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A Simple Model of Keynesian Unemployment

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ABSTRACT

This paper presents a general equilibrium model that extends a static New Keynesian framework to an overlapping generations (OLG) model. The model shows multiple stationary states, one of which has the following strong Keynesian features: (1) a reduction in wages generates increased unemployment through a decrease in consumption and (2) the fiscal multiplier is larger than unity and is increasing in the wage share in income.

Keywords: Keynesian, Unemployment, Efficiency Wage, Coordination Failure.

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1. INTRODUCTION

In a recent book and a paper, De Vroey (2004, 2005) appropriately summarizes Keynes's programme as follows:

1) demonstrating the existence of involuntary unemployment,

2) demonstrating that wage rigidity can be exonerated as its cause,

3) giving a general equilibrium or interdependency explanation for the phenomenon,

4) demonstrating that demand stimulation is the proper remedy for the problem.

Subsequently, assessing the various 'old' and 'new' Keynesian models, De Vroey concludes that none of the models fully succeed in achieving the above programme. This paper presents a model in which the above-mentioned four criteria are satisfied in one of stationary states.

The present model is a natural extension of a static New Keynesian framework to an OLG framework.[1] This model incorporates the following three elements: (1) a shirking type of efficiency wage, (2) an overlapping generations (OLG) framework and (3) monopolistic competition. As is commonly found in the literature on efficiency wage, one of the outcomes of the present model is that wages are not market clearing.[2] However, there is a significant difference between the preceding efficiency wage arguments and the argument developed below. In the preceding

[1] For static New Keynesian models, see Akerlof and Yellen (1985), Startz (1989), Blanchard and Kiyotaki (1987), Dixon (1987, 1990) and Bénassy (1995). In particular, Dixon (1990) and the current paper share the common property of a rigid nominal wage, which is a constant mark-up over an unemployment insurance payment.

[2] See Shapiro and Stiglitz (1984).

models, the cause of involuntary unemployment is the excessively high wages that are set to prevent workers from shirking; therefore, a reduction in these wages results in reducing unemployment. In contrast, the present model shows that unemployment in a stationary state is caused by an insufficient demand for outputs; accordingly, a reduction in wages results in an increase in unemployment through a decrease in consumption. This result implies that if the pressure of unemployment reduces wages, unemployment may increase, and that unemployment cannot be attributed to wage rigidity.

The model presented below also shows the effectiveness of demand stimulation by fiscal policy. In the preceding literature, a fiscal multiplier is less than unity and is decreasing in the wage share in income.[3] On the other hand, in the present model, the multiplier is larger than unity and is increasing in the wage share in income.

2. MODEL

This section presents a simple model for formulating the behaviours of firms and workers in four stages. Firms make managerial plans that include elements such as how many workers to employ, how much to produce and at what level to set the wages and prices. Workers, the number of whom is normalized to unity, are born every period, and each worker lives for two periods. In the first period, workers obtain wages if they are employed and not dismissed. Otherwise, they receive unemployment insurance payments. Since firms are only able to monitor their

[3] See Dixon (1987), Mankiw (1988), Startz (1989), Molana and Moutos (1992) and Bénassy (1995).

workers incompletely, workers, if employed, can choose their own efficiency levels. Workers can carry over their revenues, in the form of money and equities, into the next period and spend it all on consumption. Figure 1 summarizes the sequence of these events. The decision-making processes are solved by backward induction.

2.1 Stage 4: Consumption at period t + 1

According to the settings of monopolistic competition,[4] worker j at period $t + 1$ spends all of his/her equities and money on each type of consumption goods in order to maximize the consumption index $C_{t+1}^{j} \equiv \left[\int_0^1 (C_{i,t+1}^{j})^{\frac{\eta-1}{\eta}} di \right]^{\frac{\eta}{\eta-1}}$, subject to the budget constraint $\int_0^1 P_{i,t+1} C_{i,t+1}^{j} di = (D_{t+1} + S_{t+1}) E_t^j + M_t^j$, where $C_{i,t+1}^{j}$ denotes the amount of consumption goods i, $P_{i,t+1}$ is the price of the consumption goods i, D_{t+1} is the dividend, S_{t+1} is the equity price, E_t^j is the amount of equities and M_t^j is the amount of money. As a result, the demand of worker j for consumption goods i is

$$C_{i,t+1}^{j} = \left(P_{i,t+1} / P_{t+1}\right)^{-\eta} \left[(D_{t+1} E_t^j + S_{t+1} E_t^j + M_t^j) / P_{t+1}\right], \tag{1}$$

where P_{t+1} denotes the price index given by $P_{t+1} \equiv \left[\int_0^1 P_{i,t+1}^{1-\eta} di\right]^{\frac{1}{1-\eta}}$. And then we obtain the following:

$$P_{t+1} C_{t+1}^{j} = (D_{t+1} + S_{t+1}) E_t^j + M_t^j . \tag{2}$$

Through these activities, worker j obtains utility. It is assumed that utility can be expressed by the function $U(C, M/PC)$. The utility depends not only on consumption

[4] See Blanchard and Kiyotaki (1987).

but also on the ratio of money to the amount of spending, because a high money ratio, i.e. a high liquidity ratio, will reduce the efforts needed for purchasing consumption goods.[5] For simplicity, the utility function is specified as $U(C, M/PC) \equiv \log C(M/PC)^{1-\alpha}$, in which the marginal utility of the liquidity ratio diminishes faster than that of intrinsic consumption. Thus, the utility of worker *j* at Stage 4 is as follows:[6]

$$U_{j,t+1} = \alpha \log C_{t+1}^{j} + (1-\alpha)\log(M_t^j / P_{t+1}). \tag{3}$$

