Testing Efficiency Wage Theories of Wage Rigidity and Unemployment

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I . Introduction

The period from the early 1950s until the early 1970s is considered as a golden age for market economies. In the middle of 1970s there was stagflation.

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The early 1980s are likely to be seen as the age of disinflation with an upward trend in unemployment. Since then, we have experienced wage rigidity and the persistence of unemployment at the same time. In other words, the sensitivity of real wages to unemployment has fairly weakened over the past fifteen years. Thus, a number of theories have been put forward to explain the causes of unemployment.

The purpose of the present paper is to derive a critical condition for a possibility of the coexistence of wage rigidity and unemployment by considering output, employment and real wages explicitly, using the tenet of efficiency wage theories. Because of the condition, we are to show that the perfectly competitive labour market might not be successful in explaining recent events in the labour market. And then we go on test the condition. Thereby, we suggest a new way for empircal research on efficiency wage models. The fundamental idea stems from the facts that labour is different from capital in terms of its nature as a factor of production and that the labour market is informationally imperfect.

A few theories have been developed since the early 1970s to explain wage rigidity in the face of unemployment. One of them is implicit contract theory (Baily 1974 and Azaridis 1975). The theory assumes that firms can easily have access to the capital market, and that both parts of the labor market have the same views about the probability distribution of the firm's product price. Under these assumptions, the argument is that the firm, on the one hand, can insure workers against income fluctuations, and on the other hand, keep a long term employment relationship with them. The second one is an efficient bargaining model. The idea goes back to Leontief (1946), and it has been studied recently by McDonald and Solow (1981). They prove that an efficient union wage bargain can generate a constant wage rate. However, the model is likely to suffer from an unattractive assumption that the labour demand curve has a constant elasticity.

A worry about these two models is that both models rely on too strong assumptions. When one of them is relaxed, the models lose their crucial characteristics. That is, for implicit contract theory, there seems no explicit reason why individuals are more restricted in credit markets than firms. And if all states are observable, then the theory would specify the amount of labour and the wage to be paid in each state. In this case, wages may be rigid, but the theory would not give rise to unemployment. In good states, it seems possible to rationalise over-employment rather than under -employment. if it the latter is going to be explained in that state, it seems necessary to assume that the firms are risk averse and workers risk neutral, which is likely to be the reverse of one of the original assumptions of the theory (Stiglitz 1984). In short, because contracts are in implicit forms there are incentives for the firms not to reveal the true state.

For the efficient bargaining model, the problem is how to determine the bargaining power of both parties on which their utility depends along the contract curve. In addition, even though the conventional view argues that the efficient bargaining model is fundamentally different from the monopoly model of a union, but when we introduce the assumption of lay-offs by seniority, it appears hard to distinguish between them (Oswald 1985).

The third one is so-called efficiency wage theories on which this paper relies. The hypothesis is that productivity depends on real wages paid to workers. The theory implies that workers' efforts or work intensity can be influenced by internal factors as an incentive mechanism (Akerlof 1982) as well as by external factors as the cost of being unem ployed(Shapiro and Stiglitg 1984).[1] The theory has a number of other implications. One of them is that there may exist wage dispersion among observationally indistinguishable workers across industries, because the relationship between wages and productivity may be different from industry to industry. The others are on real wage variations in the business cycle and hysteresis in unemployment. On the whole, the key property of the theory is that at the optimum the elasticity of effort with respect to the real wage is unity, which is called the Solow condition (see Solow 1979).

The theory has become popular as an explanation for wage rigidity and unemployment since the early 1980s, as union power has been reduced substantially even in the European countries. This appears to be consistent with the historical view in a wage determination. That is, the wage theory of a period can be interpreted as a product of (1) the economic developments and quantities of the time and place, including the movement of wage rates; (2) the wage-setting institutions; (3) the dominant economic theory of the period; and (4) the policy issues of the day (Dunlop 1957).

As far as the econometric side of efficiency wage theories is concerned, even though it is in a very early stage, so far, most empirical works seem to concentrate on wage differentials (Kreuger and Summers 1987, 1988 and Dickens and Lang 1987), and on the cyclical behaviour of productivity changes (Weisskopf et al. 1983 and Rebitzer 1987). There have been few attempts to investigate whether the Solow condition holds or not.[2] It seems natural because it may be nearly impossible to measure effort. However, without testing the codition empirically, the persuasiveness of efficiency wage models to account for the labour market phenomena would be weaker despite their intuitive appeal.

The present paper investigates the empirical validity of the condition by using the ingredient of the theory in which the real wage enters the production function in a labour augmenting way. With this, we derive another important condition that the elasticity of output with respect to employment is equal to that with respect to the real wage. The condition cannot be rejected for annual data in the United Kingdom economy.

The rest of the paper is organised as follows. In section 2, we develop the theoretical model. In sections 3 and 4, the empirical model is estimated on annual data for the post-war period in the U.K. manufacturing industry and the national economy and the results are discussed. Other implications are discussed in section 5. Finally, the conclusions are presented in the last section.

II. The Model

Following Solow (1979), we consider the production function being an increasing function of wage and employment, concave and continuously differentiable. Technology is multiplicative, and labour input (l) and effort (e) as a function of wage (w) enter the production function in a labour augmenting way.

$$q = q(e, l) \quad q_e, q_l > 0; \quad q_{ee}, q_{ll} < 0 \tag{1}$$

where q is output and $e = e(w)$. Then the partial inverse function $l = l[e(w), q]$ will exist and show labour reqùirements as an increasing function of the rate of output and a decreasing function of the wage in the sense that the increased effort level due to a rise in wages may have a negative effect on the number of employees necessary to produce the predetermined output level. The prime cost is $w\ l[e(w), q]$. For given q the firm wants to choose the wage minimising cost. The first order condition for the cost minimisation is

$$l[e(w), q] + wl_w[e(w), q] = 0 \tag{2}$$

and we assume that the choice variables can be varied around optimal choice which means that it represents a unique interior minimum. For each rate of output given by the market there is a best wage for the firm to quote, obtained by solving epuation (2). Thus, equation (2) defines w as a function of q.

