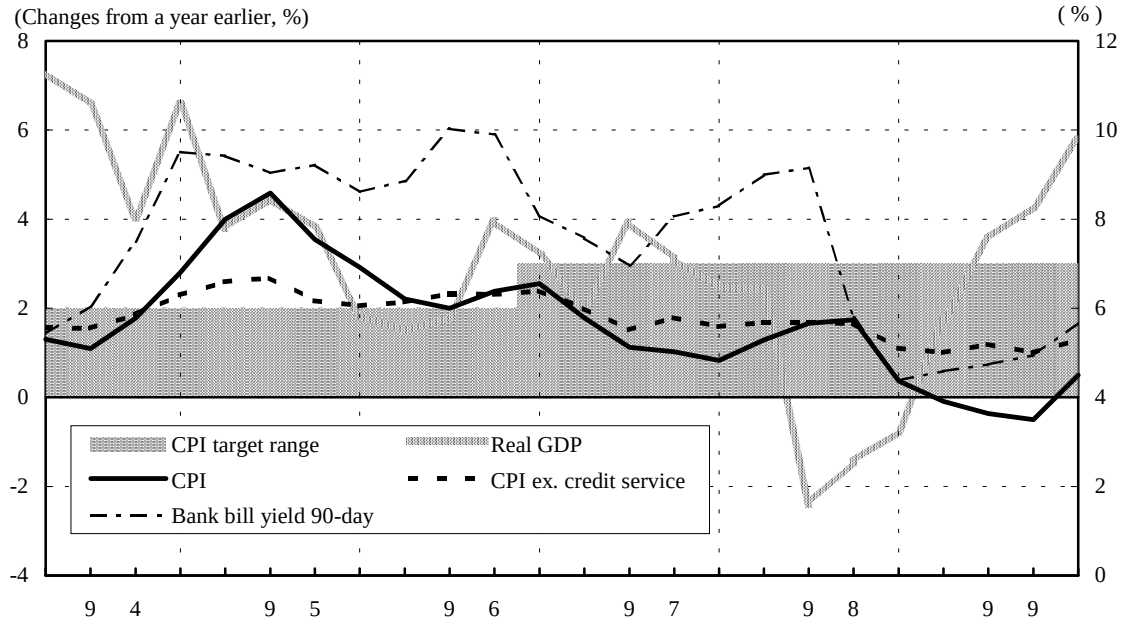
15-year sample (stdv): Inverse of standard deviation of real GDP growth and CPI inflation for the 15-year sample period.

Figure 8: Trimmed Mean Estimator



Source: Figure 8 in Shiratsuka (1997).

Figure 9: Economic Development in New Zealand



Sources: www.rbnz.gov.nz

Figure 10: Non-linear Taylor Rule (Illustration)