2.2 Stage 3: Choice between money and equities at period t

Equation (2) can be rewritten in the following manner:

$$P_{t+1}C_{t+1}^{j} = (1+R_{t+1})I_t^j - R_{t+1}M_t^j, \tag{4}$$

where $R_{t+1}(=(D_{t+1}+S_{t+1}-S_t)/S_t)$ represents the interest rate of equities, and $I_t^j(=S_tE_t^j + M_t^j)$ is the amount of income at period *t*. Note that the amount of income I_t^j is already determined during Stages 1 and 2. At this point, the proportion of money and equities to income is determined by household *j*. The problem at Stage 3 is therefore formalized as follows:

$$\underset{M_t^j}{\text{Max}}\, U_{j,t+1} \equiv \alpha \log C_{t+1}^{j} + (1-\alpha)\log(M_t^j / P_{t+1}),$$

subject to $P_{t+1}C_{t+1}^{j} = (1+R_{t+1})I_t^j - R_{t+1}M_t^j$.

[5] Feenstra (1986) discusses the equivalence of the money in utility approach and the transaction cost approach.

[6] In Shapiro and Stiglitz (1984), the utility function is assumed to be linear.

From the first-order condition, we have the following:

$$M_t^j = (1-\alpha)(1+R_{t+1})I_t^j / R_{t+1}. \tag{5}$$

As a result, the consumption index and utility at period $t + 1$ are, respectively, as follows:

$$C_{t+1}^j = \alpha(1+R_{t+1})I_t^j / P_{t+1}, \tag{6}$$

$$U_{j,t+1} = \log \alpha^\alpha (1-\alpha)^{1-\alpha} \left(\frac{1}{R_{t+1}}\right)^{1-\alpha} \frac{(1+R_{t+1})I_t^j}{P_{t+1}}. \tag{7}$$

2.3 Stage 2: Determination of efficiency at work

Let W denote nominal wages; V, unemployment insurance payments for a dismissed worker, and τ, premium rates of insurance. The net income of employee j, I_t^j, is $(1-\tau_t)W_t$ if the employee is not dismissed and $(1-\tau_t)V_t$ if he/she is dismissed.[7] Accordingly, from (7), the utilities of a wage earner and of a non-wage earner are, respectively, as follows:

$$U_{t+1}^w \equiv \log \alpha^\alpha (1-\alpha)^{1-\alpha} (1/R_{t+1})^{1-\alpha} (1+R_{t+1})(1-\tau_t)(W_t / P_{t+1}), \tag{8}$$

$$U_{t+1}^v \equiv \log \alpha^\alpha (1-\alpha)^{1-\alpha} (1/R_{t+1})^{1-\alpha} (1+R_{t+1})(1-\tau_t)(V_t / P_{t+1}). \tag{9}$$

For an employee, the utility expected at period t is given by[8]

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[7] To simplify the analysis, V is defined as a gross payment. Paying some lower amount of wages to dismissed workers might be more realistic, but it would complicate the analysis. Furthermore, in our model, firms do not have any incentive to pay a part of full wages to dismissed workers.

[8] Subscripts are abbreviated where it does not lead to any confusion.

$$EU \equiv \beta(e)(U^W - \delta e) + (1-\beta(e))(U^V - \delta e), \quad (10)$$

where e denotes the efficiency at work, and δ (> 0) is the marginal disutility of e. Efficiency e is normalized to unity under no shirking. Function $\beta(e)$ yields the probability of no dismissal and reflects incomplete monitoring. Appendix 1 provides the derivation of $\beta(e)$. As shown in Figure 2, function $\beta(e)$ can be characterized by an S-shape, i.e. $\beta'(e) \geq 0$ for all values of e and $\beta''(e) \leq 0$ for a right side range of e.

The employed worker will decide efficiency level e in order to maximize the expected utility given by (10).[9] The first-order condition is as follows:

$$\beta'(e)\log(W/V) - \delta = 0. \quad (11)$$

Then, from (11), we obtain

$$e'(W) \equiv \frac{de}{dW} = \frac{(\beta'/W)}{-\beta''\log(W/V)} > 0, \quad (12)$$

which shows that efficiency increases with a rise in nominal wages. While an increase in efficiency enhances disutility, it reduces the probability of dismissal. In these circumstances, as has been described in the literature on efficiency wages, if a firm pays a higher wage to its workers, the workers will perceive that the opportunity cost of being dismissed is increasing; accordingly, they will select a higher efficiency, with the purpose of avoiding dismissal.

2.4 Stage 1: Firm's behaviour

[9] Due to the two-period OLG structure, there is no opportunity for the dismissed workers to be re-hired. This assumption simplifies the analysis by allowing workers to determine e, independent of employment rates.

