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On the Role of Monetary Policy in a Deflationary Economy: The Case of Japan

Motoshige Itoh
Naoki Shimoi
University of Tokyo

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Abstract

In this paper we review the role of monetary policy for a country facing deflationary pressure based on the recent experience of the Japanese economy. We discuss economic background of inflation policy in Japan and analyze the impacts of the policy.

Japanese economy is in a liquidity trap now. Two types of reasons were pointed out to be in liquidity traps. They are a real factor and a monetary factor. The former factor is the case analyzed by Krugman, where IS curve shifts due to structural reason such as aging of population. Under this condition a negative real interest rate is requested to escape from the liquidity trap. However, liquidity trap can also arise from monetary reason and the scenario of escape from the trap is different. We illustrate the case where deflationary expectation leads the economy to a liquidity trap.

If it is necessary to utilize monetary policy for generating inflation expectation, we then need some explicit monetary policy rules, which is strong enough to escape from liquidity traps but at the same time which is effective to suppress unnecessary political pressure and to keep the independence of the central bank. Inflation targeting is a candidate for such a rule.

On the role of monetary policy in a deflationary economy: The case of Japan[*]

Motoshige Itoh and Naoki Shimoi
Graduate School of Economics,
University of Tokyo

1. Introduction

Macro-economic performance of the Japanese economy in the 1990s provides an interesting case on the role of monetary policy in a deflationary economy. In spite of the series of aggressive fiscal and monetary stimulating policies, the Japanese economy could not recover from deep recession. Rather, as the result of the policies, the short-term interest rate, the policy target of the monetary policy of the Bank of Japan, fell to the level of almost zero, and the government debt has accumulated to a historically high level. There seems to be no more room for further stimulating the stagnant economy.

Paul Krugman's model of liquidity traps (Krugman [1998]) provoked controversy on the role of monetary policy in a deflationary economy. According to Krugman, the present state of the Japanese economy is in a liquidity trap. In contrast to old-fashioned Keynesian view that monetary policy is ineffective under liquidity traps, Krugman pointed out that aggressive monetary policy under which the central bank commits to sustained inflation for a certain length of period is quite effective for the

[*] We owe to an anonymous referee and to the editor of this volume for various useful comments.

economy to escape from the liquidity trap. He recommended that 4 % inflation for 15 years is necessary for the Japanese economy to recover from the liquidity trap.[1]

In Japan there have been increasing voices requesting economic policies generating some modest inflation. There are some divergent views on this inflation policy: some have Krugman's policy formula in mind, but some have completely different one in mind.

The idea of inflation policy originally emerged in the early 1980s, when the Japanese government faced a serious government debt issue. Inflation, at that time, was considered an effective way to decrease the real value of government debt in a short period. Although the idea could not obtain much consent at that time, economic environment in the late 1990s is far more favorable to the argument for inflation policy than that in the early 1980s. The government debt is much higher in the late 1990s than in the early 1980s. Furthermore, a large number of private firms, which now face serious balance sheet losses due to crash of stock prices and land prices, see that inflationary economic environment is far better for their balance sheet correction than deflationary economic environment.

It is also pointed out by many people that, even if intentional inflationary policy is not taken now, skyrocketing government debt will trigger serious inflation in some point in the future. The lack of sustainability of government debt is alarmed by an increasing number of people. The fact that the market interest rates on long-term government bonds are still very low indicates that market still believes sustainability of the government debt. So, it may be too early to raise a question on sustainability of the government debt. However, based on experiences of various countries in the past history, it was very rare for a country whose government debt-GDP ratio exceeded certain level to decrease that ratio without causing some inflation.

In fact, some casual observations on political aspect of monetary policy in

Japan in the previous few years, suggest that there will be increasing pressures on the Bank of Japan from the government as well as from outside the government to introduce stronger monetary measures which will generate inflation: it may even include the purchase of newly issued government bond by the Bank of Japan, which is banned in the present Finance Law. In the process of accumulating government debt, interest rates on long-term government bonds may increase, and in that case, the political pressure on the Bank of Japan to increase its purchase of long-term government bond will become very strong. This is a typical scenario of increasing government debt leading to inflation. Some people advocating inflation policy claim that present intentional modest inflationary policy is far better or less evil than forced and uncontrollable inflation in the future.

Discussion on inflation policy provoked various interesting questions on the role of monetary policies in a deflationary economy. Such issues were raised as “Is it possible to generate inflation or inflationary expectation under the condition of liquidity traps?” or “What policy measures are necessary beyond the traditional monetary policy measures in order to further stimulate the economy by monetary policy, and whether such policy measures are effective and meaningful?”.

Many people, especially those in the Bank of Japan, are doubtful of inflation policy.[2] They claim that it is difficult to increase money supply under a liquidity trap, since additional supply of base money through market operation is absorbed in the banking sector as excess reserves without changing money supply. They also claim that, even if monetary policy can generate inflation, the level of inflation such monetary policy generates is very difficult to control: such instability in macro-economy is not desirable. Some even claim that inflation policy may even trigger uncontrollable inflation.

The questions raised are not only pure economic ones but include some

political ones. When the central bank faces strong political pressure from outside regarding its monetary policy, isn't such a policy rule as inflation targeting necessary to secure independence of the central bank? To set some visible policy target may be effective for the central bank to keep its independence from political pressures. Inflation targeting can be such a policy target.[3]

Again, there are some arguments against inflation targeting. According to the views against inflation targeting, it is not easy to achieve a target level of inflation under liquidity trap due to the reasons raised above, and price indexed are not very reliable policy target for monetary policy. Some even claim that inflation targeting is for countries which control inflation and that it is not useful to escape from deflation.

This paper discusses theoretical and empirical background of inflation policy based on the recent experience of the Japanese economy. Japan's recent experience is quite unique in many respects, so an overview of Japan's experience is useful for better understanding of the role of monetary policy in a deflationary economy.

The structure of this paper is as follows. In Section 2 we overview theoretical models of liquidity traps. We present two types of models of liquidity traps: the mechanism leading to liquidity trap as well as scenario for recovering from liquidity trap is different between the two cases. In Section 3 we consider inflation policy, under which inflationary environment can mitigate debt issues of the private sector as well as the public sector. Fisher effect is crucial factor for possible debt reduction process under inflation policy. We also show some simple calculation results on the possibility of debt reduction of private and public sector. In Section 4 we discuss the role of monetary policy and consider what monetary policy can and cannot achieve. Finally brief concluding remarks are provided in Section 5.

2．Liquidity traps

In old-fashioned textbooks, liquidity traps were defined as the situations where monetary policy was ineffective to recover demand. Under liquidity traps elasticity of demand for money with respect to interest rate becomes very large, and expansion of money supply is absorbed without decreasing interest rate. Theoretically, this situation can occur at any interest rate, but the most realistic case is the one when nominal interest rate hits the floor level, zero per cent, since money can dominate other nominal assets such as government bonds there.

Figure 1 plots the relation between a short-term interest rate (uncollateralized call rate) and M1. The figure seems to show that interest elasticity increased substantially in recent years (the dotted points in lower right positions correspond to more recent data). We conducted a simple regression analysis on this data to check whether the interest elasticity has increased significantly after the collapse of the "bubble".

Our analysis consists of two steps. One is whether there is cointegrating relationship in the money demand function and the other is whether there exists a structural break in this five years.

The basic estimated equation is as follows.

$$\log\left(\frac{M_t}{P_t}\right) = a_0 + a_1 DD + a_2\, r_t + a_3 D\, r_t + a_4 \log(y_t) + a_5 D \log(y_t) + u_t,$$

where M_t / P_t is the stock of real money balance, r_t is an interest rate, y_t is real income, D is the coefficient dummy variable, DD is the intercept dummy variable and u_t is an error term.[4]

We applied a technique of dynamic OLS to estimate the efficient value of coefficients and to detect structural breaks. The result with interest rates is in Table 1.

We used 2 and 3 numbers of leads and lags (*k=2* and *k=3,* respectively which was selected by SIC) in regression and *t* ratios are recalculated from rescaled standard errors. We also estimated the regression in log forms for the interest rate and confirmed that the dummy variable of interest rate is significant in 5 % level, though rescaled Wald statistic was not desirable.[5] Our regression confirmed that the interest elasticity of money demand function increased substantially after the crush of "bubbles".

The issue of liquidity traps, although attracted considerable interests in old days, has been almost neglected for many years until Krugman raised the issue in the new context in the 1990s. Although modern liquidity trap theory has some features different from old-fashioned liquidity trap theory, it is still quite useful to reiterate here what we learned about liquidity trap in the class rooms a few decades ago.

Figure 2 and 3 are the IS-LM expositions of typical liquidity trap situations in old-fashioned textbooks. Modern liquidity trap theories emphasize the importance of intertemporal features of macro economy, so IS-LM exposition, which is basically a static framework, is not accurate exposition of liquidity traps, but there exists some similarity between static exposition by IS-LM curves and the modern theory. We thus utilize IS-LM framework for exposition, and will make explicit the intertemporal models behind the IS-LM exposition.

