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Debt to GDP Ratio from the Perspective of MMT with a Simple Microeconomic Foundation

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Abstract

This paper will argue that since the ratio of government debt to GDP cannot diverge to infinity, fiscal collapse is not possible. Using a macroeconomic model of a growing economy with a simple microeconomic foundation about consumers' behavior, with overlapping generations model in mind, we show the following results: 1) The budget deficit including interest payments on the government bonds equals an increase in the savings from a period to the next period. 2) If the savings in the first period is positive (unless the savings are made solely through stocks), we need budget deficit to maintain full employment under constant prices or inflation in the later periods in a growing economy. 3) Excess budget deficit induces inflation under full employment. 4) Under an appropriate assumption about the propensity to consume, the debt to GDP ratio converges to a finite value. It does not diverge to infinity. 5) In the case of balanced budget excluding interest payments, if an appropriate weak assumption about the propensity to consume holds, the debt to GDP ratio cannot diverge to infinity. 6) When the propensity to consume is small, we need budget deficit, not budget surplus, to prevent the debt to GDP ratio to diverge infinity.

Keywords: Budget deficit, Debt to GDP ratio, MMT, Functional Finance Theory

JEL Classification: E12, E24

1. Introduction

We consider a problem of the debt to GDP ratio from the perspective of Functional Finance Theory (Lerner (1943), (1944)) and MMT (Modern Money Theory or Modern Monetary

Theory, Kelton (2020), Mitchell, Wray and Watts (2019), Wray (2015)[1]) using a macroeconomic model with a simple microeconomic foundation about consumers' behavior .

In the next section, we examine the relation between the budget deficit and the debt to GDP ratio, and will show the following results.

1. The budget deficit including interest payments on the government bonds equals an increase in the savings from a period to the next period. (Proposition 1)

2. If the savings in the first period (Period 0) is positive (unless the savings are made solely through stocks), we need budget deficit to maintain full employment under constant prices or inflation in the later periods in a growing economy. (Proposition 2)

3. Excess budget deficit induces inflation under full employment. (Proposition 3)

4. Under an appropriate assumption about the propensity to consume, the debt to GDP ratio converges to a finite value. It does not diverge to infinity. (Proposition 4)

In that section we use the following model of consumers' behavior. The consumers live in only one period. They consume goods and leave savings or bequest to the next period which is used by the consumers of the next generation. It is not an overlapping generations model, but it can be interpreted as an overlapping generations model in which the consumers live over two periods, but the consumption in the old age is zero, and the bequest is given to the next generation in the old age period. Also, we assume that the economy grows at the constant rate.

In Section 3 we examine the so-called Domar condition (Domar (1944), Yoshino and Miyamoto (20202)) that under balanced budget excluding interest payments on government bonds the interest rate should be smaller than the growth rate to prevent the debt to GDP ratio diverging infinity, and will show that under an appropriate assumption about the propensity to consume it is meaningless. We will show the following results.

5. (1) In the case of balanced budget excluding interest payments, if an appropriate weak assumption about the propensity to consume holds, the debt to GDP ratio cannot diverge to infinity.

(2) When the propensity to consume is small, we need budget deficit, not budget surplus, to prevent the debt to GDP ratio to diverge infinity. (Proposition 5)

2. Budget Deficit and Debt to GDP Ratio

2.1 The Model and Utility Maximization

Using a macroeconomic model with a simple microeconomic foundation about consumers' behavior we analyze budget deficit and the debt to GDP ratio. In a broad sense, savings are made by government bonds and stocks, of which those made by government bonds is

[1] Japanese references of MMT are Mochizuki (2020), Morinaga (2020), Nakano (2020), Park (2020), Shimakura (2019).

analyzed as savings in this paper. The investment is financed by savings in the form of stocks, and it may be a decreasing function of the interest rate of the government bonds. However, for simplicity we assume that the investment is constant in each period. The interest rate of the government bonds is determined by the government.