Now the response of the wage to output is represented by dw/dp, obtained by the following implicit differentiation of equation (2)

$$\frac{\delta l}{\delta e}\frac{\delta e}{\delta w}dw + \frac{\delta l}{\delta q}dq + w\frac{\delta^2 l}{\delta w \delta w}dw + w\frac{\delta^2 l}{\delta w\ \delta q}dq = 0$$

$$dq(l_q + wl_{wq} + dw(l_w + wl_{ww} = 0$$

$$\frac{dw}{dq} = -[\frac{l_q + wl_{wq}}{l_w + wl_{ww}}] \tag{3}$$

The responsiveness of the wage to cyclical variations in output now depends on whether $l_q + wl_{wq} = 0$. Let us solve for w in equation (2) and substitute for w in $l_q + wl_{wq} = 0$. We find a partial differential equation for wage rigidity at all levels of output.

$$\frac{1}{l} l_w l_q - l_{wq} = 0 \tag{4}$$

We can confirm equation (4) by logarithmically differentiating labour demand function, $l = l[e(w), q]$, partially.

$$\frac{\delta^2 \ log\ l}{\delta w\ \delta q} = \frac{1}{l} l_{wq} - \frac{1}{l^2} l_w l_q$$

Thus equation (4) suggests that $\frac{\delta^2 \ log\ l}{\delta w\ \delta q} = 0$. The general solution for equation (4) is therefore

$$log\ l = A(q) + B(w) \tag{5}$$

where A and B are arbitary functions increasing and decreasing, respectively. If we set $\alpha = e^A$ and $\beta = e^{-B}$,

$$l = e^A e^B = e^A / e^{-B},\ l = \frac{\alpha(q)}{\beta(w)},\ so\ \alpha(q) = \beta(w) l$$

$$q = \alpha^{-1}[\beta(w) l] = q[\beta(w) l] \tag{6}$$

where q (the inverse function of α) and β are increasing functions.

This model can give an answer to the question of why wages are rigid regardless of the slackness or the tightness of the labour market. The model, however, does not seem to have anything to say about the occurrence and the persistence of high unemployment rates. The reason is that it is quite possible for unemploment to fall while wages are still rigid in the above model. It would be meaningless to think literally of (real) wage rigidity as the Solow model suggests.

So it is probably a better idea to link wage rigidity to the fluctuations of the unemployment rate·like the percentage responsiveness of real wages to unemployment. It is because wage rigidity is to be understood as a relative concept to something else. In other words, if the real wage is rigid at the level compatible with full employment, which means that the level of the real wage can change as taste, technology and external circumstances change, the wage rigidity would be regarded as the situation of a desirable market equilibrium. However, the problem is : why do not the unemployed bid dowm wages ?

Despite the widespread view that wage rigidity is responsible for much of unemployment dates back to the early 1930s, and Keynes' argument that wage flexibility would not in any case help maintain full employment, because of adverse effects of expected deflation on demand and employment (see De long and Summers 1986), the fact that the same issues reappear in economics without much progress having been made in reaching definitive solutions illustrates the enormous obstacles encountered in attempting to provide a sound empirically based understanding of exactly how the economic universe operates.

However, the assumption that wages are rigid is an essential one in most macroeconomic models that contend to explain fluctuations in the rate of unemployment. In order to relax the assumption, a few theories-labour contracts, union models and efficiency wage models-have been developed. But their empirical works are still in their infancy.

Therefore, it may not exaggerate to say that we have put much attention into the theory of wage rigidity in order to find a clue to find a clue to the explanation of unemployment, if we assume that high or/and rigid wages are the main culprit of unemployment. Hence, in order for the Solow model to explain wage rigidity as well as unemployment, it needs a critical addition to equation (6).

The Solow model has the following intrinsic meaning. Let $e(w)$ be efficiency unit of a worker being paid a wage w. What employers want to do is to minimise the cost of labour inputs. That is, each firm's cost per efficiency unit of labour, $w/e(w)$, not the cost of workers. Employers believe that the labour cost is inversely related to the wages paid to workers. Let θ be $w/e(w)$. In order to minimise θ with respect to w, we differentiate it logarithmically,

$$\frac{1}{w}-\frac{1}{e(w)}\frac{\delta e}{\delta w}=0 \quad or \quad e'(w)=\frac{e(w)}{w} \tag{7}$$

This is what is called the Solow equilibrium condition, which means that the wage elasticity of effort is unity in equilibrium.[3] That is, the, marginal effort is equal to the average effort. This implies that the firm wants to minimize total unit cost, not a direct labour unit cost. Moreover, the wage determination is independent of the level of employment, which leads to wage rigidity in the face of demand shocks.

Now we can express equation (1) as a Cobb–Douglas type production function like

$$q = \beta_0 \ [le(w)]^{\beta} \tag{1'}$$

wjere β_0 is a positive constant.[4] Thus, employer's profits can be represented by

$$\text{II} = \beta_0 \ [le(w)]^{\beta} - wl \tag{8}$$

First order conditions for profit maximisation are that the marginal product of labour is equal to the real wage, and that wage is chosen so that one unit of labour equals the change in output through the real wage change :

$$\beta_0 \ \beta \, l^{\beta-1}[e(w)]^{\beta} = w \tag{9}$$

$$\beta_0 \ \beta \, l^{\beta} \ [e(w)]^{\beta-1} \frac{\delta e}{\delta w} = l \tag{10}$$

We define $e_l = \delta log\ q/\delta log\ l$ *and* $e_w = \delta log\ q/\delta log\ w$. We can now derive an important condition with equation (9) and (10) for explanation both for wage rigidity and unemployment at the same time in the Solow model. Dividing equation (9) by (10), and then combining them with equation (7), we have the following condition.

$$\frac{\delta log\ q}{\delta log\ l} = \frac{\delta log\ q}{\delta log\ w} \tag{11}$$

That is, the labour elasticity of output (e_l), *the percentage change of output with respect to labour*, is equal to the wage elasticity of output (e_w), *the percentage change of output to wage*. This is another interpretation of the Solow equilibrium condition given in (7). In other words, Equation (11) may imply that the cost minimizing wage per efficiency unit of labour is to be equal to the ratio of e_w to e_l.

Condition (7) and (11) are equivalent ways of stating the equilibrium condition of efficiency wage theories. When condition (7) is satisfied, (11) as well and vice versa. However, it is very difficult to confirm the equilibrium condition with (7), that *the percentage change of effort being made during employees' works to the real wage is unity*. Instead with condition (11), it is possible for us to investigate whether the condition can be satisfied or not.

Thus, putting equation (6) and condition (11) together is going to give a clear foundation for the effciency wage version of wage rigidity and unemployment. That is, it is possible to test efficiency wage theories.

