

*Aggregate Demand, Investment and the NAIRU*<sup>1</sup>

by

Malcolm Sawyer\*

Working Paper No. 202

August 1997

\*The Jerome Levy Economics Institute and the University of Leeds

## **1. Introduction**

The NAIRU (non accelerating inflation rate of unemployment) is generally viewed as a supply-side determined short run equilibrium rate of unemployment. Aggregate demand plays no essential part in the determination of the equilibrium rate of unemployment. In those models from which a NAIRU is derived where aggregate demand makes an appearance, the nature of the model is such that the level of demand adjusts to the level of employment set by the supply-side factors, and those supply-side factors are invariant to the level of demand. The adjustment of aggregate demand can take place through a variety of routes, such as the real balance effect and fiscal stance used to avoid accelerating inflation, but the precise mechanism is not of central significance here (for further discussion see Sawyer, 1997).

The focus of this paper is on the role of aggregate demand on the determination of the level of employment within the general context of some form of NAIRU (by which we mean an equilibrium level of unemployment consistent where the forces determining that equilibrium arise from price and wage determination). Two aspects of the relationship between the level of aggregate demand and the NAIRU are of particular significance. First, it is argued that the real wage - employment relationship based on enterprise decisions (which many mistakenly refer to as the demand for labor schedule) cannot be fully articulated without reference to the level of aggregate demand. Second, and more significantly for this paper, a model is derived in which investment through additions to the capital stock shifts that real wage - employment relationship, and with a sufficiently expansionary

environment investment can shift that relationship until the NAIRU is compatible with full employment. A number of limitations on this conclusion are discussed.

In order to focus on the central points which we are seeking to make in this paper, a number of other features are ignored. A particularly significant one is that no hysteresis effects arising from the labor market are included nor any effects of changes in unemployment on the rate of wage inflation (and we would anticipate that the inclusion of these effects would strengthen the point which we seek to make). Further, a closed economy is assumed and aggregation from the enterprise to the macro level is treated as unproblematic. For simplicity the trend rate of growth of productivity is taken as zero (or this approach could be viewed as having normalized our variables relative to the trend rate of productivity growth), though the effects on labor productivity of variations in the level of output and in the level of the capital stock are included.

The NAIRU models are generally short-run in the sense that the capital stock is held constant.<sup>2</sup> The equilibrium position is defined by expectations being fulfilled and the real wage rising in line with productivity (and hence that the rate of inflation is constant). In models where aggregate demand has a role, it is (implicitly) assumed that the level of demand adjusts to the supply-side employment level. Little attention appears to have been paid to the plausibility of these adjustments, and specifically whether the speed of adjustments of those mentioned factors can be viewed as rapid relative to other adjustments (notably for the purposes here the capital stock).<sup>3</sup>

The heart of the models from which a NAIRU is solved for as the equilibrium (un)employment rate (under conditions of fulfilled expectations etc.) is two equations, one of which is largely derived from wage determination considerations, and the other from price and output considerations. Each of the equations involves real product wage as a function of the level of (un)employment, from which the

equilibrium levels of real wage and (un)employment can be solved.

## 2. Wage equations

Many formulations of the wage equation have been used in models from which a NAIRU has been derived as an equilibrium level of unemployment. Since the focus here is on the equilibrium outcome, considerations of the adjustment processes and of differences between expected and actual outcomes are overlooked. The equilibrium wage relationship can be viewed in one of two ways, but in both cases the level of unemployment restrains wages relative to some reference level.<sup>4</sup> The first alternative is an equilibrium relationship between real wages relative to some target or reference level and the level of unemployment<sup>5</sup>, and this can be expressed as  $w/p - T = f(U)$  where  $w$  (money wage),  $p$  (price) and  $T$  (target real wage) are in logs and  $U$  is the rate of unemployment. The second alternative is an equilibrium relationship which starts from the enterprise level where money wages relative to alternative income (which is a weighted average of alternative wages, if employment can be found, and of unemployment benefits if employment cannot be found) are a function of the level of unemployment.<sup>6</sup> This can be expressed as  $w/a = g(U)$  where  $a$  is (log) of alternative income. Since  $a$  is a weighted average of alternative wages and unemployment benefits ( $b$ ), in equilibrium it is usually assumed that all enterprises offer the same wage, and then the relationship simplifies to  $w/b = g(U)$ . When the level of unemployment benefits in real terms is set by the government, the relationship can be re-written as  $w/p - b/p = g(U)$ , which has the same basic form as the target real wage equation above. When the ratio of benefits to wages is fixed by the government, then the equation  $w/b = g(U)$  immediately yields the level of unemployment.

