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Multiple equilibria in the British labour market

Some empirical evidence

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This paper takes a simple imperfectly competitive aggregate labour market model with increasing returns which can lead to non-existence or multiplicity of equilibria. The model is estimated using annual aggregate data for Britain. Some evidence is found, and recent British economic history is interpreted using the model.

1. Introduction

In recent years the view that the traditional model of the aggregate labour market with a unique equilibrium (the natural rate) cannot explain the observed movements in macroeconomic variables has become more popular [see, e.g., Blanchard and Summers (1988)]. One popular direction in which to move away from single equilibrium models is in the direction of models with multiple equilibria. These models are a priori quite appealing as unemployment often seems to spend long periods at very different unemployment rates which is difficult to explain using traditional single equilibrium models, but is, perhaps, suggestive of the economy moving from one equilibrium to another. However, while there has been a considerable amount of theoretical speculation about the possibility of multiple equilibria, there has been little or no empirical work on this subject. Perhaps the main reason for this is that many of the existing theoretical models are either rather complex [e.g., Pagano (1990)] or very abstract [Cooper and John (1988)].

As a result of this, the papers that have looked for evidence of multiple equilibria have been rather atheoretical. Carruth and Oswald (1988) estimate non-monotonic labour demand and wage equations and while they do find

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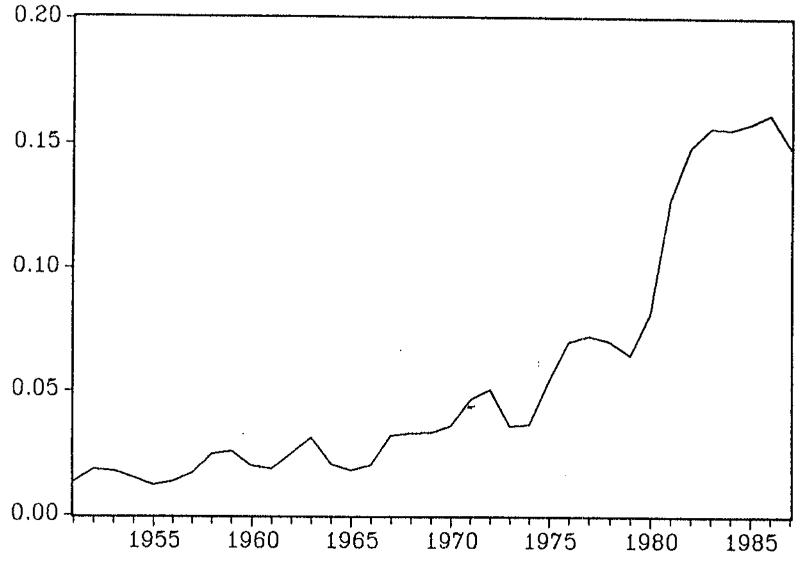

Fig. 1. The male unemployment rate.

evidence for some non-monotonicity, there is always only one equilibrium in the region of the observed data. However, as the model presented below makes clear, there is no need to have non-monotonicity or to have multiple equilibria. Dagsvik and Jovanovic (1990) use a very stylized theoretical model to investigate whether the U.S. had multiple equilibria in the 1930s paying close attention to the equilibrium selection mechanism; they find little evidence for this view. Finally, Pissarides (1986) uses a more theoretical matching model to investigate the possibility of increasing returns in the matching process; he finds no evidence for this.

This paper takes a different approach. It uses an extremely simple imperfectly competitive model of the labour market in which the possibility of multiple equilibria arises from the presence of increasing returns to scale. In fact, within the context of the assumptions made (which are all quite traditional), the presence of even the smallest amount of increasing returns will mean that the economy will either have zero or two equilibria. The fact that increasing returns can lead to multiple equilibria is hardly new or surprising [see, for example, the neglected Sawyer (1982)], but the advantage of the model presented here is that it is simple to estimate and the hypothesis of a single equilibrium can be tested against that of multiple equilibria.

The estimation and testing is done for annual British data for the period 1951–87. Britain is a good country to use for an initial attempt to test multiple equilibrium models, as it has had very sharp movements in unemployment rates (see fig. 1), which are suggestive of movements from one equilibrium to another. In particular, in the 1980s unemployment rose very fast in the period 1979–82, and then remained at a very high level. One possible explanation for this is that the economy moved to a high unemployment equilibrium in this period, although no economic fundamentals changed.

The plan of the paper is as follows. In the next section, we present the basic model of the firm. In the third section, we analyse the short-run equilibrium where the capital stock is fixed, and in the fourth section the long-run equilibrium with a variable capital stock. The fifth section presents the empirical evidence for Britain, and the sixth section uses these results to explain the behaviour of U.K. unemployment.

The main conclusions are the following. We do find evidence of increasing returns, and, hence, multiple equilibria. A model based on multiple equilibria does at least as well in explaining the behaviour of unemployment as a model based on a more traditional single equilibrium model. And, movements in British unemployment do appear to be explained best by a model in which there was a move from a low to a high equilibrium unemployment rate in the early 1980s. However, it should be emphasized that one cannot decisively reject the single equilibrium model and so there must remain considerable uncertainty about the appropriate framework for analysing unemployment.

2. The basic model

The model is essentially a version of the Blanchard–Kiyotaki (1987) imperfectly competitive model of the economy. It also has similarities to the models used by Layard and Nickell (1985, 1986) to account for the behaviour of unemployment in the British economy. The economy is assumed to be made up of F identical imperfectly competitive firms.[1] Firm i is assumed to have a production function of the form

$$Y_i = A_i H_i K_i^{\beta} N_i^{\alpha}, \tag{1}$$

where Y_i is output, N_i is employment, H_i is hours and A_i is the compound effect of variables like raw material inputs and technology.[2]

The demand for firm i's output is assumed to be given by the following demand curve:

$$Y_i = \frac{1}{F}\left(\frac{P_i}{P}\right)^{-\theta} G(P, X), \tag{2}$$

[1]In the analysis that follows, we assume that the number of firms is fixed. However, allowing the number of firms to vary would be likely to strengthen the results as in Pagano (1990).

[2]The unit elasticity of output with respect to hours is tested and accepted in the empirical section presented below so is imposed from the start here. The relaxation of this assumption would not affect any of the substantive conclusions.

where P_i is the ith firm's price, P is some price index for the economy, F is the number of firms and $G(P, X)$ is some measure of total aggregate demand, X being a set of variables which influence this. As $G(P, X)$ will play no role in the determination of the equilibrium of the real side of the economy, its precise specification will not be spelt out. But it might, for example, be given by (M/P) the level of real money balances [as in Blanchard and Kiyotaki (1987)] or, in an open economy, influenced by competitiveness. This specification of the demand function could be derived more explicitly from a CES specification of preferences.

Using (1) and (2) we can derive

$$N_i=(A_iH_i)^{-1/\alpha}K_i^{-\beta/\alpha}\left(\frac{G}{F}\right)^{1/\alpha}\left(\frac{P_i}{P}\right)^{-\theta/\alpha}. \tag{3}$$

If the nominal wage is W_i, the labour tax rate is t_1 and the real user cost of capital is C then real profits for firm i, Π_i can be written as

$$\Pi_i=\frac{G}{F}\left(\frac{P}{P_i}\right)^{1-\theta}-(1+t_1)\left(\frac{W_i}{P}\right)(A_iH_i)^{-1/\alpha}K_i^{-\beta/\alpha}\left(\frac{G}{F}\right)^{1/\alpha}\left(\frac{P_i}{P}\right)^{-\theta/\alpha}-CK_i. \tag{4}$$

In the first part of the paper we will concentrate on the short-run case where the capital stock is regarded as fixed: Later on, we will allow the capital stock to be variable.

3. Short-run equilibrium: Capital stock fixed

3.1. Partial equilibrium

3.1.1. Price and employment determination

I assume that each firm i chooses P_i to maximise (4) treating W_i and K_i as predetermined and assuming that it is too small to affect the aggregate price level, P. We also assume that normal hours are institutionally determined which may not be a bad assumption for much of the British economy.[3]

For the profit function (4) to be concave in P_i, treating K_i as fixed we require that $\alpha'=\alpha(\theta-1)/\theta<1$. This means that if we have increasing returns to labour, i.e., $\alpha>1$, then θ must be small enough to ensure that the profit maximisation problem is well-defined. This implies that each firm must have

[3]Obviously, hours do vary in the very short run. However, the emphasis of the paper is on more long-run notions of equilibrium in which hours are at their normal level and output fluctuations are taken up by fluctuations in employment and/or capital.