Furthermore, the equality of the two elasticities, e_l and e_w is going to weaken the possibility of the existence of perfectly competitive labour market, because in order for the labour market to function as standard economic theory predicts, e_l must be greates than e_w, because this makes the law of diminishing marginal productivity work properly, while the present model implicitly assume that there may be a tendency to increasing returns on the part of workers. Secondly, the condition that $e_l = e_w$ can enable us to avoid the case where equilibrium dose not exist. However, that is possible when the utility function is linear in the real wage and effort, $w(w, e) = w - e$ (Shapiro and Stiglitz 1984). In this kind of model, profit maximization means maximizing the ratio of e to w.

However, if effort(e) is linearly increasing in the real wage(w) and $e=0$ at positive w, there is no upper bound on e/w (Sparks 1986). In the context of the present model, this means that e_l is less than e_w. The firm's profit-maximizing wage thus is going to be infinite. Only the fact that $e_l = e_w$ prevents us from facing this implausible situation. Hence, the theoretical mechanism put forward by the present model is to give a good help to an answer to the question of why the market clearing models have often been less successful in accounting for unemployment.

Therefore, we show that there could be a trade-off between wages and employment to produce the predetermined level of output in terms of employers' interest, which is consistent with the firm's cost minimisation and/or profit maximisation behaviour. In addition, we could now open another way for an investigation of the empirical validation of efficiency wage models.

III. Empirical Tests

1). Model Specification

Contrary to other empirical work which is mainly concerned with wage dispersion across industries (Krueger and Summers 1987 and 1988, Dickens and Katz 1987 and Leonard 1987), and cyclical behaviour of productivity changes (Weisskopf et al.1983, Rebitzer 1987, van der Ploeg 1987 and Wadhwani and Wall 1988), we are concerned with investigating whether $e_l = e_w$.

The production function equation to be tested is coming form equation (6), (1') and (11) as follows,

$$log\ q_t = c_t + \beta_1\ log\ l_t + \beta_2\ log(w/p)_t + e_t \qquad (12)$$

With the condition (11), we have the null hypothesis ;

$\beta_1 = \beta_2$

Following efficiency wage considerations in which the firm sets wage to equate marginal benefits to marginal costs, we have used the real product wage as the wage variable, which is defined as the nominal wage deflated by the price of the value added at factor cost in the productive activity.

In order to test equation (12), we have added one period lagged dependent variable (q_{t-1}), time trend terms (t, t^2) to the right hand side variables, so the testable equation has turned up as a dynamic model. And we also have added an error term, ε_t which is assumed to be normally distributed with mean zero, and variance σ^2.

$$log\ q_t = c_t + \beta_0\ log\ q_{t-1} + \beta_1\ log\ l_t + \beta_2\ log(w/q)_t$$
$$+ \delta_1\ log\ k_t + \delta_2\ log\ k_{t-1} + t + t^2 + e_t \qquad (13)$$

Even though the model does not contain the capital stock, it is not unusual to put it in the model for the purpose of empirical specification. One difficulty arising from the test of the production function is that equation (13) may not be the reduced form of the model because of correlation between productivity and real wages, which may cause simultaneous equation bias. In a sense, high productivity in a certain industry may cause high wages. To eliminate the problem, instrumental variables estimates will be used with and without the capital stock. Unemployment benefits and the level of national unemployment will be used as instrumental variables (see the next sub-section for choice of the instrumental varables).

We use two sources of annual data. One is from the U.K. manufacturing industry, the other from the U.K. national economy.

2). The Relative Wage and Unemployment

Efficiency wage theorists argue that as far as an effort being made by a worker is concerned, the relative wage (w_l/w) and unemployment (u) matter (Jackman, Layard and Nickell 1989 and Stiglitz 1984). That is, the net productivity of a worker may depend positively on the level of the relative wage and the level of unemployment in the economy.

Let us consider these one by one. As for the relative wage, the argument seems true as a matter of fact when we take an individual firm into account to investigate the effect of wages on output (Wadhwani and Wall 1988). In aggregate data, we are left with the aggregate wage. Now we consider an average wage in an industry acting as a criterion for workers to examine whether they are being paid a fair wage.

In this context, because there is the average wage in the industry, it seems inevitable that some firms would pay higher wages than average wage, others pay lower wages than that, Hence, a firm's wage has a positive effect on the average wage. Therefore, the effect of the wages on the industry productivity would be offset, because firms paying lower wages than the average wage have to expect their productivity to decline. For this reason, in aggregation, it seems very hard to work out the relative wage in specifying an empirical model under efficiency wage considerations. On the whole, the industry productivity is going to depend on the industry average wage, Therefore, we use the industry and national average wages in the model.

Secondly, in shirking models, when the level of unemployment is high, workers are trying to avoid shirking. Thus, employers could expect that there would be a rise in productivity due to more efforts as the cost of being unemployed increases. Under these arguments, a few empirical tests have been carried on to see whether unemployment has a positive effect on output

(Rebitzer 1987, Weisskopf 1987, and Wadhwani and Wall 1988).

However, as far as the Solow equilibrium condition is concerned, unemployment does not seem to play a role at all (see Footnote 1). That is, the condition is *not* compatible with unemployment in the present model. In the Shapiro and Stiglitz (SS) model, the critical wage, w, has the following functional relationships :

$$w = \underset{+\ +\qquad -\ +\ +}{f(e, V_u, q, r, b)} \qquad or \qquad e = \frac{q(w - rV_u}{(r + b + q)} \tag{14}$$

e : the required effort

V_u : the expected utility associated with being unemployed

q : the probability of being detected shirking

r : the rate of interest

b : the exogenous quit rate

When we substitute "e" in the SS model for "e" in equation (1'), we get the following result through first order conditions for profit maximization :

$$rV_u = w(\beta_1 - \beta_2) \tag{15}$$

As β_1 is equal to β_2 in equation (11), rV_u is to be zero in equation (15). Thus, in the aggregate model, when the firm sets the efficiency wage, there might be a possible situation in which the cost of being unemployed is zero as far as the Shapiro and Stiglitz model is concerned. In other words, unemployment might not serve as a worker discipline device in the SS model. This is why we do not add unemployment to the right hand side variables in specifying the empirical model.

3). Unmeasurable Labour Quality

One essential advantage of this type of econometric formulation to test efficiency wage models is that we do not necessarily worry about the effect of unmeasured labour quality on labour productivity, because it is the ratio of the two elasticities, e_l and e_w, that matters in this model. We do concede that both the elements embodied by the tenet of efficiency wage theories and those related to human capital theory appear to affect productivity. One problem facing most empirical works of efficiency wage model is how to sort out each component's contribution to the change in productivity.[5] Thus, what we have to do is to find out which element is more important than the other through empirical investigation .

