DBJ Discussion Paper Series, No.1106

A Keynesian endogenous growth theory with a rigorous microeconomic foundation

Masayuki Otaki
(Institute of Social Science, University of Tokyo)

February 2012

A Keynesian endogenous growth theory with a rigorous microeconomic foundation

Masayuki Otaki

Institute of Social Science, University of Tokyo
7-3-1 Hongo Bunkyo,
Tokyo, 113-0033, Japan
E-mail: ohtaki@iss.u-tokyo.ac.jp
Phone: +81-3-5841-4952
Fax: +81-3-5841-4905

Keywords: Microeconomic foundation for the accelerator-principle investment function; Progress of labor productivity; Demand-driven endogenous growth; Self-fulfilling prophecy
JEL Classifications: E12, E22, E24, O42

Abstract

Extending the effective demand theory developed by Otaki (2007, 2009), we construct a demand-driven endogenous growth theory with a rigorous microeconomic foundation. An accelerator-principle investment function is derived by the intertemporal maximization behavior of monopolistic competitive employers. Under this investment function, an economy endogenously begins expanding even if the stability condition for goods markets is satisfied.

There are three factors that determine the equilibrium growth rate: the degree of monopoly (the inverse of the price elasticity of each good) η^{-1}; marginal propensity to saving s; Mashallian k that can be manipulated by the government and is denoted by κ. The higher value of η^{-1} and s, the lower value of κ, the more rapid the expansion of the economy.

1 Introduction

It is important to establish the dynamic microeconomic foundation for the Keynesian endogenous growth theory once we admit that some idling resources, such as labor, possibly exist even when an economy is expanding. On the basis of the standard two-period OLG model with money developed by Lucas (1972) and Otaki (2007, 2009), we construct a monetary growth model possessing such a feature.

Harrod (1939) is the seminal work in this field. However, his investment function, which plays a crucial role in his theory, is not compatible with the intertemporal maximization behavior of the firm.

This paper defines the equipment investment as the cost for improving the labor productivity. This is necessary for accomplishing more efficient and lower cost production to accumulate various intangible know-hows besides increasing in capital. Such costs comprise our notion of equipment investment.

Under the assumption of monopolistic competition in goods markets, real GDP becomes a shift parameter for each small firm. If every firm expects future macroeconomic expansion, the optimal production increases, and thus, the benefit from cost reduction is also raised. Accordingly, whenever higher future economic growth is rationally anticipated, current equipment investment is accelerated and the expectations become self-fulfilling. This is our microeconomic foundation for the accelerator-principle investment function proposed by Hicks (1950).

There are three crucial factors that determine the equilibrium growth rate: the degree of monopoly (the inverse of the relative price elasticity of each good) η^{-1}; marginal propensity to saving s; Marshallian k, which is denoted by κ.

When employers can obtain more marginal monopoly profits η^{-1}, they find the business environment favorable, and thus, increase their equipment investment. Accordingly, a higher value of η^{-1} upturns the equilibrium

growth rate. Second, if the marginal propensity to saving s is high, it means that the funds are sufficient for equipment investment. This also increases the growth rate. Third, when the nominal money stock per nominal GDP (i.e., Marshallian k) κ takes a higher value, more resources are allotted to the older generation's consumption. As a result, fewer funds are available for investment, thereby, dampening economic growth.

The remainder of the paper is organized as follows. In section 2, we build up the model and solve the equilibrium growth rate, and explore the welfare economic implications. Section 3 contains the concluding remarks.

2 Model

2.1 Structure of the Model

We basically use the same model as Otaki (2007) except for the equipment investment decision. In every period, individuals are born in the dense of $[0,1] \times [0,1]$. This implies that there is no population growth. There are differentiated goods z in the dense of $[0,1]$. Each good is monopolistically produced by a single employer z. Fiat money is the only store of value.

Each individual has the identical utility function U:

$$U \equiv c_{1t}^{1-s} c_{2t+1}^{s} - \delta_t \alpha, \quad c_{i,t+j} \equiv \Big[\int_0^1 [c_{it+j}(z)]^{1-\eta^{-1}} dz\Big]^{\frac{1}{1-\eta^{-1}}}, \quad 0 < s < 1, \tag{1}$$

where $c_{it+j}(z)$ is the consumption of good z during period $t+j$ at the i-th stage of the life. α denotes the disutility of labor. δ is a definition function that is one when employed and zero when unemployed.