Figure 2 corresponds to Krugman's model. Nominal interest rate is plotted on the vertical axis and real income (GDP) is plotted on the horizontal axis. We assume very simple structure for the supply side: aggregate supply curve is vertical at the full employment output level y_f. We here assume that price level is downwardly rigid. If the intersection point of IS curve and LM curve is located in the left of y_f, the short-run output level is bound by this demand level; that is, deflation gap exists.

In Figure 2 IS curve is located in such a position where income level *y* is lower than y_f for any non-negative level of interest rate. Here, we assume that the

expected rate of inflation is zero, although that assumption is not essential. If IS curve is located in such a position, one cannot reach full employment income level by shifting LM curve through expansionary monetary policy. Figure 2 shows the situation where money supply is expanded to the level where the interest rate become zero. Under zero interest rate money can perfectly substitute bonds or the former even dominates the latter, and LM curve becomes flat at zero interest rate.

Krugman considered a simple intertemporal macroeconomic model, where the representative consumer maximizes his/her intertemporal utility according to the following Euler equation:[6]

(1) $MRS = (1+i)P/P^*$,

where MRS is the marginal rate of substitution in consumption between today and tomorrow, i is the nominal interest rate, P^* is the price level tomorrow, and P is the price level today.[7] The right hand side of equation (1) is 1 plus the real interest rate, and the left hand side MRS is a decreasing function of the ratio of consumption today c to that tomorrow c^*, that is, c/c^*. Full employment will be achieved tomorrow, so $c^* = y^*$ is satisfied (full employment output level of tomorrow, y^*, is given exogenously). Given the rigidity of today's price level P, the present income y is given by the c satisfying (1) as long as that c is lower than today's full employment output level y_f. We thus have y (=c) as a decreasing function of the nominal interest rate i. Krugman then introduced a cash-in-advance constraint on money, that is,

(2) $M/P \geq c$.

Under the above formulation, Krugman obtained an equilibrium like the one depicted in Figure 2. When the cash constraint (2) is binding at c which corresponds to a positive i in (1), the equilibrium point is below full-employment level with a positive interest rate, and when (2) is not binding for c corresponding to zero interest rate in (1), then the economy is in liquidity trap, where nominal interest rate is zero and the income

level is below full employment level.

Figure 3 illustrates another type of a model of liquidity trap. In this case deflationary expectation plays a crucial role. Crucial point here is that the position of IS curve is determined by the real interest rate, while the position of LM curve is determined by the nominal interest rate. Thus, when people expect inflation or deflation, the position of IS curve drawn on the diagram of the nominal interest as Figure 3 will shift by the amount of inflation/deflation.

In Figure 3 two IS curves are drawn: one is the curve with zero expected inflation rate, and the other is the one with a negative inflation rate expectation (deflationary expectation). Since the position of IS curve is determined by the real interest rate, IS curves drawn on the diagram of nominal interest rate will shift downward as the expected deflation rate becomes higher.[8] In order to emphasize the difference between Figure 2 and Figure 3, Figure 3 is drawn in such a way as full employment is attained under zero expected inflation rate. Even in this case, once deflationary expectation is built in, IS curve shifts downward and a liquidity trap case can arise if deflationary expectation is substantial. In the case drawn in Figure 3 where people have deflationary expectation, monetary expansion which shifts LM curve to the right is not enough to attain full employment: monetary policy can increase real output only to the point where nominal interest hit the lower bound, zero interest rate floor.

Buiter and Panigirtzoglou [1999] presented the following type of simple macroeconomics model of a liquidity trap, which essentially illustrates the mechanism given by Figure 3. They introduced continuous dynamic model where representative consumer maximizes his/her intertemporal utility function according to the following Euler equation:

(3) $\dot{c} = (r - \delta)c$,

where c is consumption, r is a real interest rate, and δ is a discount factor. In order to

derive this Euler equation, simple log linear utility function is assumed where money is assumed in utility function with a separable form.

A crucial assumption for Buiter and Panigirtzoglou to obtain a liquidity trap is so called Taylor rule:

(4) $i = \bar{i} + \gamma\pi$ when $i \geq 0$

$= 0$ otherwise,

where i is the nominal interest rate, π is the inflation rate, and γ is a parameter which is larger than 1.[9]

Assuming the simplest kind of accelerationist Phillips curve,

(5) $\dot{\pi} = \beta(y - \bar{y})$,

where perfect foresight is assumed, we can obtain the following two set of differential equations:

(6) $\dot{\pi} = \beta(c + g - \bar{y})$

(7) $\dot{c} = [\bar{i} + (\gamma - 1)\pi - \delta]c$ *if* $\bar{i} + \gamma\pi \geq 0$

$= [-\pi - \delta]c$ *otherwise*

Drawing the differential equation system (6) and (7) on the phase diagram of π and c, one can obtain two zones, one in which nominal interest rate is positive and the other in which nominal interest rate sticks to zero. Once the economy gets into the zone of a liquidity trap (where nominal interest rate is zero) under deflationary expectation, it tends to stay in the trap unless some drastic fiscal policy measure is introduced.

The two cases, the case of Figure 2 and that of Figure 3, are not mutually exclusive. Both can arise at the same time. However, the two cases have some different features. In the case of Figure 2 liquidity trap can arise even without deflationary expectation. Krugman pointed out that rapid aging of a society, under which future output and income level are lower than the present ones, forces people to

save now in order to smooth the intertemporal stream of consumption. In his model excess supply for goods (excess saving) will arise today under positive real interest rates. The real interest rate must be lowered to some negative level in order to increase present consumption level to the point of full employment. What caused liquidity trap in Krugman model is a real factor, so unless negative real interest rate cannot achieved, the economy cannot get out of the trap.

Contrary to Krugman model, in Buiter and Panigirtzoglou model liquidity trap arises as a monetary phenomenon. Deflationary expectation is the reason for liquidity trap in this model: liquidity trap can arise even if equilibrium real interest rate is positive.

It should be noted that the scenario for escaping from the liquidity trap can be different depending on the structure of the model.

To see this point, consider the possibility for escaping from the liquidity trap by some fiscal policy measures. Since tax deduction is not effective due to Ricardian theory in these types of intertemporal macroeconomics models, we consider increase in government expenditure financed by issuing of government bond.[10] Just like the old-fashioned liquidity trap argument, the fiscal measure is effective to increase demand by shifting IS curve to the right. The question then arises whether the effect of fiscal policy is large enough to get out of the liquidity trap. In the type of models like the one in Figure 2 fiscal policy should be continued until the fundamental factor causing the liquidity trap disappears. In the Krugman's analysis of the Japanese economy this fundamental factor is the aging of the society, and it seems difficult to continue supporting demand by government expenditure until aging factor disappears. In fact the Japanese government have introduced a series of government expenditure program and by these policies the government debt is accumulating to a historically high level, which makes it difficult to continue further fiscal expansion program.

The situation is different for the type of model like the one by Buiter and Panigirtzoglou. In their model temporary drastic government expenditure expansion may be effective for the economy to escape from the liquidity trap. Although we do not discuss the detail of the process of dynamic path for getting out of the liquidity trap, one can easily guess why temporary fiscal expansion program is effective for getting out of the liquidity trap in their model. In their model the economy cannot get out of the liquidity trap unless it can expel deflationary expectation. Under the accelerationist Phillips curve the only way to generate inflationary expectation is by raising real demand above full employment output level (see equation (6)). Fiscal policy is effective to increase the demand for a short time.

３．Inflation policy and balance sheet correction

As we mentioned in the beginning of this paper, generating inflation may be effective to recover the balance sheet of the public sector as well as the corporate sector. This view is very popular in the business community, since deflationary environment is adverse condition for the business community, which has accumulated a large amount of debt.

Figure 4 shows the recent trend of the ratio of total loan to GDP in Japan. As is evident from this figure, loan/GDP ratio started increasing from around 70 % since the beginning of 1980s, increased rapidly during the so called bubble period, hit the peak at about 108 % in 1990, and then declined gradually. Behind these aggregate data exist accumulating debts of the corporate sector, which were used for purchasing increasing amount of assets such as real estates, equity shares as well as capital equipment. Crash of the “bubble” economy lowers the values of the asset side of the

balance sheet of the corporate sector, while the debt size remained: this is the balance sheet problem of corporate sector. Figure 5 depicts how the asset and debt of each sector changes in the 1980s and 1990s.

There are a large number of companies that carry large amounts of debts while losing the values of their assets substantially as the result of the crash of bubbles. Let us consider typical case of companies facing serious balance sheet problems; one is the case of Daiei, the largest retail chain store in Japan, and the other is the case of Hazama and Kumagai-gumi, two construction companies famous for their request of debt reduction. Both cases are frequently and widely reported in Japan as typical case of companies facing balance sheet problem.

A large portion of Daiei's liability takes such forms as short-term loans and bonds, while the majority of its asset side takes such forms as equities, and real estates. As publicly announced by Daiei, the total debt (borrowings and issued bonds) of Daiei group was about two trillion and six hundred billion yen at the end of 1998, which covered not only Daiei Inc. but also its related company, Daiei Holding Company. This is a tremendous amount, since only one percent increase in the interest rate means 26 billion yen increase in interest payment, which is comparable to Daiei's annual operating profit. Daiei group is now under drastic restructuring process. It announced to sell many of its assets in order to cut its liabilities. Some assets have already been sold and the revenues from the sales were used to cut liabilities. Although these processes are necessary for recovery of balance sheet, low asset prices make it difficult for them to sell their assets in high prices that are required to cancel the large amount of debt.