Let us assume identical and monopolistically competitive firms, the number of which is normalized to unity. Each firm is constrained by the following production and demand functions:

$$Y_i = eL_i, \tag{13}$$

$$Y_i = (P_i / P)^{-\eta} Y, \qquad (\eta > 1), \tag{14}$$

where Y_i denotes the output of firm *i*, L_i is the number of workers employed by firm *i*, P_i is the output price of firm *i* and *Y* is the aggregate real expenditure.[10] Taking (13) and (14) into account, the firm will maximize its profit Π_i in the following manner:

$$\underset{W_i, P_i}{\text{Max}}\ \Pi_i \equiv P_i Y_i - W_i \beta L_i = P_i Y_i - \frac{W_i \beta}{e} Y_i,$$

where W_i is the nominal wage in firm *i*. The firm will determine W_i in order to minimize the unit cost $(W_i \beta / e)$ or to maximize $e/(W_i \beta)$. The first-order condition is

$$\frac{e' W_i}{e}(1 - \frac{e \beta'}{\beta}) = 1, \tag{15}$$

which implies that the Solow condition is modified due to $\beta(e)$. With regard to P_i, the firm will mark-up the unit cost

$$P_i = \frac{W_i \beta}{\theta e}, \tag{16}$$

where $1/\theta\ (\equiv \eta/(\eta - 1))$ represents a mark-up ratio. It should be noted that θ also implies the wage share in income; this is because $W\beta L / PY = \theta$.

[10] Equation (14) is consistent with equations (1), (17) and (18).

2.5 Government and insurance system

The government minimizes discretionary spending $\int_0^1 P_i G_i di$, subject to

$\left[\int_0^1 (G_i)^{\frac{\eta-1}{\eta}} di\right]^{\frac{\eta}{\eta-1}} = G$. G denotes the index value to be attained, and G_i is the amount of consumption goods i that the government consumes. As a result, the government's demand for consumption goods i is given by

$$G_i = (P_i / P)^{-\eta} G. \tag{17}$$

For simplicity, let us assume that government spending is financed by corporation tax T as follows:[11]

$$\int_0^1 P_i G_i di = PG = T. \tag{18}$$

Consequently, the dividends on equities will be represented by the following after-tax profits: $\Pi - T$.[12] In order to focus on the demand effect of G, it is assumed that G does not have any direct effect on the utility and production functions (i.e. a complete waste).

Let us assume that the budget for unemployment insurance is independent of the government's tax system. The budget constraint in the insurance system can be represented as follows:

$$V(1-\beta L) = \tau W \beta L + \tau V(1-\beta L), \tag{19}$$

where the premium rate of insurance τ is an endogenous variable. The left- and

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[11] Since a comparison between the different tax schemes is not the focus of this study, a corporation tax—one that is convenient for analysis—is adopted.

[12] See footnote 20.

right-hand sides of (19) are payments from and revenues into the insurance system, respectively, (note that the number of workers is normalized to unity).

3. EQUILIBRIUM

This section examines equilibrium in each market. Firstly, we identify the nominal wage and efficiency in equilibrium. Secondly, we specify equilibria in the markets for outputs and money. Finally, by integrating these results, we examine the dynamics and stationary states with regard to outputs.

3.1 Nominal wage and efficiency

By introducing (12) into (15), we obtain the following:

$$\log(W/V) = (1-\varepsilon_1)/\varepsilon_2\,, \tag{20}$$

where $\varepsilon_1 \equiv e\beta'/\beta$ and $\varepsilon_2 \equiv -e\beta''/\beta'$. Once the level of unemployment insurance V is set, efficiency e and nominal wage W are determined in (11) and (20).[13] Equation (11) implies that firms will never reduce the nominal wage to the level of unemployment insurance even if there are many unemployed workers who could be useful to the firms for replacing current employees. Further, as far as an internal solution holds with respect to e, we obtain the following:

$$EU = \beta(e)(U^w - U^v) + U^v - \delta e > \beta(0)(U^w - U^v) + U^v > U^v\,. \tag{21}$$

[13] Appendix 2 provides a numerical example of (11) and (20) only for the purpose of confirming the existence of a meaningful e and W.

The expected utility of an employed worker is higher than that of an unemployed worker. Unemployed workers hope to acquire jobs at the current wage (or even a lower wage). However, firms neither reduce wages nor hire additional workers. Hence, the unemployment occurring in this case is involuntary.[14]

From (11) and (20), it is evident that an increase in V results in a proportional increase in W, without affecting e and $\beta(e)$. However, as shown later, an increase in V can have a positive effect on aggregate demand and employment.

3.2 Output and money markets

The following indicates equilibrium in the output market:

$$PY_{t+1} = \alpha(1+R_{t+1})(1-\tau_t)W\beta L_t + \alpha(1+R_{t+1})(1-\tau_t)V(1-\beta L_t) + PG \,. \tag{22}$$

The first and second terms in the right-hand side of (22) represent the consumption of wage earners and non-wage earners, respectively. By taking into account (13), (16) and (19), (22) can be represented as follows:

$$Y_{t+1} = \alpha(1+R_{t+1})\theta Y_t + G \,. \tag{23}$$

The money market equilibrium is given by

$$\overline{M} = \frac{1+R_{t+1}}{R_{t+1}}(1-\alpha)(1-\tau_t)W\beta L_t + \frac{1+R_{t+1}}{R_{t+1}}(1-\alpha)(1-\tau_t)V(1-\beta L_t) \,, \tag{24}$$

where $\overline{M}$ is a given amount of money.[15] The first and second terms in the right-hand

[14] If the insurance payment for an unemployed worker is much higher than that for a dismissed worker, unemployment could be voluntary.