We consider utility maximization of consumers in a period, for example, Period 1. The utility function of a representative consumer is

$$u(C,S)=C^{\alpha}S^{1-\alpha},\ 0<\alpha<1.$$

C is his/her consumption, and S is savings or bequest. The consumers live only one period. Their utility depends on the consumption and the bequest which is carried over to the next period and used by the consumers of the next generation. Thus, this model is not an overlapping generations model. However, it can be interpreted as an overlapping generations model in which the consumers live over two periods, but the consumption in the old age is zero, and the bequest is given to the next generation in the old age period.

The budget constraint for the consumers is

$$C+S=(1+r)S_0+Y-T.$$

S_0 is the savings (or bequest) by the consumers of the previous generation. r is the interest rate of government bonds. Y and T are income and tax. The Lagrange function is

$$\mathcal{L}=C^{\alpha}S^{1-\alpha}-\lambda(C+S-(1+r)S_0-Y+T).$$

λ is the Lagrange multiplier. The conditions for utility maximization are

$$\alpha C^{\alpha-1}S^{1-\alpha}-\lambda=0,$$

and

$$(1-\alpha)C^{\alpha}S^{-\alpha}-\lambda=0.$$

From these equations we obtain

$$S=\frac{1-\alpha}{\alpha}C.$$

Therefore, we get

$$C=\alpha[(1+r)S_0+Y-T],$$

and

$$S=(1-\alpha)[(1+r)S_0+Y-T].$$

α is the propensity to consume.

2.2 Period 0

First consider Period 0 at which the world starts. All variables represent nominal values. Let Y_0, C_0, I_0, T_0 and G_0 be the GDP, consumption, investment, tax and fiscal spending in

Period 0. Then,

$$Y_0 = C_0 + I_0 + G_0.$$

The consumption is written as

$$C_0 = \alpha(Y_0 - T_0),$$

because in this period there is no previous period. Therefore,

$$Y_0 = \alpha(Y_0 - T_0) + I_0 + G_0.$$

From this

$$(1-\alpha)(Y_0 - T_0) = I_0 + G_0 - T_0.$$

The savings in Period 0, which is carried over to the next period, is

$$S_0 = (1-\alpha)(Y_0 - T_0) - I_0.$$

Therefore, we have

$$G_0 - T_0 = (1-\alpha)(Y_0 - T_0) - I_0 = S_0.$$

Let us assume full employment in Period 0, and denote the full employment GDP by Y_f, that is,

$$Y_0 = Y_f.$$

Then, we obtain

$$G_0 - T_0 = (1-\alpha)(Y_f - T_0) - I_0 = S_0. \tag{1}$$

This is the budget deficit we need to achieve full employment in Period 0. It is determined by Y_f, I_0 and T_0. From this we get the following equation.

$$G_0 = (1-\alpha)(Y_f - T_0) + T_0 - I_0.$$

This is the fiscal spending needed to achieve full employment given T_0 and I_0. If the budget deficit is larger than the value in (1), then Y_f increases and (1) still holds.

Unless the savings are made solely through stocks, (1) is positive.

Note that as we said at the beginning of this subsection, all variables represent nominal values.

2.2 Period 1

Next, consider Period 1. Again, all variables represent nominal values. Let Y_1, C_1, I_1, T_1 and G_1 be the GDP, consumption, investment, tax and fiscal spending in Period 1. Then,

$$Y_1 = C_1 + I_1 + G_1.$$

Let r_0 be the interest rate of the government bonds, which is carried over from Period 0 to Period 1. The consumption is written as

