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The Importance of Demand Structure in Economic Growth: An Analysis Based on Pasinetti's Structural Dynamics

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1. Introduction

Harrod (1939) is no doubt one of the pioneers in the field of economic growth as well as the Keynesian dynamics. Since Solow (1956) had appeared, however, the Keynesian features were gradually fallen into oblivion in the field of economic growth. A few exceptions are the growth theories built by the Cambridge Keynesians, such as Goodwin (1967), Kahn (1972), Kaldor (1957, 1961), Pasinetti (1974, 1981, 1993a, 2007), and Joan Robinson (1956, 1962). They persistently stressed the importance of effective demand and classical-Marxian economics as the foundation of macroeconomics.[1]

The important implication derived from Solovian growth model is that technical progress is a crucial factor to economic growth, although Solow (1956) treated it exogenously. Therefore, economists and policy-makers began to pay attention to technical progress, which gives birth to the emergence of the so-called new growth theory.[2] Without doubt, the implication is quite adequate and the attempt by economists and policy-makers is understandable. Indeed, many industrialised economies have strategically conducted a set of economic policies to promote technical progress. However, the achievements of such supply-side policies are far less satisfactory; many advanced economies suffer from unstable and sluggish circumstances. The demand-side policies are thought of as being necessary just in the short term, such as the depression after serious economic crises.

The supply-side economic policies are certainly successful if demand follows a homothetic function. However, such a function cannot be empirically observed; demand follows S shape curve (i.e. a logistic or Gompertz function) and finally saturates. Under such a situation, demand growth may not be able

[1] See Harcourt (2006) and Pasinetti (2007) concerning the economics of the Cambridge Keynesians after the 2nd World War. Kalecki (1954, 1971) should be also included into those who emphasise the importance of effective demand.

[2] The characteristic of the new growth theory is that the growth rate is endogenously determined. See, for example, Acemoglu (2009) concerning the new growth theory. See also Kurose (2013a) concerning the fact that it has the classical, rather than the neo-classical, feature.

to keep up with the increase in productive capacity promoted by technical progress. As a consequence, the strong economic growth cannot be achieved. Perhaps, the economic system may fall into prolonged stagnation.[3]

In this paper, we focus on the effects of demand-side conditions on the macroeconomic performances in the labour market and the relationship between unemployment and inflation, by using a stochastic multisectoral model based on Pasinetti's (1993a) pure labour model. The model multisectorally describes the growth process accompanying structural dynamics. In other words, it describes the evolution of structures of quantities, prices, and employment in the economic system.[4] It reflects the basic conviction that the sectoral growth rates of productivity and of consumption demand are different with each other in a normal growth process. Therefore, the steady state is not a reference point for our analysis. In fact, the long-run positive correlation between the real growth rate of national income and the speed at which the structure of the economic system evolves is observed in some industrialised countries, such as Germany and Japan, as Yoshikawa and Matsumoto (2001) showed.

Here, we focus on the difference in the macroeconomic performance generated by the difference in the structural dynamics of consumption demand. We compare the macroeconomic performance obtained when the speed of demand saturation is faster with that obtained when it is slower. The relevance of such an investigation, as already argued in Kurose (2009, 2013b), is that the economic growth of advanced economies from the 1990s onward characterised

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[3] Carter (1987) wrote a provocative paper the title of which is 'Can technology change too fast?' She made the suggestion that technological change may go 'too fast' and a slower and more orderly introduction of technological changes might be more beneficial and might avoid or greatly diminish the suffering of many people. Furthermore, Brynjolfsson and McAfee (2011) attributed the recent stagnation observed in many industrialised countries to the rapid improvement of information and communication technology. Their arguments are quite interesting but do not focus on the demand-side conditions at all.

[4] See Pasinetti and Scazzieri (1987) and Pasinetti (2012) with respect to the concept of structural dynamics in detail.

by the term 'jobless economy' or 'new economy' is closely related to such a tendency of consumption demand that the speed of demand saturation for the products recently emerged becomes faster.

This paper is organised as follows: section 2 presents the model shown in Kurose (2009), which is used as a basic model throughout this paper. In section 3 we show the proposition on the relationship between the dynamics of the labour market and the structure of consumption demand. In section 4 we derive further implications on the importance of demand structure, which is critical to the hypothesis of the *natural* rate of unemployment (Friedman, 1968) or the non-accelerating inflation rate of unemployment (the NAIRU hereafter). In section 5 we examine Caballero et al. (2008), in which the effects of firms (termed *Zombies*), despite lower productivity, surviving during depression or recession on the macroeconomic performance are investigated. We take up the model as an example of the model in which the importance of the harmonisation between the evolution of the structure of technology and that of demand is completely ignored. We argue that the policy proposal from the model lack of the harmonisation may be misleading. Section 6 presents the concluding remarks.