4). Choice of the Instrumental Variables

It is not easy task to choose a proper instrument because most economic variables are in some way related to general economic fluctuations. But we require that the instrument be correlated with real wages, and that it not be related to output.

In efficiency wage models, we can see unemployment benefits may be a positive function of the real wage, because the benefits are going to be a negative function of effort (see Shapiro and Stiglitz 1984), and a rise in the benefit may affect turnover rates. However, there seems no reason to believe that unemployment benefit can affect output. The level of unemployment itself may act as such an instrument in this vein of argument.

IV. Results

1). Manufacturing Industry

Table 1 (equations 1-1 to 1-4) presents the results of OLS estimation of equation (13) without capital stock (k_t).The elasticities of output with respect to employment (e_l) range from 0.55 to 0.70. and those with respect to the real wage (e_w) are around 0.70 Except for β_1 and β_2, almost all coefficients are statistically insignificant. The *t-statistics* for testing the equality of two regression coefficents fall far short of even 1, which is given as follows :

$$t = \frac{\beta_1 - \beta_2}{\sqrt{var(\beta_1) + var(\beta_2) - 2\, cov(\beta_1, \beta_2)}}, \ a = 5\%$$

In the second and fourth columns of Table 1 (equations 1-2 and 1-4) in which one period lagged employment, the real wage and capital stock are included as the right hand side variables, the two elasticities are roughly the same as those without them. On the whole, the null hypothesis cannot be rejected. Therefore, the Solow equilibrium condition which is the wage elasticity of effort is unity seems to be satisfied.

We have introduced time trend terms, t and t^2, to capture technical progress and capital accumulation. When we put t and t^2 together, in most cases, with a few exceptions, the coefficients of t and t^2 are positive, but they are statistically insignificant.

Equations 1-3 and 1-4 show the results of the estimates with capital stock. Including the capital stock does not seem to change e_l and e_w at all. One noticeable result is that the elasticities are nearly the same as those shown in the equations 1-1 and 1-2. Needless to say, it has no effect on the Solow equilibrium condition. Moreover, the *t-statistics* for the coefficients of the capital stock are too low to be statistically significant. These results seem to apply for all regressions. Even when we include one period lagged capital as one of the independent variables, the results do not appear to change at all. Except for β_1 and β_2, all the *t-statistics* are statistically insignificant.

The fact that capital stock does not change the two elasticities, e_l and e_w, does not mean that the capital stock has no effect on changes of output at all. What we are arguing is that, at given capital stock, the real wage and employment are going to have the same effects on output. When capital stock changes, there would be the trade-off between the real wage and employment to produce the predetermined level of output.

Table 2 (equations 2-1 and 2-2) shows the results of instrumental variables estimates with and without capital stock respectively. The general results are that overall nothing has changed, except for the fact that while the employment elasticity of output, e_l, seems to be a bit larger, the wage elasticity of output, e_w, seems very stable around 0.7, which is quite close to OLS estimates. Thus, IV estimates do not seem to affect the elasticity of effort with respect to the real wage.

2). The National Economy

For the national economy, we have followed exactly the same procedure as we have followed for manufacturing. We have also found evidence that the hypothesis for the Solow equilibrium condition cannot be rejected for the whole economy as well. One thing to note is that e_w has substantially become smaller than those in the manufacturing industry. It seems hardly surprising that we have those results in the sense that the change of output of some sector of an economy (e.g.service sector) would be less senstive to the change in real wages than that of manufacturing industry, in particular, under efficiency wage considerations.

Moreover, concerning instrumental variables estimates, on the whole, the output elasticities with respect to employment, e_l, appear to be smaller than those in OLS estimates, while the elasticities to the real wage, e_w, have not changed.

Introducing capital stock into the model, we have confirmed that constant returns to scale seems to be maintainable in the United Kingdom economy. And the capital stock has no effect on the elsticity of effort with respect to the real wage, even though, in most estimates, *t-statistics* on the capital stock are statistically significant unlike in the manufacturing industry (see equations 3-3, 3-4 and 4-2).

One interesting result is that as we have noticed in the manufacturing industry, wage elasticities of output, e_w, seem fairly stable around 0.42 in either OLS or IV estimates, while those with respect to employment are around 0.53 to 0.70 in OLS estimates, but they seem to be a little smaller in IV estimates than those in OLS ones. In other words, a unit percentage change in the real wage would result in about 0.70 and 0.42 percentage change in output in the manufacturing industry and national economy respectively, while that in employment is likely to increase output by around 0.55 to 0.65 respectively.

In either the manufacturing industry or the national economy, in almost all regressions, *t-statistics* on the lagged dependent variable (q_{t-1}) are too low to be statistically significant, and we obtained very low coefficients on the variable. Therefore, the model is unlikely to be dominated by the dynamics.

Overall, strong evidence seems to be found in support of the efficiency wage hypothesis. Moreover, in the context of the sizes of the elasticities, comparing those in the manufacturing industry with those in the national economy, the present findings seem consistent with the theory.

V. Implications

1). Real Wages in the Business Cycle

Evidence based on the U.K. labour market is, along efficiency wage theories, found to support the argument that real wages move procyclically. In booms, firms want to get more effort, therefore they increase real wages rather than employ new workers.

Depending on the labour force availability in the economy, either the real wage or employment may be stable. If the growth of the labour force is lagging behind output growth, the present employees could easily cause their wages to increase. Even there are excess supply of labour, wage increases would be possible. In other words, generally, in booms, real wages tend to rise, while employment is going to become stable. In a recession, the reverse case seems true in the sense that employers choose to take the form of layoffs rather than a reduction in wages. Moreover, there is another possible story for real wages and output to move together in the sense that the present unemployed are ineffective on wage pressure partly because they are technologically out of date partly because the quality of the labour force may fall short of requirements of employers.

The following simple regressions in the manufacturing industry and the national economy in the U.K.could make our evidence more convincing.