$$C_1 = \alpha[(1 + r_0)S_0 + Y_1 - T_1].$$

Thus,

$$Y_1 = \alpha[(1 + r_0)S_0 + Y_1 - T_1] + I_1 + G_1.$$

From this

$$(1 - \alpha)(Y_1 - T_1) = \alpha(1 + r_0)S_0 + I_1 + G_1 - T_1.$$

Therefore,

$$G_1 - T_1 = (1 - \alpha)(Y_1 - T_1) - I_1 - \alpha(1 + r_0)S_0.$$

The savings in Period 1, which is carried over to Period 2, is

$$S_1 = (1 - \alpha)(Y_1 - T_1) - I_1 + (1 - \alpha)(1 + r_0)S_0.$$

This means

$$G_1 - T_1 = S_1 - (1 + r_0)S_0.$$

Alternatively,

$$G_1 - T_1 + r_0S_0 = S_1 - S_0. \quad (2)$$

We assume that the economy grows by technological progress. The real growth rate is $g > 0$. Also, the prices may rise from Period 0 to Period 1, that is, there may be inflation. Let p be the inflation rate. Then,

$$(1 + g)(1 + p) - 1 = g + p + gp$$

is the nominal growth rate.

Under nominal growth at the rate of $g + p + gp$,

$$Y_1 = (1 + g)(1 + p)Y_f.$$

Tax and investment also increase at the same rate as follows under the assumption that inflation is predicted,

$$T_1 = (1 + g)(1 + p)T_0,\ I_1 = (1 + g)(1 + p)I_0.$$

Then, the savings in Period 1 is

$$S_1 = (1 - \alpha)(1 + g)(1 + p)(Y_f - T_0) - (1 + g)(1 + p)I_0 + (1 - \alpha)(1 + r_0)S_0.$$

It is rewritten as

$$S_1 = (1 + g)(1 + p)S_0 + (1 - \alpha)(1 + r_0)S_0. \quad (3)$$

Since $\alpha < 1$, we have

$$S_1 > (1 + g)(1 + p)S_0. \quad (4)$$

From (2) and (3) we obtain

$$G_1 - T_1 + r_0 S_0 = (1+g)(1+p)S_0 + [r_0 - \alpha(1+r_0)]S_0,$$

and

$$G_1 - T_1 = (1+g)(1+p)S_0 - \alpha(1+r_0)S_0 < (1+g)(1+p)(G_0 - T_0).$$

They are budget deficits, with or without interest payments on the government bonds, we need to achieve full employment in Period 1 under nominal growth at the rate of $g + p + gp$.

If

$$G_1 - T_1 + r_0 S_0 = (1+g)S_0 + [r_0 - \alpha(1+r_0)]S_0$$
$$< (1+g)(1+p)S_0 + [r_0 - \alpha(1+r_0)]S_0,$$

the economy grows at the real growth rate g without inflation. Therefore, we can say that excess budget deficit induces inflation.

2.3 Period 2

Next, consider Period 2. Also, in this subsection all variables represent nominal values. Let Y_2, C_2, I_2, T_2 and G_2 be the GDP, consumption, investment, tax and fiscal spending in Period 2. Then,

$$Y_2 = C_2 + I_2 + G_2.$$

Let r_1 be the interest rate of the government bonds, which is carried over from Period 1 to Period 2. The consumption is

$$C_2 = \alpha[(1+r_1)S_1 + Y_2 - T_2],$$

and so

$$Y_2 = \alpha[(1+r_1)S_1 + Y_2 - T_2] + I_2 + G_2.$$

From this

$$(1-\alpha)(Y_2 - T_2) = \alpha(1+r_1)S_1 + I_2 + G_2 - T_2.$$

Therefore,

$$G_2 - T_2 = (1-\alpha)(Y_2 - T_2) - I_2 - \alpha(1+r_1)S_1.$$

The savings in Period 2, which is carried over to Period 3, is

$$S_2 = (1-\alpha)(Y_2 - T_2) - I_2 + (1-\alpha)(1+r_1)S_1.$$

This means

$$G_2 - T_2 = S_2 - (1+r_1)S_1.$$

Alternatively,

$$G_2 - T_2 + r_1 S_1 = S_2 - S_1. \quad (5)$$

Again, we suppose that the economy nominally grows by technological progress and inflation at the rate of $g + p + gp$, then

$$Y_2 = (1+g)^2(1+p)^2 Y_f.$$

We assume that, for simplicity, the inflation rate p is constant. Tax and investment also increase at the same rate as follows,