The total borrowing (short-term and long-term borrowing) of Hazama and Kumagai-gumi are smaller than Daiei group. A total debt of Hazama was about 422 billion yen and that of Kumagai-gumi was 1057 billion yen, both at the end of 1999

fiscal year. However, the case of these companies attracted wide attention, since they requested debt reduction for more than half of their borrowings.

Simple but radical market response to the companies that face serious balance sheet problem, is bankruptcy: the companies can be broken up, assets can be sold, and remaining liabilities should be borne by creditors. Although this process already started for some companies, bankruptcies in a grand scale may accelerate deflationary process in Japan. So, voices are raised to seek some other options. Inflation policy is one of these options. Inflation can mitigate the balance sheet problem of the corporate sector and thereby stimulate corporate activities. What is more important is the other side of the story; that is, deflation, if it cannot be stopped, may worsen the balance sheet problems the corporate sector faces. Although it is not easy to make accurate prediction about how much aggregate stimulation effect inflation policy has, it is meaningful to examine what role can inflation play for the balance sheet correction process.

In order to consider the possibility of balance sheet correction through inflation policy and possible deterioration of balance sheet by deflation, we must refer to Fisher effect, the effect of inflation on nominal interest rate. If Fisher effect works completely, that is, if the nominal interest rate increases by the amount of inflation or inflation expectation, then inflation is not effective for the correction of corporate balance sheet. As have already mentioned, a large portion of liabilities of the corporate sector is short-term loan, whose interest rate is revised frequently responding to the fluctuation of the short-term interest rate. So, if Fisher effect is satisfied and the nominal interest rate adjusts to inflation rate, the total amount of debt will increase by the amount of inflation.

One of the important aspects of liquidity traps is that Fisher effect will not work. One can easily confirm this in Krugman model, where nominal interest rate

remains at zero even if the expected inflation becomes higher. In order to see why Fisher effect is not satisfied under liquidity traps, it is useful to examine under what condition Fisher effect works.[11] In a neoclassical model of full employment the intersection point of aggregate supply curve and aggregate demand curve is always located on the full employment point.[12] Price level always adjusts so that full employment output is achieved. Under this equilibrium condition, IS and LM curve will intersect at this full employment output-income level. Now, suppose that inflation rate becomes higher for some reason. IS curve, which is drawn on the diagram of the nominal interest rate will then shift upward by the amount of the inflation rate. However, the price level adjusts so that full employment is achieved. Thus, LM curve will also shift upward by the amount of the inflation rate. So, at the new equilibrium point, full employment is recovered, and the nominal interest rate will increase by the amount of the inflation rate. Fisher effect is satisfied in this case.

The essential point in the above argument is that IS curve can be drawn on the real interest rate and that only one particular level of the real interest rate corresponds to the full employment income level. So, even if inflation rate changes, the same real interest rate will prevail as long as full employment is satisfied. It is obvious that this argument is not correct under liquidity traps, where full employment is not achieved. When the real interest rate and income level have negative correlation along IS curve, and when inflation makes the point on IS curve slide along this IS curve toward the right (that is, toward a higher income), then inflation will make the real interest rate lower. This means that nominal interest rate will not increase as much as the inflation rate. Note that in Krugman model nominal interest rate will not change at all when inflation rate rises. But, this may be an extreme case. The IS curve drawn on the real interest diagram may shift to the right as a result of inflation if inflation has some demand expanding effect through balance sheet correction as discussed below. In this case

nominal interest rate may move above zero but not as much as inflation rate (so, the real interest rate will decrease).

We thus have seen that nominal interest will not increase as much as the inflation rate under the liquidity trap. So, inflation may have balance sheet effect. Liability side consists mostly of nominal debt such as loan and bond, while asset side consist of assets such as real estates and equities, whose prices move in the same direction of the inflation rate. We may presume that price of real estates and equities will increase by the rate of inflation rate, when the real values of these assets are independent of the inflation rate.

Now we can make simple calculation on the back of an envelope to see how inflation changes the real values of debts in the balance sheets. Take the case of Daiei, and suppose that 2 % inflation continues for 10 years. If the nominal interest rate is not affected by this inflation (as in the case of Krugman model), then the real value of the liability side will depreciate by 2 % every year (about 22 % in ten years), while the real value of asset sides will be the same as long as real prices of assets such as real estates and equities do not change. If we apply this calculation to the case of Daiei, whose debts were about 2,600 billion yen, the real value of its debt will shrink to 2,131 billion yen at the present price in ten years. The amount of debt reduction through the inflation is more than ten times of Daiei's annual operating profit (five year average of Daiei's annual operating profit for the period 1995 though 1999 was about 44 billion yen). This is a significant amount. For Daiei, the sales of its 30 % share of Recruit (a large information-service company) was the biggest issue when the first version of this paper was prepared. The prices negotiated between Daiei and Recruit then was between 100 billion yen and 150 billion yen. The sales value was much lower than possible depreciation of liabilities through inflation. We do not mean that sales of assets such as the shares of Recruit is not necessary for balance sheet correction of Daiei.

What we mean by our simple calculation is that the magnitude of inflation on balance sheet correction is substantially larger than the magnitude of restructuring of the company. It should also be emphasized that the real value of net debt will increase substantially if the economy is in deflation.

We can make similar calculations for Hazama and Kumagai-gumi. 2 % inflation for ten years, similar to the exercise of Daiei case, will decrease the real value of their borrowings by 22 %. For the case of Hazama, the amount of debt reduction through 2 % inflation is about 93 billion yen, equivalent to five times as large as its annual profit (the average annual profit of Hazama for the previous five years was about 18 billion yen). For the case of Kumagai-gumi, the amount of debt reduction through 2 % inflation is about 233 billion dollar, being 8.6 times as large as its average annual profit (average annual profit of Kumagai-gumi for the previous five years was about 27 billion yen). Both Hazama and Kumagai-gumi requested debt reduction to banks and the amount of debt reduction they requested are more than 50 % of their borrowings. In order to achieve this level of debt reduction through inflation, they need more than 4 % inflation for ten years. So, modest inflation alone may not be enough for them to recover from debt overhang, but inflationary environment certainly will help them to a great extent. It should also be noted that deflation, if it occurs, will deteriorate their position substantially.

Needless to say, depreciation of the real debt value of the corporate sector and the public sector through inflation is accompanied by the equal amount of depreciation of real asset value for creditors. Thus, if creditors are mostly domestic residents, what inflation generates is income transfer from creditors to debtors. If propensities to spend out of asset values are the same among these economic agents, income transfer through inflation will not change aggregate spending behavior. This is very orthodox criticism against inflation policy. We are not prepared to discuss the pattern of

spending behavior here, but a few comments on this point will follow below regarding the reason why IS curve shifted to the liquidity trap zone after the crash of bubbles.

As noted in Section 2, leftward shift of IS curve can be considered a reason for the emergence of liquidity traps. If the position of LM curve has not change much from the 1980s to 1990s, IS curve must have shifted to the left substantially so that the economy fell in a liquidity trap. Krugman claims that aging population in Japan is the main reason explaining the position of the IS curve. According to him, the fact that IS curve was not in a liquidity trap zone in the 1980s in spite of aging being predicted may be due to "bubble economy", which "masked the underlying decline in investment opportunities".[13] If this is the reason why IS curve was not in a liquidity trap zone during the bubble period (the latter half of the 1980s), inflation may not change the position of IS curve (drawn on the diagram of the real interest rate).

Alternative interpretation for the shift of IS curve to the liquidity trap zone is deterioration of balance sheet condition of the corporate sector. According to this view, deterioration of the balance sheet position of the corporate sectors discouraged corporate investment as well as consumption. Discouraged consumption was due to worsening labor market condition and pessimistic perspective for the future income. If this view is correct, balance sheet condition is crucial to determine aggregate spending pattern even if we take into account income transfer effect of inflation; recovery of balance sheet conditions of the corporate sector through inflation will shift the IS curve to the right, or further deterioration of the balance sheet through deflation will shift the IS curve to the left.

Let us now look at the government debt. Government debt/GDP ratios in various measures have been rising rapidly. As in the case of the private sector, the real value of government debt can be decreased substantially by inflation. Not like the case of private sector, a large portion of government debt is in the form of long-term bond.

So, even if Fisher effect works in the way that the nominal interest rate increases by the amount of inflation rate, the real value of government debt will still decrease by inflation. This is because the redemption prices of the bonds were already determined. If the government carries over the debt by issuing new bonds at the point of the redemption of old bonds, the interest rate on the new bonds will include inflation rate if Fisher effect works.

In Table 2 we show how much the real value of government debt (here we look at only national government bond) will decrease by 3 % and 5 % inflation for 10 years with full Fisher effect (that is, 3 % or 5 % increase in nominal interest rate).[14] Even if nominal interest rate increases by the amount of inflation rate through Fisher effect, the government can decrease its debt through inflation, since a large portion of the debt still carries long maturity periods.