In each case there are a range of other variables which enter these relationships, but are not of particular relevance to the discussion here. For each of the relationships specified above, the expected

sign of the relationship between real wage and unemployment is a negative one. It is useful to work with a relationship between real wage and employment, and it is generally assumed that there is a one-for-one mapping between unemployment and employment with a fixed level of full employment (though this is not a crucial assumption). These relationships can be summarized as  $w/p - T = F(L)$  and  $w/p - b/p = G(L)$ , respectively with  $F'$  and  $G'$  positive.

There are two considerations on these relationships which are significant for our later discussions. First, what are the factors which determine  $T$  and  $b/p$  ?, and specifically for the discussion below to what extent would changes in the capital stock and in the number of enterprises lead to changes in  $T$  and  $b/p$ . Second, does the relationship permit full employment ?, or does the relationship have full (or some lower level of) employment as an asymptote (as in, for example, the model of Shapiro and Stiglitz, 1984). Direct answers to these questions are not provided, but rather these questions are used below to provide a classificatory system for when a NAIRU may or may not be compatible with full employment.

### **3. Real wage employment relationships**

In the modeling of enterprise behavior with regard to price, real wage, employment and output determination (which are, of course, interdependent) we wish to allow for varying returns to scale (and the related possibility that the productivity of labor may vary either positively or negatively with the volume of employment). At the level of the enterprise we make explicit allowance for the capital stock, and at the aggregate level for changes in the number of enterprises. In effect, this distinction corresponds to capacity replacing (though productivity enhancing) investment and capacity enhancing investment. The general environment within which the enterprise is assumed to operate is that of imperfect competition : the position of the demand schedule facing the individual enterprise is

assumed to depend on the decisions of other enterprises and on the level of aggregate demand.

The short-run profit maximizing decision facing the enterprise is given by maximize  $\pi = p(q,Z).q - w.l$  where  $q = f(l^\alpha k^{1-\alpha})$ :  $Z$  is a vector of variables influencing the demand facing an enterprise including the level of aggregate demand, lower cases letters refer to the enterprise level. Since the inclusion of material inputs would complicate the analysis without being of importance to the points which we wish to explore here we do not include those inputs. Using the level of employment as the key decision variable, with the capital stock and  $Z$  held constant, the first order condition for profit maximization yields:

$$\frac{(e-1)}{e} \alpha l^{\alpha-1} k^{1-\alpha} f'(l^\alpha k^{1-\alpha}) = \frac{w}{p(q,Z)} \quad (1)$$

This first order condition looks rather like a demand for labor schedule but should not be so regarded since the enterprise does not face parametric output prices, though it does face a given nominal wage (and hence sets the real product wage which it faces through its actions over its price). Further, this equation provides a 'point' outcome: it is an equation in  $l$  ( $k$  being exogenous as this point,  $p$ ,  $q$  being functions of  $l$ ) which can be solved to give the level of employment, from which the level of output, real product wage and price can be derived.

One way to map out a relationship between the real product wage and the level of employment is to vary the  $Z$  variable. In particular, movements in the level of aggregate demand would generate movements in employment, real product wage etc.. Making such variations in  $Z$  would lead to a relationship as sketched in Figure 1, where it is assumed that the function  $f$  is such that it initially displays increasing returns to labor and then diminishing ones. With a constant elasticity of demand (which is not a crucial assumption), the relationship in Figure 1 is merely the inverted U-shaped short

run cost curve. The significance of the role of aggregate demand here is that it provide the mechanism for the generation of a curve such as the one in Figure 1 : without that (or similar) mechanism, the decisions of the enterprise would merely yield a point outcome (in terms of real product wage and employment). Further, any point on the real wage employment relationship is supported by a particular level of aggregate demand.

Figure 1 near here

It is readily apparent from eqn. (1) that an increase in the capital stock would lead to an upward shift in the real product wage - employment relationship (and in the case of a Cobb-Douglas production function with  $f = 1$  a 1 per cent rise in  $k$  would lead to a 1 per cent rise in  $l$  for a given real product wage). However, for a given level of  $Z$ , an increase in  $k$  would lead to a combination of higher real product wage (induced by the lower price required to sell the increased output) and of employment. Moving to the aggregate level, the real product wage - employment relationship is the horizontal summation of the individual enterprise relationship. The relationship in Figure 1 is regarded as relating to a representative enterprise, and that aggregation across enterprises does not raise any particular problems. Figure 2 sketches the aggregate real wage - employment relationship. An increase in the number of enterprises will shift the relationship to the right, whereas an increase in the capital stock of the representative enterprise shifts the relationship up. In Figure 2, the shift from A to B reflects an increase in the average capital stock per enterprise and the shift from A to C an increase in the number of enterprises. (It can be noted that this distinction is immaterial in the case of a Cobb-Douglas production function with constant returns to scale, since the scale of the representative enterprise is not relevant).