Each employer faces the identical production function $y^s(z)$:

$$y_t^s(z) = \gamma_{t-1}(z) l_t(z), \quad \gamma_{-1}(z) = \overline{\gamma}, \quad \forall z, \tag{2}$$

where $\gamma_{t-1}(z)$ is the current labor productivity accumulated by equipment investment. $l_t(z)$ denotes the employment level. The real investment cost

function $I_t(z)$, which is deflated by the price index P_t, is defined as

$$I_t(z) = \sigma[\gamma_t(z) - \gamma_{t-1}(z)], \quad P_t \equiv \Big[\int_0^1 [p_t(z)]^{1-\eta} dz\Big]^{1-\eta}, \tag{3}$$

where σ denotes the marginal cost for investment.

2.2 Maximization Problem of Economic Agents

• Individuals

Since the utility function is (1), we can easily induce the demand function for good z $D_t(z)$ and saving function S as

$$D_t(z) = [\frac{p_t(z)}{P_t}]^{-\eta} y_t^d, \tag{4}$$

$$S(y_t) = sy_t, \tag{5}$$

where y_t^d is the real aggregate effective demand and y_t^s is the real national income.

Since the expenditure function is Cobb-Douglas form on prices, we can easily derive the nominal reservation wage W_t^R as

$$W_t^R = \alpha A P_t^{1-s} P_{t+1}^s, \quad A \equiv s^s (1-s)^{1-s}. \tag{6}$$

In what follows, we assume that equilibrium is interior in the sense that some individuals are always unemployed. Hence, the equilibrium nominal wage is equal to the nominal reservation wage W^R.

• Employers

The optimal behavior of an employer is assumed to be

$$\max_{\gamma_t(z), p_t(z)} \Big[\Big[\frac{p_t(z)}{P_t} - \frac{W_t^R}{P_t \gamma_{t-1}(z)}\Big] D_t(z) - \Big[I_t(z) + \frac{W_{t+1}^R}{P_{t+1}\gamma_t(z)} D_{t+1}(z)\Big]\Big]. \tag{7}$$

Although the inflation rate should be used as the discount rate concerning future cost reduction, for simplicity, we assume that the gain from the inflation is entirely canceled by the proportional corporate tax. It is also assumed that future wages are actually paid by the employer who will succeed to the business at the next period.

The solutions of (7) are

$$p_t^*(z) = \frac{W_t^R}{[1-\eta^{-1}]\gamma_{t-1}}, \tag{8}$$

$$I_t^*(z) = [1-\eta^{-1}][y_{t+1}^d - y_t^d]. \tag{9}$$

(9) is our investment function that gives a microeconomic foundation for the acceleration principle. Furthermore, from (3) and (9), we must note that the aggregate employment l_t is obtained as

$$l_t = \frac{y_t^d}{\gamma_{t-1}} = \frac{\sigma}{1-\eta^{-1}} < 1. \tag{10}$$

Thus, the unemployment rate is independent of the equilibrium growth rate.

• **Government**

The government levies a tax that is proportional to the net cash flow of the firm. The gross tax rate is $\frac{P_t}{P_{t+1}}$. This tax is entirely and equally transferred to individuals regardless of whether or not they are employed. Consequently, the earned income that consists of wages and profits is entirely distributed to individuals.

Under this set-up, the only government revenue is the seigniorage. We assume that the monetary-fiscal policy of the government keeps the Marshallian k constant, and that accrued seigniorage is entirely spent on wasteful objects and bears no social utility. That is,

$$M_{t+1} = (1+g^*)\pi_t^* M_t, \tag{11}$$

where M_{t+j} denotes the nominal money stock. g^* is the equilibrium growth rate that we shall solve. π_t^* is the equilibrium gross inflation rate that is obtained by (6) and (8). That is,

$$P_t^* = \frac{\alpha A[P_t^*]^{1-s}[P_{t+1}^*]^s}{[1-\eta^{-1}]\gamma_{t-1}} \quad \Rightarrow \quad \pi_t^* = \Big[\frac{[1-\eta^{-1}]\gamma_{t-1}}{\alpha A}\Big]^{\frac{1}{s}}. \tag{12}$$

Thus, inflation is accelerated by the evolution of labor productivity because the heightened labor productivity incessantly raises nominal wages. In turn, it implies that if the progress of labor productivity, which corresponds to the

TFP in our model, stagnates and the growth rate slows down, disinflation becomes prominent. This result is consistent with the empirical research on Japanese economy by Hayashi and Prescott (2002).