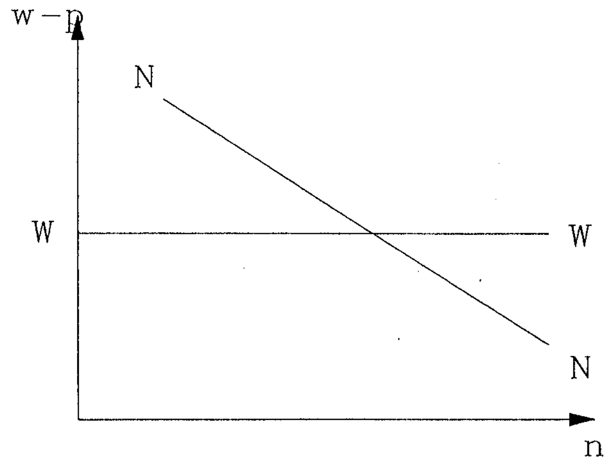

Fig. 2. Partial equilibrium.

sufficient market power. In what follows we assume that the condition $\alpha' < 1$ is always satisfied.[4]

Maximisation of (4) with respect to P_i leads to the following partial equilibrium pricing equation:

$$[\alpha(1-\theta)+\theta](p_i-p) = -\alpha\log\alpha - \alpha\log\left(\frac{\theta-1}{\theta}\right) + (1-\alpha)(g-f)$$

$$-a_i - h_i - \beta k_i + \alpha(w-p+t_1), \tag{5}$$

where lower case letters denote logs of upper case letters, and $\log(1+t_1)$ is approximated by t_1. As $\alpha' < 1$ the term multiplying $(p_i - p)$ is positive.

Using (3) to convert (5) to an employment equation leads to

$$n_i = \frac{1}{1-\alpha'}\left[\log\alpha + \log\left(\frac{\theta-1}{\theta}\right) - (w_i - p + t_1) + \frac{1}{\theta}(g+f)\right.$$

$$\left. + \frac{\theta-1}{\theta}(a_i + h_i + \beta k_i)\right]. \tag{6}$$

This is a quite standard labour demand curve for an individual firm. It is downward-sloping in real wage–employment space, and is shifted in the usual ways by changes in the exogenous variables. It is represented by the *NN* line in fig. 2.

[4]There may be some mechanism whereby the amount of competition in markets is determined by the extent of increasing returns to scale in which case the economy will have some mechanism which ensures that $\alpha' < 1$.

3.1.2. Wage determination

We assume that the nominal wage in each firm is determined by bargaining between a union and the employer. Assume that the utility function of the union is given by

$$V\left(\left(\frac{W_i}{P_c}\right), N_i\right) = N_i^{\gamma}\left(H_i^{\eta}\left(\frac{(1-t_2)W_i}{P_c}\right)^{\delta} - \bar{V}\right)^{1-\gamma}, \tag{7}$$

where t_2 is the direct tax rate, P_c is the consumer price index (which differs from the producer price index because of indirect taxes and the prices of imported goods), and $\bar{V}$ is the alternative utility available to union members in this firm who become unemployed. From the point of view of the individual firm $\bar{V}$ is exogenous; in aggregate it is endogenous and below we present a model if its determination. Eq. (7) encompasses a number of popular specifications of union preferences: $\gamma = \frac{1}{2}$ is the utilitarian model of Oswald (1982); $\gamma = 0$ is the seniority model of Oswald (1987).

We assume that W_i is chosen to solve the following problem:

$$W_i = \arg\max \lambda \log V\left(\frac{W_i}{P_c}, N_i\right) + (1-\lambda)\log \Pi_i, \tag{8}$$

that is we have an asymmetric Nash bargain with λ as the bargaining power of the workers.

Now using (4) and (5), we can eliminate P_i from the profit function and write Π_i as a function only of (W_i/P):

$$\Pi_i = (1-\alpha')(\alpha')^{\alpha'/(1-\alpha')}\left[\frac{F}{G(P,X)}\right]^{-1/\theta(1-\alpha')}(A_i H_i K_i^{\beta})^{(\theta-1)/\theta(1-\alpha')}$$

$$\times (1+t_1)^{-\alpha'/(1-\alpha')}\left(\frac{W_i}{P}\right)^{-\alpha'(1-\alpha')}$$

$$= Z_i\left(\frac{W_i}{P}\right)^{-\alpha'/(1-\alpha')} \tag{9}$$

where Z_i is all the terms in (9) apart from the wage terms.

Substituting (7) and (9) in (8) we get that the wage will be chosen to maximise

$$\lambda\gamma \log N_i + \lambda(1-\gamma)\log\left[H_i^{\eta}\left(\frac{(1-t_2)W_i}{P_c}\right)^{\delta} - \bar{V}\right] + (1-\lambda)\log Z_i$$

$$-\frac{\alpha'(1-\lambda)}{1-\alpha'}\log\left(\frac{W_i}{P}\right). \tag{10}$$

The first-order condition from this using the fact that from (6),

$$\frac{\mathrm{d}\log N_i}{\mathrm{d}\log W_i} = -\frac{1}{1-\alpha'}$$

leads to the wage equation

$$H_i^{\eta}\left(\frac{(1-t_2)W_i)}{P_c^2}\right)^{\delta} = \frac{\lambda\gamma + (1-\lambda)\alpha'}{\lambda\gamma + (1-\lambda)\alpha' - (1-\alpha')\delta\lambda(1-\gamma)}\bar{V}, \tag{11}$$

which can be written as

$$H_i^{\eta}\left(\frac{(1-t_2)W_i}{P_c}\right)^{\delta} = \mu\bar{V}. \tag{12}$$

This is a quite traditional mark-up type wage equation, e.g., increases in the alternative wage $\bar{V}$ and in the bargaining power of the union lead to increased wages.

Putting together the wage eq. (12) and the employment eq. (6) we have a very traditional picture for the determination of wages and employment at the level of the individual firm. This is represented in fig. 2. However, this is a partial equilibrium picture: We now turn to the general equilibrium story.

3.2. General equilibrium

3.2.1. Price and employment determination

Now consider the determination of aggregate employment and real wages. As we are assuming that all firms are identical, we will have $Y_i=(1/F)Y$, $N_i=(1/F)N$, $K_i=(1/F)K$, $A_i=A$, $P_i=P$, $W_i=W$, $H_i=H$ where unsubscripted variables denote aggregate variables.

In equilibrium $p_i = p$ so (5) becomes[5]

$$\alpha(p-w-t_1) = -\alpha\log\alpha - \alpha\log\left(\frac{\theta-1}{\theta}\right) + (1-\alpha)(g-f) - a - h - \beta(k-f). \tag{13}$$

Now, using (1) and (2) we can derive

$$a+h+\beta(k-f)+\alpha(n-f)=g-f. \tag{14}$$

Using (14) to eliminate $(g-f)$ from (13) leads to

$$(p-w-t_1) = -\log\alpha - \log\left(\frac{\theta-1}{\theta}\right) + (1-\alpha)n - a - h - \beta k - (1-\alpha-\beta)f. \tag{15}$$

This is the aggregate pricing equation relating the price wage mark-up to employment and the exogenous variables. Using the identity that $n=\log(1-u)+l$ where u is the unemployment rate and l the log of the labour force, we can write (15) as

$$(p-w-t_1) = -\log\alpha - \log\left(\frac{\theta-1}{\theta}\right) + (1-\alpha)\log(1-u) + (1-\alpha)l - (a+h+\beta k) - (1-\alpha-\beta)f. \tag{16}$$

The slope of this relationship between $w-p$ and u depends crucially on

[5]It might be thought that setting $p_i = p$ is not valid in an open economy where the prices of domestic producers may differ from those of competing foreign producers. But, any competitiveness effects can be included in the aggregate demand function. To see this, suppose the price of domestic producers is P, that of foreign producers P_m. Then we might write the demand curve (2) as $Y_i = (G/F)(P_i/P^{1-v}P_m^v)^{-\theta} = (G'/F)(P_i/P)^{-\theta}$ where $G' = G(P_m/P)^{v\theta}$ where the new aggregate demand term G' includes competitiveness.

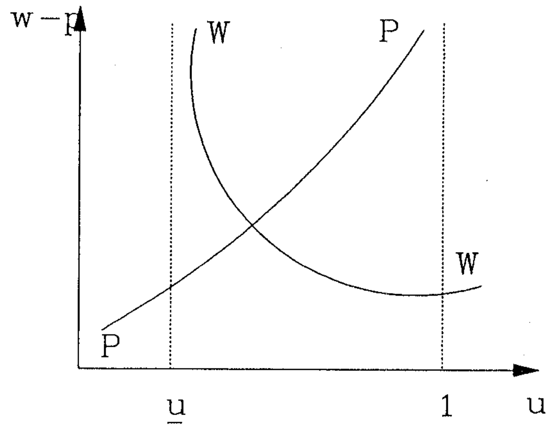

Fig. 3. The traditional case: Single equilibrium.

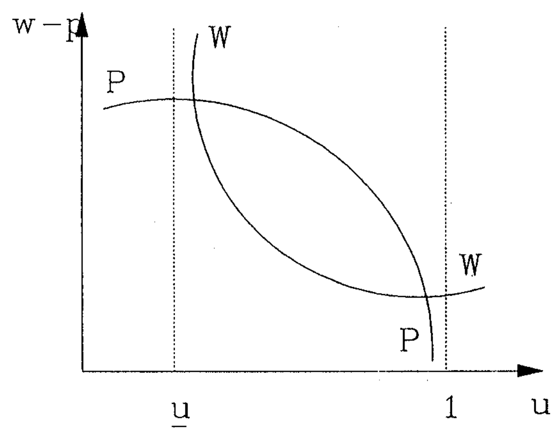

Fig. 4. Multiple equilibria.

whether $\alpha \gtrless 1$. If $\alpha < 1$ so there are decreasing returns to labour then (16) is upward-sloping in $(w-p)$–u space as shown by the *PP* line in fig. 3. This is the conventional case. But if $\alpha > 1$, so there are increasing returns to labour, then the *PP* line will be downward-sloping as drawn in fig. 4. The consequences of this will be spelt out later.

