

# An Effect of the Intensity of Labour on Employment, Distribution and Growth

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## I. Introduction

Employment and distribution are observed in any modern economic system. Since labour is one of the factors to create wealth, and since the amount of labour laid out is dependent of the level of employment, results of economic activities are generally much influenced by employment. Nevertheless, it should be remarked that the level of employment is conceptually different from the amount of labour. Moreover, the level of employment does not uniquely determine the amount of labour expended.

If we employ fixed technical coefficients to describe an economy, the amount of labour necessary for the production of a certain level of output may seem to be determined uniquely. Most explanations so far made concerning employment seem to adopt this approach: they assume that the employment level determines uniquely the amount of labour laid out. This explanation is valid, however, only if hold hidden assumptions that working hours are kept constant, and that the intensity of labour is also constant.

A natural way of measuring the level of employment is to grasp it in terms of heads. Then, a basic relationship between the amount of labour laid out and the level of unemployment is that the former is the product of the latter, working hours per head and the intensity of labour per one working hour. Apart from the constancy of working hours, which is observed in most of modern economic systems, the intensity of labour is a sociopsychological flexible. It is true that in each stage of economic development a normal level of the intensity of labour is established. However, its normal level is not necessarily the maximum level. Expenditure of labour can be intensified by various policies.

It seems, however, that the role of the intensity of labour has not been fully studied in the discussion of employment and distribution. The purpose of this paper is to develop the idea that explicit introduction of a socio-psychological factor such as the intensity of labour will bring about a deeper insight into unemployment in a capitalist economy and the premium system in a socialist economy.

Section II will be devoted to the discussion of the inevitability of unemployment in a capitalist economy. By applying comparative static analysis, it will be proved that the net profit rate, which will also be defined in Section II, is maximised when the rate of unemployment takes a certain positive value.

In Section III, a rough sketch of a planned economy will be made. Under full employment, it will be proved that the introduction of premiums brings about the maximization of the growth rate of the economy.

The discussion will be carried out in the macro level. The following notations concerning the technique used in the economy and other variables will be employed in both section II and III:

$A$  : material input coefficient

$L$  : labour input coefficient

$N$  : the number of workers in terms of heads

$e$  : intensity of labour

$x$  : output

$f$  : nominal wage per head.

The following assumptions are also made:

(A1) point-input, point-output.

(A2) Distribution takes place at the end of the period.

(A3) Working hours per head in a unit of period is constant, and hence put as a unit.

(A4)  $A, L > 0$ .

As for mathematical notations, we shall utilise the symbol  $C^2$  to denote the set of two times differentiable and continuous functions. We shall also use both  $dz/dz$  and  $z'( )$  alternatively to denote the derivative of  $z$ .  $z'( )$  is used especially when it is necessary to specify the value of the independent variable.

## II. Unemployment in a capitalist economy

The problem of unemployment has been discussed mostly in relation to the process of accumulation. Marx, for example, argued that the reserved army is formed in the accumulation process in which more advanced techniques are introduced. However, unemployment is characteristic to a capitalist economy not only in growth but also in simple reproduction or the contracting state of the economy<sup>(1)</sup>. Even if there is no technical progress, persistent unemployment can be observed in a capitalist economy. Therefore, unemployment in a capitalist economy needs to be discussed from a different angle. The aim of this section is to spotlight unemployment from the viewpoint of the effect of unemployment on the intensity of labour; the inevitability of unemployment based on the maximization of the profit rate will be discussed.

In order to discuss the problem precisely, it is necessary to assume:

(A5) The society has two, and only two classes—the capitalist class, being the representative of owners of the means of production, and the working class possessing only their labour power.

(A6) No goods can be reproduced with labour only.

(A6) implies that for the production of any type of goods the means of production is required, and hence, all goods are supplied by

capitalists.

Let us call the economy satisfying these two assumptions a pure capitalist economy. It may be said that most economists accept these two either implicitly or explicitly. Nevertheless, it seems that (A6) is often overlooked.

It is self-evident that consumption goods are necessary for the maintenance of labour power. Even if one is not employed, one needs some consumption goods so that one may be able to reproduce one's labour power and appear in the labour market. In other words, if the unemployed receive nothing, they will be unable to maintain their labour power in its normal condition, and hence they can no longer be tough competitors against the employed. *Ceteris paribus*, the supply of labour will be decreased by the number of the unemployed, and equalised to the demand of labour in the next period. However, this is not what has actually happened. Then, the problem arises: what is the source of the consumption goods for the unemployed?