[15] It is assumed that the amount of $\overline{M}$ was issued in the past activities of the government and that thereafter $\overline{M}$ has passed from one generation to another through transactions in markets.

side of (24) represent the money demand of wage earners and non-wage earners, respectively. Again, considering (13), (16) and (19), the above-mentioned equation (24) can be represented as follows:

$$m = \frac{1+R_{t+1}}{R_{t+1}}(1-\alpha)\theta Y_t, \tag{25}$$

where $m \equiv \overline{M}/P$ is the real money balance. The pair of equations (23) and (25) specifies the dynamics of *Y* and *R*.

3.3 Equilibrium dynamics and stationary states

From (23) and (25), we obtain the following difference equation that characterizes the equilibrium dynamics of *Y*:

$$Y_{t+1} = \frac{m\alpha\theta Y_t}{m-(1-\alpha)\theta Y_t} + G. \tag{26}$$

The curve in Figure 3 depicts (26) and is convex downward. This is because the interest rate R_{t+1} in (25) increases with Y_t, i.e. the higher the income, the greater is the money demand and the higher is the interest rate. Figure 3 shows that two stationary states can exist in this system.[16] The necessary and sufficient condition for two stationary states is as follows:[17]

[16] In an OLG model with fixed prices, Madden (1992) shows two temporary equilibria that are similar to the ones in this study. Based on an efficiency wage mechanism, the current paper provides an explicit explanation of why nominal wages (and thereby prices) do not fall despite the existence of unemployment.

[17] Inequality (27) can be derived from the discriminant of a quadratic equation, into which (26) is transferred.

$$\frac{(1-\alpha\theta)^2 m}{\theta(1-\alpha)(1+\sqrt{\alpha\theta})^2} > G > 0\,. \tag{27}$$

Since an increase in *G* shifts the curve in Figure 3 upwards, it can be stated that for stationary states to exist, *G* must lie within a limited range.

The fraction in (26) indicates consumption, and the marginal propensity to consume is smaller than unity at point *K*, although it is larger than unity at point *N*. While stationary state *K* is stable, stationary state *N* is unstable; as long as the initial value Y_0 falls within the range $0 \le Y_0 \le Y^{**}$, the path of *Y* is non-divergent. In this range, any initial value of Y_0 is consistent with perfect foresight.[18] Therefore, in the short run, output levels are indeterminate. In the long run, however, output levels converge to Y^*, with the exception of the case of $Y_0 = Y^{**}$. Notice that *Y* is an aggregate variable, which no single agent can control. Accordingly, without coordination, there is no guarantee that agents behave according to the expectation that $Y_0 = Y**$. For instance, if every agent believes that $Y_0 = Y*$, the situation where each firm maximizes its profit with making Y_i equal to $Y*$ is consistent with perfect foresight. Thus, we cannot eliminate the possibility that coordination failure brings about Pareto-inferior state *K*.[19]

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[18] If *G* = 0, stationary state *K* disappears. In this case, however, the path that starts from a positive $Y_0(< Y^{**})$ and converges to zero would remain consistent with both perfect foresight and individual optimization. Therefore, making government spending zero does not guarantee that $Y_0 = Y^{**}$.

[19] For coordination failure, see Cooper and John (1988) and Cooper (1999).

4. COMPARATIVE ANALYSIS

This section develops comparative statics concerning nominal wages, unemployment insurance and government spending. Since stationary state *K* is stable while stationary state *N* is unstable, the correspondence principle indicates that the result of comparative statics at stationary state *N* is just the opposite of that at stationary state *K*. Our main concern is for the economy trapped at lower levels of output, and hence the focus of this section is on the characteristics of stationary state *K*.[20]

4.1 GS-LM diagram

Firstly, as a useful tool for analysis, the *GS-LM* diagram is presented. In the analogy of the *IS-LM* diagram, let two curves represent the equilibria in output and money markets. Equations (23) and (25) can be rewritten as follows:[21]

$$G = (1 - \alpha(1 + R)\theta)Y, \tag{28}$$

$$\frac{1 + R}{R}(1 - \alpha)\theta Y = m. \tag{29}$$

In Figure 4, (28) is drawn as a *GS* curve, indicating that government spending is equal to savings. Equation (29) is drawn as a *LM* curve, indicating that the money demand (liquidity preference) is equal to the money supply.[22] Note that the *GS* curve always

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[20] While the characteristics of stationary state *N* might be familiar, those of stationary state *K* would not. This is also one of reasons why stationary state *K* is worth examining.

[21] We consider the case where $L = Y / e < 1$ under sufficiently small *G* and *m*.

[22] Taking into account *PG* = *T*, $(1-\theta)PY - T = R(\theta PY - \overline{M})$ is derived from (28)

has a positive slope because consumption increases with increasing interest rates. Point *K* in Figure 4 corresponds to point *K* in Figure 3.

4.2 Nominal wage and unemployment

Let us examine the case in which an increase in insurance payment *V* results in a proportional increase in nominal wage *W* (see (11) and (20)). This increase in *W* enhances price *P* proportionally (see (16)). Therefore, real wage *W*/*P* and real insurance payment *V*/*P* remain constant; however, the real money balance *m* is reduced. Responding to the decrease in *m*, the *LM* curve shifts upwards, as in a typical *IS*-*LM* exercise. Then, Y^* and R^* in Figure 4 are enhanced. Thus, together with an increase in *W*, aggregate demand and employment will increase. Unemployment cannot be attributed to high nominal wages. This finding is contradictory to the results typically obtained in the literature, including Dixon (1990) and others. The reason why the real balance effect does not work is intuitively explained as follows. In the OLG framework without bequests, the primary asset of each household is labour endowments. Using labour endowments in the first period, households earn wage income and save it in the form of money and equities. In the second period, they spend the entire amount. Now, let us suppose that nominal wages are reduced. The output prices are reduced through a mark-up mechanism, and accordingly, the real money balance increases. However, the total asset value does not necessarily increase because a decrease in equity values can negate an increase in the real money balance. Further, the lower interest rates resulting from an increased real money balance diminish the purchasing power of households in the second period. Thus,

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and (29), i.e. the after-tax profit of firms equals the net return on equities.

consumption decreases despite the increase in real money balance.