3.2.2. *Wage determination*

Eq. (12) was the wage equation for a single firm which could take $\bar{V}$, the alternative wage, as exogenous. For the general equilibrium case we need to model $\bar{V}$. A reasonable specification is

$$\bar{V} = (\xi u)\left[\phi\left(\frac{B}{P_c}\right)^{\delta'}\right] + (1-\xi u)\left[H^{\eta}\left(\frac{(1-t_2)W}{P_c}\right)^{\delta}\right], \tag{17}$$

where B is the level of nominal unemployment benefits. Eq. (17) says that the alternative wage is a weighted average of the utility of real benefits and of real wages, the weight on real benefits being an increasing function of the unemployment rate. This formulation can be derived from a more explicit dynamic model [see Manning (1991) for details]. We also assume that unemployed workers value income differently from employed workers, i.e., $\delta \neq \delta'$. This could be because of the different amounts of leisure the two groups have.

Substituting (17) into (12), rearranging and taking logs yields

$$(w-p_c-t_t)=\frac{1}{\delta}[\eta h+\log\phi+\delta'(b-p_c)+\log u-\log(u-\underline{u})], \tag{18}$$

where

$$\underline{u}=\frac{(\mu-1)}{\mu\xi}. \tag{19}$$

Expression (18) is the aggregate real wage equation. It has two interesting features. First, as unemployment rises the wage tends to an asymptote which ensures that employed workers are better off than unemployed workers. This means that for high unemployment rates, the wage equation is virtually horizontal. Secondly, there is a lower bound to the unemployment rate in the economy. This is given by $\underline{u}$ as defined in (19). As $u \to \underline{u}$ the wage becomes infinite, i.e., the wage equation is vertical close to $\underline{u}$. This unemployment trap, $\underline{u}$, is higher the higher is the mark-up in wage-setting, μ, and the easier it is for workers to get a job if they are unemployed (a low ξ). The shape of the real wage equation is represented by *WW* in figs. 3 and 4.

3.3. Equilibrium and comparative statics

Fig. 3 represents the case where there is decreasing returns to labour. A unique equilibrium always exists. Factors which tend to reduce prices like increases in productivity move the *PP* schedule to the left, increasing real wages and reducing unemployment. Increases in wage pressure move the *WW* schedule to the right increasing both real wages and unemployment. This is all quite standard and familiar.

However, if there are increasing returns to labour, matters are considerably more complicated. Fig. 4 looks at this case. There are several points to note.

First, if the *PP* schedule is sufficiently far to the left, there may be no equilibrium. There is no unemployment rate which can reconcile pricing and wage-setting. Secondly, if the *PP* and *WW* schedules do intersect then they always do so twice,[6] i.e., if there are any equilibria there are two of them. One of the equilibria has low unemployment and high wages, the other has high unemployment and low wages.

In the low unemployment equilibrium, increases in productivity move the *PP* schedule up leading to lower unemployment and higher wages. By contrast higher wage pressure leads not only to higher unemployment but also to lower wages, raising the possibility that while an individual group of workers rationally believe they can gain an increase in real wages from an increase in their power, if all workers do the same the eventual consequence will be lower real wages.

In the high unemployment equilibrium, the comparative statics are very different. Increases in productivity lead to higher unemployment and lower wages. By contrast higher wage pressure leads to lower unemployment and higher wages.

However, it is not very plausible that there are increasing returns to labour alone, i.e., $\alpha > 1$. However, it may be the case that there are increasing returns once we allow for the adjustment of the capital stock. It is to this that we now turn.

4. Long-run equilibrium: Variable capital stock

Now, consider the optimal choice of capital stock of the firm. As we have asssumed that the firm is on the labour demand curve and, in our model, the wages paid by a firm are not influenced by its capital stock, we do not have to worry about the effects of unions on investment discussed by Grout (1984) [see Manning (1987) for more details of this argument].

Maximising (4) with respect to K_i and using the equilibrium condition $w_i = w, p_i = p, a_i = a$, leads to the following equation for k_i:

$$(\alpha+\beta)k_i = \alpha \log \beta - \alpha \log \alpha + \alpha(w - p + t_1) - a - h + (g - f) - \alpha c. \tag{20}$$

Now, using (14) to eliminate $(g-f)$ from (20) and the fact that $k_i = k - f$ leads to

$$k - f = \log \beta - \log \alpha + (w - p + t_1) + (n - f) - c. \tag{21}$$

Substituting into (15) leads to the following long-run pricing equation:

[6]The two equilibria arise from the particular assumptions about technology and preferences, and, although these have been quite standard, other specifications may, of course, lead to a number of equilibria other than two. If there are two equilibria, they are always in the economically meaningful region as, if $\alpha > 1$, $\lim_{u \to 1}(w-p) = -\infty$ from the pricing equation [see (16)] while from the wage equation $\lim_{u \to 1}(w-p)$ is finite. Also, from the wage equation $\lim_{u \to \underline{u}}(w-p) = +\infty$, and from the pricing equation $\lim_{u \to 0}(w-p)$ is finite.

$$(p-w-t_1)=-\log\alpha-\frac{\beta}{1-\beta}\log\beta-\frac{1}{1-\beta}\left[\log\left(\frac{\theta-1}{\theta}\right)+(a+h)\right]$$

$$+\frac{(1-\alpha-\beta)}{1-\beta}(n-f)+\frac{\beta}{1-\beta}c. \tag{22}$$

As long as $\beta<1$ this shows that we have a negative long-run relationship between prices and employment if $(\alpha+\beta)>1$, which is what we would expect.[7]

So, the short-run pricing equation may have a different slope than the long-run pricing equation. This has the implication that, given the level of the capital stock, there may be a unique short-run natural rate of unemployment, but once we allow the capital stock to vary there may well be two long-run natural rates. This suggests that 'animal spirits' among investors may be very important in determining what happens to the economy in the long run; if investors are optimistic and invest a lot then the economy will achieve the low unemployment equilibrium while if they are pessimistic the economy may end up at the high unemployment equilibrium.

In models with multiple equilibria it is common to use stability criteria to argue that one equilibrium is more likely to occur than another. Manning (1990) argues that on a priori theoretical grounds there is no reason to believe that one equilibrium is more stable than another. For example, suppose that the only rigidities are in wage-setting so that the economy is always on the *PP* curve. Then, at an unemployment rate between the two equilibrium rates, the wage from pricing is above the equilibrium wage from wage-setting (look at fig. 4). Real wages will fall and the economy will move towards the high equilibrium unemployment rate which will be the locally stable equilibrium. On the other hand, if all the rigidities were in price-setting, the low unemployment equilibrium would be the only locally stable one. And, if we have both sorts of rigidity, either or both of the two equilibria may be locally stable [see Manning (1990) for more details]. So, unless we are very sure about the nature of rigidities in the economy, stability analysis is unlikely to allow us to conclude that we are more likely to observe one equilibrium than another.

5. Empirical evidence

The main advantage of the multiple equilibrium model presented in the previous sections is that it is simple enough to be estimable. This is done in

[7]The case $\beta>1$ leads to very perverse equilibria in which, although the *PP* line is upward-sloping as in fig. 2, the comparative statics are all the opposite of the usual ones.

this section. We estimate a price equation, a wage equation and a capital stock equation. As data we use annual aggregate data for the U.K. economy for the period 1951–1987. The data used is described in more detail in the appendix but is essentially that used in the well-known studies of Layard and Nickell (1985, 1986).

It may be thought that the estimation of multiple equilibrium models presents considerable econometric difficulties. This would be the case if we were estimating reduced form equations because the comparative statics of the model and, hence, the expected signs of coefficients in a reduced form, are different in the two equilibria. But the approach here is based on estimating structural equations which we would expect to hold irrespective of the equilibrium that the economy is actually in.

One other worry is whether it is possible to estimate what is essentially an equilibrium model if, as is quite possible, no equilibrium exists. However, if there are any rigidities in the economy, e.g. costs of adjustment, the short-run behaviour of the economy will be well-determined even though there is no long-run equilibrium [in fact, Manning (1990) shows that in this case the economy will display a type of hysteresis]. In this case, the model will still be estimable. So, we believe that it need be no more complicated to estimate a multiple equilibrium model than a more traditional single equilibrium model.

5.1. The price equation

As a price equation, we estimate a rearranged version of (15):

$$(p-w-t_1+h) = -\log\alpha - \log\left(\frac{\theta-1}{\theta}\right) + (1-\alpha)(n-k) - a$$
$$+(1-\alpha-\beta)k - (1-\alpha-\beta)f. \tag{23}$$

The advantage of (23) is that it allows a simple test of the hypothesis of multiple equilibria which, in the context of the model presented above is simply a test of increasing returns to scale. If we have increasing returns $(\alpha+\beta)>1$ and the coefficient on the capital stock in (23) will be negative; if we have decreasing returns then the coefficient on k will be positive.

From the practical point of view the main problem with (23) is that it includes several variables for which we have no satisfactory observation, e.g., the extent of product market competition, θ, the number of firms, f, and the shift in the production function, a.