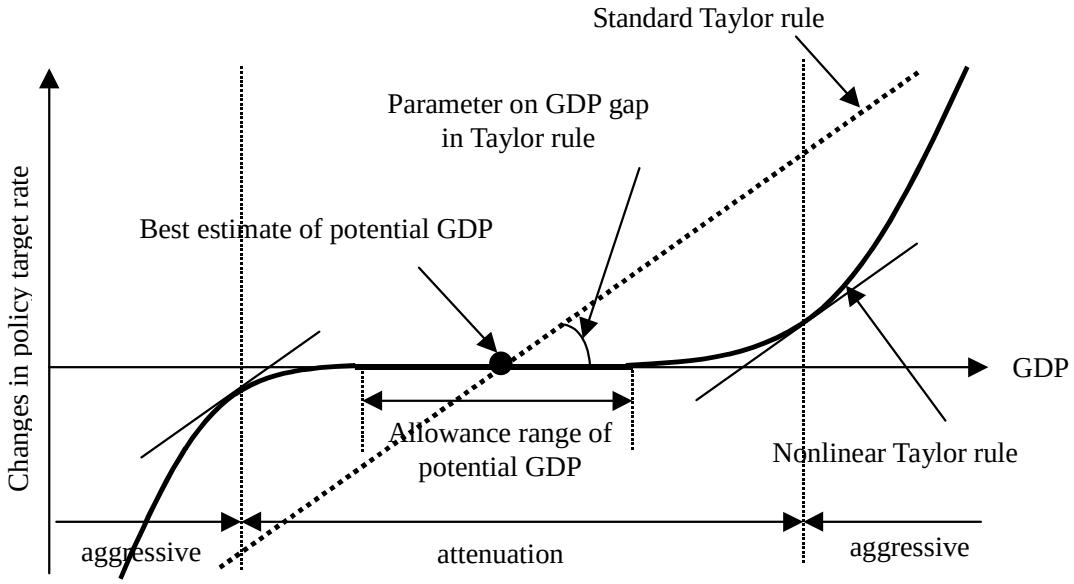


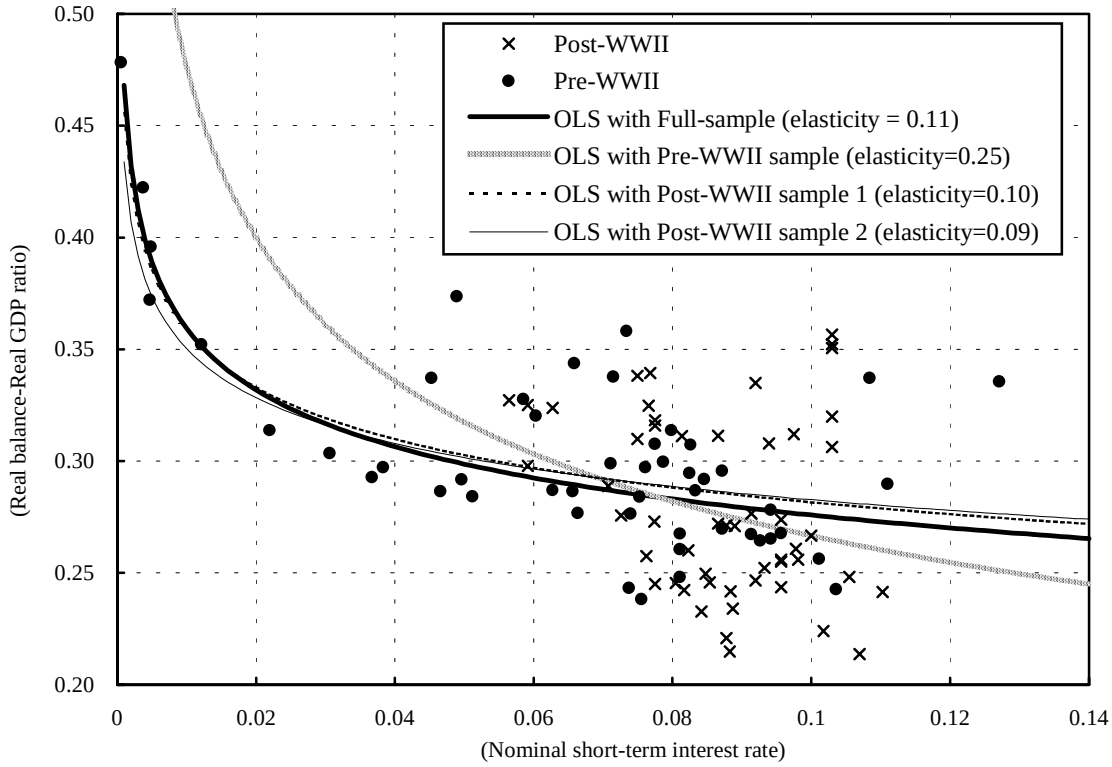
Table A-1: Money Demand Function

	Full sample		Pre-WWII sample		Post-WWII sample 1		Post-WWII sample 2	
	1885-1936;1950-1999		1885-1936		1950-1999		1950-1995	
A	-1.552	$(0.005)^{***}$	-1.901	$(0.455)^{***}$	-1.508	$(0.055)^{***}$	-1.477	$(0.168)^{***}$
μ	-0.115	$(0.012)^{***}$	-0.252	(0.179)	-0.104	$(0.011)^{***}$	-0.093	(0.060)
Adj. R^2	0.340		0.059		0.541		0.051	
D.W.	0.386		0.382		0.232		0.205	
White test	9.521	[0.000]	6.342	[0.042]	3.394	[0.183]	1.088	[0.581]
B-G test	63.254	[0.000]	32.261	[0.000]	31.324	[0.000]	32.088	[0.000]
Sample	102		52		50		44	

Notes: 1. Standard errors in parenthesis, and *p*-values in blankets. Standard errors are autocorrelation-heteroscedasticity robust estimators computed by the Newy and West's (1987) procedure.