Some economists explain as follows. A capitalist economy includes, to some extent, a natural economy or a backward economy, eg agriculture, which absorbs the unemployed, and therein they can obtain income to purchase necessary goods. This explanation is, however, unsatisfactory. In the first place, it violates (A6). The discussion of unemployment in a capitalist economy should be carried out, based on the idea that production and distribution of consumption goods for the unemployed take place within a pure capitalist economy, and not in a natural or backward economy. Then, it becomes possible to discuss whether or not unemployment is intrinsic to a capitalist economy. In the second place, most of the modern capitalist economies have the unemployment benefit system. It is obvious that unemployment benefit never comes from a natural or backward economy.

Let us call commodities supplied by the capitalist class the social products. The source of unemployment benefit is a part of the social products. Therefore, in the macro economic level, the social products are divided into four parts: replacement of capital goods, consumption goods

for the employed as wages, consumption goods for the unemployed as unemployment benefit and the net share of the capitalist class.

What is the distinction between wages and unemployment benefit? It is evident that as opposed to the employed the unemployed make no immediate contribution to the capitalist class, in so far as the creation or appropriation of surplus value or profit is concerned. Hence, consumption goods for the unemployed do not enter into variable capital. It will be forced to conclude that unemployment benefit comes from surplus value. Since surplus value is realised as profit, unemployment benefit is part of profit.

Although the distinction between the two is clear, unemployment benefit will appear as a part of cost for production in the eyes of capitalists, if the capitalist class is obliged to pay unemployment benefit somehow or other: wages and unemployment benefit constitute variable capital in a broader sense.<sup>2)</sup> Let us call the rate of net share of capitalists on advanced capital the rate of net profit. It is clear that what matters to the capitalist class is not the rate of gross profit, but the rate of net profit. Therefore, we shall discuss the maximization of the rate of net profit in the following.

Then, the class struggle between the two classes determines wages. However, what is determined is not the real wages, but nominal wages. Once an agreement is made between the two classes, the nominal wages will be kept constant. The problem is how the profit rate is maximised under given  $f$ .

Let us introduce a macro economic model of unemployment. Employ the following notations additionally:

$r$  : net profit rate

$N_d$  : the number of the employed

$u=1-N/N_d$  : rate of unemployment

$h$  : unemployment benefit per head

Let us assume:

$$(A7) \quad f > h > 0.$$

$$(A8) \quad N \geq N_d > 0,$$

The implications of these two are economically trivial. From the definition of  $u$ , we have

$$(1) \quad N_d = (1-u)N.$$

In view of (A8), the range of  $u$  is  $[0, 1)$ .

Bearing in mind that part of the social products should be distributed to the unemployed, and taking into account (A2), we can write

$$(2) \quad x = (1+r)Ax + fN_d + uNh.$$

Whilst, the amount of labour necessary for producing the level of  $x$  is expressed by

$$(3) \quad Lx = eN_d.$$

The system of equations (1)-(3) gives a relationship among  $x$ ,  $r$ ,  $e$  and  $u$ , where all the others are exogeneous.

Since the unemployed compete with the employed, the position of workers in the labour market is weakened, and hence the increase in the rate of unemployment tends to increase the intensity of labour laid out by the employed. Hence,  $e$  can be regarded as a function of  $u$ :  $e = e(u)$ ,  $u \in [0, 1)$ . As for properties of  $e(u)$ , let us suppose:

$$(A9) \quad e \in C^2. \quad de/du > 0, \quad d^2e/du^2 < 0.$$

$$(A10) \quad e(0) = 1, \quad e'(0) > h/f.$$

The last two premises in (A9) reflect the reaction of the employed to the increase in the unemployment rate. The first premises in (A10) means simply that the intensity of labour is normalised as unit in the case of full employment. The second specifies the range of  $e'(0)$ .