Manufacturing Industry :

$$w_t = \underset{(4.69)}{-3.67} + \underset{(5.18)}{0.84w_{t-1}} - \underset{(2.10)}{0.30w_{t-1}} + \underset{(3.70)}{0.28q_t} + \underset{(1.53)}{0.005t} + \underset{(0.28)}{0.000t^t}$$

$R^2 = 0.99$ SE=0.02 DW=1.47 (*t* values in brackets)

National Economy :

$$w_t = \underset{(4.27)}{-5.32} + \underset{(4.18)}{0.65w_{t-1}} - \underset{(1.65)}{0.23w_{t-2}} + \underset{(4.13)}{0.73q_t} - \underset{(1.03)}{0.01t} + \underset{(0.02)}{0.00t^t}$$

$R^2 = 0.99$ SE=0.02 DW=1.66 (*t* values in brackets)

Thus, our evidence seems consistent with the findings of Dunop(1938) and Tarshis (1939) that real wages are positively likely to be related to cyclical activity and hence negatively likely to be related to the unemployment rate. We also have relevant evidence as follows.

Manufacturing Industry :

$$w_t = -\underset{(2.53)}{0.70} + \underset{(11.79)}{0.73w_{t-1}} - \underset{(6.41)}{0.08u_t} + \underset{(3.73)}{0.01t} + \underset{(1.32)}{0.001t^2}$$

$R^2 = 0.99$ SE$=0.01$ DW$=1.37$ (t value in brackets)

National Economy :

$$w_t = \underset{(3.36)}{0.27} + \underset{(7.47)}{0.59w_{t-1}} - \underset{(6.44)}{0.08u_t} + \underset{(4.26)}{0.012t} + \underset{(0.77)}{0.001t^2}$$

$R^2 = 0.99$ SE$=0.01$ DW$=1.75$ (t values in brackets)

Ruggles (1940) and Tobin (1947) challenged the results of Dunlop and Tarshis in the sense that the statistical significance of theirs is not sufficient. More recently, works by Neftci (1978) and Sargent (1978) show counter-cyclical real wage mevement. The paper by Geary and Kennen (1982) showing indepenence of the employment-real wage relationships has, in turn, been criticized by Sachs (1983) and Symons (1985).

2). Rent Sharing

This is one of the theories to try to give a microeconomic foundation for an explanation for the existence of involuntary unemployment, which relies on the employees' market power arising from turnover costs that the employed impose on the unemployed workers. According to the theory, wage inflation depends only on the change in unemployment not on the level (Blanchard and Summers 1986). The fundamental idea is that either the insiders set wages or they have some very big influences on setting wages.

Under the insider wage determination, there would be a tendency for productivity gain to be captured in the form of higher wages. This may reduce the firm's incentive to increase output and employment and, in turn, could result in persistent unemployment (Nickell and Wadhwani 1988).

However, the case where turnover costs matter seems to be limited to specific industries. As for an industry in which turnover costs are relatively low or it is not much important, it may not necessarily give the power to insiders to exert an influence over employment and wage setting decisions, even if we put the unemployed aside because they are no longer regarded as effective labour supply. Layard and Nickell (1986b, p. 13) present other defects of the theory by pointing out that the insider-outsider model can not not explain the relationship between the growth of the labour force and its effect on employment in the long run , the inconsistency of high levels of labour turnover with not steadily falling employment, and its inability to account for the sensitiveness of wages to general unemployment rater than industry specific unemployment. On the side of empirical tests, little evidence has been found to support that insider membership dynamics can explain the persistence of unemployment (Alogoskoufis and Manning 1988))

The theory and evidence the present paper presents is that $e_l = e_w$ would provide a plausible theoretical foundation for insiders or unions to intervene wage setting and employment decisions for their own benefits. Under the condition, even when the level of output for them to turn out declines, there would be a possibility that they could keep their wages constant by reducing the number of insiders. What we are arguing is that the influence for insiders or the unions to exert on wages and employment may be subject to their potentiality to produce the given level of output.

VI. Conclusions

We have found evidence that Solow equilibrium condition which means that the elasticity of output with respect to employment, e_l , is equal to that with respect to the real wage, e_w, cannot be rejected for the UK labour market. The e_l is around 0.55 and 0.65, and e_w is around 0.70 and 0.42 in the manufacturing industy and national economy respectively. These results remain robust even when we have replaced the real product wage with the real consumer wage. An important finding is that e_w seems to be more stable than e_l throughout regressions, while keeping the ratio of the two elasticities unity statistically. Adding the capital stock to the model, we have found that the UK economy encounters constant returns to scale.

These results may imply that wage determinations may not necessarily be based on the marginal productivity theory of labour only. Thus, as far as the condition holds, it is quite possible that firms may simply raise wages rather than increase labour force because of the cost incurred by new workers. Employers thus believe that high wages do not necessarily mean high cost per efficiency unit. In this context, an economy can face a situation where both wage rigidity and persistently high unemployment exist at the same time.

In booms, firms want to get more effort. Therefore, they increase real wages as one of incentive plans. Table 8 shows situations that real wages vary with output seem to be dominant in the context of the present model. Thus, the results confirm procyclical movements of real wages.

With the empirical evidence, unions or insiders can claim wage increases without taking non-union members or the unemployed into account in the sense that it is quite possible that increasing wages have the same effect as increasing employment on the determination of output.

Footnotes

1. Strictly speaking, we may have to distinguish between the efficency wage hypothesis and shirking models, because, as a dominant factor, in the former, efforts being made by workers depend on the real wage, but in the latter, on the cost of being unemployed. However, in general, we include shirking models in the efficiency wage hypothesis (see section 3).

2. Wadhwani and Wall (1988) present interesting findings on the Solow equilibrium condition, even though their approach is different from ours

3. This condition can be derived more formally than that given here. Let us take equation (6) as the production function. Then, we have first order condition for profit maximization with respect to labour like $q=w/e(w)$ which is the same as the form for the cost minimization per efficiency unit of labor.

4. β_0 may be a random technology shock as usual in real business cycle models. But we just put β_0 as a positive constant.

5. One good example is given in Wadhwani and Wall (1988).

Appendix

1). Data

MI : Manufacturing Industry.

NE : The National Economy.

q = logarithm of gross domestic product at factor cost at 1980 prices.

Source ;

MI : HMSO, National Income and Expenditure(Blue Book), 1956, 1965-1975, 1981, 1986 and 1987.

NE : HMSO, Economic Trends Annual Supplement (ETAS), 1988

l = logarithm of the number of employees.

Source :

MI : Department of Employment Gazette (DEG), various issues.

NE : ETAS, 1988.

k = logarithm of gross capital stock, 1980 prices.