2. The Model

In this section, we briefly present the model shown in Kurose (2009). It is based on Pasinetti's (1993a) pure labour model but the stochastic emergence of new products is introduced.

Briefly reviewing Pasinetti (1993a), it consists of the two systems of $m + 1$ linear and homogeneous equations: the price and quantity system. The former is given as follows:

$$\begin{bmatrix} 1 & 0 & \cdots & 0 & -l_1(t) \\ 0 & 1 & \cdots & 0 & -l_2(t) \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 1 & -l_m(t) \\ -c_1(t) & -c_2(t) & \cdots & -c_m(t) & 1 \end{bmatrix} \begin{bmatrix} p_1(t) \\ p_2(t) \\ \vdots \\ p_m(t) \\ w(w) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \\ 0 \end{bmatrix},$$

where $c_i(t)$, $l_i(t)$, $p_i(t)$, and $w(t)$ denote the per-capita consumption and the labour coefficient, the price of commodity i $(i = 1, 2, \cdots, m)$, and the nominal wage rate, at period t, respectively. Similarly, the latter is given as follows:

$$\begin{bmatrix} 1 & 0 & \cdots & 0 & -c_1(t) \\ 0 & 1 & \cdots & 0 & -c_2(t) \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 1 & -c_m(t) \\ -l_1(t) & -l_2(t) & \cdots & -l_m(t) & 1 \end{bmatrix} \begin{bmatrix} Q_1(t) \\ Q_2(t) \\ \vdots \\ Q_m(t) \\ N(t) \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ 0 \\ 0 \end{bmatrix},$$

where $Q_i(t)$ and $N(t)$ denote the physical quantity of commodity i and the total population, at period t, respectively.

Since they are the system of linear and homogeneous equations, the necessary condition for non-trivial solution is that the determination of coefficient matrix is zero. Since, moreover, the coefficient matrices are transpose ones with each other, the determinant of coefficient matrix of the price system is the same as that of the quantity system. Therefore, the condition for non-trivial solution of both systems can be expressed as follows:[5]

$$1 = \sum_{i=1}^{m} c_i(t) l_i(t). \tag{1}$$

This is a condition that must be satisfied over time in order to maintain full employment. Term $c_i(t)l_i(t)$ can be interpreted in two ways. According to the quantity system, it denotes the proportion of the potential national income generated in sector i by effective demand. According to the price system, on the contrary, it denotes the proportion of the overall employment required by

[5] See Kurose (2009,p. 154) and Pasinetti (1993a, pp. 20–22) concerning the economic significance of this condition

sector i (Pasinetti, 1993a, pp. 20–22). From the viewpoint of the quantity system, therefore, condition (1) can be regarded as the equilibrium condition for commodities market and, form the viewpoint of the price system, it can be regarded as the equilibrium condition for labour market.

Note, as already mentioned, that the characteristic of Pasinetti's model is that structural dynamics takes place. Therefore, the following is assumed: $c_i(t)=c_i(0)\exp[r_{it}t]$ and $l_i(t)=l_i(0)\exp[-\rho_{it}t]$, where r_{it}, ρ_{it}, $c_i(0)$, and $l_i(0)$ denote the growth rate of per-capita demand for commodity produced by sector i at period t, the growth rate of labour productivity of sector i at period t, the initial value of the per-capita consumption coefficient and that of the labour productivity of sector i, respectively. Furthermore, it is assumed that $r_{it} \neq r_{jt}$ and $\rho_{it} \neq \rho_{jt}$ if $i \neq j$, and $r_{it} \neq \rho_{it}$ for $i = 1, 2, \cdots, m$. Therefore, condition (1) is not automatically fulfilled over time. Therefore, it implies to tend to generate the *technological* unemployment in growth process (Pasinetti, 1993a, Chap. 4).