The difficulty in observing the last variable is likely to be the most serious. Part of the shifts in the production function will be due to changes in real import prices which we do include in our estimated equations but part will also be due to technological progress which we cannot observe and is likely to be positively correlated with capital leading to a downward bias in the coefficient on capital in (23).[8] This is a very difficult problem and we take two approaches to it in this paper. The first is to attempt to model technological progress by a complicated collection of trends and to see how robust the capital stock effect is to a variety of specifications. The models are estimated as partial adjustment equations although the results are very similar if a static equation is estimated. The second approach is to assume that productivity follows a random walk with a (possibly time-varying) drift. Then, by estimating (23) in first differences, we can obtain consistent estimates of returns to scale.

Table 1a presents a selection of price equations based on the first method of dealing with unobserved technical progress. The notation used is the same as in the theoretical section above except that $v(p_m - p)$ are real import prices weighted by the share of imports. In column (1) we present a model with a cubic time trend and in column (2) we present a model with split time trends, the splits occurring in 1974 (to correspond with the first oil price shock) and 1981 (to correspond with the Thatcher 'miracle').

From the point of view of this paper the main interest is in the negative coefficient on the capital stock in both equations indicating the presence of increasing returns to scale and hence, multiple equilibria.

In column (1) the coefficient on k_t is significantly different from zero indicating that one could reject the hypothesis of constant returns to scale. However, in column (2) one could accept the hypothesis of constant returns to scale at the 5% significance level. In fact these findings are not untypical. It is common in price/labour demand equations to obtain spot estimates of increasing returns but to be able to accept the hypothesis of constant returns. However, unless one has very strong a priori beliefs about the existence of constant returns to scale it is impossible to interpret an equation like that in column (2) as evidence of constant as opposed to increasing returns to scale.[9] For example, if one was a Bayesian with a diffuse prior about the

[8]One might think of trying to obtain a measure of technological progress by some indirect means. For example, the production function (1) implies that $a=(y-f)-h-\beta(k-f)-\alpha(n-f)$ and we could substitute this into (23). However, if we do this, α and β disappear from (23) and the price equation will tell us nothing about returns to scale and, hence, nothing about the existence of multiple equilibria. Other studies have used estimates of the Solow residual but this index has implicitly assumed perfect product competition and constant returns to scale making them unsuitable for use here.

[9]Of course one might think there are strong a priori arguments for constant returns to scale. For example, we might believe that we do not have increasing returns as we observe multi-plant firms. But, in the model presented here, there is product differentiation so the relevant issue is whether we observe many plants in the same firm making the same product. This is much less clear and, even if we do observe this, it could be part of a divide and rule strategy on the part of the employer to keep wages down. So an a priori argument for constant returns is likely to be fraught with difficulty.

Table 1a

Price equations. Dependent variable: $\Delta(p-w+h-t_1)_t$. Sample: 1951–87.[a,b]

	(1)	(2)	(3)	(4)
c	3.77 (1.56)	2.67 (1.06)	1.14 (0.60)	-1.80 (5.39)
$(p-w+h-t_1)_{t-1}$	-0.75 (7.45)	-0.79 (6.75)	-1.74 (7.97)	-0.76 (8.00)
$(n-k)_t$	0.16 (0.92)	0.08 (0.48)	0.19 (1.49)	0.36 (4.44)
k_t	-0.78 (2.28)	-0.56 (1.73)	-0.37 (1.55)	–
$v(p_m-p)_t$	2.15 (6.92)	2.23 (7.14)	2.23 (9.17)	2.05 (9.78)
time	-0.77×10^{-3} (0.11)	-0.4×10^{-4} (0.00)	-0.14×10^{-2} (0.22)	-0.98×10^{-2} (3.36)
time^2	0.55×10^{-3} (0.96)	–	–	–
time^3	-0.67×10^{-5} (0.77)	–	–	–
d74 × *time*	–	0.61×10^{-2} (1.66)	0.51×10^{-2} (1.81)	0.76×10^{-2} (3.19)
d81 × *time*	–	0.23×10^{-2} (0.57)	0.14×10^{-2} (0.45)	0.40×10^{-2} (1.47)
Estimation method	2SLS	2SLS	3SLS	3SLS
Standard error	0.0147	0.0147	0.0133	0.0140
R^2	0.77	0.77	0.76	0.75
BAS	1.53 (15, 14)	1.80 (15, 14)	–	–
AR(2)	0.46 (2, 25)	0.68 (2, 25)	–	–
HET	0.10 (3, 26)	0.22 (3, 26)	–	–
LIN	1.62 (2, 27)	1.55 (2, 27)	–	–
ARCH(2)	0.48 (2, 24)	0.92 (2, 24)	–	–
NORM	1.65(2)	2.61(2)	–	–
CHOW(79)	1.17 (8, 21)	0.69 (8, 21)	–	–
CHOW(83)	0.20 (4, 25)	1.29 (4, 25)	–	–

[a] t-statistics in parentheses.

[b] For details of instruments used and misspecification tests please see data appendix.

returns to scale parameter one would emerge from eq. (2) with a 90% weight on increasing returns to scale. However, the fact that our estimates of returns to scale have considerable imprecision means that we cannot be very certain about whether we should use a single or multiple equilibrium model. However, there is as strong a case for the multiple equilibrium model as for the traditional single equilibrium model and, for this reason alone, the multiple equilibrium model deserves further research.

In the simulations that follow in the next section we use the equation of column (2) as our price equation as the time trends can be given more economic justification than those in column (1). The implied values of α and β from the spot estimates of eq. (2) are $\alpha \cong 0.9$, $\beta \cong 0.8$. These indicate substantial increasing returns. Column (3) presents the estimate of the price equation when it is estimated jointly with the wage and capital stock equations (to be presented below). The results are basically similar although the estimates of returns to scale are lower with $\alpha \cong 0.75$ and $\beta \cong 0.75$.

Table 1(b) presents estimates of price equations estimated in first differences which will be appropriate if technical progress follows a random walk with drift. Column 1 presents estimates assuming that the drift is constant, column 2 presents estimates allowing a drift with trend and column 3 presents estimates, that allow the drift to change in 1974 and 1981. In all cases, the spot estimates are of increasing returns to scale, although one could accept the hypothesis of constant returns to scale at the 5% level. As before, it would be somewhat perverse to interpret this as favouring constant as opposed to increasing returns. The high standard errors could be because first-differencing magnifies problems of measurement error.

Of course, the present author has something of an interest in finding increasing returns to scale and this may cause some readers to question the strength of the results presented here. But other authors, interested in other areas apart from multiple equilibria, have concluded that there is increasing returns to scale. Two examples will be given here. First, Hall (1988a) found evidence of substantial price–marginal cost margins in U.S. industry. To be consistent with the observed average profits rates this implies that marginals are below average costs so we have increasing returns; Hall (1988b) presents evidence for this. And, increasing returns to scale have been a central assumption in the popular endogenous growth literature [see Romer (1986)] and some evidence has been presented for this [Romer (1987)]. So, the claim that the economy is characterised by increasing returns to scale is not unique to this paper and there is a substantial amount of other evidence in favour of this hypothesis.

Of course the finding that the long-run price equation is downward sloping as in fig. 4 may not be due to declining marginal costs at the level of the individual firm as modelled here. For example, Rotemberg and Saloner (1986) argue that the mark-up of prices over costs [θ in (23)] is counter-

Table 1b
First-differenced price equations. Dependent variable: $\Delta(p-w+h-t_1)_t$. Sample: 1951–87.[a,b]

	(1)	(2)	(3)
c	0.0073	0.0005	0.0005
	(0.54)	(0.03)	(0.02)
$\Delta(n-k)_t$	0.075	0.13	0.10
	(0.30)	(0.49)	(0.40)
Δk_t	−0.92	−0.81	−0.74
	(1.90)	(1.59)	(1.11)
$\Delta(v(p_m-p)_t)$	2.05	2.03	2.03
	(6.40)	(6.25)	(6.14)
time	–	0.23×10^{-3}	–
		(0.73)	
d74	–	–	0.77×10^{-2}
			(0.88)
d81	–	–	-0.38×10^{-2}
			(0.33)
Estimation method	2SLS	2SLS	2SLS
Standard error	0.0188	0.0190	0.0133
R^2	0.54	0.53	0.53
BAS	2.51	2.58	2.83
	(18, 15)	(17, 15)	(16, 15)
AR(2)	1.53	2.32	2.06
	(2, 29)	(2, 28)	(2, 27)
HET	0.27	0.19	0.24
	(3, 30)	(3, 29)	(3, 28)
LIN	1.64	2.08	1.64
	(2, 31)	(2, 30)	(2, 29)
ARCH(2)	0.52	0.43	0.44
	(2, 28)	(2, 27)	(2, 26)
NORM	1.13(2)	1.13(2)	0.98(2)
CHOW(79)	0.71	0.81	0.69
	(8, 25)	(8, 24)	(8, 23)
CHOW(83)	0.67	0.53	1.14
	(4, 29)	(4, 28)	(4, 27)

[a] t-statistics in parentheses.
[b] For details of instruments used and misspecification tests please see data appendix.

cyclical, something which Bils (1987) and Layard and Nickell (1985) find evidence for. In models like that of Pagano (1990) such a price equation emerges as the result of a varying number of firms when there are constant marginal costs but fixed set up costs. And, in the endogenous growth literature, the increasing returns are generally external to the firm; again, this will lead to a downward-sloping aggregate *PP* line. Although we will talk as if the downward-sloping price equation is due to increasing returns we do not wish to exclude the possibility that these other potential explanations are the correct ones.

