Budget deficit and “The World’s smallest macroeconomic model” by Paul Krugman

Yasuhito Tanaka

Faculty of Economics, Doshisha University, Kamigyo-ku, Kyoto, 602-8580, Japan.
E-mail: ochibocho@gmail.com, yatanaka@mail.doshisha.ac.jp

Abstract

In his "The World’s smallest macroeconomic model" (Krugman(1999)), Paul Krugman argued that under the assumption of price rigidity, a shortage of money supply leads to underemployment or recession, so increasing money supply can eliminate underemployment and restore full employment. But, how do we increase the money supply? I will show that we need a budget deficit to increase the money supply in order to restore full employment from recession. Also, I will show that in a growing economy, if people hold money, a budget deficit is necessary to maintain full employment under constant price or inflation. A budget deficit is not only effective in pulling the economy out of recession, it is even necessary for continued growth without inviting either recession or inflation.

Keywords: Budget deficit, full employment, price rigidity, growth

JEL Classification: E12, E24
1 Introduction

In his "The World’s smallest macroeconomic model" (Krugman(1999)), Paul Krugman, using a very simple macroeconomic model, argued that under the assumption of price rigidity, a shortage of money supply leads to underemployment or recession, so increasing money supply can eliminate underemployment and restore full employment. He also says that these arguments may be the implications of the famous following remark by J. M. Keynes:

Unemployment develops, that is to say, because people want the moon; — men cannot be employed when the object of desire (i.e. money) is something which cannot be produced and the demand for which cannot be readily choked off. There is no remedy but to persuade the public that green cheese is practically the same thing and to have a green cheese factory (i.e. a central bank) under public control. (Keynes(1936) Chapter 17)

Murota (2017), citing Krugman (1999), presents an analysis of long-run stagnation due to deficient aggregate demand using money-in-the-utility-function model based on Ono’s model (Ono(1994, 2001)). He propose generous unemployment benefits to reduce unemployment. But, my interests are more basic and I am interested in budget deficits in general.

I have two questions about the arguments by Krugman.

1. How do we increase the money supply?

I will prove that we can increase the money supply by creating a budget deficit and thereby overcome the recession and restore full employment.

2. What is needed to maintain and sustain full employment in a growing economy at stable price or inflation?

On this issue as well, we show that a budget deficit is effective in achieving full employment at stable price or inflation. If the price is not constant and is expected to increase, we need a budget deficit whose nominal value is larger than that with constant price to maintain full employment. Or, we can say that the larger budget deficit induces inflation.

The famous Lerner's functional fiscal theory (Lerner (1944)) does not consider whether to run a budget surplus or deficit to be meaningful in and of itself, but rather believes that fiscal policy should be used to achieve a state of near full employment while avoiding inflation as much as possible. This paper follows Lerner's functional fiscal theory, using a simple macroeconomic model by Krugman. Please refer to Forstater (1999) about Lerner’s functional finance theory.

2 Krugman’ model

We consider the following simple model of the economy. There is only one good,
produced at constant returns to scale by the single factor of production, labor. One unit of labor produces one unit of the good, and the price level and the wage rate must be the same, and can be referred to with a single symbol, $P$. There is also only one asset, money.

Agents start the current period with $M$ units of money, and end with $M'$ after spending on consumption and earning the wage.

The model of consumers’ behavior is the so-called money-in-the-utility-function model. As Krugman said, “the utility of money presumably reflects its usefulness in providing future consumption; but we sweep this implicit dynamic problem under the rug”. The agents derive utility both from consumption and from the expected purchasing power of the money they hold at the end of the period.

The utility function is assumed to take a specific form:

$$U = (1 - s) \ln C + s \ln \left( \frac{M'}{Pe} \right), \quad 0 < s < 1.$$  

$C$ is the consumption. $Pe$ is the expected price level. However, consumers are assumed to have static expectations, so that

$$Pe = P.$$  

Employment is $L$ units of labor. Then, the budget constraint for the people is

$$C + \frac{M'}{p} = L + \frac{M}{p}.$$  

By the first order conditions for utility maximization, we get

$$C = (1 - s) \left( L + \frac{M}{p} \right),$$  

and

$$\frac{M'}{p} = s \left( L + \frac{M}{p} \right).$$  

If the money supply is constant, then

$$M' = M,$$  

and

$$\frac{M}{p} = s \left( L + \frac{M}{p} \right).$$  

This means

$$P = \frac{1 - s M}{s L},$$  

or

$$M = \frac{s}{1 - s} PL.$$  

Denote the employment under full employment, or labor supply, by $L_f$. Now let us introduce some rigidity of the price. Murota (2017) presented an argument about price rigidity or wage rigidity. He considers nominal wage stickiness attributed to union wage setting\(^1\). He assumes that labor unions are concerned not with a rise in real wages but with that in

---

\(^1\) Greiner (2013) and Raurich, Sala, Sorolla (2006) considered real wage stickiness attributed to union wage setting.
nominal wages because of money illusion. For Krugman’s model the nominal wage stickiness is more appropriate than the real wage stickiness. However, Krugman said “never mind why the price and the wage are sticky. It comes from overwhelming empirical evidence.” Anyway, I assume that price (wage) level is fixed above the level consistent with full employment, so that real balances $M/P$ are too low. Formally, we assume

$$P > \frac{1 - s}{s} M,$$

or

$$M < \frac{s}{1 - s} P L_f.$$

They mean

$$L < L_f.$$  

Therefore, under the price rigidity insufficient money supply induces insufficient demand for the good for full employment. If the money supply is increased to $M'$ which satisfies

$$M' = \frac{s}{1 - s} P L_f,$$

then

$$L = L_f,$$

and full employment is restored.

But, how do we increase the money supply. Let's consider that in the next section.

