RIETI Discussion Paper Series 02-E-010

Fiscal Consequences of Inflationary Policies

KOBAYASHI Keiichiro
RIETI

The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 02-E-010

June 2002

Fiscal Consequences of Inflationary Policies

(Revised March 2004)

Keiichiro Kobayashi

Abstract

In this paper I examine from a theoretical perspective the policy proposal made by Krugman (1998a) for inducing inflation to rejuvenate the Japanese economy. The main findings are that the government's budget constraints imply that (1) in order to realize long-term inflation, it is insufficient to just have the central bank issue currency; an expansionary fiscal policy is also necessary; and (2) the government can credibly commit to future inflation by undertaking expansionary fiscal policy in the current period. I also examine the optimal policy mix of fiscal and monetary policies for an economy that suffers from a huge fiscal deficit and a liquidity trap. In addition, I modify the Krugman model to a three-period model and show that in circumstances in which the nominal interest rate is zero, temporary deflation may be aggravated if fiscal policies remain unchanged and the central bank increases the money supply.

Keywords: inflationary policies, monetary easing, expansionary fiscal policy

JEL classification: E31, E52, E58, E62

Fiscal Consequences of Inflationary Policies

Keiichiro Kobayashi

Fellow, The Research Institute of Economy, Trade and Industry

1-3-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8901, JAPAN

TEL +81-3-3501-8308

FAX +81-3-3501-8416

e-mail: kobayashi-keiichiro@rieti.go.jp

March 15, 2004 (First draft: July 7, 2002)

Abstract

In this paper I examine from a theoretical perspective the policy proposal made by Krugman (1998a) for inducing inflation to rejuvenate the Japanese economy. The main findings are that the government's budget constraints imply that (1) in order to realize long-term inflation, it is insufficient to just have the central bank issue currency; an expansionary fiscal policy is also necessary; and (2) the government can credibly commit to future inflation by undertaking expansionary fiscal policy in the current period. I also examine the optimal policy mix of fiscal and monetary policies for an economy that suffers from a huge fiscal deficit and a liquidity trap. In addition, I modify the Krugman model to a three-period model and show that in circumstances in which the nominal interest rate is zero, temporary deflation may be aggravated if fiscal policies remain unchanged and the central bank increases the money supply.

Keywords: inflationary policies, monetary easing, expansionary fiscal policy

JEL classification: E31, E52, E58, E62

1 Introduction

Krugman (1998a) (1998b) (2000) describes a very simple general equilibrium model for the Japanese economy and argues that in order to resolve current problems associated with a lack of demand, the central bank should commit itself to policies that would sustain long-term inflation (he proposes 4% inflation for a period of 15 years as an example). Krugman's thesis has triggered a macroeconomic policy debate over whether Japan can escape its economic stagnation not through fiscal policy but through monetary policy of the central bank. There are, among other things, two important points in controversy: (1) whether the economy can escape from a liquidity trap without expansionary fiscal policy; and (2) how the monetary authority can make a credible commitment to sustaining long-term inflation. As for the first point, people in Japan became enthusiastic about Krugman's policy recommendation because his thesis is thought to imply that no more fiscal stimulation is necessary and monetary easing alone can get the economy out of recession: Since the mid-1990s the government debt has followed an explosive path, and policymakers and economists have come to think that there is no more room for fiscal expansion, which had been the major policy tool to cope with the protracted slump throughout the 1990s. As for the second point, Svensson (2003), for example, argues that a government's (or central bank's) declaration to sustain long-term inflation associated with aggressive monetary easing is not credible under zero nominal interest rates, at least from theoretical point of view. He shows that in an open economy setting the government can credibly commit to long-term inflation in the future by raising the exchange rate today, instead of undertaking mere monetary easing under zero interest rates.

In this paper I review the Krugman model from a theoretical point of view. In considering explicitly the budget constraints of the government, which includes the central bank, I show that monetary expansion alone would be insufficient to sustain long-term inflation and that an expansionary fiscal policy would also be required to fulfill the commitment. In this closed economy setting, it is also shown that the government's commitment to future long-term inflation can be made credible by expansionary fiscal

policy today.

The literature on monetary policy under a liquidity trap has grown considerably in recent years. Papers include, for example, Watanabe and Iwamura (2002), Benhabib, Schmitt-Grohe, and Uribe (2002), Eggertsson and Woodford (2003), Auerbach and Obstfeld (2003), and Svensson (2003). Although I independently developed the idea that government budget constraints should be incorporated in Krugman's model, this idea is basically the same as that of Watanabe and Iwamura. There are some differences though. They impose certain restrictions on fiscal and monetary policies and argue that in order to realize an inflation target the government must implement fiscal expansion at present *and* in the future. Thus they do not examine fiscal consolidation, which will be one of the most important policy needs in the near future in Japan. In a simpler setting of this paper I consider both macroeconomic stabilization today and fiscal consolidation in the future. As for the credibility problem (how to commit credibly to future inflation), while I argue in this paper that fiscal policy in the current period can make the commitment credible, Watanabe and Iwamura do not examine the relationship between the credibility problem and fiscal policy. Benhabib, Schmitt-Grohe, and Uribe also point out that monetary policy must be accompanied by fiscal expansion in order to escape from a liquidity trap in a money-in-utility model, which is slightly different from Krugman's cash-in-advance setting that I examine in this paper.