In order to make a distinction between the total population and the number of labour demanded, we introduce one more variable $\mu(t)$. It denotes the proportion of labour demanded to the total population: $L(t)=\sum_{i=1}^{m} L_i(t)=\mu(t)N(t)$, where $L(t)$ and $L_i(t)$ denote the total number of labour demanded and the number of labour demanded in sector i, respectively. Condition (1) is thus rewritten as follows:

$$\mu(t)=\sum_{i=1}^{m} c_i(t)l_i(t). \qquad (2)$$

On the other hand, we assume that the proportion of available labour to the total population is simply a unity; we ignore the existence of people, like the older and children, who consume but cannot work. Therefore, $1-\mu(t)$ can be regarded as the unemployment rate. In what follows, we regard the increase (the decrease) of $\mu(t)$ as the decrease (the increase) of the unemployment rate.

Although the non-trivial solutions exist when condition (1) or (2) is satisfied, we should note that each system has *two* degree of freedom; one is an initial value of the variable selected as the numéraire and the other is the rate of change over time.[6] With respect to the quantity system, it would be natural for the size of the total population to be selected as the numéraire. In other words, it implies that we should formulate as follows: $N(t) = N(0)\exp[gt]$, where $N(0)$ and g denote the initial value and the growth rate of the total population respectively. Concerning the price system, on the other hand, various ways of the selection of the numéraire are conceivable. Following Pasinetti (1993a), we select the wage rate as the numéraire, which implies that we can arbitrarily exogeneise an initial value of the wage rate and its rate of change over time.

To this end, we define a special composite commodity for which the growth rate of labour productivity is exactly equal to the weighted average of the growth rates of labour productivity of all sectors. Pasinetti (1993a, p. 70) calls the composite commodity the dynamic standard commodity. On the basis of condition (2), the weight coefficient of commodity i is defined as follow:

$$\eta_i(t) = \frac{1}{\mu(t)} c_i(t) l_i(t). \tag{3}$$

Note that it follows $\sum_{i=1}^{m} \eta_i(t) = 1$. Therefore, the growth rate of labour productivity for the dynamic standard commodity is defined as follows:

$$\rho_t^* = \sum_{i=1}^{m} \eta_i(t) \rho_{it} . \tag{4}$$

Measuring the initial value of the wage rate in terms of the dynamic standard commodity, the exogeneised wage rate is expressed as follows:

$$w^*(t) = w^*(0)\exp[\rho_t^* t], \tag{5}$$

where $w^*(0)$ is the initial value of the wage rate in terms of the dynamic standard commodity. Note that the composition of the dynamic standard

6 The initial value of a variable chosen as the numéraire and the rate of change over time can be exogenised in any dynamic model.

commodity is affected by the interaction between the growth rate of productivity and of consumption demand.

Using $w^*(t)$ to close the price system means that all commodity prices and the wage rate are also measured in terms of the dynamic standard commodity whose growth rate of labour productivity is the weighted average of the growth rate of labour productivity. It means that half of the prices on the weighted average will increase while the other half will decrease, so that the general price level is kept constant. It implies that the wage rate shown by function (5) corresponds to the real wage rate. The dynamic standard commodity is the composite commodity satisfying one of qualifications for the Ricardian invariable measure of value in a dynamic model: 'now and all times requires precisely the same quantity of labour to produce it' (Ricardo, 1951, p. 17n). In other words, it is the commodity that always requires the average labour productivity to produce, and thus it always '"command" through time as many physical commodities as correspond to the quantity of (augmented) labour embodied into them' (Pasinetti, 1993a, p. 74).

Note, furthermore, that the property of the dynamic standard commodity that keeps the inflation rate zero is entirely independent of the composition of the dynamic standard commodity. No matter how the composition of the dynamic standard commodity evolves, it continues to play a role of the invariable measure of value.[7]

Now, let us introduce the stochastic emergence of new products into the model. The assumed stochastic process is a continuous Markov chain called the Yule process. It is a pure birth process with the birth rate $\lambda > 0$. According to the Yule process, the probability of the emergence of a new product at the given interval depends on the number of products that already exist; the probability is expressed by $\lambda M \Delta t$, where M denotes the number of products at period t. Furthermore, we assume that the productivity and consumption

[7] See Pasinetti (1993a, pp. 73–74).

demand for a new product evolve over time. The labour coefficient of the product that emerges at period τ evolves at period t as follows: $l(t-\tau)=l(0)\exp[-\rho_{t-\tau}(t-\tau)]$. As mentioned in section 1, we are interested in the difference in the macroeconomic performance caused by the difference in the structural dynamics of consumption demand. Therefore, we assume the evolution of the per-capita consumption coefficient for a product, which emerges at period τ, at period t as follows: $c(t-\tau)=\frac{K}{1+\alpha\exp[-r_\tau K(t-\tau)]}$, where $\alpha=\frac{K-c(0)}{Kc(0)}$ and r_τ is the parameter denoting the growth rate of consumption demand.[8]