3 Budget deficit for full employment under the price rigidity

We introduce the government expenditure $G$ and the tax $T$. The budget constraint for the consumers is

$$C + \frac{M'}{P} = L_f + \frac{M}{P} - T.$$

Then, the consumption and the money holding are

$$C = (1 - s)\left(L_f + \frac{M}{P} - T \right),$$

and

$$\frac{M'}{P} = s \left(L_f + \frac{M}{P} - T \right).$$

The equilibrium condition for the good market is

$$C + G = L_f.$$  

By (2) and (4),

$$(1 - s)\left(L_f + \frac{M}{P} - T \right) + G = L_f.$$  

From (3) and (5), we obtain

$$G - T = \frac{M'}{P} - \frac{M}{P}.$$  

This is the budget deficit. Therefore, we have shown the following result.

**Proposition 1**

*Under the price rigidity, the increase in money supply required to restore full employment*
from recession can be achieved through a budget deficit.

Or, a budget deficit is necessary to restore the economy from recession to full employment.

The conclusion calls for a budget deficit, but there are two main ways to run a budget deficit: increase spending and decrease taxes. If society's needs call for the enhancement of public capital, it may be desirable to increase fiscal spending, and if society's needs call for the support of people's consumption, it may be appropriate to reduce taxes.

**Graphical representation**

Assume that $T$ and $\frac{M}{P}$ are given. For now, let us assume that employment is not necessarily full employment, denoted by $L$. Then, (2) and (4) are

$$C = (1 - s) \left( L + \frac{M}{P} - T \right),$$

and

$$C + G = L.$$

From them

$$L = \frac{(1-s)(\frac{M}{P} - T) + G}{s}.$$  \hspace{1cm} (7)

Under the constant price to achieve full employment, $G$ must be a value that satisfies the following equation.

$$L_f = \frac{(1-s)(\frac{M}{P} - T) + G}{s}.$$ \hspace{1cm} (8)

This is the multiplier property of the government expenditure. From this

$$G = sL_f - (1 - s) \left( \frac{M}{P} - T \right) = G_f.$$ \hspace{1cm} (9)

On the other hand, from (6)

$$\frac{M'}{P} = G_f - T - \frac{M}{P}.$$ \hspace{1cm} (6)

This is the real money supply under full employment. In Figure 1, I depict the value of (7) with $G = 0$ by $\tilde{L}$.

$$\tilde{L} = \frac{1 - s}{s} \left( \frac{M}{P} - T \right),$$

The line $\tilde{LA}$ depicts (7). Its slope is $\frac{1}{s}$. $L_f$ is the value of (8).
Figure 1: Government expenditure for full employment

4 Budget deficit in a growing economy under full employment with constant price

Next I consider a growing economy under full employment with or without inflation expectation. The reason for growth can be population growth, technological progress, or anything else. The real growth rate is

\[ 0 < n < 1. \]

The point is that the real money holding at the end of the period should be

\[ (1 + n) \frac{M'}{P} = (1 + n) \frac{M}{P}. \]

\( P^e \) is the expected price in the next period. \( M' \) is the nominal money holding at the end of the period. Then, the nominal growth rate is

\[ (1 + n) \frac{P^e}{P} - 1. \]

The budget constraint for the consumers is

\[ C + (1 + n) \frac{M'}{P^e} = L_f + \frac{M}{P} - T. \]

The consumption and the money holding are

\[ C = (1 - s) \left( L_f + \frac{M}{P} - T \right), \]

(9)

and

\[ (1 + n) \frac{M'}{P^e} = s \left( L_f + \frac{M}{P} - T \right). \]

(10)
The market equilibrium condition is

\[ C + G = L_f. \] (11)

By (9) and (11),

\[ (1 - s) \left( L_f + \frac{M}{p} - T \right) + G = L_f. \] (12)

From (10) and (12), we obtain

\[ G - T = (1 + n) \frac{M'}{P_e} - \frac{M}{p} = n \frac{M}{p}. \]

This means that the real budget deficit equals an increase in the real money supply. Therefore, the real value of the budget deficit required to maintain full employment is independent of inflation expectations. Its nominal value is

\[ P_e (G - T) = (1 + n)M' - \frac{P_e}{p}M > P(G - T) \text{ if } P_e > P. \]

Thus, under inflation expectation we need larger nominal budget deficit than under static expectation. We have shown the following result.

**Proposition 2**

*In a growing economy, the increase in money supply required to maintain full employment under constant price can be achieved through a budget deficit. The real value of the necessary budget deficit does not depend on the rate of expected inflation. But, under inflation expectation we need larger nominal budget deficit than under static expectation.*

We can also say that a budget deficit is necessary to maintain full employment under constant price, and that the larger budget deficit induces inflation.

5. **Some concluding remarks**

I have shown mainly the following two results.

1. Under the price rigidity, the increase in money supply required to restore full employment from recession can be achieved through a budget deficit.
2. In a growing economy, the increase in money supply required to maintain full employment under constant price or inflation can be achieved through a budget deficit. The real value of the necessary budget deficit does not depend on the rate of expected inflation. But, under inflation expectation we need larger nominal budget deficit than under static expectation.

A budget deficit is not only effective in pulling the economy out of recession, they are even necessary for continued growth without inviting either recession or inflation.

During the last 10 to 20 years, Japan's economy has not been able to easily boost its economy and increase its growth rate in spite of low interest rates while continuing to run budget deficits. This can be attributed to the fact that Japan has not necessarily been spending enough despite the apparent budget deficit, and to the fact that the consumption
tax hike was implemented even though the economy was still recovering. In my opinion, the current Japanese people's propensity to consume is so small that even a modest fiscal deficit may not solve the demand shortage. However, this is a subject for future research.

References