If Fisher effect does not work, the amount of depreciation of the government debt through inflation will be much larger. The basic logic is the same as the case of the liabilities of private firms. In Table 2 we also calculate how government debts depreciate for four cases of inflation for ten years: 3 % inflation without any change in the nominal interest rate, 3 % inflation with 1 % increase in the nominal interest rate, 5 % inflation without any change in the nominal interest rate, and 5 % inflation with 1 % nominal interest rate increase. In all cases the amount of depreciation is substantial.[15]

Note that debt depreciation through inflation is different from inflation tax through expanding money supply. In addition to depreciation of the real value of the government debt, the government sector can deduct income from the private sector through inflation tax. The amount of inflation tax that the government can collect is estimated by the following equation:[16]

$$(\pi + g_y)k_H ,$$

where π is the inflation rate, g_y the real growth rate of GDP, and

$$k_H = H/(PY),$$

that is, the ratio of high powered money over nominal GDP (Marshallian *k* for high powered money).

If we apply 3 % inflation for k_H in 1998, that is, 0.11, then inflation tax revenue is about 0.33 % of GDP, which is about 1,600 billion yen. If one can collect that amount for ten years, it amounts to 16 trillion yen. Although inflation tax revenue is substantial, it is far smaller than the amount of government debt depreciation we calculated in Table 2. This is due to the fact that the Japanese government has already accumulated a large amount of debt: the government bond circulating in the market is much larger than the amount of high powered money.

We do not mean that inflation policy is recommended for government debt reduction. It is needless to say that inflation policy triggers substantial transfer from bond holders to borrowing corporate sector as well as to the government. Such transfer of income is quite a controversial issue. What we intend in our simple calculation is to show that substantial amount of income transfer and debt reduction will be achieved through inflation. It should also be noted that similar magnitude of transfer is generated by deflation, although the direction of transfer is in the opposite direction.

4. Monetary policy

As shown in the previous sections, generating inflation or inflation expectation is effective for the economy to get out of liquidity traps. Crucial question is then whether monetary policy can be or should be used for that purpose.

Traditional channel of monetary policy, that is, supply of liquidity to inter-bank call market is not effective to generate modest inflation or inflation expectation. Under almost zero interest rate on deposit, opportunity cost for holding money is almost zero, and additional base money supply from the central bank is absorbed without much affecting the real activities. The recent trend of the ratio of money (M2+CD) over high powered money (money multiplier) is shown in Figure 6. We can confirm that the ratio has been decreasing considerably in recent years reflecting increasing cash-deposit ratio (Cash-deposit ratio is also plotted in this figure). The amount of excess reserve held by the banking sector has been increasing since the end of 1998. Under almost zero inter-bank interest rate opportunity cost for holding excess reserve is very small, and commercial banks are ready to hold some excess reserves. This also contributed to the declining money multiplier.

Table 3 indicates the transactions in the inter-bank call market by the Bank of Japan in November 1999. It is interesting to note that the Bank of Japan supplied liquidity to the market at the same time it absorbed liquidity from the market. In this month the total gross amount of liquidity supplied by the Bank was 17,232 billion yen, while it also absorbed 12,409 billion yen from the market through sales of short-term bond with repurchase agreement. These two transactions are offsetting each other from the viewpoint of total amount of high powered money offered to the market. One of the interpretation often heard from market participant concerning this offsetting transaction is that banks supplying liquidity to the market and the banks absorbing liquidity from the market are different. Local banks, which do not have enough opportunities for loan activity, are usually supplying liquidity to the market, while larger banks having more opportunities for loan activities tend to borrow money from the inter-bank call market. If the inter-bank market function in a normal way with a positive interest rate, demand and supply in the inter-bank call market is equalized with

adjustment of the interest rate. Under this normal circumstance the Bank of Japan can lower the interest rate by supplying additional liquidity to the market. However, under the almost zero interest rate condition such mechanism of balancing demand and supply through interest rate adjustment does not work. It is not easy to expand liquidity in this market through operation. In fact, the inter-bank market may even stop working. The Bank of Japan becomes an intermediator to sustain the market: absorbing liquidity from one side and supplying liquidity to the other.

Inter-bank market and bank loan market are inter-related with each other. In a normal situation zero interest rate in the inter-bank market would be very effective to stimulate loan market. However, demand for loan from the corporate sector is very weak. As we discussed in the previous section many firms have been in the process of cutting their liabilities by selling their assets. It is very difficult to expand loan to these firms. The banking sector has been in drastic process of restructuring, under which excess loans were cut in order to satisfy BIS regulations. Under this weak demand for and supply of loan, demand for inter-bank market liquidity is also very weak. It is not easy to expand loan through operations in the inter-bank market.

We thus have seen that it is very difficult to expand money supply through operations in the inter-bank market under liquidity traps. However, this does not imply that zero interest rate policy in the inter-bank call market is not effective to stimulate economic activities. The message that the central bank commits itself to continuing zero interest rate policy for certain period of time, if it is credible, may be effective to generate inflation expectation. As shown in Krugman model in Section 2, what is crucial for getting out of liquidity traps is not present monetary expansion but continuing monetary expansion towards the future.[17] What is crucial for the aggregate demand is the long-term interest rate not the short-term interest rate. If the long-term interest rate is determined by the future trend of expected short-term interest rates,

commitment by the central bank to continuing low interest rate may be effective to lower long-term interest rate. However, it is not clear whether the central bank can credibly commit to the prolonged zero interest rate policy.

Although continuing zero interest rate in the inter-bank call market is useful to inform the market that expansionary monetary policy will continue for some time, the traditional inter-bank channel cannot be expected to be used to expand money supply. The question then arises whether there are any other channels for monetary expansion.

The channels the Bank of Japan has already tried were operation through private firm securities such as commercial papers and a channel through foreign exchange market. As can be seen in Table 3, the Bank of Japan supplied liquidity to the market through the operation of commercial papers. It offered 4,100 billion yen through this channel out of 4,823 billion net supply of liquidity in one month (November 1999). Since these operations by commercial papers are with banks, it is not clear how it differs from traditional operations through short-term government bonds.[18]

Theoretically, the Bank of Japan can purchase any securities from the market; it includes not only commercial papers but also bonds and equities issued by private firms. Concerning the type of securities the Bank of Japan purchases, questions are raised whether the content of assets in the balance sheet of the Bank of Japan affects the rating of the central bank. It is often pointed out that deterioration of assets of the Bank of Japan may lower the rating of the government bond, and it will result in declining government bond prices and depreciation of yen. For example, the risk of the deterioration of the balance sheet of the Bank of Japan was pointed out by the Governor of the Bank in his comment to the public.[19] Although this point seems to be plausible, no serious analysis is provided regarding the relation between the balance sheet of the central bank and the long-term interest rate (market prices of long-term

government bonds).

Regarding monetary policy through foreign exchange market, the Bank of Japan seems to have been committing to sterilization policy, that is, neutralizing its high-powered money from foreign exchange intervention. In Japan decision on foreign exchange market intervention is made by the Ministry of Finance. Under the condition of appreciating yen as in the latter half of 1999, the Ministry purchased dollar from the market and equivalent amount of yen was supplied to the market. Then, as neutralization operation, the Bank of Japan sold equivalent amount of securities to the market to absorb the yen. Voices were raised against this operation by the Bank, which claim that leaving the yen used for foreign market intervention in the market may be desirable. Non-neutralized intervention is more effective than neutralized intervention to the exchange rate.[20] Furthermore, through non-neutralized intervention, the central bank can supply more liquidity to the market.

Purchasing of long-term government bonds from the market is the alternative channel for monetary expansion, which attracts the strongest attention. The Bank of Japan has already been engaged in purchase of long-term government bond for the purpose of supplying additional money to accommodate to economic growth. There is no official explicit rule for the purchase of long-term government bond but a simple rule of buying the amount of government bond equal to additional cash supply to the market. The Bank of Japan seems to interpret that additional amount of cash supply to the market is a good indicator of potential economic growth rate; under this interpretation buying long-term government bond by the amount equal to cash growth results in supplying high powered money required for the growth of the economy. The Bank of Japan purchases about 400 billion yen of long-term government bond every month.

Purchase of long-term government bond is different in nature from other monetary policy channels. It is useful to compare with the textbook example of

helicopter money. Although we do not have any explicit model in mind, it is almost trivial that inflation can be generated if the government keep dropping cash from helicopters. Helicopter money is equivalent to lump-sum income tax deduction financed by money printing (that is, purchase of newly issued government bond by the central bank). Thus, helicopter money is not simple monetary policy; it is a combination of fiscal and monetary policy.

Purchase of newly issued government bond by the Bank of Japan is banned by the Finance Law; it is not desirable to give such easy money to fiscal authority from the viewpoint of fiscal discipline. However, purchase of government bond circulating in the market (the bonds issued before) is not illegal. It is often pointed out that purchasing government bond circulating in the market by the Bank of Japan is almost equivalent to purchasing newly issued government bond by the Bank. The two cases seem different, since money is paid to original bond holder in the former case, while money is paid to the government in the latter case. However, if both cases weaken fiscal discipline and induce the government spends more, the results of the two cases become similar; in both cases, government spending is financed by printed money. Whether this point is correct or not depends on what rule is applied for the purchase of the government bond.