The organization of this paper is as follows. In Section 2 I describe Krugman's model and specify the budget constraints for households and the government. In Section 3 I show that monetary policy must be accompanied by fiscal policy in order to realize long-term inflation, and examine the optimal policy mix for macroeconomic stabilization today and fiscal consolidation in the future. In Section 4 I extend the argument to a three-period model and show that the price level may fall in the intermediate period. Section 5 provides some concluding remarks.

2 Krugman Model

First of all, let us review Krugman's original model briefly (Krugman [1998b]).

The economy is comprised of infinitely many representative households, each of which lives forever, and these households maximize the following utility function through choosing consumption c_t for each period:

$$\max_{\{c_t\}} \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\rho}}{1-\rho}. \tag{1}$$

In order to introduce money into the economy, Krugman imposes a cash-in-advance constraint, i.e. "the nominal value of consumption ... cannot exceed money holdings." Accordingly, the money demand M_t^d for the household in each period satisfies the following:

$$p_t c_t \leq M_t^d \quad \text{for } t = 0, 1, \cdots, \tag{2}$$

where p_t is the price of consumer goods. In each period, the representative household is endowed by nature with the maximum volume of the consumer goods (y_t^f) that can be produced during that period, and consumer goods y_t can be produced without cost within the scope of that maximum volume. Thus,

$$y_t \leq y_t^f. \tag{3}$$

Now I introduce government bonds to Krugman's model in order to consider the budget constraints explicitly. I denote by B_t the nominal value of government bonds, which are purchased during period t by the representative household and yield $(1+i_t)B_t$ in the next period $t+1$, where i_t is the nominal interest rate. I assume that the government imposes a lump-sum tax and that the net tax payable (or the fiscal surplus) during period t is given a nominal value of $p_t s_t$. I assume that s_t can be negative. In the case where $s_t < 0$, we can interpret $-p_t s_t$ as a lump-sum subsidy from the government to households.

Although Krugman did not deal explicitly with transaction timing, in this paper, in order to discuss subsequent periods, I make use of it. This timing is equivalent to that in the standard cash-in-advance model. (See Sargent [1987] or Cochrane [2000].) It works as follows:

First, at the beginning of period t, asset markets open and the interest and the principal on government bonds held over from the previous period by households ((1 +

$i_{t-1})B_{t-1})$ are received. Therefore, the disposable assets of the representative household at the beginning of period t become the sum of cash holding from the previous period (M_{t-1}) and government bonds with interest $((1+i_{t-1})B_{t-1})$. Then the household pays tax $(p_t s_t)$ and purchases the current cash demand M_t^d and government bonds B_t for the current period. Subsequently the household produces goods y_t. It cannot use the goods produced by itself for its own consumption but must purchase consumer goods from other households. After production the household splits into a seller (husband) and a buyer (wife) in its activities. The buyer takes currency M_t^d to the market, where she buys the consumer goods c_t. At the same time the seller takes products y_t to the market and sells them. They act taking the sequence of prices and interest rates $\{p_t, i_t\}_{t=0}^{\infty}$ as given. At the end of period t, the cash balance becomes $M_t = M_t^d - p_t c_t + p_t y_t$, and the household moves into period $t+1$ still holding B_t and M_t. The budget constraints for the representative household are the following for $t \geq 0$, given $(1+i_{-1})B_{-1} + M_{-1}$.

$$(1+i_{t-1})B_{t-1} + M_{t-1} \geq p_t s_t + B_t + M_t^d, \tag{4}$$

$$M_t = M_t^d + p_t(y_t - c_t), \tag{5}$$

$$p_t c_t \leq M_t^d. \tag{6}$$

The equilibrium condition for the goods market is $c_t = y_t (\leq y_t^f)$ for $t \geq 0$. In the equilibrium,

$$(1+i_{t-1})B_{t-1} + M_{t-1} = B_t + M_t + p_t s_t \text{ for } t \geq 0. \tag{7}$$

