Labor Demand and Equilibrium Wage Formation
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Chapter II.3

DYNAMIC MODELS OF EMPLOYMENT BASED ON FIRM-LEVEL PANEL DATA [1]

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ABSTRACT

In this paper we derive dynamic models of employment in the presence of firm-union bargaining. The distinctive feature of our theoretical approach is that the bargaining process is assumed to be repeated afresh in each period so that current employment decisions will generally affect future wage negotiations. This has important implications for the identification of employment equations under different bargaining scenarios. We derive Euler equations for employment under alternative bargaining regimes and these Euler equations are estimated using a panel of 232 UK companies over the period 1980-86. It appears that a dynamic version of the right-to-manage model best describes the data.

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1. INTRODUCTION

The role of unions in wage and employment determination has been a focus of interest for labour economists and policymakers alike. As a result, a wide range of theoretical and empirical studies have attempted to establish the implications of alternative bargaining regimes. The principal competing approaches in this literature are the right-to-manage and efficient bargaining models. In the former, unions and employers bargain over the wage but employers retain their right-to-manage by setting employment unilaterally conditional on the agreed wage. In the latter, unions and employers agree on a wage-employment package conditional on their relative bargaining power.

With few exceptions, the models that have been proposed are static and ignore the fact that both the bargaining process and the production process are repeated through time. In most cases, a static model of employment determination is derived, and then enriched with an *ad hoc* lag structure to fit the data. In this literature, tests of the right-to-manage model are typically based on the exclusion of the alternative wage from a static employment equation (see, *inter alia*, Brown and Ashenfelter (1986), MaCurdy and Pencavel (1986)). However, if one moves to an intertemporal framework, these tests may no longer be appropriate and inference based on them may prove to be misleading.[2]

In recent years, substantial advances have been made in the specification of dynamic models of labour demand. In such dynamic models, employers typically face costs of adjusting employment, and choose the time path of employment to maximise profits subject to a given time path for wages. However, in most UK companies wages are negotiated between unions and employers, and this assumption of a given wage is unlikely to be a reasonable one. In this case, wages are likely to be affected by past employment and the endogeneity of the wage needs to be recognised by the firm when choosing employment.

The aim of this paper is to derive models of employment which are consistent with the intertemporal nature both of firms' decisions and of the bargaining process. To do so, we derive Euler equations for employment under different bargaining scenarios and then estimate the resultant models using panel data on 232 UK companies over the period 1980-86.

Card (1986) has presented tests of alternative bargaining models in a dynamic framework. He, however, assumes that wages and employment in every period are determined in a single bargain : this corresponds to a commitment situation. In our models the bargaining process is assumed to be repeated afresh in each period so that current employment decisions will generally affect future wage negotiations. This is an important difference : for example, without commitment the right-to-manage model is empirically distinguishable from the standard

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[2] See, for example, the theoretical analysis of Lockwood and Manning (1989) who show that the labour demand curve in a dynamic bargaining context differs from the standard one, and includes, for instance, union bargaining power.

labour demand decision rule; this is not the case with commitment. Given that we will be using annual data, and that UK labour contracts are usually one year in length, we therefore use models which are based on wages and employment being determined period by period with no commitment.[3]

The issue of what trade unions bargain over, and in what order, is a subject that has been discussed for some years. In the UK it has often been claimed that trade unions do not bargain directly over employment, and that employment setting lies firmly in the hands of employers. This stylised fact receives support from a number of sources, including the content of actual contracts and consideration of institutional arrangements under which wage and employment setting occur.

Oswald and Turnbull (1985) provide descriptions of the provisions made in a number of actual UK labour contracts. They reach the conclusion that direct bargains over total employment are rare, and that the "typical" bargain specifies a firm-union agreement over wages, after which employment is set unilaterally by the employer. Clark and Oswald (1989) sent a postal survey to the major UK unions[4] asking them what they negotiate about. Out of 57 union responses, 49 claimed that the level of employment was usually decided by the employer. Further to this, an important practical point is that wages are normally set annually in the UK. On the other hand, employment adjusts continuously throughout the year. Hence, one might expect bargains over employment for a fixed time period to be more difficult to implement.