5.2. *The wage equation*

For the wage equation, we will estimate a version of (18). The estimation of wage equations with the theoretical curvature derived here and represented in figs. 2 and 3 has been common practice in much of recent work [see, e.g., Nickell (1987)]. However, the curvature in the wage equation has normally been captured through a $\log u$ term. From the point of view of the theory presented above this has the rather undesirable feature of making the lower bound on the unemployment rate zero. So, in this section, we will estimate a traditional wage equation of this type together with one based more explicitly on the theoretical structure implied by (18).

The theoretical wage equation (18) that was derived above had very precise implications about the incidence of taxes. For example, it implies that the incidence of direct taxes and labour taxes is totally on the employer. In the empirical analysis these theoretical restrictions are not imposed for two reasons. First, as Lockwood (1990) and Lockwood and Manning (1989) have shown, incidence is not straightforward in slightly more complicated models and secondly, our measure of tax rates are likely to be fairly imperfect. We also need a measure of union power in wage determination; in the absence of anything better we use trade union density.

Table 2 presents our wage equation. Columns (1) and (2) present traditional wage equations in which unemployment effects are represented by $\log u$ [column (1), and $\log u$ and $\Delta \log u$ column (2)], the latter formulation having been found to work well in Nickell (1987).

From column (1) we can see that all variables have the correct sign although the coefficient on $\log u_t$ is not very large and not very significant. Column (2) is very similar, the $\Delta \log u_t$ term being insignificant. One potential worry with the wage equations (1) and (2) is the presence of a strong time trend which has not been explained by theory. In many recent studies of U.K. wage equations it has been conventional to include a productivity type term, e.g., the capital–labour ratio to reduce the importance of this time trend. The inclusion of these terms is normally justified in terms of a model virtually identical to the one presented above but involving a different

Table 2

Wage equations. Dependent variable: $\Delta(w-p-t_1-t_2-t_2-v(p_m-p))_t$. Sample: 1951–87.[a,b]

	(1)	(2)	(3)	(4)
c	0.74 (0.57)	0.88 (0.64)	0.81 (1.05)	1.28 (2.09)
$[w-p-t_1-t_2-t_3$ $-v(p_m-p)]_{t-1}$	−0.68 (8.96)	−0.68 (8.89)	−0.74 (11.19)	−0.68 (12.61)
$[b-p-t_3-v(p_m-p)]_t$	0.26 (3.87)	0.25 (3.00)	0.21 (3.28)	0.19 (3.93)
h_t	0.41 (1.28)	0.39 (1.17)	0.47 (2.14)	0.31 (1.96)
t_{1t}	−1.39 (4.46)	−1.35 (3.95)	−0.44 (2.30)	−0.43 (2.92)
t_{2t}	−0.44 (1.36)	−0.38 (1.02)	−0.39 (1.26)	−0.75 (3.15)
t_{3t}	−0.04 (0.15)	−0.08 (0.26)	−0.68 (3.10)	−0.72 (4.14)
$v(p_m-p)_t$	−2.11 (5.25)	−2.20 (4.62)	−2.67 (6.55)	−2.50 (6.90)
time	0.011 (3.72)	0.011 (3.65)	0.011 (7.51)	0.010 (7.76)
den_t	0.51 (4.96)	0.49 (4.36)	–	–
$\log u_t$	−0.03 (1.41)	−0.03 (1.33)	–	–
$\Delta \log u_t$	–	−0.006 (0.34)	–	–
$\tilde{u}t$	–	–	0.21 (5.83)	0.28 (6.00)
$\underline{u}_0$	–	–	0.055	0.046
$\underline{u}_1$	–	–	0.065 (8.32)	0.056 (10.38)
Estimation method	2SLS	2SLS	NL2SLS	NL3SLS
Standard error	0.0131	0.0132	0.0130	0.0125
R^2	0.89	0.89	0.89	0.86
BAS	1.66 (12, 14)	1.88 (11, 14)	1.57 (13, 14)	–
AR(2)	3.50 (2, 22)	2.84 (2, 21)	2.57 (2, 23)	–
HET	0.19 (3, 23)	0.18 (3, 22)	0.69 (3, 24)	–
LIN	0.64 (2, 24)	0.61 (2, 23)	1.09 (2, 25)	–
ARCH(2)	0.64 (2, 21)	0.41 (2, 20)	1.03 (2, 22)	–
NORM	4.59(2)	4.52(2)	1.08(2)	–
CHOW(79)	0.90 (8, 18)	0.85 (8, 17)	0.84 (8, 19)	–
CHOW(83)	1.63 (4, 22)	1.40 (4, 21)	1.63 (4, 23)	–

[a]*t*-statistics in parentheses.

[b]For details of instruments used and misspecification tests please see data appendix.

writing of the first-order condition for wage determination. These models would imply the validity of the wage equations estimated here. So, one cannot explain the time trends in the wage equations presented here as omitted productivity terms. In addition, Newell and Symons (1989) find a significant time trend even when productivity terms are included. This leaves the trend as something of a puzzle but it might be picking up unmodelled trends in union power or product market competition, or trends in search intensity or wealth effects or the 'golden age' variable of Newell and Symons (1989).

Column (3) presents a wage equation based more precisely on the theoretical structure in (18). The unemployment term is now u_t where

$$\tilde{u}_t = \log u_t - \log(u_t - \underline{u}_t),$$
$$\underline{u}_t = \underline{u}_0 + \underline{u}_1 den_t. \tag{24}$$

We would expect a positive coefficient on $\tilde{u}_t$ in a wage equation. The lower bound on unemployment, $\underline{u}_t$, was modelled as a linear function of trade union power. Obviously, the wage equation with these changes is non-linear. There was a problem in achieving unconstrained estimates of this model because of the difficulty in ensuring that $u_t > \underline{u}_t$ in all periods. Consequently, a grid search was conduced on $\underline{u}_0$ and all other parameters were estimated freely. The results are presented in column (3). The results are generally very satisfactory. The unemployment terms and the coefficient on density are very significant. The fit is as good as the conventional wage equations and there is no sign of misspecification. Consequently the equation in column (3) is used as the wage equation in the simulations below. However, there is a difficulty in conducting a very wide-ranging specification search for the $\underline{u}_t$ term because of the difficulty in ensuring that $u_t > \underline{u}_t$ in all periods, and it is possible that the specification used is too simple. Column (4) presents the estimates of the chosen wage equation when it is estimated as part of a system with the preferred price and capital stock equations.

5.3. Capital stock equation

For the capital stock equation we estimate a version of (21) which is shown in column (1) of table 3. We impose the unit long-run elasticity on the real producer wage and employment to generate a dependent variable $[k-n-(w-p+t_1)]$. For the cost of capital, c, we include a long-term real interest rate which was found to work best when lagged two years and the real price of investment goods, $(p_i - p)$, which worked best with both the level and the change. However, it also proved necessary to include some split time trends to achieve an acceptable equation as the dependent variable shows a

Table 3
Capital stock equation. Dependent variable: $\Delta[k-n-(w-p+t_1)]_t$. Sample: 1951–87.[a,b]

	(1)	(2)	(3)
c	−6.10 (5.11)	−7.24 (2.71)	−5.68 (6.01)
$[k-n-(w-p+t_1)]_{t-1}$	−0.76 (5.10)	−0.58 (2.40)	−0.71 (6.01)
$\Delta(p_i-p)_t$	−0.81 (4.75)	−0.76 (3.84)	−0.88 (6.25)
$(p_i-p)_{t-1}$	−0.48 (2.87)	−0.44 (2.41)	−0.54 (4.13)
r_{t-2}	−0.47 (4.06)	−0.34 (1.75)	−0.43 (4.74)
time	-0.51×10^{-2} (3.13)	−0.012 (1.72)	−0.004 (3.36)
$d67\times time$	0.019 (4.49)	0.019 (4.30)	0.017 (5.16)
$(w-p+t_1)_{t-1}$	–	0.20 (0.97)	–
n_{t-1}	–	0.18 (0.55)	–
Estimation method	2SLS	2SLS	3SLS
Standard error	0.020	0.020	0.018
R^2	0.68	0.68	0.68
BAS	2.39 (16, 14)	2.46 (14, 14)	–
AR(2)	2.45 (2, 26)	2.59 (2, 24)	–
HET	1.34 (3, 27)	0.46 (3, 25)	–
LIN	1.20 (2, 28)	1.32 (2, 26)	–
ARCH(2)	0.20 (2, 25)	0.31 (2, 23)	–
NORM	1.09(2)	0.71(2)	–
CHOW(79)	0.38 (8, 20)	–	–
CHOW(83)	0.45 (4, 24)	–	–

[a]*t*-statistics in parentheses.
[b]For details of instruments used and misspecification tests please see data appendix.

strong downward trend to 1967 followed by a strong upward trend. The explanation for this is unclear but, given the traditional difficulties in estimating satisfactory investment and capital stock equations it was decided to stick with the equation of column (1). However, this does mean that the capital stock equation is probably the least satsifactory part of the model. The problems this causes will be discussed later. Column (2) presents the same equation but including the lagged real wage and employment to test that the long-run elasticity is unity. This hypothesis is easily accepted. Column (3) is the same as column (1) but estimated as part of a system.

Given our price, wage and capital stock equations we can now proceed to analyse the nature of the model.