4.3 Unemployment insurance and welfare

Now, let us examine how an increase in *V* affects individual utility. Firstly, an increase in *V* affects the utilities in (8) and (9) through an increase in interest rates; however, the effect of the increased interest rate is ambiguous because it works in two opposite directions. On the one hand, an increase in interest rates allows the workers to consume more as a result of a greater return from equities. However, on the other hand, an increase in interest rates leads to a higher cost of money holdings, inducing workers to reduce money holdings. Considering (29), it is found that

$$\frac{\partial((1+R)/R^{1-\alpha})}{\partial R} \gtreqless 0 \quad \Leftrightarrow \quad \theta Y \gtreqless m.$$

Since the positive demand for equities requires that aggregate real wage θY is greater than real money balance *m*, it must hold in equilibrium that $\theta Y > m$.[23] Thus, an increase in *V* enhances utilities through an increase in interest rates.

Secondly, since employment is increasing in *V*, individual workers always obtain a certain gain from a lower premium rate τ.[24] Thirdly, since the expected utility of an employed worker is greater than that of an unemployed worker, additional employment is a positive factor in ex ante utility. Thus, it is concluded that an increase in *V* is Pareto-improving in an ex ante sense.

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[23] For the last inequality to hold, we have to assume that $G > (1-\theta)m/\theta$. The right-hand side of this inequality is derived by setting $Y_{t+1} = Y_t = Y = m/\theta$ in (26) and solving for *G*.

[24] From (19), it is confirmed that τ is decreasing in *L* (note that $W > V$).

An increase in V enhances the ex post utility of those workers with an unchanging employment status; however, a newly employed worker who is eventually dismissed will suffer a discontinuous amount of δe loss in ex post utility.

4.4 Fiscal policy

Let us now examine the effect of G in terms of its multiplier. Let c denote the marginal propensity to consume. Noting that $C = \alpha m\theta Y/(m-(1-\alpha)\theta Y)$ and $1+R = m/(m-(1-\alpha)\theta Y)$, the marginal propensity to consume can be expressed as $c = \alpha\theta(1+R)^2$, which is smaller than unity at stationary state K.[25] From (26), we obtain the following multiplier that can be found in Keynesian textbooks:

$$dY/dG = 1/(1-c). \tag{30}$$

The above result is similar to that of Dixon (1987), Mankiw (1988), Starts (1989), Molana and Moutos (1991) and Bénassy (1995); however, while their multiplier decreases with the wage share in income, the multiplier in this study increases along with the wage share. This is because $\partial c/\partial\theta > 0$.[26] Hence, the current model may be more Keynesian-like than those of the above-mentioned previous studies.[27]

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[25] Unlike its usual definition, c includes the effect of a change in R as well as the direct effect of Y on consumption.

[26] From a *GS-LM* exercise in Figure 4, it is easy to observe that R is increasing in θ.

[27] Bénassy (2007) recently presents a model where the multiplier is greater than unity. However, his multiplier is not the balanced budget one.

5. CONCLUDING REMARKS

This paper presents a simple, but carefully micro-founded, general equilibrium model, which consists of the following familiar elements: efficiency wage, monopolistic competition and OLG structure. While each element is orthodox, the unemployment occurring in a low level stationary state should be understood not as a consequence of high wages but as that of an insufficient demand for outputs. Further, the model yields the following policy implication: For this type of unemployment, it is desirable to enhance unemployment insurance which supports wages and thereby prevents further reduction in aggregate demand. Combined with relatively high levels of government spending, this can lead to a Pareto improvement.

Since the model presented is specific, the above-stated conclusion should be cautiously dealt with in practical application. However, it does suggest that the achievement of Keynes's programme is in fact possible.

APPENDIX 1: DERIVATION OF $\beta(e)$

Let us divide one period into Z sub-periods, where Z is assumed to be sufficiently large. Assume that a worker has the following two choices in each sub-period: to shirk or not to shirk. Further, assume that if a worker is shirking at a sub-period, the probability of its detection is exogenously given by q, which is less than unity because of imperfect monitoring. Moreover, assume that due to the difficulty in verification, a firm can dismiss a worker only if it detects the worker shirking more than $\bar{k}$ times. If S denotes the number of sub-periods where a worker is shirking, the probability distribution of detection k times is given by the following binomial distribution:[28]

$$P(k|S) = \frac{S!}{k!(S-k)!} q^k (1-q)^{S-k} . \tag{A-1}$$

Figure 5 draws (A-1) as a continuous curve. From (A-1), the probability of being dismissed is obtained as follows:

$$P(S) = \sum_{k=\bar{k}+1}^{S} \frac{S!}{k!(S-k)!} q^k (1-q)^{S-k} , \tag{A-2}$$

which is drawn in Figure 6. Let us now define the efficiency as $e \equiv (Z - S)/Z$. Then, noting that $S = Z(1\text{-}e)$, $\beta(e) \equiv 1 - P(Z(1-e))$ is obtained, as drawn in Figure 2.