The above discussion seems to lend support to modelling the wage-employment bargain using a dynamic right-to-manage approach. Nevertheless, our theoretical and empirical work also considers the theoretical and empirical consequences of efficient contracting. One should also note that there are other aspects of the firm-union bargain that our approach does not cover. For example, Clark and Oswald (1989) present evidence that unions also negotiate over various working practices. Given a lack of detailed institutional information on the nature of agreements in our sample of firms, we are forced to abstract from this issue in this paper.

The layout of the paper is as follows. Section 2 sets out the formal model, beginning with the usual dynamic optimisation framework considered by, *inter alia*, Sargent (1981) or Nickell (1984), then generalising this to allow a sequential bargain over wages and/or employment to occur between firms and unions. In this context we consider both the right-to-manage and efficient bargaining models and discuss explicitly the issues relating to identification of the employment equation. Estimation techniques are then outlined in the

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[3] More specifically we focus on Markov perfect equilibria in which strategies only depend on state variables and not otherwise on history. This rules out the reputation type effects of Strand (1986).

[4] The 83 affiliated to the Trades Union Congress in December 1987.

following section, whilst Section 4 describes the data, which is a panel of 232 UK companies over the late 1970s and early 1980s. Section 5 presents our results and, finally, Section 6 offers some concluding remarks.

2. THEORETICAL APPROACH

2.1 *THE FIRM'S OPTIMISATION PROBLEM*

Consider a firm operating in a world of perfect capital markets which at the start of every period t inherits a capital stock K_{t-1} and a stock of labour L_{t-1}. Investment (I_t) and hiring (H_t) decisions are made to maximise the expectation of the firm's present value $V_t(\cdot)$. The value of the firm evolves as

$$V_t(L_{t-1},K_{t-1}) = \Pi_t(L_t,K_t,I_t,H_t) + \beta_F E_t V_{t+1}(L_t,K_t) \qquad (2.1)$$

where β_F is the firm's discount factor. In (2.1) $\Pi_t(\cdot)$ denotes current profits, and adjustment costs for capital and labour justify the inclusion of investment and hires in the profit function. E_t is the expectations operator, given information at time t (uncertainty comes from a number of factors, e.g. future product prices, interest rates and wages in the competitive sector).
The adjustment cost function is assumed additively separable in hires and investment so that, from now on, we focus solely on employment decisions and drop I_t from the analysis. Hires are defined as $H_t = L_t - (1-\delta)L_{t-1}$ where δ is the separation rate. Substituting for H_t means one can easily derive the first order conditions for labour as

$$(\partial\Pi_t/\partial L_t) + \beta_F E_t(\partial V_{t+1}/\partial L_t) = 0 \qquad (2.2a)$$

$$(\partial V_t/\partial L_{t-1}) = (\partial\Pi_t/\partial L_{t-1}) \qquad (2.2b)$$

Taking (2.2b) one period ahead and substituting in (2.2a) yields the Euler equation representation of the first order conditions :

$$\beta_F(\partial\Pi_{t+1}/\partial L_t) + (\partial\Pi_t/\partial L_t) + u_{t+1} = 0 \qquad (2.3)$$

Under rational expectations $E_t(u_{t+1}) = 0$, and we adopt this assumption in deriving our empirical models below. Before that, note that the Euler equation approach has a number of advantages. One especially important point is that it contains only variables observed in the sample period. This should be contrasted with the forward solution of the first order conditions which requires (out of sample) predictions of the future marginal product of labour.[5] In the forward solution approach, estimates might therefore be viewed as subject to a Lucas

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[5] See, among others, Sargent (1981), Card (1986) or Kennan (1988). In our notation the forward solution method yields $\partial\Pi_t/\partial L_t = -E_t\Sigma_{s=0}^{\infty}\beta_F^s\partial\Pi_{t+s}/\partial L_{t+s}$. The future values of $\partial\Pi_t/\partial L_t$ need to be predicted.