Under the above assumption, we obtain the expectation of $\mu(t)$ from function (2):

$$E[\mu(t)]=\lambda\int_0^t e^{\lambda\tau}c(t-\tau)l(t-\tau)d\tau+c(t)l(t), \qquad (6)$$

where $c(t)=\frac{K}{1+\alpha\exp[-r_0Kt]}$ and $l(t)=l(0)\exp[-\rho_0 t]$.[9] They denote the evolution of the per-capita consumption coefficient and the labour productivity of the product that exist at period 0, respectively. Similarly, the expectation of the growth rate of the real wage rate is obtained as follows from function (4):

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[8] This type of function is called the logistic function. In a deterministic case, the function is the solution of the following differential equation: $\dot{c}(t)=rc(t)[K-c(t)]$. This demand function seems curious to some readers, since it is independent of the relative prices. Of course, it is just a simplification. We can formulate demand function so as to depend on the prices. The justification of the simplification is that we are concerned with the medium or long run growth, not the short one, and thus, in the case, the following would be generally valid; 1) the per-capita demand increase disproportionally, 2) the change in the price structure may have an effect on the evolution of consumption demand but the effect of the change in the price structure cannot be significantly measured, according to Van den Bulte (2000). This is because the effect has the collinearity with other variables. Moreover, Lavoie (2006, pp. 25–31) showed that the 'substitution' effect works less than economic theory assumes. See Kurose (2013b) concerning the justification in detail.

[9] See Kurose (2009) in detail concerning the derivation of functions (6) and (7).

$$E\left[\rho^*(t)\right]=\frac{\int_0^t e^{\lambda\tau}c(t-\tau)l(t-\tau)\rho_{t-\tau}d\tau}{\int_0^t e^{\lambda\tau}c(t-\tau)l(t-\tau)d\tau}. \tag{7}$$

Kurose (2009) analyses the simulation in order to compare the differences in the evolution of functions (6) and (7) when the speed of demand saturation changes. We suppose two cases: one is the case of the faster saturation of the per-capita consumption demand and the other is the case of the slower saturation, as shown below.

【The faster saturation case】

$$r_\tau^+ = 0.01 + 0.0035\tau. \tag{8}$$

【The slower saturation case】

$$r_\tau^- = 0.01 + 0.00035\tau. \tag{9}$$

In order to focus on the effect of the differences in the speed of demand saturation, we suppose the same evolution of the labour productivity in both cases:

$$\rho_{t-\tau} = 0.015 + 0.0009(t-\tau). \tag{10}$$

Moreover, we assume the initial values as follows: $K=20$, $c(0)=0.008$, and $l(0)=0.085$. Note that the supply-side conditions are the same although we suppose the two demand-side conditions shown by functions (8) and (9).

The characteristic of the model is that it includes the heterogeneity in that there is a disparity in the growth rates of both productivity and demand across sectors at the arbitrary period ε, as shown in Figures 1 (a) and (b). The former figure illustrates the growth of the consumption coefficient of the product that, as example, emerges at τ =0, 5, 10, 15, and 20 under function (9): $c(t)$, $c(t-5)$, $c(t-10)$, $c(t-15)$, $c(t-20)$. The latter illustrates the growth of productivity according to function (10) under the same assumption as in the former: ρ_0, ρ_{t-5}, ρ_{t-10}, ρ_{t-15}, ρ_{t-20}. In other words, each sector has the specific growth rates of per-capita consumption and productivity at each period and the rates evolve over time. It means that the sectoral employment share also evolves over time. The characteristic demonstrates that the structural dynamics of quantities, prices, and employment occurs in the model.

Insert Figures 1 (a) and (b) here.

3. The Implication on the Labour Market

Here, we focus on the evolution of employment and real wage rate. The expectation of employment rate in the case of faster demand saturation is obtained by substituting functions (8) and (10) into (6), and the expectation in the case of slow demand saturation is obtained by substituting functions (9) and (10) into (6). Similarly, the expectation of the growth rate of real wage in the case of faster demand saturation is obtained by substituting functions (8) and (10) into (7), and the expectation in the case of slower demand saturation is obtained by substituting functions (9) and (10) into (7).