What we have in mind here as the purchase of circulating long-term government bond is rule-based purchase of government bond. By increasing the amount of purchase we can expect some kind of monetary expansion effects. A question arises as to whether increasing the purchase of long-term government bond can generate inflation or inflation expectation. Some kind of model is necessary to answer the question, but just like the case of helicopter money, we can guess that purchase of government bond linked with some fiscal stimulus package will generate inflation. Analysis based on a model is necessary to consider this point. However, this is beyond

the reach of this paper.

Concerning increasing purchase of circulating-government bond, the following concern is often mentioned: purchasing circulating long-term government bond is almost equivalent to purchasing newly issued long-term government bond, which is banned by the present law. It is true that if circulating long-term government bonds are purchased by the central bank without any rule, the economy will lose its discipline of restricting budget deficits and government debts. The government will request the central bank to purchase government bonds without limits and the economy will face the risk of increasing inflation rate. Some rules are necessary to restrict the amount of purchase of circulating government bonds.

Inflation targeting attracts considerable attention from this viewpoint. Inflation targeting is originally used in the countries facing the risk of high inflation rates. By committing to an upper bound of inflation rate the central bank can lower inflation expectation of the market and lower the actual inflation rate. What is different here from this type of traditional inflation targeting is that commitment to inflation rate is not only with respect to an upper bound but also to a lower bound. The lower bound will help the economy to escape from a liquidity trap and the upper bound will allow the central bank to keep its independence of money supply from political pressure. Commitment to higher inflation by inflation targeting is nothing but what Krugman recommend in his liquidity trap model.

So far, we have seen the possibility of generating inflation and inflation expectation by monetary policy. We have observed that it is not an easy task to generate inflation by the traditional monetary policy. Liquidity trap condition makes it difficult to utilize the standard channel of operations in inter-bank call market for expansion of money supply. Purchase of long-term government bond is alternative channel for expansion of money supply. Simple exchange of long-term government

bond and base money may not be effective to stimulate the economy under the liquidity trap, since government bond and money is almost perfect substitute under zero interest rate. However, if the purchase of government bond is combined with government expenditure (or tax reduction), the situation is almost equivalent to the textbook case of helicopter money. One can think of various reasons against such a policy including the following ones; (1) easy purchase of government bond will kill fiscal discipline, (2) inflation generated by that way may not become controllable and may lead to hyper inflation, and so on. The question then arises as to whether some policy rule such as inflation targeting can be used to mitigate these problems. We do not have anything more to say on this point. Some more research should be made on this point.

5. Concluding remarks

In this paper we review the role of monetary policy for a country facing deflationary pressure based on the recent experience of the Japanese economy. We discuss economic background of inflation policy in Japan and analyze the impacts of the policy.

Japanese economy is in a liquidity trap now. Expanding fiscal deficits and historically high government debt make it difficult to rely further on fiscal policy. As pointed out by Krugman a certain type of monetary policy is quite effective in this circumstance: what is necessary is not temporary monetary expansion but commitment to continuing monetary expansion for a certain period of time and to some inflation target.

It should be noted that liquidity traps arise from various reasons. The case analyzed by Krugman is the one where IS curve shifts due to structural reason such as

aging of population. Under this condition a negative real interest rate is requested to escape from the liquidity trap. However, liquidity trap can also arise from monetary reason and the scenario of escape from the trap is different. In Section 2 we illustrate the case where deflationary expectation leads the economy to a liquidity trap. We can also think of a case where the economy gets into a liquidity trap because of falling asset prices, although we do not show any explicit model for this case in this paper. The channels for escaping from liquidity traps are different depending on whether the trap is from structural factor or monetary factor.

Another important aspect of liquidity traps is that Fisher effect does not work perfectly, which is crucial when one considers the possibility of correcting balance sheet loss of private sector as well as the government by relying on inflation. If nominal interest rate increases by the same rate as inflation under Fisher effect, inflation will not change the real value of net debts of corporate sector and the government. However, under liquidity traps, nominal interest rates will not rise as much as an inflation rate. We presented simple calculations concerning how much the real value of debt of selected companies under certain hypothetical inflation rates and found that substantial amount of debt reduction is expected under mild inflation. Similar calculation was made about the government debt, and the result shows that the debt reduction effect of mild inflation is quite large for the government debts.

If inflation or inflation expectation can be generated by monetary policy, the policy will be effective to let the economy to escape from a liquidity trap. Question is whether monetary policy can and should generate inflation or inflation expectation. As we have seen in Section 4, traditional channel for monetary policy such as operation in the inter-bank market is not effective under liquidity traps. Economists in the Bank of Japan claim difficulty of raising inflation rate through the traditional monetary policy, that is, operations in inter-bank market. It is necessary to consider alternative channels

for monetary expansion such as the purchase of commercial papers or the purchase of long-term government bonds in the market.

Use of these new channels may weaken fiscal discipline. The government will depend on printing of money more easily. There may arise stronger political pressure to expand money supply without limit. This may lead to uncontrollably unstable inflation. Inflation also implies drastic income transfer from bond holders to debt holders, which may not be justifiable from income distribution view point. There are many reasons including the ones mentioned above for being skeptical about the use of monetary policy for generating inflation. Crucial question is whether there is some alternative policy other than inflation policy for escaping from a liquidity trap. Our analysis in Section 2 illustrates the point that it depends on what is the factor causing the liquidity trap.

If it is necessary to utilize monetary policy for generating inflation expectation, we then need some explicit monetary policy rules, which is strong enough to escape from liquidity traps but at the same time which is effective to suppress unnecessary political pressure and to keep the independence of the central bank. Inflation targeting, under which not only an upper bound but also a lower bound of the inflation rate is set, is a candidate for such a rule. Some other rules such a money supply targeting or base money targeting are also candidates for the rules.

References

[1] Bernanke, Ben S., Thomas Laubach, Frederic S. Mishkin, and Adam S. Posen, [1999], *Inflation targeting: Lessons from the international experience*, Princeton: Princeton University Press.

[2] Buiter, Willem H., and Nikolaos Panigirtzoglou, [1999], “Liquidity traps: How to avoid them and how to escape them”, mimeo.

[3] Fischer, Stanley, [1982], “Seigniorage and the case for a national money,” *Journal of Political Economy*, 90, pp. 295-313.

[4] Krugman, Paul, [1998], “It’s baaack! Japan’s slump and the return of the liquidity trap”, *Brookings Papers on Economic Activity,* 2, pp. 137-205.

[5] Okina, Kunio, [1999], “Monetary policy under zero inflation: a response to criticisms and questions regarding monetary policy,” *Monetary and Economic Studies*, 17, pp. 157-200.

[6] Taylor, John, B., [1993], “Discretion versus policy rules in practice,” *Carnegie-Rochester Conference Series on Public Policy*, 39, pp. 195-214.

Table 1: Dynamic OLS

Coefficients

Constant	Interest Rate	Interest Dummy	Real GDP	GDP Dummy	Wald statistic
k=2					
–1.092	-0.00759	-0.159	0.809	0.107	32.0*
(-1.341)	(-1.007)	(1.732)**	(13.228)*	(0.006)	
k=3					
-0.793	-0.00758	-0.115	0.787	0.547	25.4*
(-0.892)	(-0.888)	(-1.161)	(11.849)*	(0.310)	

Figures in parentheses are *t* ratios. "*" and "**" each denotes 1 % and 10 % significant level.

Table 2. Annual table of payment of straight government bond

(billion yen)

		Full Fisher effect		No Fisher effect		Intermediate case	
Fiscal year	Amount	Case of 3%	Case of 5%	Case of 3%	Case of 5%	Case of 3%	Case of 5%
1998	34,284	34,284	34,284	-	-	34,284	34,284
1999	23,968	23,270	22,827	-	-	15,660	15,362
2000	20,236	19,074	18,354	-	-	13,093	12,599
2001	21,512	19,686	18,583	-	-	1,072	13,011
2002	20,005	17,774	16,458	-	-	12,693	11,754
2003	23,615	20,370	18,503	-	-	14,839	13,478
2004	19,028	15,935	14,199	-	-	11,840	10,550
2005	23,297	18,942	16,557	-	-	14,356	12,548
2006	25,972	20,503	17,579	-	-	15,849	13,589
2007	30,581	23,438	19,713	-	-	18,481	15,544
2008	1,862	1,385	1,143	-	-	1,114	919
2009	1,209	873	707	-	-	716	580
2010	1,023	717	570	-	-	600	477
2011	942	642	500	-	-	548	427
2012	1,626	1,075	821	-	-	936	715
2013	1,019	654	490	-	-	581	435
2014	1,534	956	703	-	-	866	636
2015	2,046	1,238	893	-	-	1,144	825
2016	2,596	1,525	1,079	-	-	1,437	1,017
2017	1,595	910	631	-	-	874	607
				-	-		
2019	37	20	13	-	-	20	13
				-	-		
Total	257,988	223,273	204,606	138,681	92,603	161,004	159,369

Note: The intermediate case is the case of 3% inflation with 1% increase in the nominal interest rate.
Source: *Government Bond Statistics Annual*, Ministry of Finance.