APPENDIX 2: A NUMERICAL EXAMPLE OF (11) AND (20)

In Figure 7, the reversed U-shape line and the second line depict the right-hand side of (20) and that of the following equation, respectively:

$$\log(W / V) = \delta / \beta'(e) , \tag{11'}$$

where the parameter values are $\bar{k} = 4$, q = 0.1, Z = 105 and $\delta = 0.005$. Although these lines intersect at two points, only the right-hand point in Figure 7 satisfies the second-order condition in the firm's decision.

[28] For example, see Eric W. Weisstein, 'Binomial Distribution', from *MathWorld*—A Wolfram Web Resource. http://mathworld.wolfram.com/BinomialDistribution.html.

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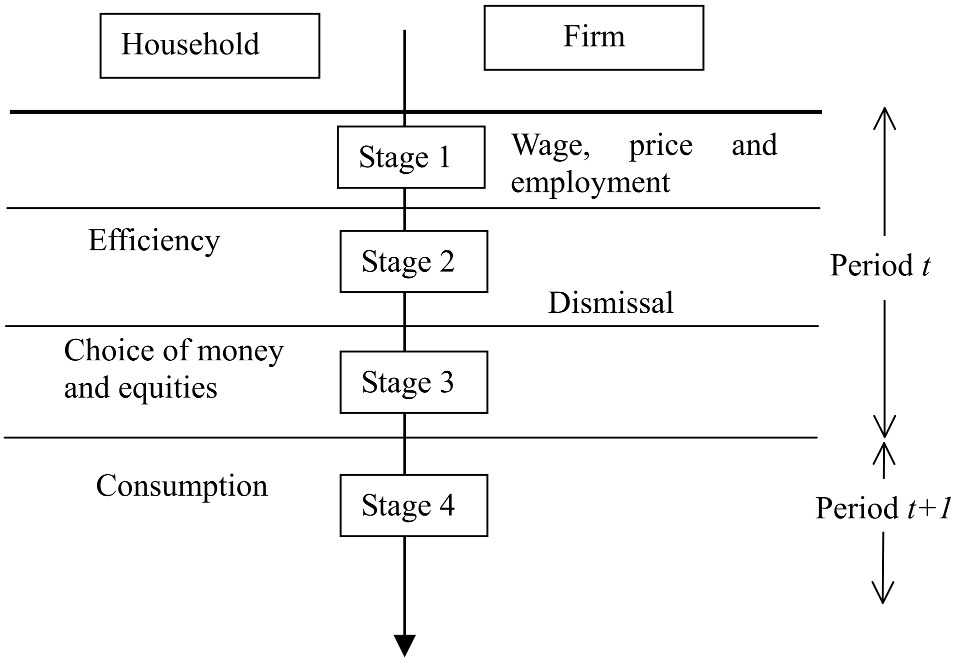

Figure 1. Flowchart of decisions.