Under the above assumptions, we can obtain the following proposition:

Proposition 1: *The faster demand saturation accelerates the growth of employment but decelerates that of the real wage rate.*

Proof: At first, let us prove the proposition concerning the growth of employment. According to functions (8) and (9), it follows that $\frac{K}{1+\alpha\exp\left[-r_\tau^+ K(t-\tau)\right]} \geq \frac{K}{1+\alpha\exp\left[-r_\tau^- K(t-\tau)\right]}$ for $\forall t$. Since, as already mentioned, the supply-side conditions are the same in both cases, the integration of function (6) becomes larger in case of function (8) than in case of function (9). Since, therefore, the term $c(t-\tau)l(t-\tau)$ denotes the proportion of the employment at period t required by the sector that emerges at period τ, the faster demand saturation accelerates the total employment than the slower demand saturation does.

Next, let us address the proposition concerning the growth of real wage rate. Recall that the real wage rate is defined by a special consumption basket–the dynamic standard commodity–and the growth rate of the real wage is defined by the weighted average of the growth rates of the productivity of the entire economic system. Since the evolution of the productivity, shown by function (10), is the same in both cases, the difference in the weighted average in those cases just lies in the difference in the evolution of the weight coefficients – $\eta_i(t)$ in function (3). The weight coefficient denotes the *proportion* or *share* of employment of sector i. In the stochastic process, the coefficient denotes the *proportion* or *share* at period t of employment of the sector that emerged at period τ. Obviously, the proportion of employment of each sector decrease earlier in the case of faster demand saturation than in the case of slower demand saturation, given the same assumptions on the supply-side conditions. This is because a faster demand saturation implies the earlier end of the growth of effective demand under the same assumption of the supply-side conditions. ■

Insert Figures 2 (a) and (b) here.

Figures 2 (a) and (b) depict the evolutions of the employment rate and that of the growth rate of real wage under the above assumptions, respectively. Note that the proposition is valid independently of the initial values of parameters and the forms of functions that we assumed. The crucial assumption is that the same supply-side conditions are applied for the different demand-side conditions.

The proposition seems to be counterintuitive, since the conventional wisdom asserts that the real wage rate increases at a faster pace when the increase in employment is strong. The proposition can be interpreted as the warning against the tendency of always thinking about the labour market by the framework of a downward sloping demand and an upward sloping supply of labour. The reason why we obtain such a result is that our model accompanies structural dynamics: the compositions of quantities and prices are evolving. In particular, it shows the importance of the structure of consumption demand to growth path. The consumption structure under the homothetic demand function does not vary. When the non-homothetic demand function is assumed, as we do, the consumption structure evolves over time. Under our assumptions, the structure evolves as follows: the rise in productivity lowers the prices, which leads to increase the consumption demand. Following the consumption demand function assumed here, even though the prices become lower, the demand saturates earlier in the case of faster demand saturation. Therefore, the increase in the demand is not substantial in comparison with the reduction of the price. Recall that the real wage rate in our model is defined by the dynamics standard commodity. This implies that the quantities of commodities, the prices of which are relatively lower owing to technical progress, are smaller in the commodity basket, which constitutes the composite commodity, in the case of faster demand saturation than in the case of slower demand saturation. The difference in the evolution of growth of real wage rate is generated by the difference in the structural dynamics of consumption demand.[10]

The Economist recently took up the argument that the pace of innovation has slowed, which explained why growth of real income in advanced countries had long been slowing (12th January 2013). Although it mentions the various views on it – the pessimistic, optimistic, and historical ones –, it does not take into account the changes in consumption structure caused by the innovation at

[10] It can be proven that Proposition 1 is fulfilled when capital is introduced. See Kurose (2013b) in detail.

all. The examination by *the Economist* is entirely one-side: the supply-side. As we show, the impact of the innovation on the real income or employment is not solely determined by the supply-side conditions; it is determined by the interaction between the demand-side and the supply-side conditions. Let us cite Pasinetti (1993b, p. 6), though at length:

'It is a mistake to present the relevance of technical progress for society as a sheer increase of production of goods and services per given amounts of inputs. No society, as long as composed by human beings, could go on benefiting from such a form of technical progress. … I should like to stress that these arguments have nothing to do with notions such as "quality of life"… improvements on the technical side have relevance for the wealth and welfare of their citizens only if simultaneously accompanied by an appropriate variation, or … an appropriate *structural dynamics*, of the main magnitudes of the whole of economic system.'