This demonstrates that the redemption of government bonds for the current period is to be covered by issuance of new bonds, seigniorage, and the fiscal surplus in the next period. In other words, it is assumed that in this economy the government neither invests nor consumes but uses the fiscal surplus collected from the people to redeem government bonds. Krugman assumes that the economy attains the steady state from period 1 onward. Therefore, I also assume for $t \geq 1$,

$$c_t = y_t = y_t^f = y^*, \tag{8}$$

$$M_t = M^*, \tag{9}$$

$$s_t = s^*, \tag{10}$$

$$p_t = p^* = M^*/y^*, \tag{11}$$

$$i_t = i^* = \beta^{-1} - 1, \tag{12}$$

where y^*, M^*, and s^* are positive constants. The interest rate is determined by the first-order condition (FOC) for the household's utility-maximization and the equilibrium condition for the steady state ($c_t = y^*$). The FOC in period 0 becomes

$$\frac{1}{\beta}\left(\frac{y^*}{c_0}\right)^{\rho} = \frac{p_0(1+i_0)}{p^*}. \tag{13}$$

Furthermore, Krugman made the following extraordinary assumption.

Assumption 1 *The supply capacity of the Japanese economy will shrink in the future. Thus the following condition is assumed to be satisfied:*

$$\frac{y^*}{y_0^f} < \beta^{\frac{1}{\rho}} < 1. \tag{14}$$

Under this assumption, unless the inflation rate p^*/p_0 is sufficiently large, the above-mentioned FOC solution c_0 will not be able to achieve the maximum supply y_0^f even when the nominal interest rate i_0 falls to zero, resulting in a supply and demand gap ($y_0^f - c_0 > 0$). In the case where prices are sticky, i.e., $p_0 = \overline{p}$ for a certain constant $\overline{p}$, if p^* does not increase sufficiently, $c_0 = y_0^f$ cannot be realized.[1] Krugman emphasizes that the existence of the supply and demand gap $y_0^f - c_0$ is equivalent to the current Japanese economic recession and that one of the challenges for Japanese economic policy is to eradicate the gap. As the cause of the gap, in addition to the above Assumption 1, Krugman makes the following assumption.

[1]Krugman implicitly presupposes that for the chosen household consumption c_0 when this is smaller than the supply maximum y_0^f, selling off consumer goods up to the maximum capacity y_0^f of the household will not be possible. Yoshikawa (2000) points out that Krugman does not address or explain why the household produces only c_0, even though it is natural in the free-market environment to consider that households would be able to sell off to the market all products up to the supply maximum. This paper hypothesizes that at times when the chosen consumption c_0 is less than y_0^f, rationing in the market occurs and unsold products $y_0^f - c_0$ remain in each household without being consumed.

Assumption 2 *The price p_0 of the current period (period 0) is sticky and exogenously fixed at $p_0 = \overline{p}$. From the next period on the price p^* is decided through equilibrium in a manner that does not create a supply and demand gap, but if the government does not change the money supply in the next period on, the inflation rate p^*/p_0 is insufficiently large, so that*

$$\frac{p^*}{p_0} < \beta \left(\frac{y_0^f}{y^*} \right)^{\rho}.$$

It is then Krugman's proposal that in order to eradicate the supply and demand gap $y_0^f - y_0$ in the current period , you should enlarge the future money supply M^*, increase $p^* = M^*/y^*$, and thereby adequately raise the rate of inflation. If this is to be done, there exists a nonnegative nominal interest rate i_0 that assures that the consumption c_0, the solution of (12), will equal the supply capacity y_0^f.

3 The Budget Constraints

This section examines in detail the household's budget constraints. In the Krugman model, the reason for the GDP gap in the current period (period 0) is that the value of c_0 that solves the FOC is less than the supply capacity y_0^f. This section considers policies to enlarge consumption that satisfies the FOC. We define the following concerning fiscal and monetary policies.

Fiscal policy is the government's choice for the real fiscal surplus s_t in each period, $\{s_t\}_{t=0}^{\infty}$, where s_t can be not only a positive number but also zero or a negative number. Monetary policy is the monetary authority's choice of interest rates, stock of cash, and stock of bonds outstanding. In other words, although the central bank cannot alter $\{s_\tau\}_{\tau=t}^{\infty}$ in period t, it is able to manipulate the following: $\{i_\tau, M_\tau, B_\tau\}_{\tau=t}^{\infty}$. Monetary policy is defined as the operation of these three variables.[2]

Fiscal policy $\{s_t\}_{t=0}^{\infty}$ and monetary policy $\{i_t, M_t, B_t\}_{t=0}^{\infty}$ can never be independently decided and are instead decided in such a manner as to satisfy household budget con-

[2]In reality, a method of monetary policy will be employed whereby the central bank provides currency to the market as a payment for the purchase of assets in the market. The model in this paper also supposes that the central bank adjusts the amount of money in the market by buying and selling government bonds.