The total amount of wages paid to the employed is expressed by

$$fL_d = (f/e)Lx$$

in the light of (3). Let us put

$$w = f/e$$

and call it the real wage rate.  $w$  is measured by output unit per labour, and hence equivalent to the conventional definition of the real wage rate. Then, we can confirm the following:

**Proposition 1.** Suppose that (A9) holds. Then, the real wage is inversely related to the rate of unemployment:

$$dw/du < 0.$$

**Proof.** Trivial. In fact,

$$dw/du = -(f/e^2)de/du < 0. \quad \text{Q. E. D.}$$

This shows that even if nominal wages are kept unaltered, the real wage rate can be decreased by the increase in the intensity of labour, provided that (A9) holds.

Now, from (1)-(3), we have

$$(4) \quad Lx = e(1-u)N,$$

which shows that  $x$  is also a function of  $u$ :  $x = x(u) \in C^2$ ,  $u \in [0, 1)$ . Then, we obtain

$$(5) \quad x = (1+r)Ax + fN(1-u) + Nhu.$$

This gives a functional relationship between  $r$  and  $u$ :  $r = r(u) \in C^2$ ,  $u \in [0, 1)$ .

From (4) and (5), we get

$$(6) \quad 1 - (1+r)A = L(f(1-u) + hu)/e(1-u).$$

Let us call  $u^*$  satisfying

$$r(u^*) \geq r(u) \quad \text{for } \forall u \in [0, 1)$$

the optimum rate of unemployment. Then, we can prove:

**Proposition 2.** Suppose that (A7)-(A10) hold. Then, there exists a unique, positive  $u^*$ .

**Proof.** By differentiating (5), we obtain

$$(7) \quad Axdr/du = (1 - (1+r)A)dx/du + (f-h)N.$$

Since we have from (4)

$$dx/du = ((1-u)de/du - e)N/L$$

and  $r$  and  $x$  in (7) can be eliminated by dint of (4) and (5), we obtain

$$(A/L)dr/du = -F(u)/e^2(1-u)^2,$$

where

$$F(u) = eh - (1-u)(f + (h-f)u)de/du.$$

It is easily seen that in view of (A7) and (A10)

$$F(0) = h - fe'(0) < 0,$$

and in view of (A7), (A9) and (A10)

$$F(1) = e(1)h > 0.$$

It then follows that there exists at least one  $u \in [0, 1)$  such that  $dr/du = 0$ .

Whilst, from (7), we have, for  $u$  such that  $dr/du=0$ ,

$$Axd^2r/dn^2=(1-(1+r)A)^2x/du^2.$$

As we have, in the light of (A4) and (A9),

$$d^2x/du^2=[N(1-u)d^2e/dn^2-2Nde/du]/L<0$$

and, from (6), for  $u\in[0,1)$

$$1-(1+r)A>0$$

and, in view of (A4),

$$Ax>0,$$

we obtain

$$d^2r/du^2<0$$

for  $u$  such that  $dr/du=0$ . Therefore,  $u$  satisfying  $dr/du=0$  is unique and maximises  $r(u)$ . Q. E. D.

It may be said that this proposition explains the inevitability of unemployment in a capitalist economy. The fact that unemployment decrease the real wage rate is empirically known, and formulated as the Phillip's curve. The above may be regarded as a direct supplementary to the theory of the Phillip's curve. In short, if the employed react to unemployment sensitively, unemployment is favorable from the viewpoint of the maximization of the profit rate.

Finally, it should be remarked that  $r(u)>0$  for  $\forall u\in[0,1)$  is not necessarily ensured, even if we have a reasonable premise that there exists  $u\in[0,1)$  such that  $r(u)>0$ , which entails  $r(u^*)>0$ .

**Proposition 3.** Suppose

$$(8) \quad A<1-fL/e(1).$$

Then,  $r(u)<0$  for  $\forall u\in[0,1)$ , if and only if  $h=0$ .

**Proof.** Since (8) entails  $r(0)>0$ , we have  $r(n^*)>0$ . Whereas, from (6), we obtain

$$\lim_{u\rightarrow 1} (1+r(u))A=1-fL/e>A$$

if and only if  $h=0$ . From (8), we have

$$\lim_{u\rightarrow 1} r(u)>0$$

Since  $r(u)$  is convex in  $[0,1)$ , the conclusion soon follows. Q. E. D.



This proposition shows that the rate of unemployment cannot be heightened beyond a certain level in general, if unemployment benefit is paid.

### III. Material incentives in a planned economy

There may be no doubt that one of most important features of a planned economy is full employment. As a matter of fact, it can be said that persistent unemployment has never been observed in planned economies.