This is a very important indication, fallen into oblivion by many economists and policy-makers. The focus on the supply-side conditions – the rise in productivity – is not sufficient to increase the 'quality of life'. We must take into account the structural dynamics of consumption demand as well. The harmonisation between the evolution of the structure of technology and demand is more important for the 'quality of life' than whether the pace of technological progress is faster or slower.

4. The Hypothesis of the Natural Rate of Unemployment

Let us derive a further implication from our model. As already mentioned, the price level is kept constant in our model as long as the dynamic standard commodity is adopted as the numéraire. It means that the wage rate is measured by the dynamic standard commodity, as shown by function (5). In this case, $1-E[\mu(t)]$ is the expectation of the unemployment rate consistent with stable price level.

At first glance, it is equivalent to the natural rate of unemployment put forward by Friedman (1968) or the NAIRU. It is the unemployment rate consistent with stable price level, given 'the actual structural characteristic of the labor and commodity market, including market imperfection, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the cost of mobility, and so on'(Friedman, 1968, p. 8). The level of effective demand cannot affect the natural rate of unemployment in the long run. It just affects the price level. The growth of productivity also cannot affect it in the long run, since the real wage rate is determined in accordance with the growth of productivity. In other words, the long-run Phillips curve is vertical and the trade-off between the rate of unemployment and inflation is merely observed in the short-run.[11] The level of the natural rate of unemployment changes when such the supply-side factors as legal minimum wage rate, ease of employment exchange, of availability of information about job vacancies and labour supply alter (Friedman, 1968, p. 9). These factors are the *structural* characteristic perceived by Friedman. As long as such a structural characteristic is unchanged, the unemployment rate consistent with the stable price level is constant. The hypothesis is influential in macroeconomic models and policies (e.g. Ball and Mankiw, 2002; Daly et al., 2012; Stiglitz, 1997).

The structural characteristic in the sense of Friedman is obviously contained in our model.[12] However, we can derive the following proposition critical to the hypothesis:

Proposition 2: *The unemployment rate consistent with the stable price level is not*

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[11] The short-run trade-off is shown by the expectations-augmented Phillips curve.
[12] See Kurose (2013b) in detail.

independent of the level of effective demand in the model accompanying structural dynamics.

We do not need to prove it; the reason why Proposition 2 is valid has already been shown in the previous section.[13] From the viewpoint of the structural dynamics, we obtain the unemployment rate consistent with the stable price level independent of the level of effective demand in the following two cases; one is the case where all the growth rates of productivity are equal to those of per-capita consumption. Expressing it by the deterministic model, it follows that $\rho_1(t)=\rho_2(t)=\cdots=\rho_m(t)=r_1(t)=r_2(t)=\cdots=r_m(t)$. In this case, the growth rate of the real wage, corresponding to function (4), is given by $\rho^*(t)=\dfrac{\rho(t)\sum_{i=1}^{m}c_i(0)l_i(0)}{\sum_{i=1}^{m}c_i(0)l_i(0)}$, where $\rho(t)\equiv\rho_1(t)=\rho_2(t)=\cdots=\rho_m(t)$. The other is the case where the sectoral equality of the growth rates of productivity and per-capita consumption is maintained. In other words, the following is fulfilled: $\rho_i(t)=r_i(t)$ for all i but $\rho_i(t)=r_i(t)\neq\rho_j(t)=r_j(t)$ if $i\neq j$. In this case, the growth rate of the real wage, corresponding to function (4), is given by $\rho^*(t)=\dfrac{\sum_{i=1}^{m}c_i(0)l_i(0)\rho_i(t)}{\sum_{i=1}^{m}c_i(0)l_i(0)}$. In those cases, the employment rate consistent with the stable price level is as follows: $\mu=\sum_{i=1}^{m}c_i(0)l_i(0)$. It is constant over time.

However, these cases have no empirical significance at all. The former case is lack of the structural dynamics completely; the structure of quantities, prices, and employment determined by the initial values never change over time. In the latter case, the structural dynamics occurs in the quantity and price system, but the effect of one system is offset by that of the other one within each sector. With respect to the entire economic system, therefore, the sectoral shares

[13] It has been proven that Proposition 2 is still valid even though capital is introduced. See Kurose (2013b).

of the output measured by the current price and employment do not change over time.

It can be regarded that Proposition 2 demonstrates that the level of effective demand has an effect on the unemployment rate consistent with the stable price level in empirically significant cases in which the structural dynamics occurs. Therefore, the policy prescription on the basis of the hypothesis of the natural rate of unemployment and the expectations-augmented Phillips curve might be misleading.