6. Explaining the behaviour of U.K. unemployment

In this section we attempt to see how well the estimated models of the previous section account for the behaviour of U.K. unemployment in the period 1951–87, and compare the performance of the multiple equilibrium model with a more traditional single equilibrium model.

6.1. The workings of the model

The model presented here can be summarised by three equations:

$$(p-w)_t = Z_{1t} + (1-\alpha)\log(1-u_t) + (1-\alpha)l_t - \beta k_t, \tag{25}$$

$$(w-p)_t = Z_{2t} + \gamma[\log u_t - \log(u_t - \underline{u}_t)], \tag{26}$$

$$k_t = Z_{3t} + (w-p)_t + l_t + \log(1-u_t), \tag{27}$$

where Z_{1t}, Z_{2t}, Z_{3t} represent the exogenous variables affecting prices, wages and capital accumulation and l_t is the labour force. We focus on two notions of equilibrium. First, we consider a short-run equilibrium unemployment rate, u^s, where the capital stock is treated as fixed. Adding (25) and (26) we obtain the following implicit equation for u_t^s:

$$\begin{aligned} 0 &= Z_{1t} + Z_{2t} + (1-\alpha)l_t - \beta k_t + (1-\alpha)\log(1-u_t^s) \\ &\quad + \gamma[\log(u_t^S) - \log(u_t^s - \underline{u}_t)] \\ &= Z_t^s + (1-\alpha)\log(1-u_t^s) + \gamma[\log(u_t^s) - \log(u_t^s - \underline{u}_t)], \end{aligned} \tag{28}$$

where $Z_t^s = [Z_{1t} + Z_{2t} + (1-\alpha)l_t - \beta k_t]$ which we can think of as net short-run wage pressure. As $\alpha < 1$, (28) will have a unique solution and u_t^s will be higher, the higher is $\underline{u}_t$ and the higher is Z_t^s.

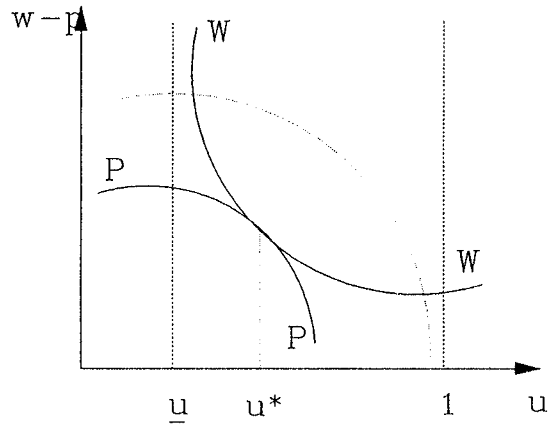

Fig. 5. The determination of u^*.

Secondly, we consider a long-run equilibrium unemployment rate where the capital stock is endogenous and determined by (27). Substituting (27) into (25) we obtain the long-run pricing equation

$$(p-w)_t = \frac{1}{1-\beta}[Z_{1t}+(1-\alpha-\beta)l_t-\beta Z_{3t}] + \frac{1-\alpha-\beta}{1-\beta}\log(1-u_t). \qquad (29)$$

Adding up (29) and (26) we obtain the following implicit equation for the long-run equilibrium unemployment rates:

$$0 = \frac{1}{1-\beta}[Z_{1t}+(1-\alpha-\beta)l_t-\beta Z_{3t}] + Z_{2t} + \frac{1-\alpha-\beta}{1-\beta}\log(1-u_t)$$

$$+\gamma[\log u_t - \log(u_t - \underline{u}_t)] \qquad (30)$$

$$= Z_t^{\mathrm{l}} + \frac{1-\alpha-\beta}{1-\beta}\log(1-u_t) + \gamma[\log u_t - \log(u_t - \underline{u}_t)],$$

where $Z_t^{\mathrm{l}} = \{[1/(1-\beta)][Z_{1t}+(1-\alpha-\beta)l_t-\beta Z_{3t}]+Z_{2t}\}$ is what we will call long-run net wage pressure. As $(\alpha+\beta)>1$ (30) will have either two or no solutions. If it does have solutions we will denote the low equilibrium unemployment rate by u_t^{l} and the high equilibrium unemployment rate by u_t^{h}. This high equilibrium unemployment rate, u_t^{h} will be positively related to Z_t^{l} and negatively related to $\underline{u}_t$, while u_t^{l} will be negatively related to Z_t^{l} and positively related to $\underline{u}_t$.

We also need to be able to tell when we have non-existence of equilibrium.

This is very simple. Consider fig. 5 where we are on the verge of non-existence of equilibrium. In this situation, at the equilibrium, the price and wage equations have the same slope. Denote this unemployment rate by u_t^*. From (26) and (29), this occurs where

$$-\frac{1-\alpha-\beta}{1-\beta}-\frac{1}{1-u_t^*}=\gamma\left[\frac{1}{u_t^*}-\frac{1}{u_t^*-\underline{u}_t}\right]. \tag{31}$$

From (31) it is clear that u_t^* is determined by $\underline{u}_t$ alone and is not influenced by Z_t^1. If we find u_t^* by solving (31) and evaluate (30) at u_t^* and the result is positive, then we have non-existence of equilibrium.

u_t^* is also interesting for two other purposes. First, it marks the dividing line between high and low equilibrium unemployment rates. If equilibrium exists in any period, it is clear from fig. 5 that we must have $u_t^h > u_t^* > u_t^l$. This is potentially useful as one can calculate u_t^* from the price and wage equation alone whereas (u_t^l, u_t^h) can only be calculated using estimates of the capital stock equation which may be inherently less reliable.

Secondly, if $u_t > (<) u_t^*$ then we are in a region where the wage equation is flatter (steeper) than the long-run price equation which has implications for the appropriate policy to reduce unemployment. So u_t^* may be useful as a basis of a quick decision about what policy changes to make.

6.2. Short-run equilibrium

In each period the Z_t^s and $\underline{u}_t$ of (28) was computed using the observed values of the exogenous variables and their estimated coefficients. The short-run unemployment rate, u_t^s, was then computed using (28). The result is plotted in fig. 6 against the observed unemployment rate. As can be seen there is a close correspondence between the two, although u_t^s shows more observed variation than the actual unemployment rate. This is because large temporary shocks to exogenous variables cause large changes in Z_t^s and correspondingly large changes in u_t^s. However, as u_t is slow to adjust towards u_t^s, there is less variation in the observed series.

It is of some interest to ask what accounts for the rise in the short-run equilibrium. Fig. 7 presents the behaviour of short-run net wage pressure Z_t^s and $\underline{u}_t$ which is a linear function of union density) for the period. Until 1967 both Z_t^s and $\underline{u}_t$ were fairly flat and unemployment was fairly constant. From 1967–74 short-term net wage pressure fell dramatically due to exceptionally fast capital accumulation in this period but $\underline{u}_t$ started to rise. These would be expected to have contradictory effects on unemployment and unemployment rose slightly in this period. From 1974–8 short-run pressure rose as capital

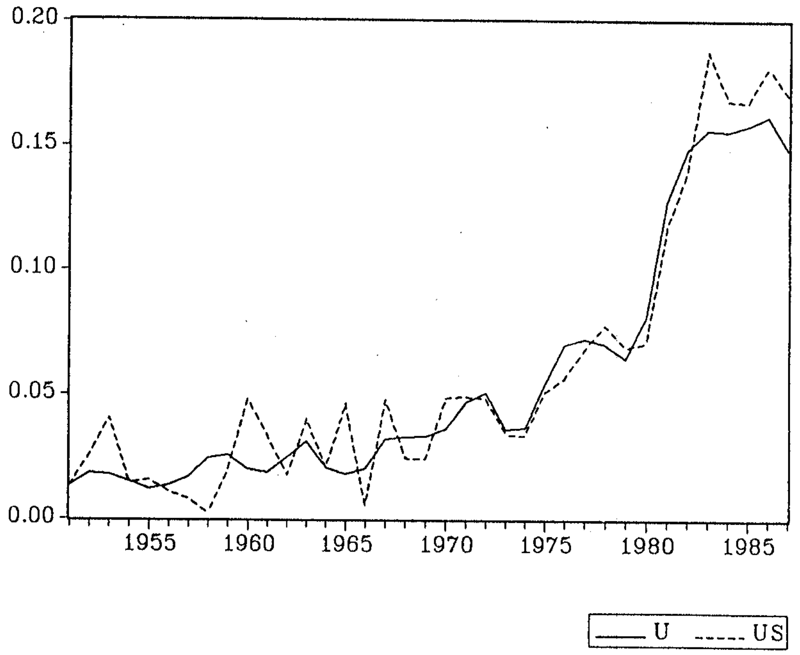

Fig. 6. The short-run equilibrium unemployment rate.