Figure 2 near here

#### 4. NAIRU and full employment

It can readily be seen that investment will lead to rightward and upward shifts in the real wage - employment relationship, and the mix of those shifts depends on the degree to which the investment leads to a rise in the average capital stock (per enterprise) and the degree to which to an increase in the number of enterprises.<sup>7</sup> This leads to the important perspective that the real wage employment relationship may be able to shift upwards and outwards through sufficient capital investment to reach a position so that the corresponding NAIRU is compatible with full employment : such a possibility is illustrated in Figure 3. The wage equation drawn in Figure 3 can be derived from either of the two considerations outlined in section 2, and the curve labeled RWE equation is based on eqn. (1) (or the equivalent). The achievement of full employment would still require the appropriate level of aggregate demand (so that enterprises would choose to operate at point A), recalling that each point on the real wage employment relationship corresponds to a specific level of aggregate demand.<sup>8</sup>

Figure 3 near here

In Figure 3, the slope of the real wage-employment relationship around point A is clearly negative. However a relationship which was positively sloped would not change any significant conclusions, though it can be noted that if the real wage employment relationship has a significant portion for which the curve is horizontal, then moving toward full employment would require an increase in the average capital stock.

In the approach adopted here, there would be unemployment in equilibrium if there is insufficient capacity for the enterprises to be willing to employ the whole of the work force at the real wage generated by the wage equation at full employment. This can be illustrated in terms of Figure 4, where enterprises would only wish to employ say  $E_1$  at wage  $(w/p)_1$ . Any NAIRU which falls short of full



employment is viewed in terms of a lack of capacity (rather than being viewed in terms of, for example, labor market imperfections). The notion that sufficient capacity can lift the NAIRU to full employment does not, of course, mean that such capacity will be forthcoming, and in particular high levels of unemployment will provide a strong disincentive for such capacity to be built.

Figure 4 near here

A number of possibilities which would entail that an increased capital stock would not eventually lead to a NAIRU compatible with full employment are now considered. Three are identified here (and there may be others which we have not been able to identify).

First, from consideration of the wage equation, full employment may require a high real wage which is greater than the wage which the enterprise is ever willing to pay. This can be subdivided into two sub-considerations. The real wage  $(w/p)_1$  in Figure 4 may be higher than the maximum output per person which is technically feasible whatever the size of the capital stock.<sup>9</sup> The second sub-consideration would arise when  $(w/p)_1$  is greater than the maximum which enterprises would ever be willing to pay based on the maximum value of output per person which could be generated and the profits which the enterprises seek to extract. In this case, a NAIRU below full employment should be seen as arising from a conflict over income distribution which cannot be resolved through additional capacity and where the claims which workers and enterprises are making on income are incompatible (with full employment).

Second, the wage equation may be asymptotic to the full employment level (or a smaller level) as in the model of Shapiro and Stiglitz (1984). It will be recalled that in that model unemployment restrains 'shirking' by workers and that full employment would entail no restraint on 'shirking' since the loss of a job entails no financial loss at full employment since an equivalent job at the same wage as the

one lost is available immediately elsewhere. This is illustrated in Figure 5. It is still the case that increased capacity will raise the level of employment (and of real wages), but full employment would clearly be unobtainable in this case. We would though make three comments here. The first is that Shapiro and Stiglitz model the effort decision as a zero:one decision ('shirk' or 'not shirk'), and assume that if the enterprise wage and the alternative income were equal (which would arise when unemployment was zero), then workers would 'shirk'. If instead it is postulated that the degree of effort varies (depending on the ratio of wage to alternative income) but would remain positive (at an 'acceptable' level) when that ratio were unity, then the specific problem highlighted by Shapiro and Stiglitz would not arise. The second comment is to the question the assumption in the model of Shapiro and Stiglitz that there is homogeneous labor so that full employment entails jobs at the going wage being readily available and hence there are no costs to job loss. If there is some cost of job loss at full employment (e.g. because there is some risk that a lower paying job would have to be accepted, that there is some waiting period between losing one job and starting another even at full employment), then the wage equation may intersect the vertical full employment line. This could also be viewed as saying that full employment can be defined in terms of the equality of unemployed people and job vacancies so that full employment involves some search unemployment. In that view, full employment involves some costs of job loss. The third comment is that if 'shirking' at full employment is the fundamental constraint on the achievement of full employment, then the policy route is to find alternative mechanisms (e.g. through job enrichment, worker participation) to ensure 'non-shirking'. Inflation may appear to be the problem but the suppression of inflation through deflation may make unemployment worse through its effect on productive capacity.