Table 3.

Bank of Japan Operations in the Money Markets (November 1999)

(100 million yen)

Instrument	Amount of successful bid
CP purchases	41,043
JGBs borrowing	34,051
Bills purchases	12,940
Bills purchases(CB)	2,178
Bills sales	89,041
TBs & FBs purchases	82,110
TBs & FBs sales	35,045

Source: *Financial and Economic Statistics Monthly*, Bank of Japan

Notes:

Bills sales: Outright sales of bills drawn by BOJ

Bills purchases: Outright purchases of bills

JGBs borrowing: Borrowing of JGBs against cash collateral

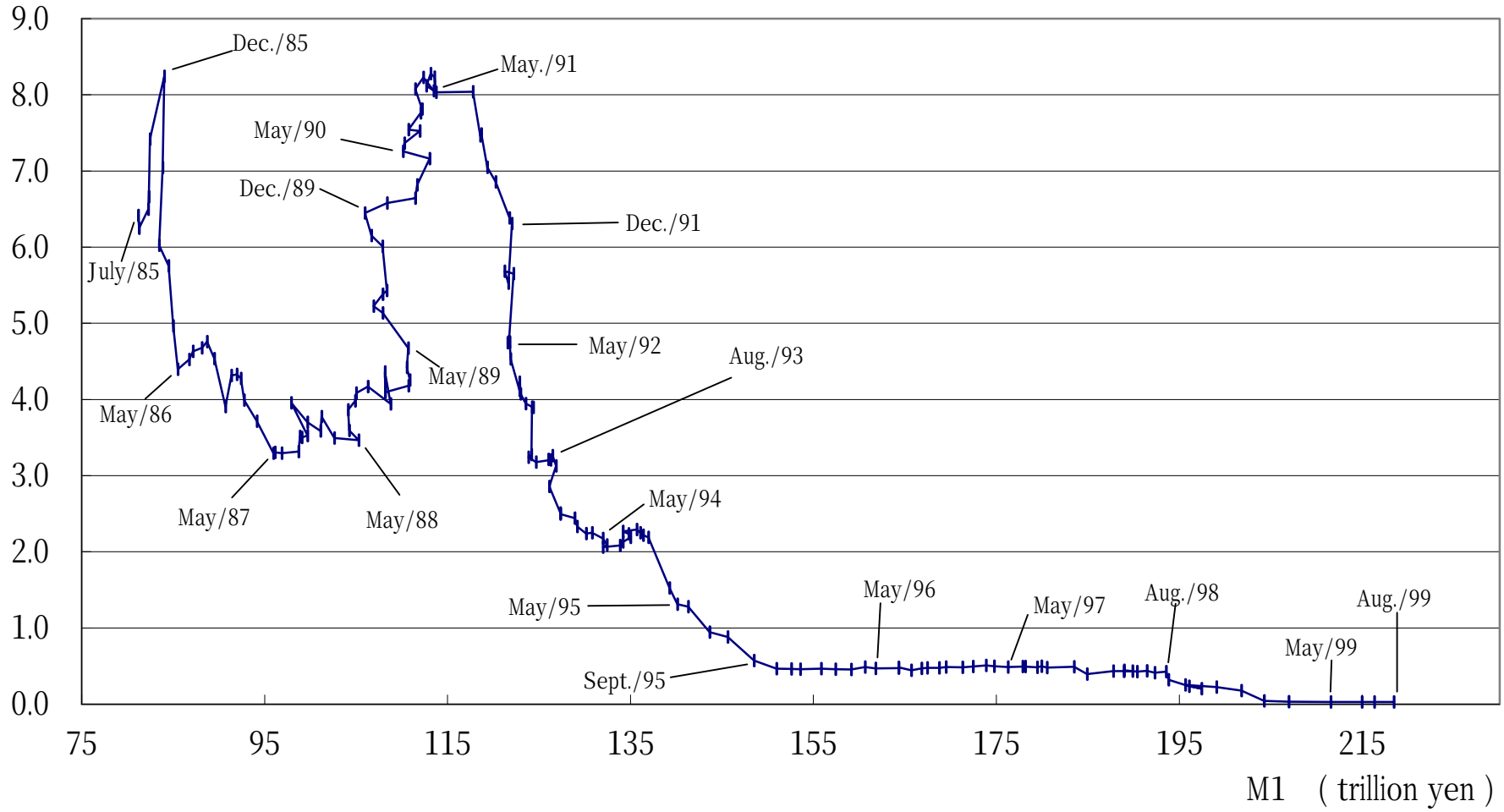
TBs & FBs purchases: Purchases of TBs and FBs under repurchase agreements

CP purchases: Purchases of CP under repurchase agreements

TBs & FBs sales: Sales of TBs and FBs under repurchase agreements

Bills purchases(CB): Outright purchases of bills(utilizing corporate bonds and loans on deeds as collateral)

Figure 1. Relation between call rate and M1



Source: *Economic Statistics Monthly*, Bank of Japan.

Figure 2.

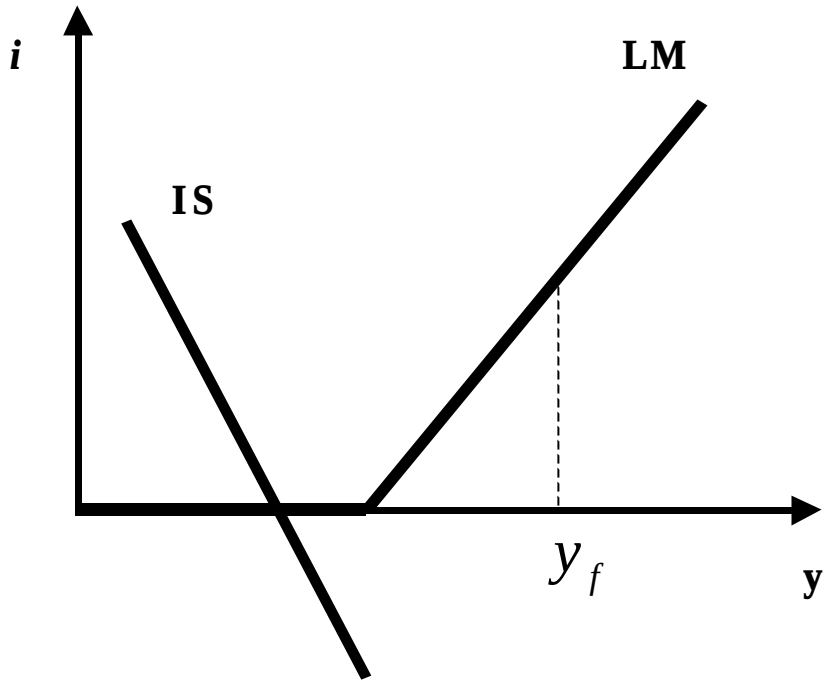


Figure 3.