$$T_2 = (1+g)^2(1+p)^2 T_0, \ I_1 = (1+g)^2(1+p)^2 I_0.$$

Then, the savings in Period 2 is

$$S_2 = (1-\alpha)(1+g)^2(1+p)^2(Y_f - T_0)$$

$$-(1+g)^2(1+p)^2 I_0 + (1-\alpha)(1+r_1)S_1.$$

It is rewritten as

$$S_2 = (1+g)^2(1+p)^2 S_0 + (1-\alpha)(1+r_1)S_1. \quad (6)$$

Since $\alpha < 1$ and

$$S_1 > (1+g)(1+p)S_0,$$

assuming

$$(1+r_1)(1+g)(1+p) > 1 + r_0, \quad (7)$$

we have

$$S_2 > (1+g)(1+p)S_1. \quad (8)$$

If the interest rate is constant, and the nominal growth rate is positive, (7) is satisfied. From (5) we obtain

$$G_2 - T_2 + r_1 S_1 = (1+g)^2(1+p)^2 S_0 + [r_1 - \alpha(1+r_1)]S_1. \quad (9)$$

and

$$G_2 - T_2 = (1+g)^2(1+p)^2 S_0 - \alpha(1+r_1)S_1. \quad (10)$$

Since

$$G_1 - T_1 = (1+g)(1+p)S_0 - \alpha(1+r_0)S_0,$$

by the assumption in (7), we obtain

$$G_2 - T_2 < (1+g)(1+p)(G_1 - T_1).$$

(9) and (10) are budget deficits, with or without interest payments on the government bonds, we need to achieve full employment in Period 2.

By (3) and (6),

$$S_2 = [(1+g)^2(1+p)^2 \quad (11)$$

$$+(1-\alpha)(1+r_1)(1+g)(1+p)+(1-\alpha)^2(1+r_0)(1+r_1)]S_0.$$

If

$$G_2-T_2=(1+g)^2S_0-\alpha(1+r_1)S_1<(1+g)^2(1+p)^2S_0-\alpha(1+r_1)S_1,$$

the economy grows at the real growth rate g without inflation. Therefore, we can say that excess budget deficit induces inflation.

2.4 Period 3 and Beyond

From now on, for simplicity, the interest rates in all periods are equal. Also, in this subsection all variables represent nominal values, and the inflation rate is constant. Denote the interest rate by r. By similar reasoning, for Period 3 we get

$$G_3-T_3=S_3-(1+r)S_2.$$

and

$$G_3-T_3+rS_2=S_3-S_2. \quad (12)$$

The savings in Period 3 is

$$S_3=(1+g)^3(1+p)^3S_0+(1-\alpha)(1+r)S_2. \quad (13)$$

Thus,

$$G_3-T_3+rS_2=(1+g)^3(1+p)^3S_0+[r-\alpha(1+r)]S_2, \quad (14)$$

and

$$G_3-T_3=(1+g)^3(1+p)^3S_0-\alpha(1+r)S_2. \quad (15)$$

(14) and (15) are budget deficits, with or without interest payments on the government bonds, we need to achieve full employment in Period 3.

From (11) and (13), we get

$$S_3=[(1+g)^3(1+p)^3+(1-\alpha)(1+r)(1+g)^2(1+p)^2$$
$$+(1-\alpha)^2(1+r)^2(1+g)(1+p)+(1-\alpha)^3(1+r)^3]S_0.$$

Proceeding with this argument, we obtain the following result for Period n, $n \geqq 1$.

$$G_n-T_n+rS_{n-1}=S_n-S_{n-1}. \quad (16)$$

With or without inflation in Period n, we have

$$S_n=[(1+g)^n(1+p)^n+(1-\alpha)(1+r)(1+g)^{n-1}(1+p)^{n-1}+\cdots \quad (17)$$
$$+(1-\alpha)^{n-1}(1+r)^{n-1}(1+g)(1+p)+(1-\alpha)^n(1+r)^n]S_0.$$

Similarly, for Period $n-1$,

$$S_{n-1}=[(1+g)^{n-1}(1+p)^{n-1} \quad (18)$$

$$+(1-\alpha)(1+r)(1+g)^{n-2}(1+p)^{n-2}+\cdots$$
$$+(1-\alpha)^{n-2}(1+r)^{n-2}(1+g)(1+p)+(1-\alpha)^{n-1}(1+r)^{n-1}]S_0.$$

2.5 Some Propositions

From (2), (5), (12) and (16) we obtain the following proposition.