5. A Digression: the Relevance of the Evolving Structure of Demand

As already pointed out, the important implication of structural dynamics is that the rise in productivity must accompany the appropriate structural dynamics of demand-side in order to maintain the full employment and to raise the 'quality of life'.

This is completely neglected by many economists and policy-makers, and thus they often focus only on the supply-side conditions. One of the examples is the argument of *Zombies* (e.g. Caballero et al., 2008; Hoshi and Kashyap, 2004). The Zombies are firms which, despite lower productivity, survive during depression or recession because banks supply credit to them. This problem was said to be frequently observed in Japan and thus there are many empirical studies on it using the Japanese data, but *the Financial Times* recently reported the rise of Zombies in Europe (9th January 2013).

According to Caballero et al. (2008), the existence of the Zombie distorts the market competition: it softens a negative shock's impact on the destruction of firms and exacerbates its impact on the creation of firms. Therefore, the congestion created by the Zombies reduces the profits for healthy firms. It is shown that Zombie-dominated industries exhibit more depressed job creation and destruction, and lower productivity of the entire economic system.

Caballero et al. (2008) is one of typical models in which the relevance of technical change is just equivalent to the increase in productivity, in contrast to the above Pasinetti's (1993b) quotation. The model can be regarded as a multisectoral model since it includes some firms, but it is entirely lack of structural dynamics; it fails to describe the interaction between the evolution of technology and that of demand. It is assumed that each firm has the specific characteristic concerning the technology and demand for the product, and potential entrants have technological advance more than incumbents. It means that the productivity for a potential new firm is always higher than incumbents in the model. The existence of the Zombies lowers the productivity of the entire economic system, since it depresses the new entry. Therefore, the Zombies must be removed; the economic policy recommended is to dissolve them in order to raise the productivity and increase the job creation of the entire economic system.

However, the careful examination is required; the entry of firms that have technological advance does not necessarily bring in the favourable things alone. If the growth rates of labour productivity of the entry of firms are high enough to satisfy $\rho_i > r_i + g + \rho^*(t)$ or $\rho_i > r_i + g$ in the deterministic model presented at section 2, the outcome generated by the entry is not favourable for the entire economic system. This is because the output of sector i measured by the current price the numéraire of which is the dynamic standard commodity declines in the former case, and the employment of sector i declines in the latter case. The effect of technical progress on the entire economic system cannot be evaluated from the supply-side factors alone. In any case, the harmonisation between the evolution of the structure of technology and demand is definitely relevant.

It would be obvious that the rise in productivity has nothing to do with the 'quality of life' if it accompanies the decline of employment. The structural interaction between the evolution of technology and demand should not be neglected in growth models.

6. The Concluding Remarks

We have demonstrated the importance of the demand structure in economic growth. More specifically, it is shown that the structural interaction between the evolution of technology and that of demand is crucially important.

Many economists and policy-makers should keep in mind the significance of Pasinetti's (1993b) words quoted at section 3. The increase in productivity does not necessarily lead to the prosperity of our society. We must not interpret the *correlation* between the growth of productivity and the growth rate as the *causality* which runs from the former to the latter. It is only when the structure of demand appropriately changes that the growth of productivity leads to the successful results in the macroeconomic sense.

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Figure 1 (a): The dispersion of per-capita consumption coefficient at period ε