Figure 5 near here

The third possibility is that, in effect, the wage equation may shift up for any shift in the real wage employment equation : for example, a target real wage responds to what can be achieved, and as the real wage employment relationship shifts up (permitting a higher real wage for any given level of employment) so the target real wage adjusts, and the wage equation shifts. A similar consideration arises when the level of unemployment benefits rises in line with wages and hence  $b/p$  rises in line with any rise in the real wage. In effect what happens is that a given relationship between real wage and the target real wage or between the (real) wage and the (real) level of benefits requires a particular level of unemployment. If the target real wage (real benefits) moves in line with actual real wages, then the effect on the equilibrium level of employment will depend on the elasticity of the real wage employment relationship. It could be said that if the response of the wage equation to a shift in the real wage employment relationship arising from an increase in the aggregate capital stock, then workers (or at least those in employment) in association with employers are to that extent taking the increase in productivity in the form of higher wages rather than as an increase in employment.

It would seem that through some apparently innocuous assumptions the models developed in the influential book by Layard, Nickell and Jackman (1991) imposed conditions to the effect that any shift in the real wage employment relationship generated a corresponding shift in the wage equation, such that the equilibrium level of unemployment did not change (and the benefits of higher productivity fed through into real wages). Layard, Nickell and Jackman use a Cobb-Douglas production function with constant returns to scale (and hence there is no significance to be given to the division of increases in the capital stock between the average per enterprise and the number of enterprises). In the Cobb-Douglas case,  $w/p = (e-1)/e \cdot \alpha L^{\alpha-1} K^{1-\alpha}$  and it can readily be calculated that the employment level will be constant if the proportionate rise in the real wage (imposed on the enterprise) is equal

to the proportionate rise of output following a rise in the capital stock for a given level of employment. Any mechanism which imposes that condition (whether by a rise in the target real wage, the level of unemployment benefits or some other means) would lead to constant equilibrium level of employment (and hence a constant NAIRU). In the case of a CES production function, with the elasticity of substitution less than unity, then such a proportionate rise in the real wage would be compatible with a rise in employment.

In Layard, Nickell and Jackman (1991), there are a number of reasons why the capital-labor ratio does not influence the equilibrium level of unemployment. In the union bargaining model deployed in their Chapter 2, they conclude that 'if the production function is Cobb-Douglas (not a bad assumption) and benefit replacement ratios are kept stable, then unemployment in the long run is independent of capital accumulation and technical progress. .... If, however, the elasticity of substitution is less than one, capital accumulation (with no technical progress) raises the share of labor and reduces unemployment' (p. 107). Rowthorn (1996) argues that the estimates of the elasticity of substitution between labor and capital are considerably below unity, and hence that a rising capital-labor ratio reduces the equilibrium level of unemployment.

In their Chapter 8, the approach is somewhat different (and described as 'wages may be determined by a variety of methods and in this chapter we do not propose to be too specific', p.364). They use, however, an insider-outsider approach. The significant element here is that their approach (which we have criticized elsewhere, Sawyer, 1997) leads to two equations for the real wage (based on price consideration and on wage considerations) which contain the capital-labor ratio in exactly the same form (cf. their eqns. 27 and 28 in Chapter 8), with the consequence that the solution for the equilibrium level of unemployment (cf. eqn. 31) does not contain any reference to the capital-labor

ratio.

In Layard, Nickell and Jackman (1991) Chapter 2, the mark-up of the wage over alternative income (a weighted average of wages elsewhere and the unemployment benefits) in a bilateral bargaining model does not depend on the capital-labor ratio, whereas Rowthorn (1996) shows (his eqn. A3.30) that with a CES production function, that mark-up does depend on the capital-labor ratio. The equilibrium level of unemployment depends on the relationship between actual wage and the alternative wage. In the case of the Cobb-Douglas production function with a constant wage to benefit ratio, the level of equilibrium unemployment remains unchanged in the face of changes in the capital-labor ratio since the relationship between the wage-alternative wage and the level of unemployment remains unchanged. In the case of the CES production function, that relationship changes when the capital-labor ratio changes permitting a change in the equilibrium level of unemployment (and specifically if the elasticity of substitution is below unity, the equilibrium level of unemployment falls when the capital-labor ratio rises).