Proposition 1 *The budget deficit including interest payments on the government bonds equals an increase in the savings from a period to the next period.*

(2), (4), (5), (8) and (12) mean the following result.

Proposition 2 *If the savings in the first period (Period 0)* S_0 *is positive (unless the savings are made solely through stocks), we need budget deficit to maintain full employment under constant prices or inflation in the later periods in a growing economy.*

About inflation we found

Proposition 3 *Excess budget deficit induces inflation under full employment.*

2.6 Debt to GDP Ratio

Since

$$Y_n=(1+g)(1+p)Y_{n-1},$$

(17) and (18) mean

$$\frac{S_n}{Y_n}-\frac{S_{n-1}}{Y_{n-1}}=\left(\frac{(1-\alpha)(1+r)}{(1+g)(1+p)}\right)^n\frac{S_0}{Y_0}.$$

$$0\le\frac{(1-\alpha)(1+r)}{(1+g)(1+p)}<1, \tag{19}$$

is equivalent to

$$r-\alpha(1+r)<g+p+gp. \tag{20}$$

Note that $g+p+gp$ is the nominal growth rate, r is the interest rate of the government bonds, and α is the propensity to consume. Since $0<\alpha<1$, even if the interest rate is larger than the nominal growth rate, that is,

$$r>g+p+gp,$$

(19) can be satisfied. For example, if $\alpha=0.6$, (20) is reduced to

$$0.4r<g+p+gp+0.6.$$

This is definitely true for a suitable range of variable values.

Even if $\alpha=0.2$, (20) is reduced to

$$0.8r<g+p+gp+0.2.$$

For example, when $g+p+gp=0.2$, r should be smaller than 0.5. This is not a strong condition either.

If (19) holds,

$$\text{When } n\to\infty,\ \frac{S_n}{Y_n}-\frac{S_{n-1}}{Y_{n-1}}\to 0.$$

From (17), we obtain

$$\frac{S_n}{Y_n}=\left[1+\frac{(1-\alpha)(1+r)}{(1+g)(1+p)}+\cdots+\left(\frac{(1-\alpha)(1+r)}{(1+g)(1+p)}\right)^{n-1}+\left(\frac{(1-\alpha)(1+r)}{(1+g)(1+p)}\right)^{n}\right]\frac{S_0}{Y_0}.$$

Then, if (19) is satisfied,

$$\frac{S_n}{Y_n}\to\frac{1}{1-\frac{(1-\alpha)(1+r)}{(1+g)(1+p)}}\frac{S_0}{Y_0},$$

That is, the debt to GDP ratio $\frac{S_n}{Y_n}$ converges to a finite (positive) value. It does not diverge to infinity.

Summarizing the result,

Proposition 4 *Under an appropriate assumption about the propensity to consume, the debt to GDP ratio converges to a finite value. It does not diverge to infinity.*

3. About Domar Condition

The Domar condition (Domar (1944), Yoshino and Miyamoto(2020)) says that the interest rate must be less than the economic growth rate to prevent the ratio of government debt to GDP from becoming infinitely large (in particular, if a balanced budget is achieved excluding interest payments on government bonds). However, even if this condition is not satisfied, the ratio of government debt to GDP will not become infinitely large. The issue is not the interest rate on government bonds itself. We call

$$\alpha(1+r)-1 \tag{21}$$

the *adjusted interest rate*. Since $0<\alpha<1$ It is not larger than r.