2. Post-WWII samples 1 and 2 are estimated using the sample period of 1950-99, and 1950-95, respectively.

Figure A-1: Japan's Money Demand from 1885 to 1999



Sources: Asakura and Nishiyama (1974), Fujino (1994), Okawa (1974), and Economic Planning Agency, *Annual Reports on System of National Accounts*.

Notes: 1. The details of data used plotted in the Figure are as follows (war time data from 1937 to 1949 are excluded):

M1 before 1954 is estimates of Fujino (1994) except for 1941-50, and approximation based on Asakura and Nishiyama (1974) for 1941-50.

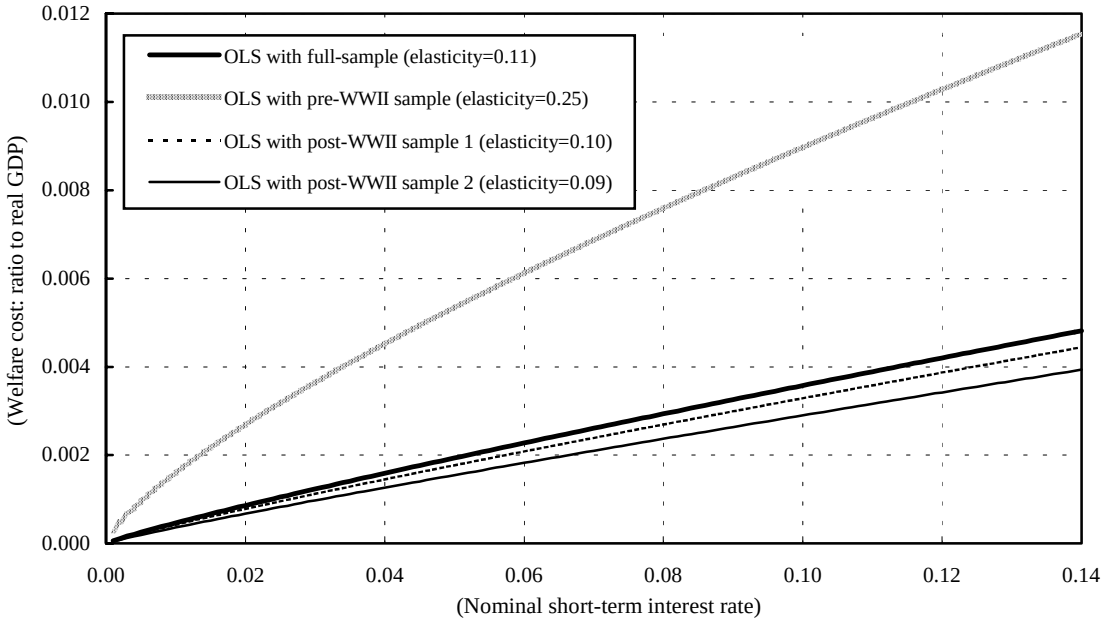
Real GDP is taken from Okawa (1974) retroactive for the series before 1955.

Nominal short-term interest rates are the connection of the following three rates: (1) the uncollateralized overnight call rate from 1986 to 1999; (2) the collateralized overnight call rate from 1970 to 1985; and (3) the official discount rate before 1969.

2. Sub-sample periods of post-WWII 1 and 2 correspond to the periods from 1950 to 1999, and from 1950 to 1993, respectively.