straints and the cash-in-advance constraint.[3] In addition, there is a controversy among economists as to whether the government, when deciding on fiscal policy $\{s_t\}_{t=0}^{\infty}$, acts taking future price levels $\{p_t\}_{t=0}^{\infty}$ and the budget constraint (7) as given. In the fiscal theory of the price level (Woodford [2001] and Cochrane [2000]), the policy regime whereby the government decides on fiscal policy $\{s_t\}_{t=0}^{\infty}$ taking price levels $\{p_t\}_{t=0}^{\infty}$ as given is called the Ricardian regime, and conversely, when the government stipulates $\{s_t\}_{t=0}^{\infty}$ without constraining budgetary limitations, the policy regime whereby price levels are coordinated so that condition (7) is satisfied ex post is known as the non-Ricardian regime.[4] However, the difference between whether fiscal policy is being operated under a Ricardian or non-Ricardian regime does not affect the results of this paper. The problem we analyze is whether it is possible, without changing fiscal policy, to eliminate the supply and demand gap with monetary policy alone. As I will show later, only the fact that condition (7) must be satisfied ex post is crucial for the results of this paper.

I will examine whether or not c_0, the solution to (12), can be increased through monetary policy alone.

3.1 The case when the nominal interest rate is positive

If i_0 takes a positive value initially, then the government can increase c_0 by reducing i_0 through monetary policy, without changing the prices p_0 or p_1. Suppose that y^* is so

[3]For example, we can consider the following two cases for the methods of monetary and fiscal policy. The first case is that the monetary authority is the leader and the fiscal authority is the follower: At date t the central bank sells and buys government bonds to decide i_t, M_t, and B_t, given the outstanding debt and cash $((1+i_{t-1})B_{t-1}+M_{t-1})$; the fiscal authority chooses s_t so that the budget constraint (7) is satisfied, given $(1+i_{t-1})B_{t-1}+M_{t-1}$, M_t, B_t, and p_t. The second case is that the fiscal authority is the leader and the monetary authority is the follower: At date t the fiscal authority decides s_t and issues additional government bonds ΔB_t if necessary; the central bank sells and buys the government bonds under constraint (7), given the total amount of debt and cash $((1+i_{t-1})B_{t-1}+M_{t-1}+\Delta B_t)$ and the fiscal surplus (s_t).

[4]In the debate over whether the government operates fiscal management under a Ricardian regime or through a non-Ricardian regime, Woodford and Cochrane stress that in reality, normal developed countries employ the Ricardian regime, while developing countries with high political instability use the non-Ricardian regime.

large that Assumption 1 does not hold and that the solution to (12) becomes $c_0 = y_0^f$ if i_0 decreases to $i_0^*(> 0)$.

The household budget constraints in periods 0 and 1 can be described as follows:

$$p_0 c_0 + p_0 s_0 + B_0 + M_0^d \leq (1 + i_{-1})B_{-1} + M_{-1} + p_0 y_0, \tag{15}$$

$$p_1 c_1 + p_1 s_1 + B_1 + M_1^d \leq (1 + i_0)B_0 + M_0 + p_1 y_1, \tag{16}$$

where $p_0 = \overline{p}$, $c_0 = y_0 \leq y_0^f$, $c_1 = y_1 = y^*$, and $M_t^d = M_t$.

Without changing the fiscal policy variable $\{s_t\}$ and the price $\{p_t\}$, it is impossible to reduce i_0 keeping the household budget constraints satisfied. If it is permitted to change the fiscal policy variable, the government can reduce the nominal interest rate by the following method: responding to the reduction in i_0, M_0 or B_0 is increased in order to satisfy the budget constraint of period 1, and s_0 is reduced in order to satisfy the budget constraint of period 0.

In other words, only by implementing expansionary fiscal policy and simultaneously reducing nominal interest rates is it possible to eliminate the GDP gap in period 0. Conversely, if expansionary fiscal policy is not implemented, it will be impossible to eliminate the GDP gap through monetary policy alone.

3.2 The case when the nominal interest rate is zero

In the case when the nominal interest rate is zero, the same conclusion can also be derived. Since the economy is in the steady state for $t \geq 2$, the following can be drawn:

$$\beta^{-1} B^* + M^* + p^*(y^* - c^*) = B^* + M^* + p^* s^*,$$

and accordingly, $p^* = \frac{1-\beta}{\beta s^*} B^* = \frac{M^*}{y^*}$. When $i_0 = 0$, the budget constraints of periods 0 and 1 imply

$$p^* = \frac{(1 + i_{-1})B_{-1} + M_{-1} - p_0 s_0}{\frac{s^*}{1-\beta} + y^*}. \tag{17}$$

When we increase p^* in order to increase c_0, the solution to the FOC, we need to reduce s_0 or s^*. To put it another way, a policy to permanently increase M^*, as advocated by Krugman, cannot be successful unless policies to reduce s_0 or s^* are simultaneously

implemented. In other words, in order to raise the price level of period 1 and the subsequent periods, aiming to eliminate the GDP gap of period 0, it will be necessary both to increase the money supply and also to implement an expansionary fiscal policy in period 0 or subsequent periods.