Full employment in a planned economy seems to raise, however, the problem whether or not there are sufficient consumption goods to distribute to workers. If the level of production is relatively low, the amount of distribution per head becomes necessarily small. Statistics of planned economies seem to show that the consumption level of workers is not fully high.

Therefore, one of the basic problem of a planned economy is to increase the level of consumption as well as production. As pointed out in section I, however, if the technical relationship alone determines the level of output and employment, then without investment there will be no room for the economy to expand. In fact, even if full employment is attained, there will be a possibility for faster growth beside investment and technical progress. Some planned economies began to adopt material incentive policies, which inspire workers with bonuses or premiums.

The aim of this section is to discuss a simple material incentives policy from the viewpoint of the intensity of labour. We shall make a sketch of a planned economy and examine the workability of the premium system.

The planned economy which will be discussed in this section is characterised by the following premises.

(A11) There is a central committee called the helmsman, that possesses the sufficient information on the economy and guides it.

(A12) Full employment is attained.

(A11) implies that, based on the information, the helmsman can indicate the level of output, which can be attained if workers lay out their labour in its socially normal intensity. Let us call this level of output the expected level. If the actual output exceeds the expected level, the difference between them is called excess output. Let us make (A13) If there is any excess output, additional wages are paid in proportion to it.

Let us call them premiums. It then follows that the total output consists of gross investment and consumption. Moreover, consumption is split into three parts: normal wages, premium and the social consumption funds.

The helmsman aims at maximising the growth rate. The problem is if it is possible to maximise the growth rate by the introduction of the premium system which inspires workers.

Let us construct a macro economic model of growth in a planned economy. The following notations are employed additionally.

$z$  : expected level of output

$C$  : social consumption funds

$g$  : growth rate

$b$  : premium coefficient per head.

Bearing in mind that we have (A3) and (A12), we can write

$$(9) \quad x = (1+g)Ax + fN + b(x-z)N + C, \quad x \geq z0,$$

and

$$(10) \quad Lx = eN.$$

It is easily seen that (9) and (10) give a functional relationship among  $x$ ,  $g$ ,  $e$  and  $b$ . The range of  $b$  is  $[0, \infty)$ .

Since the amount of premium influences the morale of workers,  $e$  can be regarded as a function of  $b$ :  $e = e(b)$ ,  $b \in [0, \infty)$ . Hence,  $x$  and  $g$  may be also regarded as functions of  $b$ :  $x = x(b)$  and  $g = g(b)$ ,  $b \in [0, \infty)$ . Let us assume here:

(A14)  $e(b) \in C^2$ ,  $e(b) < K_e$ , where  $K_e$  is a positive number.

From the first premise, it soon follows that  $x(b)$ ,  $g(b) \in C^2$ . The second premise of this means that there exists a limit to the intensity of labour.

As for other properties of  $e(b)$ , let us suppose

$$(A15) \quad de/db > 0, \quad d^2e/db^2 < 0.$$

$$(A16) \quad e(0) = 1, \quad e'(0) > A/[1 - (1 + g(0))A].$$

The reaction of workers to the premium system is shown by (A15), and the second premise in (A16) indicates that the sensitivity of their reaction to the introduction of the premium system is greater than  $A$  multiplied by  $1/[1 - (1 + g(0))A]$  which may be construed as a growth multiplier.

Note that in view of the implication of (A11), we have

$$(11) \quad x(0) = z,$$

and hence, from (10) and (A16), we get

$$(12) \quad Lz = N.$$

It should be also remarked that from (A14) and (A15) we obtain

$$(13) \quad \lim_{b \rightarrow \infty} e'(b) = 0.$$

Let us call  $b^*$  fulfilling

$$g(b^*) \geq g(b) \quad \text{for } \forall b \in [0, \infty)$$

the optimum premium coefficient. Then, we can prove:

**Proposition 4.** Suppose that (A14)–(A16) hold. Then, there exists a unique, positive  $b^*$ .

**Proof.** By differentiating (9), we have

$$[1 - (1 + g)A - bN]dx/db = (1 + dr/db)Ax + (x - z)N,$$

from which, in view of (A16), (10) and (13), we have

$$g'(\infty) < 0 < g'(0).$$

Hence, there exists at least one positive  $b$  such that  $dg/db = 0$ , which is equivalent to

$$(14) \quad [1 - (1 + g)A - bN]dx/db = Ax + (x - z)N.$$

Since the right-hand side of (14) is positive and

$$dx/db = (N/L)de/db > 0$$

in the light of (10) and (A15), we get

$$(15) \quad 1 - (1 + g)A - bN > 0$$

for  $b$  such that  $dg/db = 0$ .