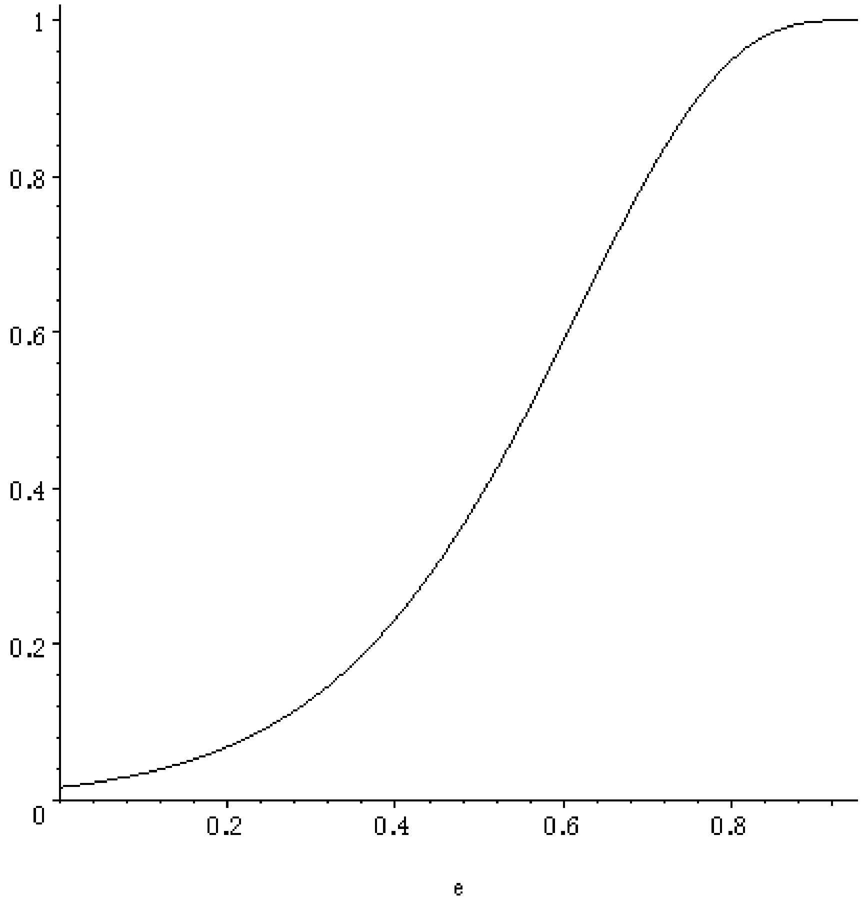

Figure 2. Function $\beta(e)$**.**

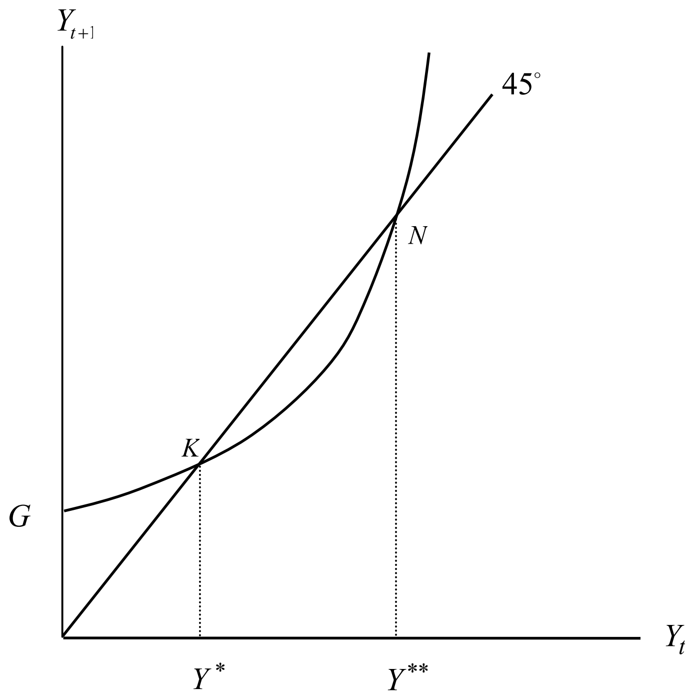

Figure 3. Dynamics of *Y*.

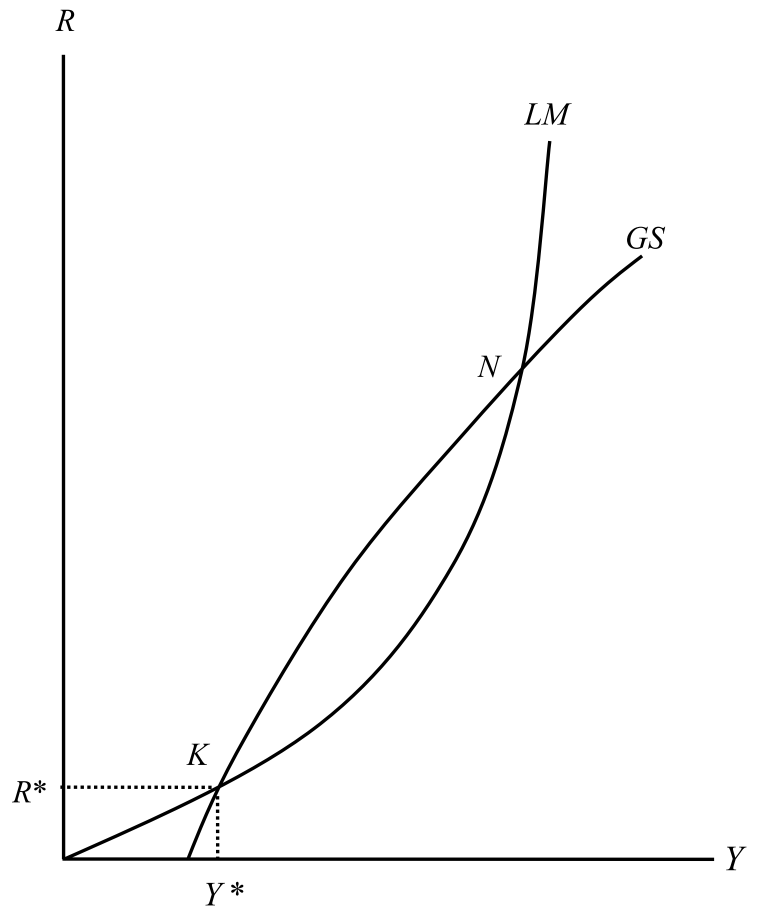

Figure 4. GS-LM diagram.