Under the constraint that nominal interest rates are fixed at zero, bringing about long-term inflation would require reducing the fiscal surplus (s_0 or s^*), and this would imply implementing an expansionary fiscal policy. In order to look at the differences between a reduction in s_0 and a reduction in s^*, we confirm the equilibrium government debt balance in the future periods (B^*). From equation (17) above the following is derived:

$$B^* = \frac{(1+i_{-1})B_{-1} + M_{-1} - p_0 s_0}{\frac{1}{\beta} + \frac{y^*(1-\beta)}{\beta s^*}}. \tag{18}$$

What this equation makes clear is that an expansionary fiscal policy in the current period (reduction in s_0) and one in the future (reduction in s^*) result in the opposite effects on B^*. In other words, in accordance with inflationary policy, i.e., expansion of M^*, if an expansionary fiscal policy is carried out in the current period, the future government debt B^* will increase. On the other hand, in accordance with inflationary policy, if an expansionary fiscal policy is carried out in the future, B^* will decrease.

Collating all the above, the following can be stated. When implementing inflationary policies (expansion of M^*) designed to eliminate the GDP gap in the current period, the fiscal surplus (s_0 or s^*) must be reduced in real terms, while the reduction of the fiscal surplus may or may not result in reduction of B^*.

On the credibility problem The above argument also indicates the answer to the credibility problem: How can the government (or the central bank) make a credible commitment to future long-term inflation? Suppose that the government does not have the ability to commit to the future variables (s^*, M^*) beforehand, while people form expectations on s^* and M^* that are independent from the government's intention. Even in this case, the government can credibly commit to future inflation by setting the present variables in period 0. Equation (17) implies that the expansionary fiscal policy in the

current period (reduction of s_0) can raise the future price level p^*. Thus by setting s_0 at an appropriate value today, the government can realize any target level of future price p^*. (Note that s_0 can be a large negative number, while the steady state surplus s^* must be nonnegative.) The policy implication that the government can credibly commit to long-term inflation by undertaking expansionary fiscal policy today seems rather simple and more robust than Svensson's proposal that the commitment can be made credible by today's exchange rate policy. This is because an exchange rate policy to escape from a liquidity trap may be infeasible in some cases if the economy is not sufficiently open and small, or if the domestic and foreign governments act in a completely noncooperative way (see Svensson [2003]).

Numerical example A quantitative discussion may help to assess the relevancy of the above arguments. I will show how much fiscal expenditure must be added in today's Japan to escape from the liquidity trap.

I assume that one period in the model is ten years in reality. The parameter values are given as follows. The discount factor for one year is set at 0.98 according to Soejima (1997). Therefore, $\beta = (0.98)^{10}$. The parameter for relative risk aversion is set as $\rho = 1.6$ based on the estimation by Kitamura and Fujiki (1997). I assume that there prevails the macroeconomic expectation that deflation at 1% a year will continue for ten years. Thus the expected price in period 1 is $p^* = (0.99)^{10} p_0$. I also set the current GDP at 5 trillion dollars: $y_0 = c_0 = 5 \times 10^{12}$. According to the Cabinet Office, the average GDP gap since 1998 is about 3%. Thus I set the supply capacity in period 0 at $y_0^f = \frac{1}{1-0.03} c_0$. Equation (13) implies that the expected future output y^* is $0.94 y_0^f$.

Equation (13) implies that in order to have $c_0 = y_0^f$, the future price must be changed to p^{**}, where p^{**} is determined by

$$p^{**} = \beta p_0 \left(\frac{y_0^f}{y^*} \right)^{\rho}. \tag{19}$$

I assume that the government wants to attain p^{**} by undertaking additional fiscal ex-

pansion in period 0. The price p^{**} can be written as

$$p^{**} = \frac{(1+i_{-1})B_{-1} + M_{-1} - p_0 s_0 + \Delta}{\frac{s^*}{1-\beta} + y^*}, \tag{20}$$

where Δ is the additional fiscal expenditure in period 0. In this numerical example Δ is calculated from equations (17) and (20):

$$\frac{1}{0.97^{1.6}} = \frac{X + \Delta}{X}, \tag{21}$$

where $X = (1+i_{-1})B_{-1} + M_{-1} - p_0 s_0$, which is the sum of public debt, high-powered money, and the fiscal deficit. In today's Japan, the public debt outstanding is about 7.5 trillion dollars, high-powered money is about 0.9 trillion dollars, and the fiscal deficit is about 0.4 trillion dollars. Therefore, X can be set at approximately 9 trillion dollars. In this case Δ is approximately 4.5×10^2 billion dollars, which is equal to about 9% of Japan's annual GDP. Since the total tax revenue of the central government was approximately 4.0×10^2 billion dollars in 2003, the necessary fiscal expansion Δ is quite large. In this numerical example, however, the target rate of inflation is surprisingly low. It is calculated that $p^{**} = 0.95 p_0$, while $p^* = 0.90 p_0$. Thus the target inflation rate to attain p^{**} is -0.5%, i.e., deflation at the annual rate of 0.5% for ten years. This target sufficient to eradicate the current GDP gap is surprisingly modest compared with Krugman's proposal of 4% inflation for 15 years.