2.3 Market Equilibrium

Since we assume that labor market is located at interior equilibrium, it is suffice to analyze the equilibrium condition for aggregate goods market. This condition is obtained by combining (5), (9) and (11):

$$sy_t^* = [1-\eta^{-1}][y_{t+1}^* - y_t^*] + \frac{M_t}{P_t} \quad \Rightarrow \quad s = [1-\eta^{-1}]g^* + \kappa. \tag{13}$$

Thus, we obtain the equilibrium growth rate as

$$g^* = \frac{s-\kappa}{1-\eta^{-1}} \equiv [s-\kappa]\sum_{j=0}^{+\infty}\eta^{-j}. \tag{14}$$

Equations (13) and (14) have interesting economic implications. First, economic growth begins endogenously by the increase in equipment investment. The initial investment is caused by the rational *animal spirits* (Keynes (1936, ch. 12)): the employers believe in the future expansion of the economy.

If employers consider that the economy will forever stagnate, the equipment investment will become zero, and so will the economic growth rate. In a such case, as proved by Otaki (2007), traditional Hicks-Samuelson's 45° analysis is valid. Hence, we must note that the mechanism of endogenous growth never depends on the instability of the goods-market equilibrium.

Second, the equilibrium growth rate g^* is an increasing function of η^{-1} and s, and is also a decreasing function of κ. $s-\kappa$ indicates the surplus of the economy normalized by current real GDP. Accordingly, the economy has abundant funds for the economic growth, thereby increasing the growth rate. Accordingly, the expansionary monetary policy under the *credibility* of money (Otaki (2011)) can stimulate the economy in the short run, but shortens the loanable funds surplus and lowers the growth rate in the long run.

Finally, the degree of monopoly η^{-1} enhances the economic growth since a higher η^{-1} implies that an improvement of in the income distribution to profits and stimulates equipment investment. It is also worthy to note that this effect is persistent, and hence, powerful, because the increment in labor productivity never depreciates.

2.4 Welfare Implication

Since, mainly for simplicity, we assume that the equilibrium nominal wage equals the nominal reservation wage, there is no welfare gain from the increase in employment. Accordingly, the source of welfare gain is confined to the real net cash flow NCF_t^*:

$$NCF_t^* = [\eta^{-1} - [s - \kappa]]y_t^*. \tag{15}$$

The indirect utility function IU is Cobb-Douglas:

$$IU \propto \frac{NCF_t^*}{[\pi^*]^s}.$$

Substituting (10), (12) and (15) into the above equation, we obtain

$$IU \propto \frac{[\eta^{-1} - [s - \kappa]]y_t^*}{[\alpha A]^{-1}[1 - \eta^{-1}]\gamma_{t-1}^*} = \frac{[\eta^{-1} - [s - \kappa]]}{[\alpha A]^{-1}[1 - \eta^{-1}]} l_t^* = \alpha A \sigma [\eta^{-1} - [s - \kappa]]. \tag{16}$$

Thus, the economic growth never provides any additional benefits as long as economy is bothered by an unemployment problem. The fruits from economic growth are entirely consumed by the acceleration of inflation.

Since IU is an increasing function of κ, the most urgent problem in a national economy is to reduce the number of unemployed individuals as Otaki (2009) proves, even if the equilibrium growth rate becomes zero. Economic growth is the second priority in the economy as a whole.

3 Concluding Remarks

We succeeded in constructing a Keynesian endogenous growth model based on neoclassical microeconomics that is as faithful as possible. Results ob-

tained are as follows.

First, the equipment investment is the driving force of economic growth. Second, a higher degree of monopoly η^{-1} (product differentiation) stimulates the economic growth because it bears more profits, and thus, invokes the cost reduction investment. a high ratio of surplus funds $s - \kappa$ also contributes to the economic expansion since it eases employers to invest much resources for the equipment investment.

Third, although the economy grows autonomously, as long as there is a serious unemployment problem, economic welfare cannot be improved by expansion. In this sense, before attaining the full-employment equilibrium, we should adopt an active aggregate demand policy even if the velocity of economic expansion is lowered.

References

[1] Harrod, Roy F., 1939, An essay in dynamic theory, Econ. J. 49, 14-33.

[2] Hayashi, Fumio and Prescott, Edward C., 2002, The 1990s in Japan: A lost decade, Rev. Econ. Dyn. 5, 206-235.

[3] Hicks, John R., 1950, A Contribution to the Theory of Trade Cycle, Oxford University Press, Oxford.

[4] Keynes, John M., 1936, The General Theory of Employment, Interest and Money, Macmillan, London.

[5] Lucas, Jr. Robert, E., 1972, Expectations and the neutrality of money, J. Econ. Theory 4, 103-124.

[6] Otaki, Masayuki, 2007, The dynamically extended Keynesian cross and the welfare-improving fiscal policy, Econ. Lett. 96, 23-29.

[7] Otaki, Masayuki, 2009, A welfare economics foundation for the full-employment policy, Econ. Lett. 102, 1-3.

[8] Otaki, Masayuki, 2011, A pure theory of aggregate price determination, Theor. Econ. Lett, 1, 122-128.