These considerations would appear more relevant when investment takes the form of increasing the average capital stock per enterprise for then labor productivity would rise, whereas in the case of increasing number of enterprises the main effect is on capacity.<sup>10</sup>

We would conclude from this discussion that when capital investment takes the form of increasing the average capital stock per enterprise, and where the elasticity of substitution is unity and the wage equation shifts up in line with the rise in output (and hence the labor share in national income remains a constant) then the NAIRU can become stuck below the full employment level, and it cannot be shifted through the expansion of the capital stock. But when the elasticity of substitution is below unity, or when the wage equation does not shift up in line with the rise in output, or when capital

investment takes the form of more enterprises, then the NAIRU can be guided into compatibility with full employment through capital investment.

### **5. An illustration**

The significance of these arguments can be illustrated as follows. Starting from a particular position of the real wage employment relationship, and a corresponding NAIRU, the reduction of inflation may entail a higher level of unemployment. Now briefly consider the cyclical and the trend effects of higher unemployment. For a cyclical down turn, a 1 per cent higher rate of unemployment may be associated with up to 3 per cent lower output (using the Okun's 'Law' estimates), and 3 per cent lower output is likely to be associated with an even greater reduction in investment of say 6 per cent. If the capital stock would have grown by 3 per cent per annum, then a reduction in net investment of 6 per cent would clip 0.18 per cent per annum off the capital stock. A reduction in gross investment of 6 per cent would have a more pronounced effect. But these numbers will indicate that 10 unemployment per cent years (e.g. 1 per cent of unemployment for 10 years, or 10 per cent for 1 year) would reduce the capital stock by 1.8 per cent, and raise the NAIRU by a similar order of magnitude.<sup>11</sup> Now consider the trend position of a 1 per cent higher level of unemployment in perpetuity. We would expect that this would involve (eventually) the capital stock being 1 per cent smaller and the NAIRU higher by the same order of magnitude (though cf. previous footnote).

The increases in the level of unemployment experienced in the 1980s and into the 1990s as compared with say the 1960s (especially in Europe) have been substantial. Hence, the reduction in the capital stock (below what it would have been if there had been sustained full employment) has been substantial, and on the basis of the argument developed above, the increase in the NAIRU correspondingly substantial. In some respects, this says little more than enterprises will adjust the

capital stock to the prevailing demand for output (and level of employment). But it suggests a clear mechanism through which the level of (un)employment experienced will be reflected in the estimated NAIRU.

## **6. Policy implications**

The difficulties for economic policy which this analysis indicates are clear. When an economy has a capital stock (and the related real wage employment relationship) which cannot readily support the real wage claims being made, then the NAIRU will appear to be relatively high. The reduction in the NAIRU requires a sustained increase in the level of aggregate demand to stimulate investment (and also to underpin higher levels of employment). According to the NAIRU approach, unemployment below the current NAIRU stimulates inflation, which often leads to policies that tend to abort the higher levels of demand. But unless the higher levels of demand are sustained, the lower NAIRU cannot be reached.

The usual discussion on the NAIRU provides a strong suggestion of the restoration of the classical dichotomy between the real side and the nominal sides of the economy. It is often specifically argued that the reduction of inflation (through control of the growth of the money supply) can be achieved without detriment to the real side of the economy, and that there is no long run trade off between inflation and unemployment. This paper suggests that the nature of any association between inflation and unemployment will be heavily dependent on the time path of unemployment and its effects on the level of the capital stock.

The approach developed here views the NAIRU in terms of capacity : the difference between a NAIRU such as B in Figure 6 and one such as A in that figure arises from differences in capacity.

Figure 6 near here

This paper has concentrated on the creation of capacity in terms of the capital stock, and treated the labor force as homogeneous. Here, it can just be noted that capacity should be viewed as having other dimensions, including the skills of the work force and the regional distribution of the capital stock. Insufficient capacity in either of these respects may be sufficient to prevent the achievement of full employment.

## **7. Conclusions**

In this paper, the role of aggregate demand and of investment in shifting the NAIRU to a level compatible with full employment has been explored. The process of inflation is much more complex than has been examined here, and specifically there has been no discussion the links between inflation and money creation nor have issues such as the role of changes in unemployment (or unemployment relative to some moving reference level) in the wage inflation equation been explored. The approach which has been adopted views the NAIRU in terms of productive capacity in light of the real wage claims. Provided that the pressures for wage claims can be met with the prevailing technology such that investment remains profitable then, given time, capacity can be expanded such that any NAIRU is coincident with full employment. But to reach such a favorable outcome requires appropriate demand policies to stimulate the investment and to underpin the full employment position. Policies which seek to restrain inflation through higher levels of unemployment may well cause the NAIRU to rise and to sustain higher levels of unemployment.