3.3 Liquidity trap and fiscal consolidation

The policy implication of the above argument is that the Japanese government should undertake a more aggressive fiscal (and monetary) expansion today in order to escape from the liquidity trap. But huge fiscal deficits and the government debt, which is building up at an explosive rate, are also extremely serious problems in the Japanese economy.

I will examine how the implication of the model changes if the fiscal deficit is socially costly. I assume that the government tries to escape from the liquidity trap by changing only s_0. The future (expected) surplus s^* is left unchanged. I assume that the economy

suffers the dead weight loss (per capita) of $\gamma(s^* - s_0)^\eta$ where $\gamma > 0$ and $\eta > 1$ in period 1. This is the cost due to the distributional friction of fiscal adjustment, and each household consumes $y^* - \gamma(s^* - s_0)^\eta$ in period 1. I assume that from period 2 onward the economy stays in a steady state where $c_t = y^*$. In order to simplify the analysis, I assume that the price level stays constant from period 1 onward. This is justified as follows: In period 1, the amount of outputs is y^* and households sell and buy y^* at price $p^* = \frac{M^*}{y^*}$, while they can consume only $y^* - \gamma(s^* - s_0)^\eta$ because they suffer the dead weight loss of fiscal adjustment. I also assume that $\rho > \frac{1}{2}$.

In this setting, the socially optimal value of s_0 is determined as the solution to the following problem:

$$\max_{s_0} \frac{c_0^{1-\rho}}{1-\rho} + \beta \frac{c_1^{1-\rho}}{1-\rho}$$

subject to

$$\begin{cases} c_0 = \min\{y^* \left(\frac{p^*(s_0)}{\beta p_0}\right)^{\frac{1}{\rho}}, y_0^f\}, \\ p^*(s_0) = \frac{(1+i_{-1})B_{-1} + M_{-1} - p_0 s_0}{\frac{s^*}{1-\beta} + y^*}, \\ c_1 = \max\{y^* - \gamma(s^* - s_0)^\eta, 0\}. \end{cases} \tag{22}$$

Since it is easily shown that in the optimum $c_1 > 0$ and $c_0 = y_0^f$ only if the optimal s_0 satisfies $y^* \left(\frac{p^*(s_0)}{\beta p_0}\right)^{\frac{1}{\rho}} = y_0^f$, the optimal value of s_0 is determined by the FOC:

$$\rho c_1^{-\rho} \eta \gamma (s^* - s_0)^{\eta - 1} = \frac{p_0^2 c_0^{1-\rho}}{(1+i_{-1})B_{-1} + M_{-1} - p_0 s_0}, \tag{23}$$

where $c_0 = y^* \left(\frac{p^*(s_0)}{\beta p_0}\right)^{\frac{1}{\rho}}$ and $c_1 = y^* - \gamma(s^* - s_0)^\eta$. Since the left-hand side of (23) is decreasing in s_0 and the right-hand side is increasing in s_0 if $\rho > \frac{1}{2}$, there exists a unique solution.

This thought experiment shows the following: (1) If the fiscal adjustment is socially costly, the optimal consumption may be $c_0 < y_0^f$ and $c_1 < y^*$; thus eradicating completely the GDP gap (the liquidity trap) in the current period may not be optimal, since fiscal expansion to eliminate the GDP gap today may generate a social cost tomorrow. (2) The optimal value of the fiscal deficit may be smaller than the currently prevalent one; although it depends on parameter values, it is possible that fiscal consolidation *today*

that exacerbates the current GDP gap may be the optimal policy, if the future cost of fiscal adjustment is expected to be too large.

I cannot assess the relevancy of the above implications quantitatively, since the functional form and the parameter values for the social costs of fiscal adjustment are not known in empirical studies. But as long as fiscal adjustment is socially costly, it is necessary to consider the trade-off between elimination of the liquidity trap today and costly fiscal adjustment tomorrow.

4 Three-Period Model

The Krugman model hypothesizes that although a GDP gap may arise through price stickiness in the current period (period 0), the steady state would prevail in subsequent periods (from period 1 onward). In other words, the model is a two-period model. From the results of the previous section, it can be seen that in this two-period model, if there are no changes to fiscal policy, it would be impossible to change prices $\{p_0, p^*\}$.