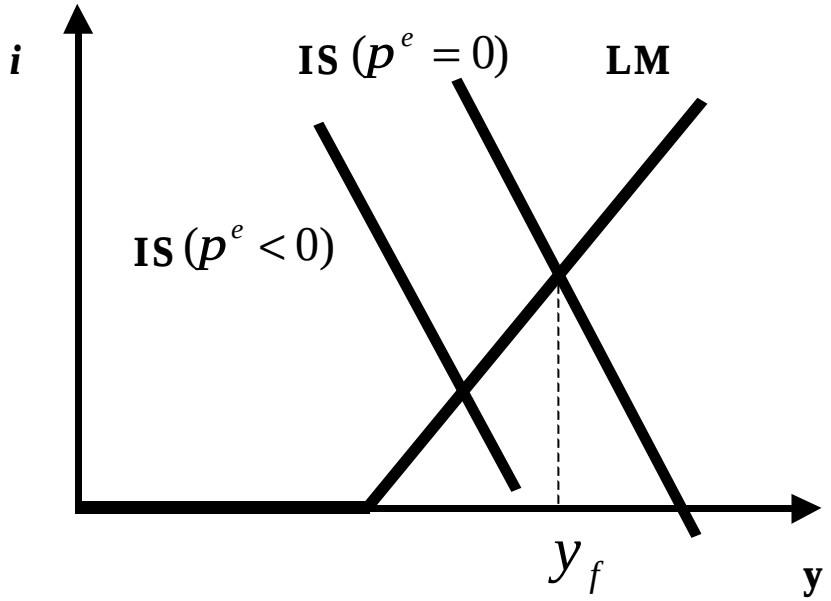
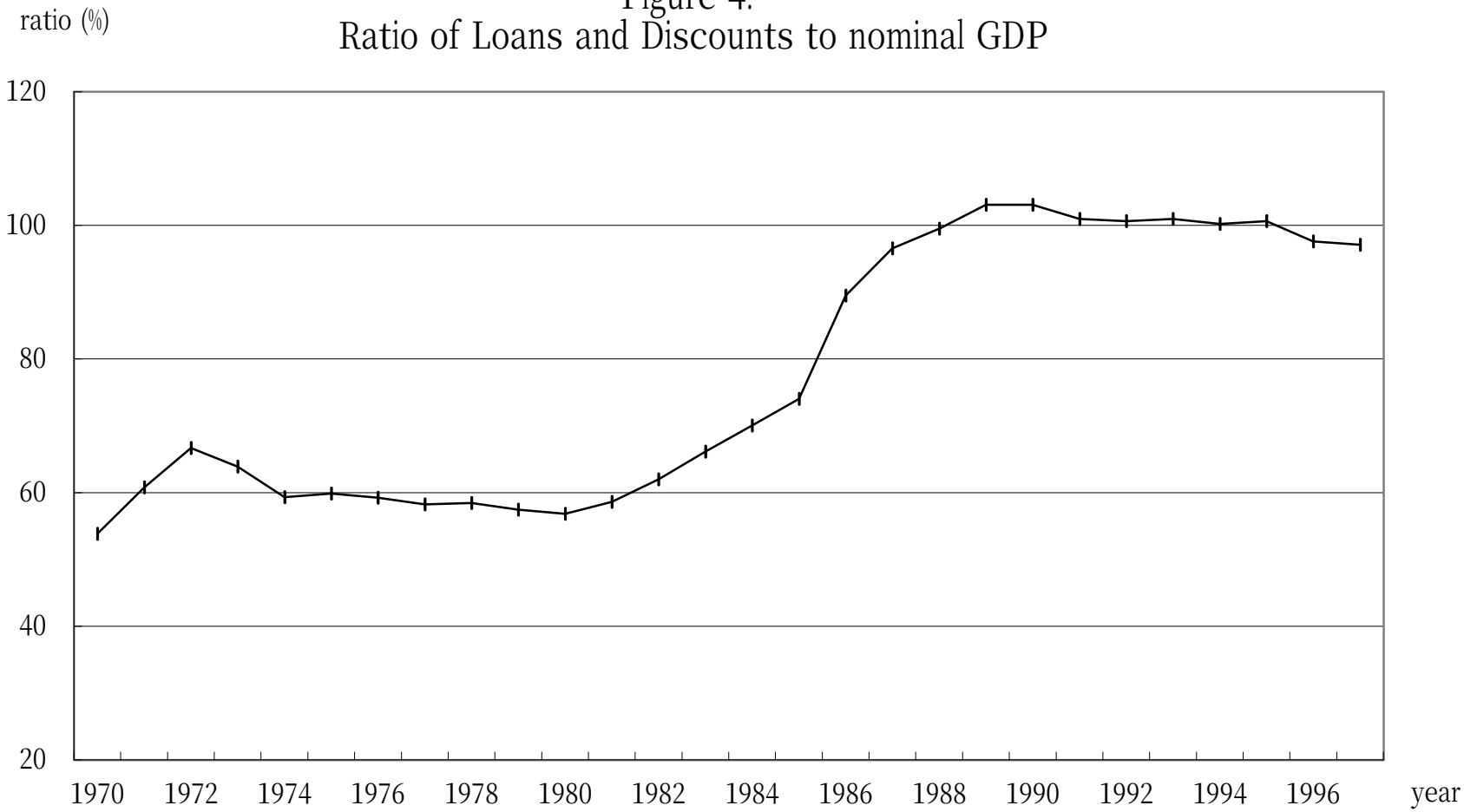
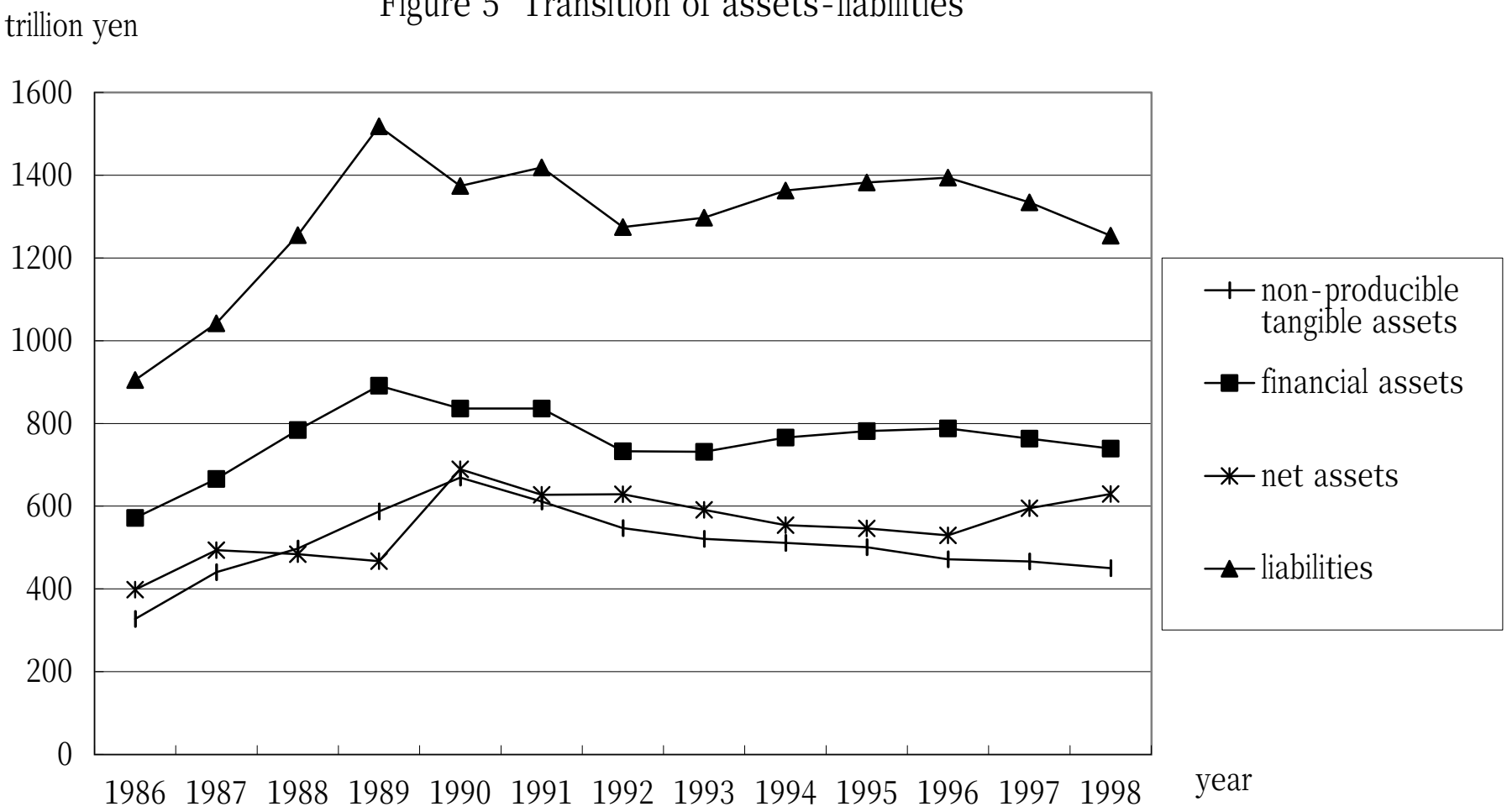


Figure 4.
Ratio of Loans and Discounts to nominal GDP



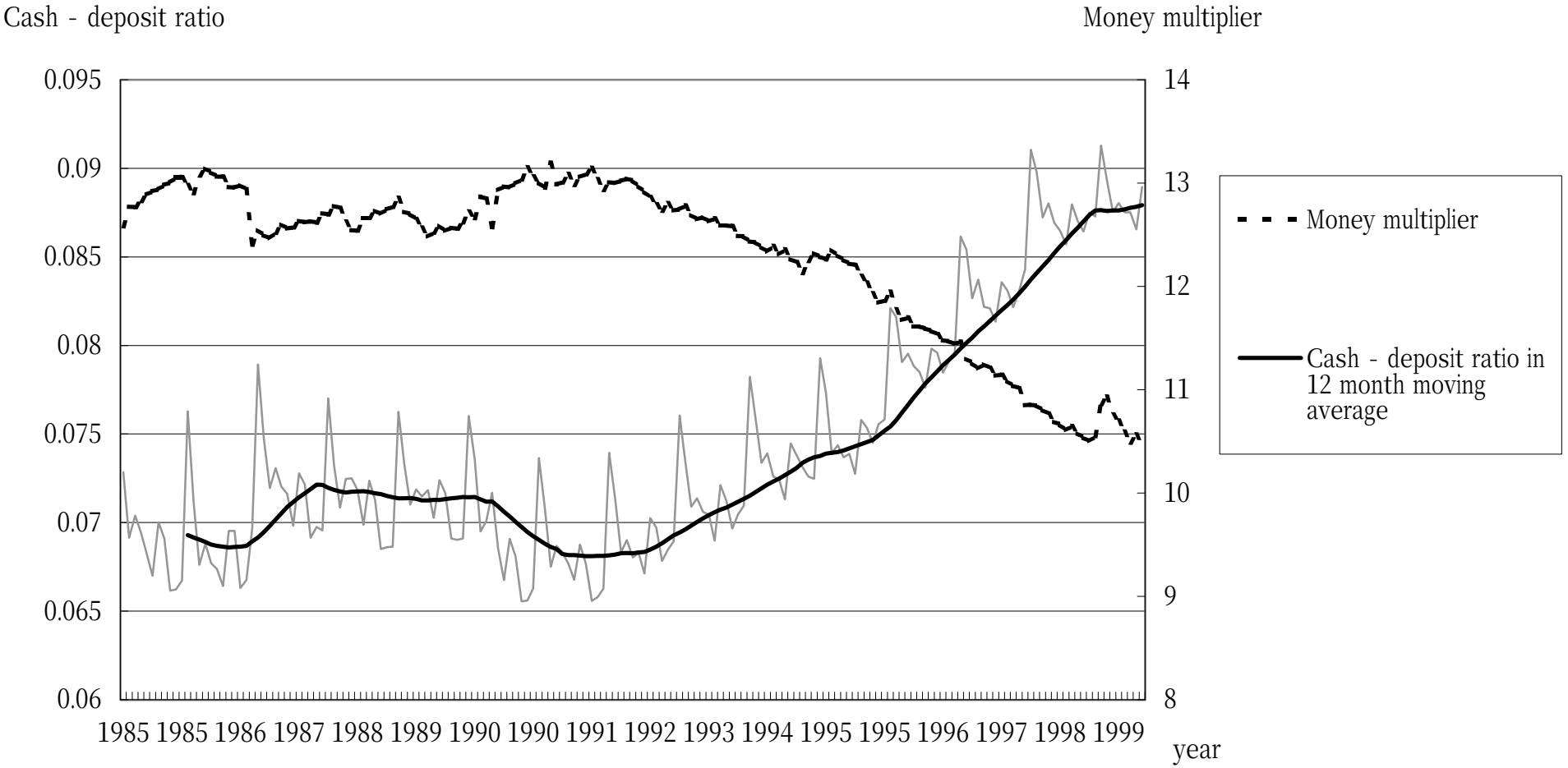
Source: *Government Bond Statistics Annual*, Ministry of Finance, *Local Finance Statistics Annual*, Institute of Local Finance, and *Annual Report on National Accounts*, Economic Planning Agency.