## Appendix

This appendix provides the formal algebra for the figures in the text. Lower case letters are used to signify enterprise (plant) level and upper case aggregates.

Suppose the typical enterprise has capital stock of  $k$ , and for that typical enterprise  $q = f(l, k)$  where  $f_l$  (the first partial derivative of  $f$  with respect to  $l$ )  $> 0$  and  $f_{ll}$  is seen as initially positive and then negative (so that the marginal productivity of labor initially increases with the amount of labor and then declines)

We can write  $Q = nq = n f(l, k)$  where  $n$  is number of enterprises (plants). The capacity of enterprise is denoted by  $q^*$ , and this is not to be thought of as physical capacity necessarily but some 'normal' level. Capacity utilization is then defined as  $u = q/q^*$ , and the mark-up of price over marginal costs is taken to be a function of  $u$ . Then  $w/p = b(u) f_l(l, k)$  where  $b$  is the inverse of the mark-up of price over marginal labor costs and it is expected that  $b'$  may be positive (i.e. mark-up falls) for low values of  $u$  but negative for relatively high values. Then  $u = q/q^* = f(l, k)/q^*$  and  $L = nl$  and hence  $w/p = b(f(L/n, k)/q^* f_l'(L/n, k))$ .

An increase in  $n$  would reduce  $L/n$ . At high levels of  $L/n$  when  $f_{ll} < 0$  this would raise  $f_l$ , and reduce  $f$  thereby raising the value of  $b$ . Hence real wage (at a given level of total employment) would rise for increase in  $n$ . However at low levels of  $L/n$ ,  $f_{ll} > 0$ , and the effect on the real wage would depend on the net effect on the inverse of the mark-up  $b$  and on  $f_l$ .

An increase in the average capital stock  $k$  would have lead to a rise in  $f_l$ , and it can be postulated that the effect of increased  $k$  is that  $q$  rises by the same proportion for all levels of employment, then  $f(l, k)/q^*$  would not be affected. Then rise in  $k$  would lead to higher real wage (for given employment).

The real wage equation given above suggests that the real wage can be viewed as a function of the

rate of capacity utilization, average employment per enterprise and the average capital stock (per enterprise).

## References

- Layard, R., Nickell, S. and Jackman, R. (1991), *Unemployment: Macroeconomic Performance and the Labor Market*, Oxford: Oxford University Press
- Rowthorn, R.E. (1996), 'Unemployment, wage bargaining and capital-labor substitution', University of Cambridge, mimeo
- Sawyer, M. (1982a), *Macroeconomics in Question*, Brighton: Harvester Press
- Sawyer, M. (1982b), 'Collective bargaining, oligopoly and macro economics', *Oxford Economic Papers*, vol. 34
- Sawyer, M. (1995), *Unemployment, Imperfect Competition and Macroeconomics*, Aldershot: Edward Elgar
- Sawyer, M. (1997), 'The NAIRU : a critical appraisal', *Working Paper*, Levy Institute: Annandale-Hudson.
- Shapiro, C. and Stiglitz, J. (1984), 'Equilibrium unemployment as a worker discipline device', *American Economic Review*, vol. 74, no. 3, pp. 433-444.

## Endnotes

1. I am grateful to Philip Arestis for comments on an earlier draft.
2. The Layard, Nickell and Jackman (1991) approach incorporates the capital stock in the modeling, but does so in a way that the capital stock (relative to full employment of labor) does not impact on the NAIRU (as further discussed below).
3. This point is further discussed in Sawyer (1997).
4. There is a third possibility, namely that the real wage employment relationship is the supply of labor function. Using such a function would generate full employment in equilibrium since clearly the equilibrium position would lie on the supply of labor function, albeit that real wages and employment would be lower under imperfect competition (compared with a perfectly competitive

alternative) (cf. Sawyer, 1995, chap 6).

5. See, for example, Sawyer (1982a, 1982b) for the target real wage approach.

6. See, for example, Layard, Nickell and Jackman (1991), Chapter 2.

7. Although the term enterprises is used, if the cost curve being used is considered as relating to the plant or factory level, then the number of plants would be the relevant consideration.