In this section, in order to analyze the effects of monetary policy, I slightly modify the Krugman model to make it possible to change monetary policy even without changing fiscal policy. To this end, I consider a three-period model in which the economy attains the steady state from period 2 on, and prices in period 1 (p_1) are determined flexibly as an equilibrium outcome. I analyze the case where the government responds to the GDP gap of period 0 by changing monetary policy but not fiscal policy $\{s_t\}_{t=0}^{\infty}$.

Assumption 3 *For production of each period and its maximum, we assume the following three conditions:* $y_0^f = y_1^f = \overline{y}$; $y_t^f = y_t = y^*$ *for* $t \geq 2$; *and*

$$\frac{y^*}{\overline{y}} < \beta^{\frac{1}{\rho}}.$$

The price p_0 *is exogenously fixed at* $\overline{p}$. *In addition,* p_t *for* $t \geq 1$ *is assumed to be flexible.*

The representative household maximizes its utility function under the following budget constraints:

$$(1 + i_{-1})B_{-1} + M_{-1} + p_0(y_0 - c_0) \geq B_0 + M_0 + p_0 s_0, \tag{24}$$

$$(1+i_0)B_0 + M_0 + p_1(y_1 - c_1) \geq B_1 + M_1 + p_1 s_1, \tag{25}$$

$$(1+i_1)B_1 + M_1 + p^*(y^* - c^*) \geq B^* + M^* + p^* s^*, \tag{26}$$

$$(1+i^*)B^* + M^* + p^*(y^* - c^*) \geq B^* + M^* + p^* s^*. \tag{27}$$

These constraints are obtained by substituting (5) for M_t^d in (4). In an equilibrium, $y_t = c_t$ for all $t \geq 0$, $i^* = \beta^{-1} - 1 > 0$, and $p^* y^* = M^*$. In order to analyze the current status of the Japanese economy, in which the short-term nominal interest rate is zero, I consider the equilibrium path in which nominal interest rates are zero in periods 0 and 1. Thus I assume $i_0 = i_1 = 0$, $p_0 c_0 < M_0$, and $p_1 c_1 < M_1$. Therefore, in the case where nominal interest rates are zero, the following can be derived from the budget constraints above and $p^* y^* = M^*$.

$$p^* = \frac{B_1 + M_1}{\frac{s^*}{1-\beta} + y^*}, \tag{28}$$

$$p_1 = \frac{B_0 + M_0 - B_1 - M_1}{s_1}. \tag{29}$$

If fiscal policy $\{s_t\}$ is invariant, the central bank will operate M_1 (or B_1) to change price levels p_1 and p^*, taking $B_0 + M_0 = (1+i_{-1})B_{-1} + M_{-1} - p_0 s_0$ as a given parameter. As can be understood from the above equations, if the central bank increases M_1 in order to raise the future price level p^*, the period 1 price level (p_1) falls. If we assume that the policy objective of the central bank is to eliminate the GDP gap in period 1, i.e., to realize $c_1 = y_1 = y_1^f$, then M_1 is determined from

$$\beta \left(\frac{\overline{y}}{y^*} \right)^{\rho} = \frac{(B_1 + M_1)s_1}{(\frac{s^*}{1-\beta} + y^*)(B_0 + M_0 - B_1 - M_1)}.$$

In this case, when p_0 is fixed at a high level, the amount of production in period 0 ($c_0 = y_0$) is determined by

$$\beta \left(\frac{y_0}{\overline{y}} \right)^{\rho} = \frac{B_0 + M_0 - B_1 - M_1}{p_0 s_1}.$$

From the above formulae, it can be seen that p_1 decreases, y_0 is reduced, and the GDP gap in period 0 expands when the central bank increases M_1.[5] There are two reasons

[5] I have analyzed the case where the objective for the central bank is to eliminate a GDP gap in period

for the occurrence of the counterintuitive phenomenon that the price level falls as the central bank increases the money supply. The first is that under zero nominal interest rates, the cash-in-advance constraint ($p_t y_t \leq M_t$) does not hold in equality. Because of this, in the model the quantity theory ($p_t y_t = M_t$) does not hold, and an increase in money M_t will not necessarily result in a rise in price level p_t. The second reason is that the real value of the fiscal surplus $\{s_t\}$ is already determined. Because of this, under the budget constraints (25) and (26), increases in M_t will result in a reduction in $p_t s_t$, and this is linked to a reduction in p_t.[6] Conversely, if it were possible in this model to reduce $\{s_t\}$, it would then be possible to raise both p_1 and p^*, which could lead to elimination of the GDP gap in both periods 0 and 1.

5 Conclusion

In this paper I have demonstrated that in order to realize a rise in future price levels, it is insufficient to increase the money supply alone. A reduction in the fiscal surplus (s_0 or s^*) is also necessary. In Japan today, discussions are proceeding along the lines that because fiscal expansion has gone as far as it can go, the central bank should invigorate the economy through inflation. People seem to believe implicitly that monetary easing alone can get the economy out of a liquidity trap, and that no more fiscal policy is necessary. The conclusion of this paper is that monetary and fiscal policies are rather complementary. If long-term inflation is attempted in order to eliminate the gap, the government will need to implement both fiscal expansion (reduction in s_0 or s^*) and expansion of currency provision.