Figure 5 Transition of assets-liabilities



Sources: *Annual Report on National Accounts*, Economic Planning Agency. * Non-financial Incorporated Enterprises and private non-profit institutions serving households.

Figure 6. Trends in money indicators



Source: *Economic Statistics Monthly*, Bank of Japan.

[1] Krugman [1998].

[2] Various arguments against inflation policy from the central bank view point are raised in Okina [1999].

[3] Bernanke et al. [1999] examine how the strategy of inflation targeting worked in implemented countries and argue its advantages.

[4] Money series is M1, and collateralized call rates were estimated as an interest rate series in the equation. Money series is deflated by the GDP deflator. Real income is real GDP. Data are quarterly time series. Both M1 and real GDP data are seasonally adjusted. Estimated period is from the first quarter of 1970 to the fourth quarter of 1999. The reason for the choice of 1995 as the boundary year is that movement of call rate is obviously crawling slightly above the horizontal line after the year.

Estimating these data may have a problem of spurious regression, so we first performed the unit root test. We applied the augmented Dickey-Fuller test. The usual practice when selecting the number of lagged changes is to use the AIC (Akaike information criterion) or the SIC (Schwartz information criterion). As for M1, the ADF *t* statistic (with constant and trend) is –0.943 with the lag length of 5 selected by the AIC. *P*–value is 0.951, so we accept the hypothesis that M1 has a unit root. To do likewise for real GDP and collateralized call rates, the lag length of 0 and 5 respectively were selected by the AIC. All these variables accept a null hypothesis at least over 80 % level.

As for the unit root test, we included the term of a trend and time in the regression in M1 and real GDP. But since we considered that interest rates seemed not to have a trend, we examined interest rates without a trend. The variables are all in logs for estimating unit roots except call rates. All variables supported the null hypothesis of following the unit root process.

Then we checked whether the variables follow I(1). First, for a variable *x*, for example, the

augmented regression

$$\Delta x_t = c + \theta\, x_{t-1} + \sum_{i=1}^{k} \theta_i\, \Delta x_{t-i} + \eta_t ,$$

is considered. After testing the parameter θ and the null hypothesis of taking the unit root process was accepted at any level below 10%, then the regression

$$\Delta^2 x_t = c + \delta\, \Delta x_{t-1} + \sum_{i=1}^{k} \delta_i\, \Delta^2 x_{t-i} + \varepsilon_t ,$$

where $\Delta^2 x_t = \Delta(\Delta x_t) = \Delta(x_t - x_{t-1}) = \Delta x_t - \Delta x_{t-1}$ were estimated. The AIC was used to pick the lag length. For M1, four past lags were used and the *t* statistic that corresponds to δ were –4.37, which is significant at the 1 % level denoting that M1 is I(1). All the rest were also implied I(1) at least at 5 % level.

[5] There may have some problems when the level of interest rate instead of logs is included in the estimated equation. Coefficients of interest rate that are not in logs regressing dependent variable, here in this case M1/P, in logs can be written as ratios of interest rate elasticity of the money demand to the level of interest rate. Remind that this is different from interest rate elasticity of money demand per se. When interest rate elasticity is constant, it is not clear whether the coefficients depend on the value of the elasticity or the level of the interest rate itself. These coefficients of the level of interest rate can be large when elasticity is high, but also when the level of interest rate is low.

[6] Although Krugman's model includes many periods, we simplify his argument here by only looking at two periods, today and tomorrow.

[7] For example, in Krugman [1998], intertemporal utility function takes the form

$$U = \frac{1}{1-\rho} \sum\nolimits_t c_t^{1-\rho} D^t ,$$

where ρ is parameter which shows relative risk aversion, *D* is the discount factor and *c* is

consumption within a period. The marginal rate of substitution MRS under this utility function becomes $\frac{c^{-\rho}}{D(c^*)^{-\rho}}$.

[8] LM curve will also shift by deflation, since the real money balance is affected by deflation. However, this point does not change the following argument in any significant way.

[9] According to Taylor [1993], monetary policy in the United States in the 1980s and 1990s can be approximated by a simple rule under which the short-term interest rate responds to inflation rate and real GDP in such a way that

$$FF = \pi_{t-1} + 0.5y_{t-1} + 0.5(\pi_{t-1} - \pi^*) + 2,$$

where π_t is the inflation rate at period *t*, *FF* federal fund rate, y_{t-1} the present deviation of real GDP from a target one, and π^* is the target inflation level. Taylor rule is a rule consistent with inflation target rule. To see this, consider a simplified Taylor rule as

$$i = \bar{i} + \gamma\pi. \qquad (*)$$

Notice that there is no *y*'s in this simplified version. If the central bank is planning to realize an inflation targeting of π^* (this is assumed to be stationary), the intercept $\bar{i}$, can be written as,

$$\begin{aligned} \bar{i} &= i - \gamma\pi^* \\ &= \delta + (1-\gamma)\pi^* \end{aligned}$$

(since $i = \delta + \pi^*$, with real interest rate in equilibrium will be δ, and the expected inflation will be π^*.)

Substituting the above equation to (*), we obtain

$$i = \delta + \pi^* + \gamma(\pi - \pi^*).$$

This equation indicates that when the central bank determines the magnitude of *i* as $\delta + \pi^*$, the target value of inflation is possible to be achieved.

This shows that Taylor rule is a rule consistent with inflation target rule.

[10] Expansion of government expenditure financed by issuing bond (which implies future tax

increase) will increase present demand level even if consumers adjust their consumption pattern expecting future tax increase.

[11] Although this may be a trivial matter for professional economists, this kind of explanation is necessary for larger population of readers. Fisher effect is often referred to as a reason against inflationary policy by many people in Japan.

[12] Here, we assume that aggregate supply curve is vertical, so that full employment output level is independent from the price level. If it is not, the following argument may not be correct.

[13] Krugman [1998], p174.

[14] We decompose the government bonds by the remaining length of maturity. The real value of the bonds will depreciate by the amount of inflation until maturity and then the new interest rate for reissuing adjust to new inflation rate.

[15] In this calculation we neglect risk premium on nominal interest rate due to inflation. Increasing inflation may make nominal government bond riskier and the nominal interest rate may rise reflecting risk premium on fluctuating inflation rate. If one makes simple calculation of risk premium from Taylor expansion of expected utility from fluctuating income of government bond, he can find out that risk premium is proportional to variance of inflation rate, where the coefficient of the proportionality depends on the relative risk aversion measure. Since inflation considered here is modest one, the variance as well as the risk premium is much smaller than the interest rate. So, we may neglect the risk premium factor.

[16] We follow Fischer [1982] for this formula.

[17] The Bank of Japan announced many times that it will continue zero interest rate policy until deflationary condition of the economy is cleared in order to show its commitment to continuing monetary expansion policy.

[18] According to Nikkei (a leading economic newspaper in Japan), November 26, 1998, the commercial papers the Bank of Japan held moved in the range between 20 % and 40 % of the total

issue of commercial papers.

[19] For example, the point is mentioned in the Governor's comment on November 16, 1999.

[20] It is pointed out by Okina [1999] that non-neutralized intervention in the foreign exchange market does not have strong effect under liquidity traps, since short-term government bond and money become almost perfect substitute under liquidity traps.