Let us assume balanced budget excluding interest payments on the government bonds in Period 1 as follows.

$$G_1-T_1=0.$$

Then, (2) means that the following equation must hold.

$$(1+g)(1+p)=\alpha(1+r_0). \tag{22}$$

If

$$1+g<\alpha(1+r_0),$$

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there is excess demand for goods. Then, the prices rise and the nominal growth rate $g + p + gp$ equals

$$\alpha(1 + r_0) - 1.$$

For the periods after Period 1 we obtain similar results.

Now we consider some cases. Denote the interest rate by r.

(i) α is large. In this case, $1 + g < \alpha(1 + r)$ is satisfied with appropriate values of g and r. Then, the balanced budget excluding interest payments induces inflation because of consumption demand from interest payments, and (22) holds. Then, (19) is satisfied for α >0.5. We think that α >0.5 is an appropriate condition for the propensity to consume. However, we also consider the case where α is small.

(ii) α is small. In this case $1 + g < \alpha(1 + r)$ may not hold for appropriate values of g and r if g is interpreted as a potential real growth rate. Then, the balanced budget excluding interest payments induces recession with involuntary unemployment because of insufficient demand for goods, and deflation occurs or the real growth rate decreases so that (22) is satisfied. (19) does not hold for α <0.5 with balanced budget excluding interest payments.

When α is small, we need budget deficit (excluding interest payments), not budget surplus, so that (19) is satisfied, and prevent the debt to GDP ratio to diverge to infinity. From (2) and (3) with budget deficit excluding interest payments, the following relation holds.

$$(1 + g)(1 + p) - \alpha(1 + r) > 0.$$

In this case (19) may be satisfied with α smaller than 0.5. Therefore, in the case of budget deficit we need very weak condition to prevent the debt to GDP ratio to diverge to infinity.

On the other hand, with budget surplus excluding interest payments, we have

$$(1 + g)(1 + p) - \alpha(1 + r) < 0.$$

In this case (19) may not be satisfied even with α larger than 0.5. Thus, the condition for the debt to GDP ratio not to diverge to infinity is stronger.

If (19) is satisfied, that is

$$0 \leq \frac{(1-\alpha)(1+r)}{(1+g)(1+p)} < 1,$$

we have

$$\frac{S_n}{Y_n} - \frac{S_{n-1}}{Y_{n-1}} < \frac{S_0}{Y_0},$$

and

$$\text{when } n \to \infty, \frac{S_n}{Y_n} - \frac{S_{n-1}}{Y_{n-1}} \to 0.$$

Therefore, the debt to GDP ratio cannot diverge to infinity.

Summarizing the results,

Proposition 5 (1) *In the case of balanced budget excluding interest payments, if an appropriate weak assumption about the propensity to consume holds, the debt to GDP ratio cannot diverge to infinity.*

(2) *When the propensity to consume is small, we need budget deficit, not budget surplus, to prevent the debt to GDP ratio to diverge infinity.*

4. Conclusion

We have argued that fiscal collapse is impossible because the ratio of the government debt to GDP cannot diverge to infinity under an appropriate assumption about propensity to consume. Using a macroeconomic model with a simple microeconomic foundation about consumers' behavior we have shown the following results.

1. The budget deficit including interest payments on the government bonds equals an increase in the savings from a period to the next period.

2. If the savings in the first period (Period 0) is positive (unless the savings are made solely through stocks), we need budget deficit to maintain full employment under constant prices or inflation in the later periods in a growing economy.

3. Excess budget deficit induces inflation under full employment.

4. Under an appropriate assumption about the propensity to consume, the debt to GDP ratio converges to a finite value. It does not diverge to infinity.

5. (1) In the case of balanced budget excluding interest payments, if an appropriate weak assumption about the propensity to consume holds, the debt to GDP ratio cannot diverge to infinity.

(2) When the propensity to consume is small, we need budget deficit, not budget surplus, to prevent the debt to GDP ratio to diverge infinity.

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