Source :

MI : A. G. Armstrong, "Capital Stock in the U. K. Manufacturing Industry 1947-1976", in K. D. Patterson and K.E.Schotteds, "Measurement of Capital : Theory and Practice" 1978. For 1977 - 1986, k is calculated by the method used by Amstrong (1978) by using data estimated by HMSO. The value of gross capital stock at the end of the year t, k_t, is defined as :

$$k_t = k_{t-1} + v_t - s_t$$

wher v_t is gross fixed capital formation, s_t is the gross value of capital consumption.

NE : Blue Book, 1964, 1967 - '77, 1972, 1986 and 1988. Before 1958, only the 1948, 1951 and 1954 observations were published. Data were interpolated using the method given in MI.

w = logarithm of average wages.
Source :
MI : DEG, various issues (average hourly wages).
NE : DEG, various issues and Annual Abstract of Statistics (AAS) 1962, 1967, and 1974.
p = logarithm of retail price index, 1980 = 100.
Source : ETAS, 1988
p^* = logarithm of GDP deflator at factor cost, 1980 = 100.
Source : ETAS, 1988.
mp = logarithm of material price.
Source : Monthly Digest of Statistics, and ETAS, 1988.
h = logartihm of weekly hours worked.
Source : DEG and AAS, various issues.
u = logarithm of the unemployment rate.
Source : DEG, various issues.
ub = logarithm of unemployment benefits.
Source : Social Security Statistics.

2). Mis-specification Diagnostics

AUT (1) is the LM test for first-order residual autocorrelation, based on an auxiliary regression of the residuals, on lagged residuals and the fitted values from the original regression.

LIN (1) is the RESET test for linearity, based on an auxiliary regression of the residuals on the fitted values from the original regression and their squares.

HET (2) is the White (1980) type test for homoskedasticity, based on auxiliary regression of the squares of the residuals on the fitted values from the original regression and their squares.

ARCH (2) is the LM test against autoregressive conditional heteroskedasticity, based on an auxiliary regression of the squares of the residuals on the lagged squared residuals (Engle 1982).

Table 1
OLS Estimates of the Production Function
in UK Manufactiong Industry
Dependent Variable : In(Output)$_t$, q_t
Equatuins

Indeqendent Variables	1−1	1−2	1−3	1−4
c	2.662	5.318	4.019	0.338
	(1.360)	(2.934)	(0.809)	(0.078)
q_{t-1}	0.185	0.487	0.208	0.505
	(1.309)	(2.947)	(1.281)	(2.935)
l_t	0.545	0.704	0.539	0.717
	(2.444)	(3.013)	(2.379)	(2.838)
w_t	0.662	0.690	0.689	0.706
	(4.324)	(3.052)	(3.834)	(3.047)
l_{t-1}	−	−0.743	−	−0.811
	−	(3.566)	−	(3.783)
w_{t-1}	−	−0.225	−	0.400
	−	(0.867)	−	(1.367)
k_t	−	−	−0.120	−0.323
	−	−	(0.297)	(0.173)
k_{t-1}	−	−	−	0.749
	−	−	−	(0.460)
t	−0.001	0.006	0.003	−0.009
	(0.196)	(1.136)	(0.201)	(0.545)
t^2	0.001	−0.002	0.000	−0.000
	(0.851)	(1.307)	(0.470)	(0.64)
R^2	0.974	0.983	0.974	0.984
SE	0.034	0.029	0.035	0.029
D	1.333	2.000	1.352	2.080
T−STAT	0.439	0.035	0.520	0.028

Notes :
1). q_{t-1} : In(one period lagged output)$_{t-1}$, l_t : In(employment)$_t$, w_t : In(real product wage)$_t$, k_t : In(capital stock)$_t$.
2). *t−statistics* in parentheses.
3). T−STAT : *t−statistics* for testing the equality of two regression coefficients.

Table 2
IV Estimates of the Production Function in Manufacturing Industry
Dedendent Variable : In(Output)$_t$: q_t

Independent Variables	Equations 2−1	2−2
c	2.391	2.810
	(1.108)	(0.539)
q_{t-1}	0.131	0.103
	(0.852)	(0.558)
l_t	0.619	0.679
	(2.444)	(2.502)
w_t	0.684	0.725
	(4.356)	(3.874)
k_t	−	−0.056
	−	(0.134)
t	−0.001	0.000
	(0.187)	(0.013)
t^2	0.000	0.000
	(0.358)	(0.811)
R^2	0.974	0.973
SE	0.034	0.035
D	1.250	1.200
T−STAT	0.223	0.142

Notes :
1).see notes in Table 1.
2).instruments used : In(Unemployment Benefits)$_{t, t-1}$, In(the Unemployment Rate)$_{t, t-1}$, In(Material Input Prices)$_{t, t-1}$, In(Weekly Working Hours)$_{t, t-1}$, In(Nominal Wages)$_{t, t-1}$, In(Consumer Price Index)$_{t, t-1}$, In(Capital Stock)$_{t, t-1}$, In(One Period Lagged Employment)$_{t-1}$, and In(One Period Lagged Real Wage)$_{t-1}$.

Table 3
OLS Estimates of the Production Function in the National Econcomy
Dependent Variable : In(Ontput)$_t$, q_t

Independent Variables	Equations 3−1	3−2	3−3	3−4
c	0.818	1.473	−0.331	0.590
	(0.615)	(0.984)	(0.266)	(0.440)
q_{t-1}	0.143	0.418	−0.173	0.090
	(1.033)	(2.156)	(1.076)	(0.460)
l_t	0.526	0.556	0.666	0.753
	(3.077)	(2.903)	(4.181)	(4.198)
w_t	0.428	0.442	0.420	0.386
	(5.473)	(4.229)	(6.023)	(4.315)
l_{t-1}	−	−0.293	−	0.384
	−	(1.368)	−	(2.018)
w_{t-1}	−	−0.168	−	0.150
	−	(1.357)	−	(1.534)
t_t	−	−	0.319	0.300
	−	−	(3.042)	(1.386)
k_{t-1}	−	−	−	0.041
	−	−	−	(0.189)
t	0.009	0.009	0.009	0.008
	(2.392)	(2.651)	(3.015)	(2.861)
t^2	0.000	−0.000	0.000	0.000
	(0.849)	(0.203)	(0.068)	(1.301)
R^2	0.997	0.998	0.998	0.998
SE	0.013	0.012	0.011	0.011
DW	1.525	1.968	1.363	1.885
T−STAT	0.620	0.623	1.696	1.835

Notes : see notes in Table 1.