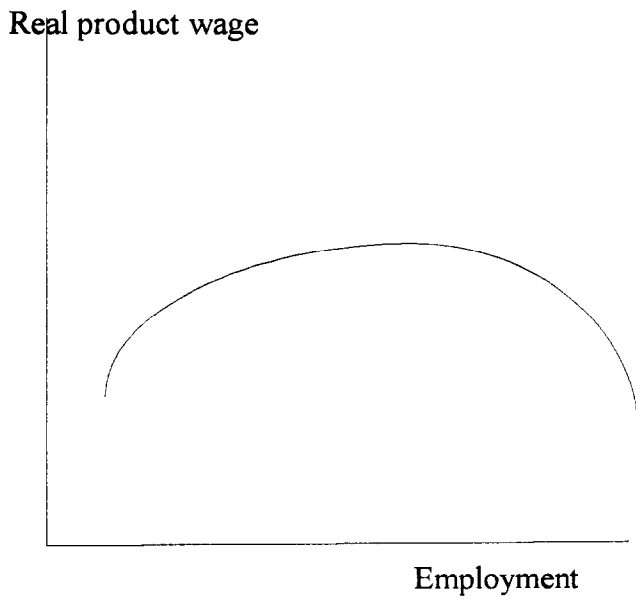
8. It is outside the scope of this paper to discuss the determinants of the level of aggregate demand, and we confine ourselves here to making the point that there is no strong reason to think that the wages and profits generated at point A would lead to a level of expenditure which would purchase the output produced at A.

9. This sub-consideration would not arise in the context of a Cobb-Douglas constant returns to scale production function since any level of output per person can be achieved there if the capital stock per person is raised high.

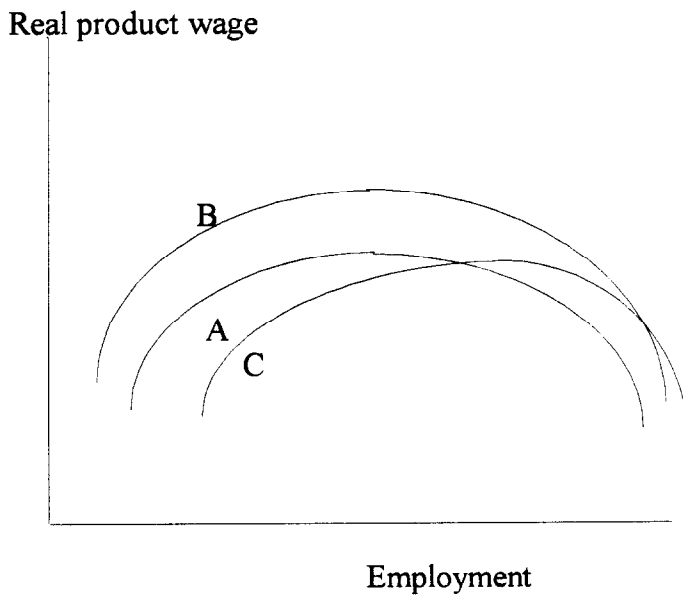
10. However, if the typical enterprise is operating in the range of diminishing returns to labor, an increase in the number of enterprises lowers the average employment and output per enterprise but raises productivity.

11. With a Cobb-Douglas production function, for a given real wage, employment would decline in the same proportion as the capital stock. However, with an upward sloping wage equation there would be a decline in real wages. Depending on the slope of the wage equation, in this Cobb-Douglas case, the effects of the lower capital stock are shared between lower employment and lower real wages.