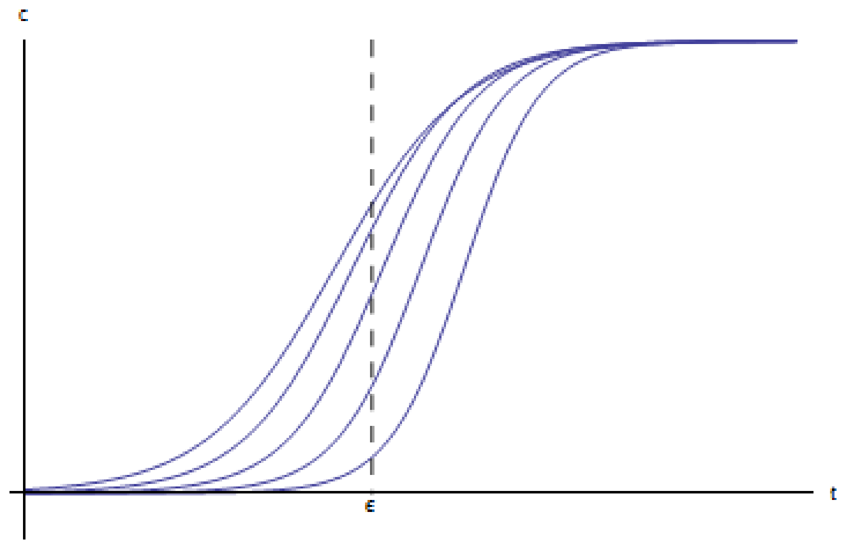

Figure 1 (b): The dispersion of productivity growth rate at period ε

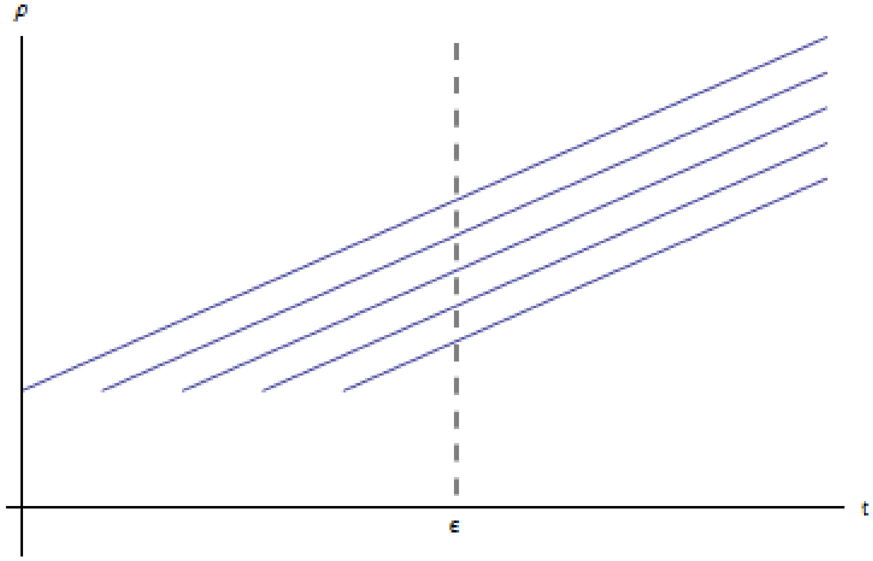

Figure 2 (a): The evolution of employment rate

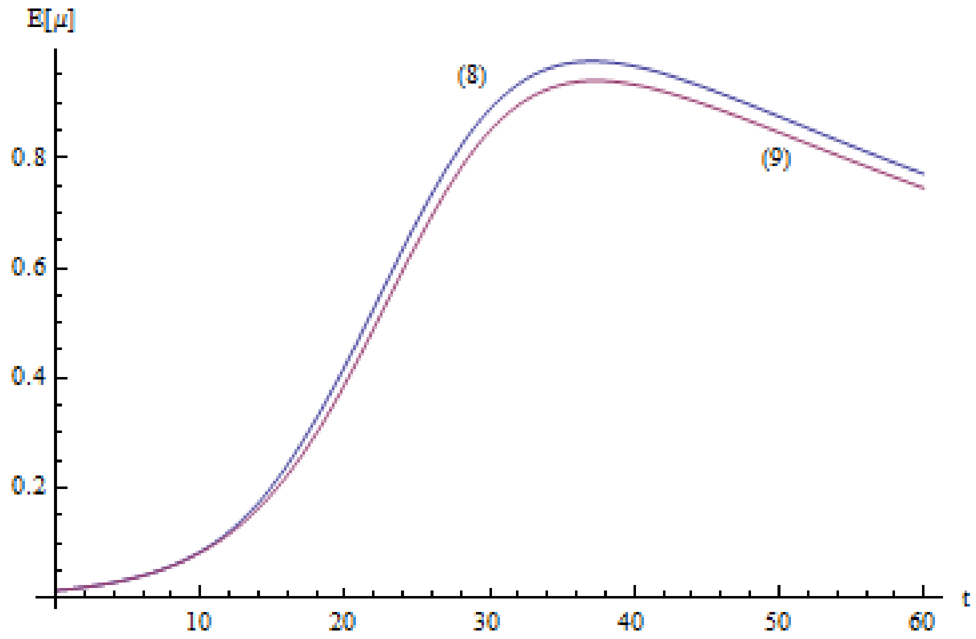

Figure 2 (b): The evolution of the growth rate of real wage