Table 4
IV Estimates of the Production Function in the National Economy
Dependent Variable : In(Output)$_t$, q_t

Independent Variables	Equations 4−1	4−2
c	2.302	0.537
	(1.397)	(0.343)
q_{t-1}	0.144	−0.216
	(0.841)	(0.943)
l_t	0.378	0.615
	(1.751)	(2.837)
w_t	0.463	0.460
	(4.982)	(5.604)
k_t	−	0.309
	−	(2.395)
t	0.010	0.010
	(2.768)	(3.094)
t^2	0.000	−0.000
	(0.314)	(0.286)
R^2	0.997	0.998
SE	0.013	0.012
DW	1.429	1.283
T−STAT	0.425	0.815

Notes :
1).see notes in Table 1.
2).Instruments used : see notes in Table 2.

Table 5
OLS Estimates of Production Function
with Real Consumer Wage

Dependent Variable : In(Output)$_t$, q_t

Independent Variables	Manufacturing 5−1	Manufacturing 5−2	National Economy 5−3	National Economy 5−4
c	1.262	3.152	1.470	0.556
	(0.696)	(0.656)	(0.940)	(0.347)
q_{t-1}	0.082	0.108	0.331	0.120
	(0.532)	(0.646)	(2.201)	(0.640)
l_t	0.759	0.765	0.326	0.419
	(3.314)	(3.284)	(1.704)	(2.198)
w_t	0.642	0.682	0.292	0.260
	(4.337)	(3.867)	(3.650)	(3.232)
k_t	−	−0.175	−	0.240
	−	(0.425)	−	(1.753)
t	−0.001	0.004	0.009	0.009
	(0.166)	(0.290)	(3.000)	(0.003)
t^2	0.000	0.000	−0.001	−0.000
	(0.872)	(1.001)	(0.108)	(0.910)
R^2	0.97	0.97	0.99	0.99
SE	0.034	0.034	0.015	0.015
DW	1.50	1.54	1.64	1.42
T−STAT	0.49	0.32	0.19	0.82

Notes : see notes in Table 1.

Table 6
IV Estimates of the Production Function
with Real Comsumer Wage
Dependent Variable : In(Output)$_t$, q_t

Independent Variables	Manufacturing 6−1	6−2	National Economy 6−3	6−4
c	0.504	1.804	2.337	1.005
	(0.247)	(0.359)	(1.235)	(0.476)
q_{t-1}	−0.023	0.004	0.247	0.320
	(0.127)	(0.020)	(2.201)	(1.273)
l_t	0.935	0.946	0.302	0.299
	(3.337)	(3.319)	(1.237)	(1.115)
w_t	0.692	0.716	0.388	0.242
	(4.410)	(3.394)	(3.803)	(2.880)
k_t	−	−0.133	−	0.131
	−	(0.312)	−	(0.823)
t	−0.002	−0.001	0.009	0.007
	(0.406)	(0.062)	(2.250)	(1.750)
t^2	0.000	0.000	0.000	−0.000
	(0.871)	(1.120)	(0.200)	(0.333)
R^2	0.97	0.97	0.99	0.99
SE	0.034	0.035	0.016	0.015
DW	1.39	1.43	1.47	1.70
T−STAT	0.88	0.78	0.37	0.22

Notes :
1).see notes in Table 1, and Table 2 for instruments used.

Table 7

Mis–specification Diagnostics

5% x^2 (1) = 3.84 and 5% x^2 (2) = 5.99

Equations	AUT(1)	LIN(1)	HET(2)	ARCH(2)
1–1	4.070	0.197	3.800	5.328
1–2	0.111	1.596	2.242	0.288
1–3	3.800	0.266	3.800	5.760
2–1	5.180	0.228	3.800	5.256
2–2	5.920	0.228	3.496	5.040
3–1	1.850	0.076	3.116	4.644
3–2	0.066	0.076	3.344	6.120
3–3	3.515	0.001	3.800	0.540
4–1	2.960	0.061	3.648	7.200
4–2	4.440	0.001	3.800	1.152

Table 8

Possible Relations Between Output, Employment and Real Wages

OUTPUT	EMPLOYMENT	REAL WAGES
↑	↑ ↑ →	↑ → ↑
→	→ ↑ ↓	→ ↓ ↑
↓	↓ → ↓	↓ ↓ →

Notes:
↑ : Increases in output employment or real wages.
→ : Stagnation in output or employment, and rigidity in real wages
↓ : Decreases in output, employment or real wages