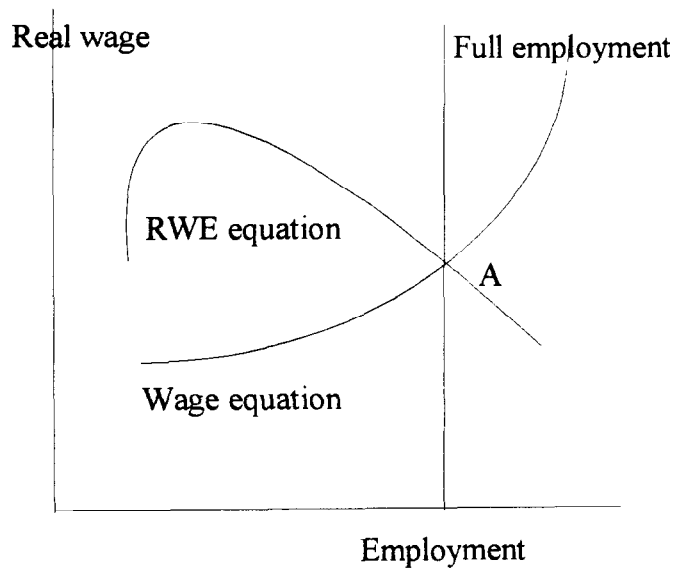
c:\nairu\paper2.doc



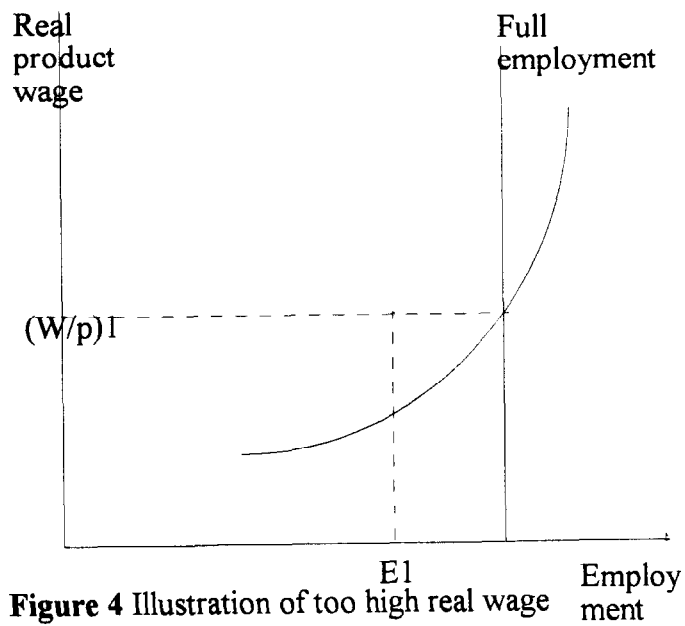
**Figure 1** Real product wage employment relationship



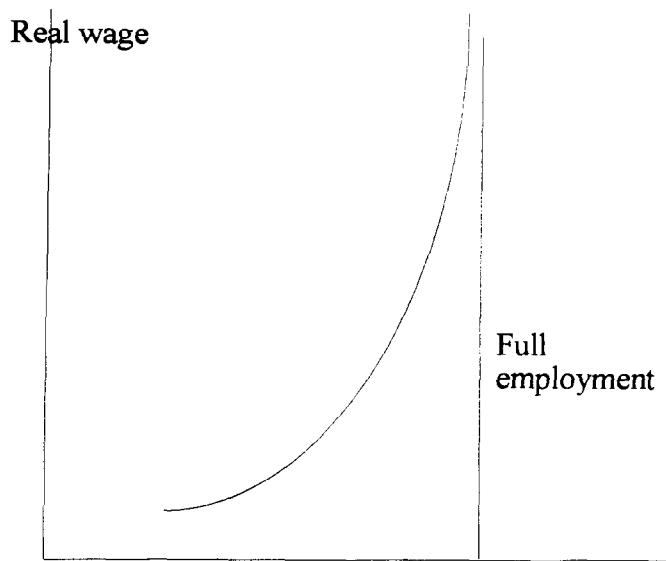
**Figure 2** Effects of capital investment on real product wage employment relationship



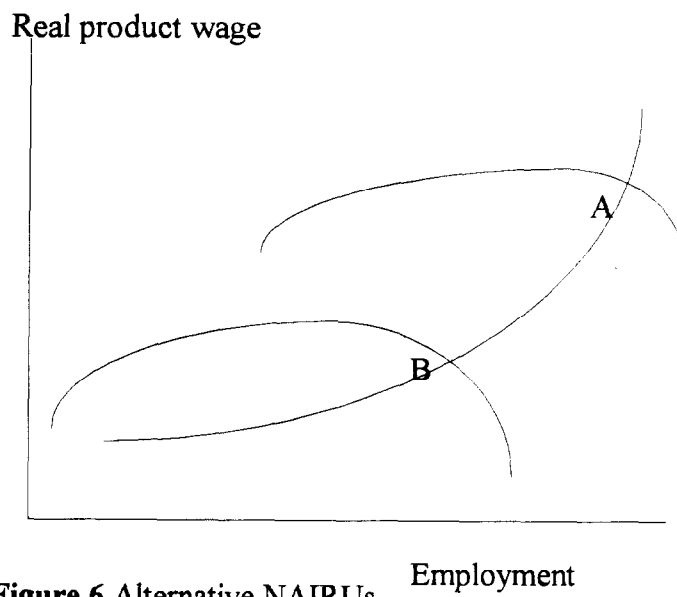
**Figure 3** NAIRU compatible with full employment



**Figure 4** Illustration of too high real wage



**Figure 5** Wage equation with full employment as asymptote



**Figure 6** Alternative NAIUs