Figure A-2: Welfare Cost

(1) Welfare cost function



(2) Welfare loss relative to nominal short-term interest rate of 2%

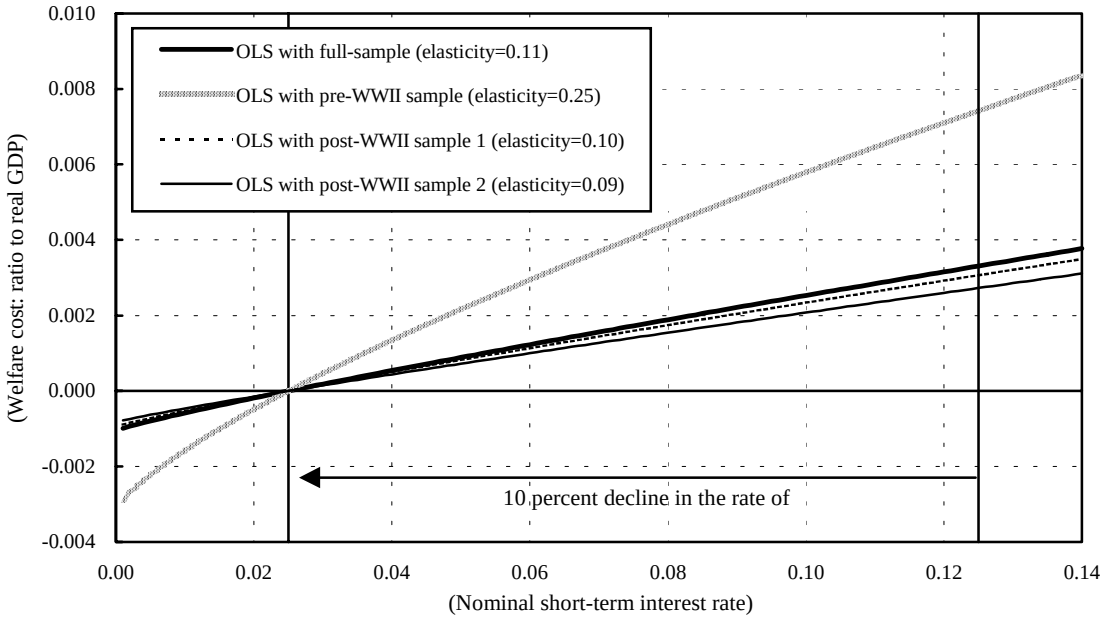
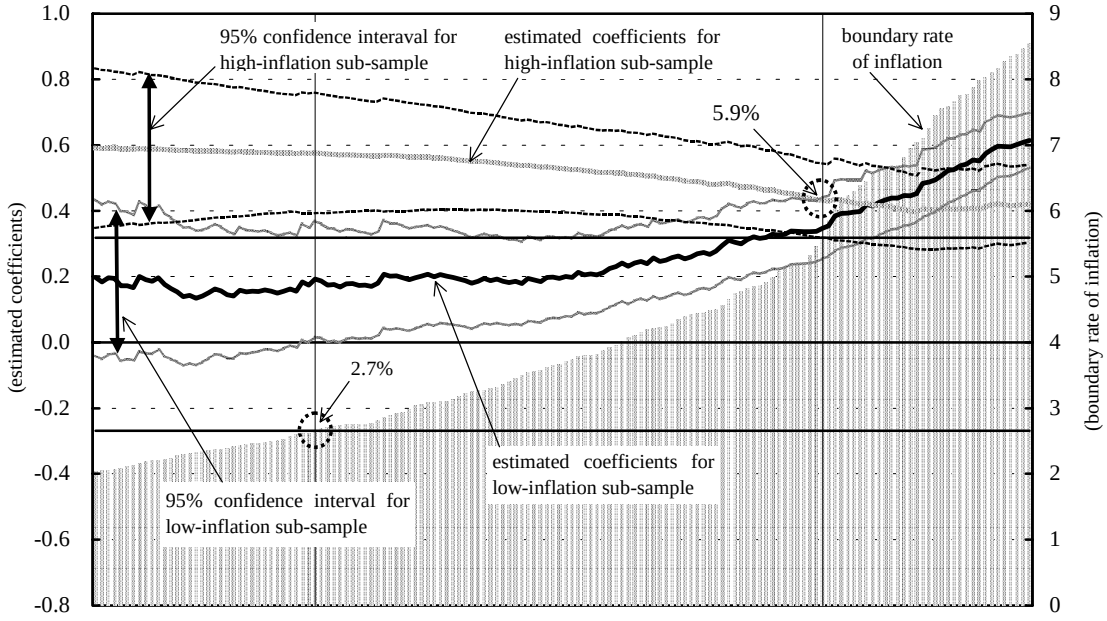


Figure A-3: Relative Price Fluctuations and Rate of Inflation



Notes: I repeatedly estimate the regression equation of relative price variability and the inflation rate as follows:

$$RPV = \alpha_1 + \alpha_2 * DUM + \beta_1 * INF + \beta_2 * DUM * INF + \varepsilon$$

RPV: Relative price variability (weighted standard deviations of CPI inflation in items)
DUM: Dummy variable for high inflation sample
INF: CPI inflation

by changing the boundary rate of inflation for lower and higher inflation samples, and plotted estimated parametersβ_1 and β_1+β_2. I used a heteroscedasticity robust standard error by employing White's (1980) procedure.