Figure 1

GDP (GA) and Employment (LA) in UK Manufacturing

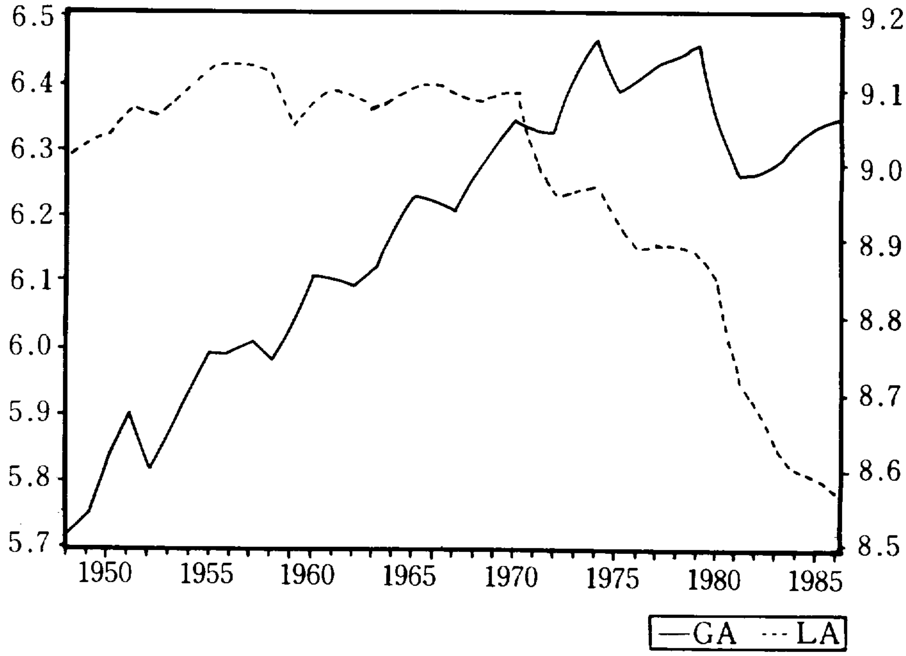


Figure 2

GDP (GA) and Real Product Wage (WP) in UK Manufacturing

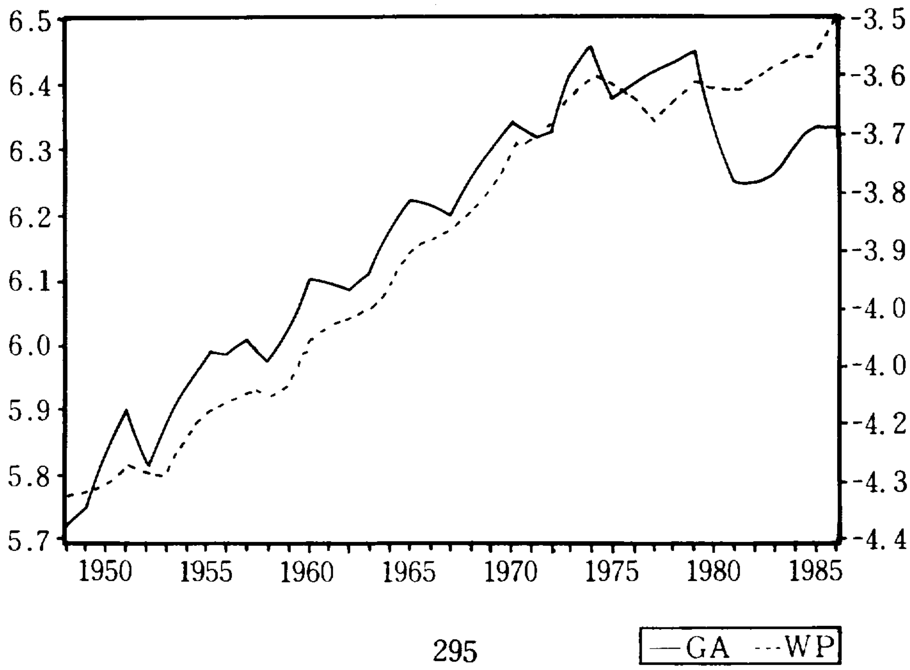


Figure 3

GDP (NGP) and Employment (NE) in the National Economy

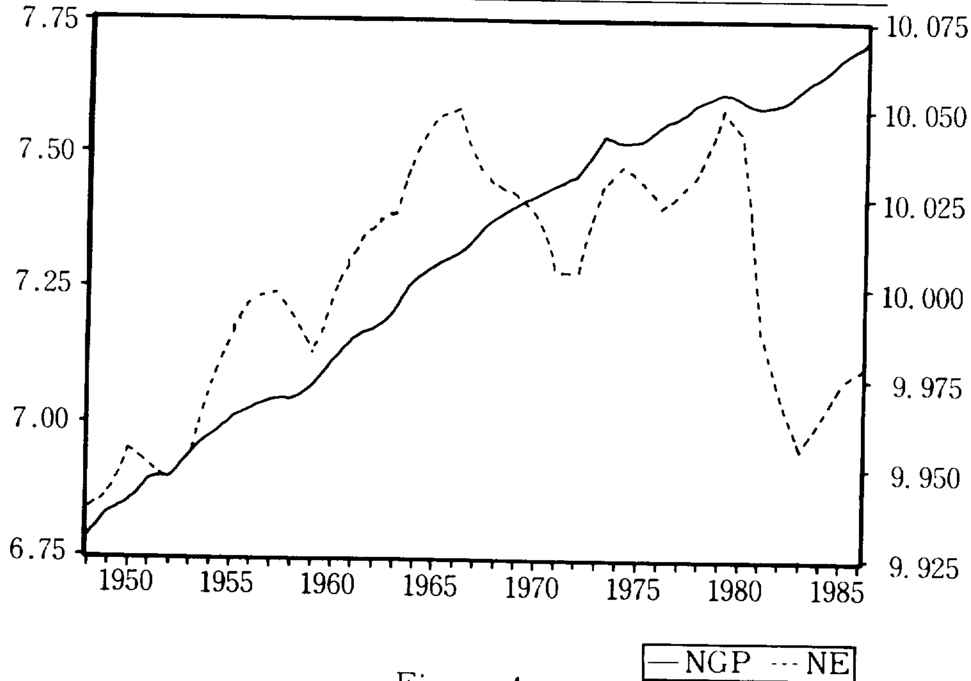
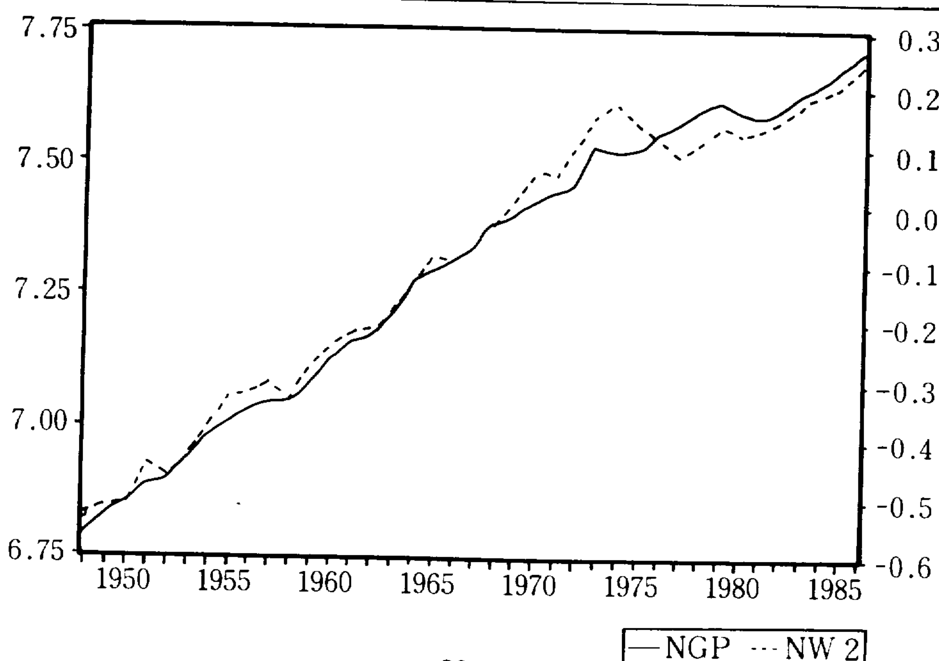


Figure 4

GDP (NGP) and Real Product Wage (NW 2) in the National Economy



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