---

1. The important point is that whatever the objective function of the central bank is, it is impossible to make the GDP gap zero in both periods 0 and 1. This is because if p^* is raised, then p_1 will fall, and vice-versa.

[6]This result demonstrates similar economic intuition to that described by Krugman (1998b): "What happens is that the economy deflates now in order to provide inflation later. That is, if the current money supply is so large compared with the future supply that the nominal rate is zero, but the real rate needs to be negative, P falls below P*.... This fall in the price level occurs regardless of the current money supply, because any excess money will simply be hoarded without adding to spending."

A theoretical difficulty in Krugman's policy proposal is that monetary easing alone cannot make the commitment to future inflation credible, no matter how unorthodox and extraordinary it is. This paper shows a very simple solution: fiscal expansion today (i.e., reduction in s_0) can make the commitment credible.

When we use three time frames for our analysis — "present," "near future," and "distant future" — instead of just the two "present" and "future" time frames of the Krugman model, we get the following results: If the central bank were to increase currency provision under zero interest rates with fiscal policy invariant, the price level would temporarily fall. This result also demonstrates the difficulty in mitigating the GDP gap through monetary policy alone.

The analysis in this paper demonstrates that we cannot eliminate the GDP gap purely through monetary policy without changing fiscal policy. And if the fiscal adjustment in the future is also socially costly, elimination of the current GDP gap by fiscal and monetary expansion may increase social costs in the future. Thus the optimal macroeconomic policy may not be aggressive enough to escape from the current liquidity trap: enduring the liquidity trap with rather modest fiscal and monetary policy may be the best we can hope for.

However, the reason for the peculiar economic plight, i.e., a GDP gap under zero interest rates, is hypothesized upon Assumption 1, namely, that the equilibrium production y^* of the future Japanese economy will contract below its current levels. If it is possible to expand y^*, the problem of a GDP gap under zero interest rates would disappear. Krugman (1998a) criticizes structural reforms thus, "Measures that raise Japan's supply capacity [y_0^f] but leave demand where it is will not help the situation." However, if structural reforms are defined as policies to expand future production y^*, structural reforms could be policies to eliminate the GDP gap under zero interest rates at the present time. Accordingly, structural reforms that increase future production capacity are considered to be a beneficial policy for the elimination of the current GDP gap, and for saving the social costs of fiscal adjustment in the future.

References

Auerbach, A. J., and M. Obstfeld (2003). "The Case for Open-Market Purchases in a Liquidity Trap." NBER Working Paper 9814.

Benhabib, J., S. Schmitt-Grohe, and M. Uribe (2002). "Avoiding Liquidity Traps." *Journal of Political Economy* 110:535–63.

Cochrane, J. H. (2000). "Money as Stock: Price Level Determination with No Money Demand." NBER Working Paper no. w7498.

Eggertsson, G., and M. Woodford (2003). "Optimal Monetary Policy in a Liquidity Trap." NBER Working Paper 9968.

Kitamura, Y., and Y. Fujiki (1997). "Estimation of Consumption-CAPM Using Supply-Side Information" (in Japanese). Bank of Japan *Monetary and Economic Studies* 16 (4):137–54.

Krugman, P. (1998a). "Japan's Trap." http://web.mit.edu/krugman/www/japtrap.html

— (1998b). "It's baaack: Japan's slump and the return of the liquidity trap." *Brookings Papers on Economic Activity* 2:1998, 137–87.

— (2000). "Thinking about the liquidity trap." *Journal of the Japanese and International Economies,* 14 (4), 221–37.

Sargent, T. J. (1987). *Macroeconomic Theory.* Academic Press.

Soejima, Y. (1997). "Effect of Innovation in Financial Technology on Macroeconomic Fluctuations" (in Japanese). Bank of Japan *Monetary and Economic Studies* 16 (2):87–122.

Svensson L. E. O. (2003). "The Magic of the Exchange Rate: Optimal Escape from a Liquidity Trap in Small and Large Open Economies." Mimeo.

Woodford, M. (2001). "Fiscal Requirements for Price Stability." NBER Working Paper no. w8072.

Watanabe, T., and M. Iwamura (2002). "Price Adjustments under a Zero Interest Rate Constraint" (in Japanese). Policy Research Institute, Ministry of Finance, *Financial Review* 64:110-39.

Yoshikawa, H. (2000). " The Japanese Economy in the 1990s and Monetary Policy" (in Japanese), in Fukao, M., and H. Yoshikawa eds., *Zero Interest Rates and the Japanese Economy* (in Japanese). Nihon Keizai Shimbunsha.