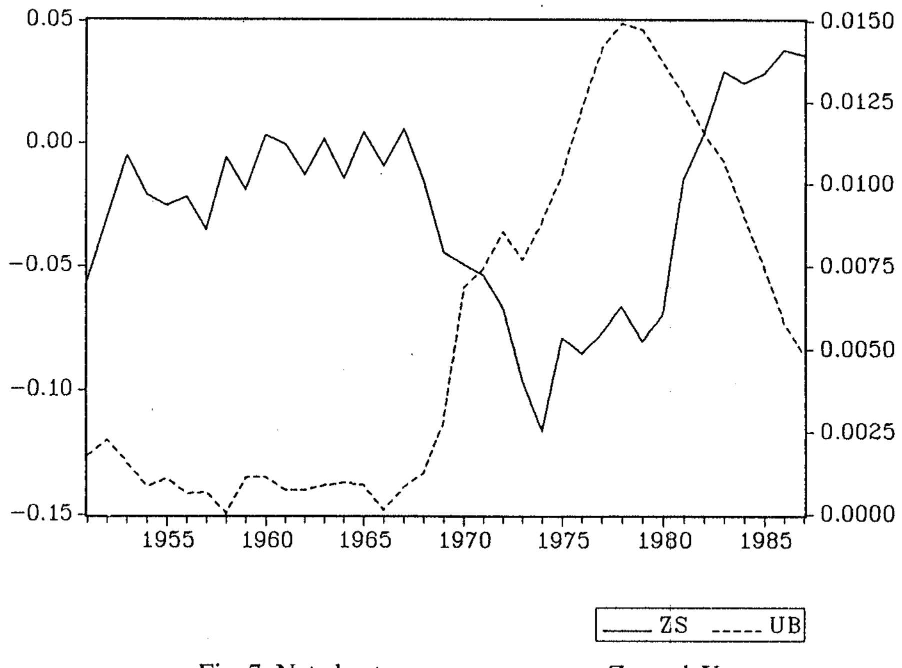

Fig. 7. Net short-run wage pressure, *Zs*, and $\underline{U}$.

accumulation collapsed and $\underline{u}_t$ rose leading eventually to the enormous rise in unemployment in the early 1980s.

6.3. Long-run equilibrium

In each period the Z_t^1 and $\underline{u}_t$ of (30) were computed and the equilibria unemployment rates were computed. For the years 1951–53, 1960, 1963, 1970

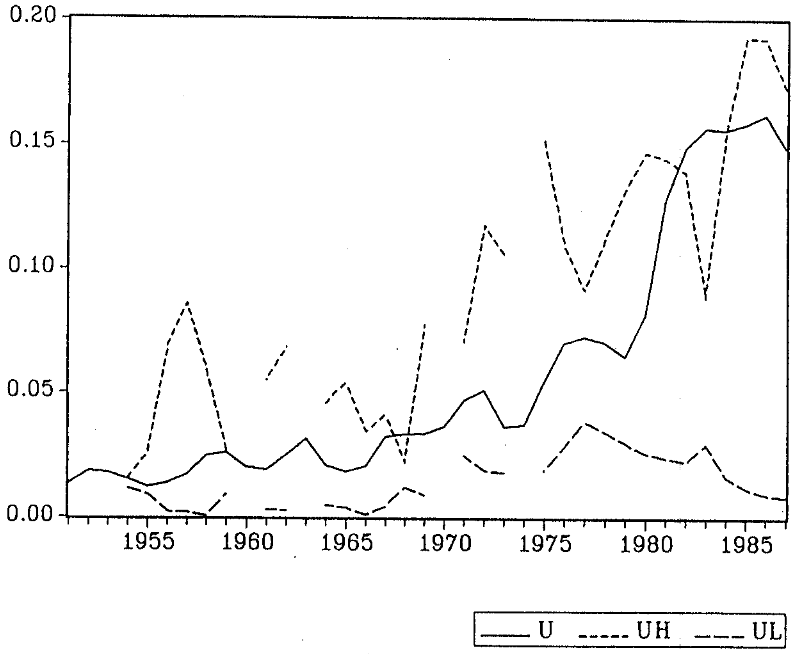

Fig. 8. High and low equilibrium unemployment rates.

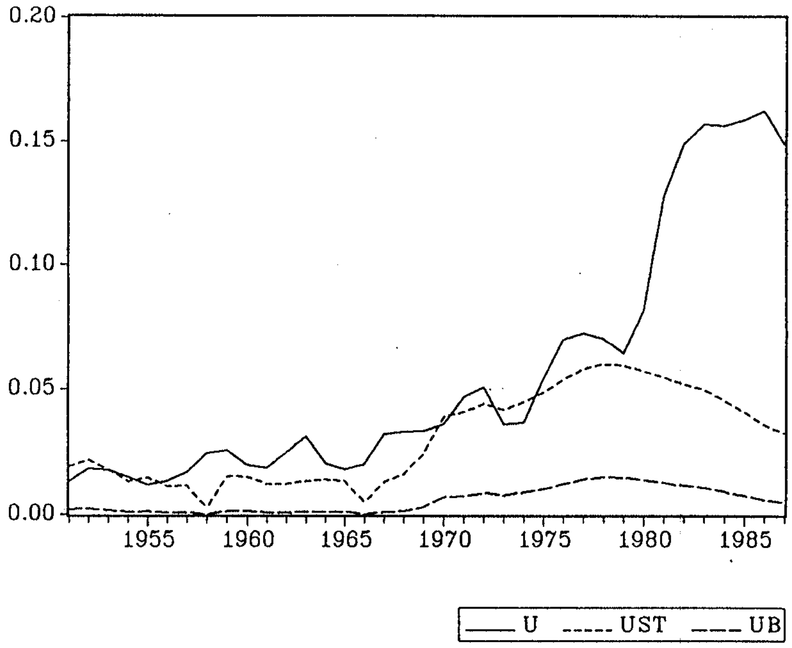

Fig. 9. U^*, $\underline{U}$, and the unemployment rate.

and 1974 no equilibrium was found to exist. For the other years $u_t^h, u_t^l, \underline{u}_t, u_t^*$ and the actual unemployment rate are plotted in figs. 8 and 9.

First, consider the 1980s. In this period the u_t seems to be fairly close to u_t^h. The big drop in u_t^h in 1982–83 is due to exceptionally low hours and high real interest rates, both of which were probably seen as temporary shocks, so that it is not surprising that u_t does not follow u_t^h in these years.

However, for the rest of the sample period, the actual unemployment rate does not seem to be very close to either of the computed equilibrium rates. There are two possible explanations for this. The first is that the multiple equilibrium model is incorrect and forcing the data to have two equilibria ensures a bad fit. In this case we would expect that a more traditional single equilibrium model would do better in explaining unemployment; we consider this below. The second possible explanation is that imprecision in the estimates means that the computed equilibrium unemployment rates are very imprecise.

There are two likely main sources of such imprecision. First, small shifts in the capital stock equation (which is not very robust empirically) can lead to big changes in the computed equilibrium unemployment rates.[10] For example, a one standard error shift in the equilibrium capital stock would in 1983 move the computed high equilibrium unemployment rate of 8.9 to 13.0% or non-existence. Secondly, the difficulties in computing $\underline{u}_t$, the lower bound on unemployment, from the wage equation would, for example, raise the low equilibrium unemployment rate which would make the model fit the data better in the early part of the estimation period.

Now consider whether the multiple equilibrium model performs better or worse than a traditional single equilibrium model in explaining unemployment. The easiest (and most conventional) way to obtain such a model is to impose constant returns to scale on the estimates from the pricing equation. This was then estimated by 3SLS in conjunction with the preferred wage and capital stock equations. The estimated price equation is presented in column (4) of table 1a (the other equations are not reported as the estimates were virtually identical to those obtained before). We then followed the same procedure as for the multiple equilibrium model to compute the predicted short-run and long-run equilibrium unemployment rates. We will denote the latter, which is the focus of interest here, as u_t^c. With constant returns to scale

[10]The imprecision of the computed equilibrium unemployment rates may be very difficult to avoid if the fragility argument of Blanchard and Summers (1988) is correct. They argued that in multiple equilibrium models, small shocks may have very large effects. However, it is important to note that shocks need not necessarily have a larger effect on equilibria in multiple as opposed to single equilibrium models. For example, a positive one standard error shock to the wage equation in 1983 would have raised the computed low long-run equilibrium unemployment rate from 2.3 to 2.6%, lowered the high equilibrium from 8.9 to 7.7%, but raised the short-run equilibrium unemployment rate (which comes from a single equilibrium model) from 18.8 to 23.1%.

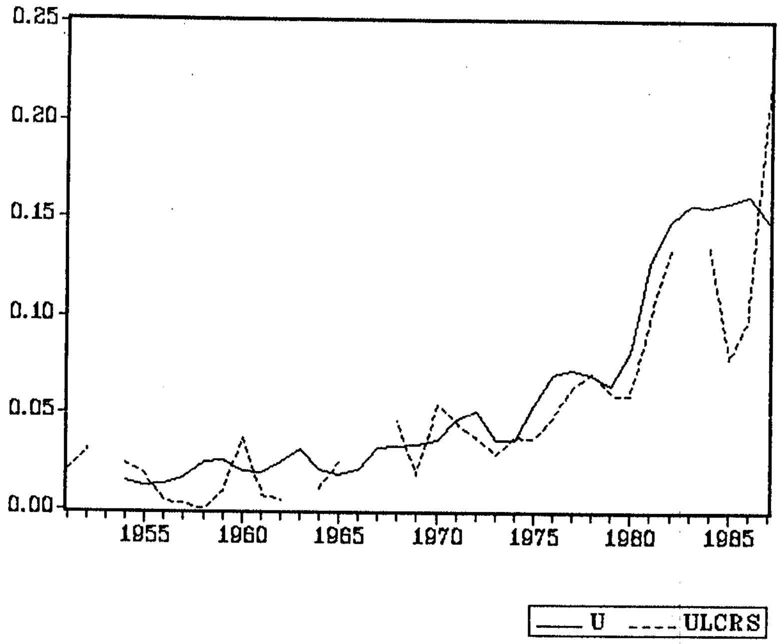

Fig. 10. Long-run single equilibrium unemployment rate.

the long-run *PP* curve of fig. 3 is horizontal so that there are either zero or one equilibria.