Let us put

$$k_1(b) = [1 - (1 + g)A - bN]dx/db$$

and

$$k_2(b) = Ax + (x - z)N.$$

By dint of (10), (A15) and (15), we get

$$dk_1/db < 0 < dk_2/db,$$

and in view of (A16) and (11), we have

$$k_1(0) > k_2(0).$$

Therefore, positive  $b$  such that  $dg/db = 0$  is unique.

Moreover, from (14), we get

$$Axd^2g/db^2 = [(x - z)N + Ax](d^2x/db^2)/(dx/db) - (A + N)dx/db < 0$$

for  $b$  such that  $dg/db = 0$  because of (A15).

Hence, this  $b$  maximises  $g(b)$ .

Q. E. D.

Nextly, let us consider an effect of the premium system on the real wage rate. Let us put  $e^* = e = (b^*)$ . Then, the real wage rate can be defined as a function of  $b$  as

$$w(b) = [f + b(x - z)]/e.$$

**Proposition 5.** If

$$(16) \quad f < b^*z,$$

then  $w(b^*) > f$ .

**Proof.** The proof is algebraic.

$$w(b^*) - w(0) = (b^*z - f)(e^* - 1)/e^* > 0$$

if (16) holds, because from (12)

$$x - z = z(e - 1).$$

Q. E. D.

Let us suppose:

(A17) There exists  $g(0) > 0$  for  $z > 0$  such that

$$z = (1 + g)Az + fN + C:$$

The following is trivial.

**Proposition 6,** (A17) implies  $g(b^*) > 0$ .

From the above we can conclude that in principle the premium system as a material incentive policy is rational in a planned economy.

It should be remarked, however, that the optimum premium coefficient depends on  $f$  and  $z$ . In Proposition 5, the condition (16)

shows that if  $f$  is set at a low level, the real wage rate is increased by the introduction of the premium system.

Note that (A17) is not immediately necessary for the maximization of the growth rate.

#### IV. Concluding remarks

So far we introduced the intensity of labour into macro economic models of capitalist and planned economies, and discussed its role in economic theory. It may be necessary here to make some remarks on the points of the discussion.

In the first place, the significance to grasp output and the real wage rate in relation to the intensity of labour should be reconfirmed. In the above it was seen that output and the real wage rate move in a complex manner. It should be also noticed that (A3) is not restrictive. Since the working hour is constant, wages discussed so far represent piece wages. If we regard the intensity of labour as a constant and the working hour as a variable, the same discussion can be repeated by interpreting  $e$  as the working hour. In such a case, wages are characterised as hour wages.

In the second place, the above discussion is a comparative static analysis in the sense that the dynamics of the economy is neglected.

In the third place, it should be emphasized that the above analysis is of highly abstract character: it depends apparently on various institutional and social, both explicit and implicit, restrictions. Historical and empirical studies are needed so as to establish hypotheses on the intensity of labour more concretely: not only the economic factors such as the difference between  $f$  and  $h$  in a capitalist economy and the initial wages in a planned economy, but also other social factors—attitudes to labour, industriousness of workers, habits in life etc. affect in a complex and subtle way the form of change in the intensity of labour. Hence, the above discussion should be carefully applied to the understanding of the actual economy.

Nevertheless, to introduce the intensity of labour into economics more explicitly and discuss it properly is one of the remaining problems

in economics.

### Footnotes

- 1) As for unemployment and technical change in Marx's economics, see Furth=Heertje=Veen (1978).
- 2) With respect to the fourth type of reserved army, such as pauperism, Marx wrote:

"...production of pauperism is included in that of the relative surplus-population, its necessity in theirs; along with the surplus-population, pauperism forms a condition of capitalist production, and of the capitalist development of wealth. It enters into the fanx forais of capitalist production: but capital knows how to throw these, for the most part, from its own shoulders on to those of the working-class and the lower middle class." (*Capital* 1, p. 644.)

Marx's remark here may be applied to the characterisation of unemployment benefit.

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