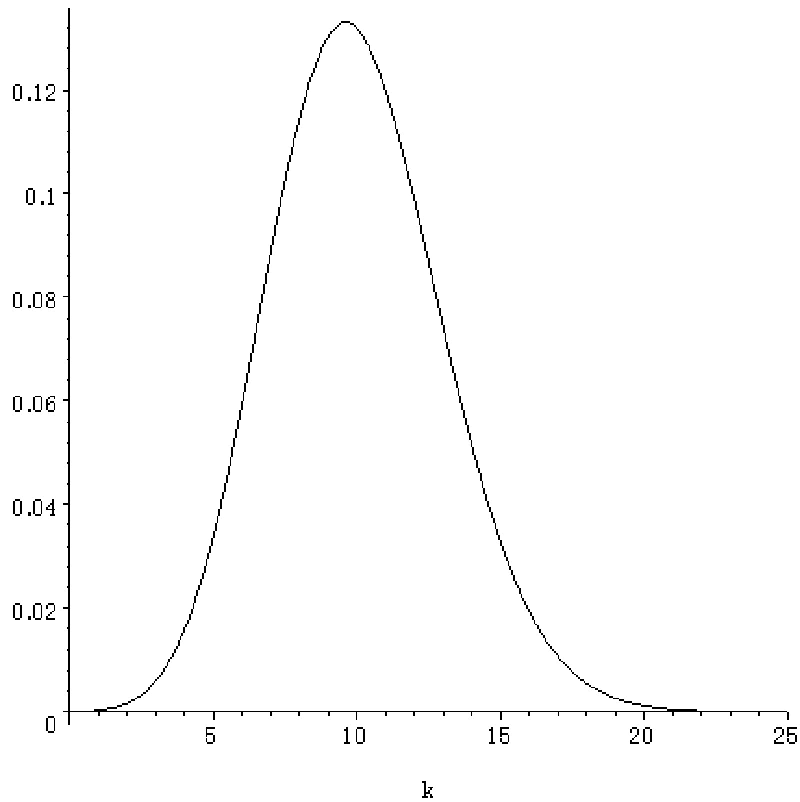

Figure 5. Binomial distribution $P(k|S)$; $S = 100$, $q = 0.1$.

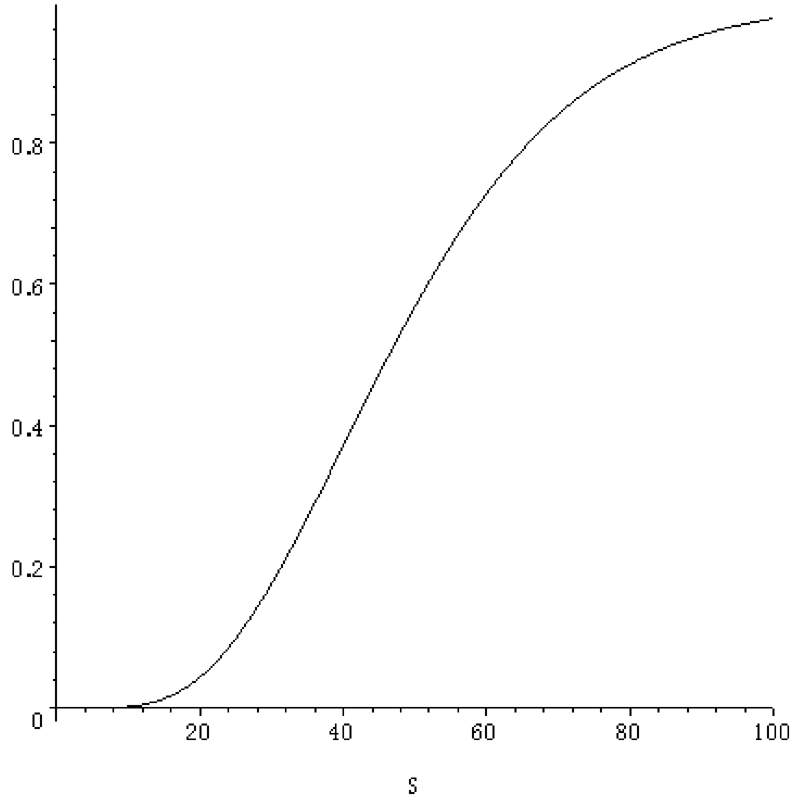

Figure 6. Function *P*(*S*); $\bar{k} = 4$**,** $q = 0.1$.

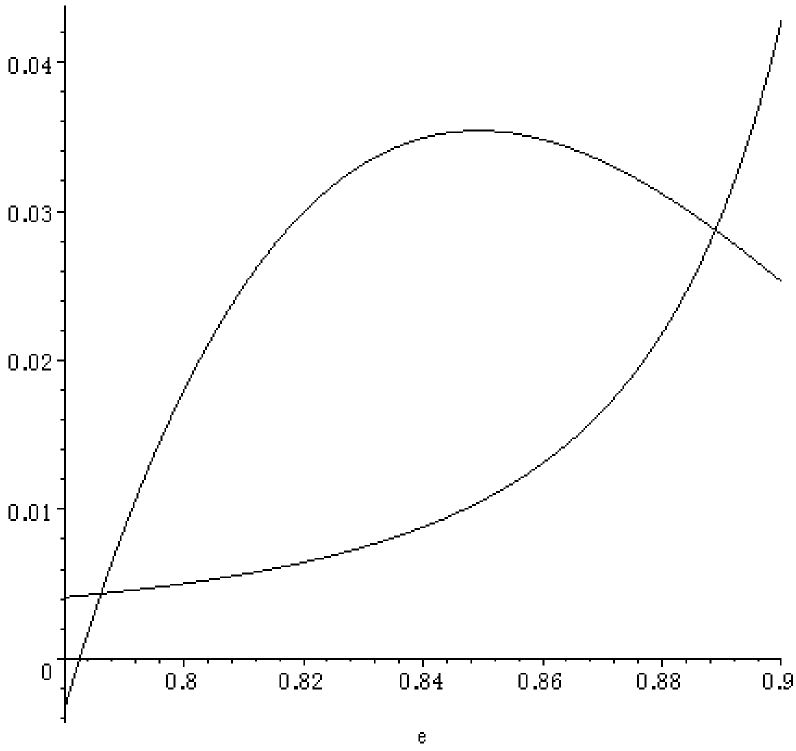

Figure 7. A numerical example of (11') and (20); $\bar{k} = 4$**,** q **= 0.1,** Z **= 105,** $\delta = 0.005$**.**