The result is plotted in fig. 10. For the years 1953, 1963, 1966–67 and 1983 no equilibrium was found to exist. This is a problem caused by the poor fit of the capital stock equation which is a problem that afflicts the single equilibrium model as much as the multiple equilibrium one.[11] For the other years, the single long-run equilibrium seems to track the actual unemployment rate much better than either of the multiple equilibrium unemployment rates. This is reflected in the fact that for the period 1954–79 the crude correlation between u_t^c and u_t is 0.87 while that between u_t^h and u_t is 0.81 and the correlation between u_t^l and u_t is only 0.42.

However, the conclusion that the single equilibrium model outperforms the multiple equilibrium model may be premature. One way of looking at which model is better, is to see which equilibrium unemployment rate best explains the actual unemployment rate. This is done in table 4 where the actual unemployment rate is regressed on u_t^l, u_t^h and u_t^c allowing the different models to 'compete' against each other. One problem in doing this is the problem of what to do in the years when one model predicts non-existence of equilibrium. We adopted the simplest procedure which is to omit these years from the sample; hopefully this does not bias the results too much as 4 years are excluded for both models.

[11]Most other studies that try to explain the movements of unemployment condition on the capital stock and hence avoid the problem of estimating a capital stock equation. When we condition on the capital stock (our short-run equilibrium) the fit of the model is very impressive.

Table 4

Unemployment equations. Dependent variable: u_t. Sample: 1954–87.[a, b]

	(1)	(2)	(3)	(4)	(5)	(6)
u_t^l	−0.26 (0.76)	–	–	–	–	–
u_t^h	0.40 (5.28)	–	–	–	–	–
u_t^c	0.58 (5.89)	–	–	–	–	–
$u_t^l \times d54\text{–}79$	–	0.93 (1.29)	1.36 (4.89)	2.22 (12.22)	2.24 (8.25)	2.22 (6.42)
$u_t^h \times d54\text{–}79$	–	0.21 (3.43)	0.22 (3.69)	–	–	–
$u_t^c \times d54\text{–}79$	–	0.23 (0.63)	–	–	–	–
$u_t^l \times d80\text{–}87$	–	−0.07 (0.13)	–	–	–	–
$u_t^h \times d80\text{–}87$	–	0.69 (7.73)	0.68 (10.08)	0.68 (8.16)	0.89 (18.26)	–
$u_t^c \times d80\text{–}87$	–	0.24 (2.64)	0.24 (2.75)	0.24 (2.23)	–	1.06 (12.83)
Estimation	OLS	OLS	OLS	OLS	OLS	OLS
Standard error	0.018	0.012	0.012	0.014	0.022	0.027
R^2	0.87	0.94	0.95	0.92	0.83	0.71
DW	1.36	1.66	1.68	1.42	1.32	1.72

[a]The sample excludes the years for which there was non-existence of equilibrium predicted by either model.

[b]t-statistics in parentheses.

Column (1) of table 4 confirms the results of the crude correlations described above. The single equilibrium unemployment rate seems to perform 'best' although not much better than the high equilibrium unemployment rate. The low equilibrium unemployment rate seems to be useless in predicting unemployment. However, this type of equation is not capable of testing the hypothesis that Britain moved from a low to a high equilibrium unemployment rate in the 1980s.

Column (2) allows for this possibility. The dummy variables *d54–79* takes the value 1 for the years 1954–79 and zero otherwise. Similarly, *d80–87* is a dummy variable taking the value 1 in the years 1980–87 and zero otherwise. When interacted with the equilibrium unemployment rates, we can test the hypothesis that the type of equilibrium changed in 1980. We experimented with the precise year of the change and the results were very similar.

The results are not significantly different. For 1954–79 both of the multiple

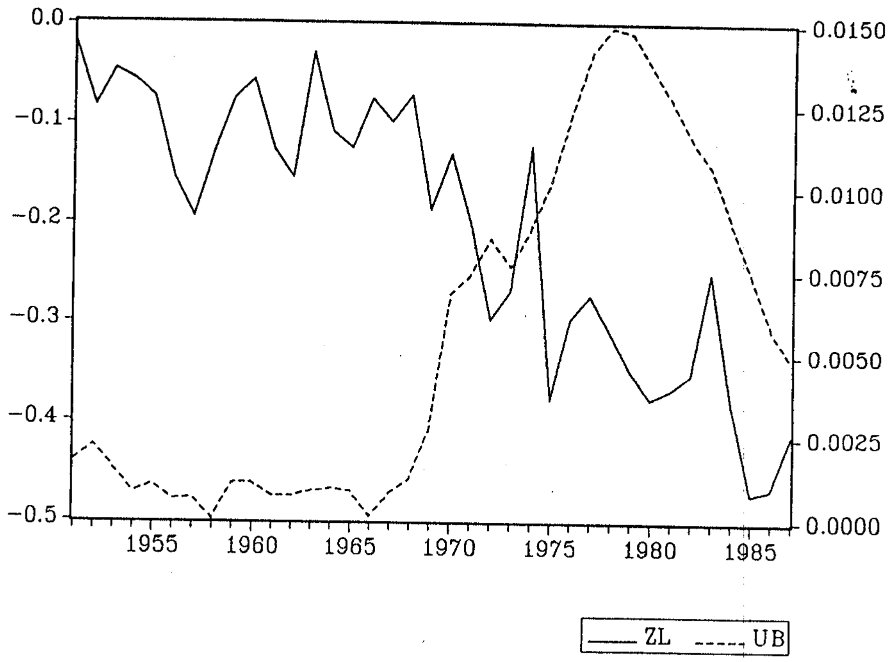

Fig. 11. Net long-run pressure, Zl, and $\underline{U}$.

equilibrium unemployment rates seem better at explaining unemployment than the single equilibrium unemployment rate. And, for 1980–87 the high equilibrium unemployment rate now seems more important than the single equilibrium unemployment rate. When we omit the very insignificant variables from column (2), these results are strengthened. It does seem that in the period 1954–79 the low equilibrium unemployment rate is best able to explain the behaviour of unemployment while in the period 1980–87 the high equilibrium unemployment rate is best. Columns (3)–(6) present a variety of other specifications confirming this. Although the performance of the multiple equilibrium model is probably not significantly better than that of the single equilibrium model it is definitely not worse.

One final question of interest is how Mrs. Thatcher managed to make unemployment so high. From fig. 8 we can see that Mrs. Thatcher achieved such high unemployment rates not only by getting the economy close to the equilibrium high unemployment rate [Manning (1990) speculates about why the transition may have taken place] but also by making that equilibrium rate the highest in the sample period. What was this latter fact due to? Fig. 11 plots $\underline{u}_t$ and net long-run wage pressure as defined in (30). Remember that in the high unemployment equilibrium, an increase in $\underline{u}_t$ and an increase in net wage pressure cause a *fall* in equilibrium unemployment. As can be seen there is a trend fall in net long-run wage pressure is largely due to capital accumulation outstripping the desired growth in real wages. This fact tends to raise the high equilibrium unemployment rate. Until the 1980s this factor was offset by the rise in union power raising $\underline{u}_t$. As union power was reduced by Mrs. Thatcher, this gave a further upward twist to the high equilibrium unemployment rate.

7. Conclusion

This paper started off by suggesting that one way of explaining the high unemployment of the 1980s in Britain was that it represented a move to a high equilibrium unemployment rate. A simple estimable multiple equilibrium model of the labour market was constructed. The main conclusions were:

(i) in the short run, with the capital stock fixed, the British economy appears to have a unique natural rate.
(ii) in the long run, the British economy does appear to have multiple equilibria.
(iii) in the 1980s British unemployment is best explained by the high long-run equilibrium unemployment rate.
(iv) in the period to 1979 British unemployment is best explained by the low equilibrium unemployment rate.
(v) Mrs. Thatcher achieved the highest equilibrium high unemployment rate by her policies of reducing wage pressure.

These conclusions must necessarily be tentative. In particular it was suggested that the difficulties in estimating an adequate capital stock equation and the lower bound on unemployment led to considerable imprecision in computing long-run equilibrium unemployment rates. And although the multiple equilibrium model does appear to perform slightly better than a more traditional single equilibrium model, it is not possible to decisively reject the latter.

These conclusions lead to some awkward policies for unemployment policy. Policies that are good for unemployment in the short run, e.g., reducing wage pressure may, in the long run, lead to increases in unemployment. If this is the case it may be one explanation of the repeated failures of British governments to solve the long-run problem of British unemployment.

Appendix

A. *Data* All the data used are derived as described in Layard and Nickell (1986) with the exception of union density where the union membership figures come from the Employment Gazette and Bain and Price (1979).

B. *Estimation* The instruments used in estimation were two lags on the real producer wage, the capital stock, employment and the unemployment rate, one lag on hours, the real interest rate, real benefits, the real price of investment goods, union density and the tax variables, a linear and quadratic time trend and the split time trends used in the text.

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