(1976) type critique.

2.1.1 An Empirical Specification

Equation (2.3) forms the starting point for the models developed in this paper. An estimatable model can be derived by specifying explicitly the structure of the within period profit function $\Pi_t(\cdot)$. We assume that $\Pi_t = A(K_t,\theta_t)L_t^{\alpha} - (\gamma H_t^2/2) - W_tL_t$ where θ_t denotes inputs other than capital and labour and W_t is the wage rate. The first term in Π_t is the revenue function, the second term represents (quadratic) adjustment costs for labour and the third is the wage bill. Note that since the adjustment costs are denominated in terms of the output price, W_t is the real producer wage. For this profit function, the Euler equation for employment can be written

$$L_{t+1} = \psi_1 L_t + \psi_2 L_{t-1} + \psi_3 (Q/L)_t + \psi_4 W_t + \nu_{1t+1} \qquad (2.4)$$

where Q_t denotes real sales. The parameters in (2.4) are related to the structural parameters of the model in the following way :

$$\psi_1 = [\beta_F(1-\delta)^2 + 1]/[\beta_F(1-\delta)]$$

$$\psi_2 = -1/\beta_F$$

$$\psi_3 = -\alpha/[\beta_F(1-\delta)\gamma]$$

$$\psi_4 = 1/[\beta_F(1-\delta)\gamma]$$

The model predicts that $\psi_1 > 2$, $\psi_2 < -1$, $\psi_3 < 0$, and $\psi_4 > 0$.[6] Thus the theoretical specification has particular empirical implications and provides a useful bench-mark against which we can evaluate our empirical results based on models that allow for union-firm bargaining.

2.2 UNIONS AND STATIC MODELS OF EMPLOYMENT DETERMINATION

There have been a number of tests of different models of firm-union bargaining, generally derived from static bargaining models. The most famous of these tests are those proposed by Brown and Ashenfelter (1986) and MaCurdy and Pencavel (1986) who suggest that wage-employment outcomes will lie on the labour demand curve if employment is set only according to the own wage : if the alternative wage is also important, the outcome lies off the labour demand curve on a contract curve denoting Pareto efficient outcomes. Additionally, if only the alternative wage matters, contracts are said to be strongly

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[6] Clearly the long run properties are conditional on productivity (Q/L) which of course is endogenous. Whenver we refer to the long run properties we will always condition on Q/L.

efficient (corresponding to a vertical contract curve).
To illustrate this more concretely, define union utility conditional on the fixed alternative wage ($\bar{W}$) as $U(W,L|\bar{W})$. Denote firm profits as $\Pi(W,L) = R(L) - WL$ where $R(\cdot)$ is revenue. A Pareto efficient wage-employment outcome lies on a contract curve which satisfies[7]

$$(\partial R/\partial L - W)/L = -(\partial U/\partial L)/(\partial U/\partial W) \tag{2.5}$$

which can be rearranged to give

$$\partial R/\partial L = W - L(\partial U/\partial L)/(\partial U/\partial W) \tag{2.6}$$

(2.6) is the condition on which the static tests are usually based. The idea is that if the second term in the equation is zero (2.6) is just the usual marginal productivity condition and W-L combinations lie on the labour demand curve. If the marginal rate of substitution between wages and employment in the union utility function ($[\partial U/\partial L]/[\partial U/\partial W]$) depends on the alternative wage rate (and $\partial R/\partial L$ does not) (2.6) can be used to discriminate between the efficient bargaining and labour demand curve hypotheses (see Andrews and Harrison (1988) for a fuller discussion of identification issues). Existing evidence using this kind of test is somewhat mixed (see, *inter alia*, Brown and Ashenfelter (1986), MaCurdy and Pencavel (1986) who use US data and Nickell and Wadhwani (1991) who use UK data).[8]
Some other observations are relevant. Alogoskoufis and Manning (1992) note that, if union strength differs in wage and employment parts of the bargain, the above test may not be appropriate. Based on Manning's (1987) sequential bargaining model, they formulate a test in which other possible outcomes (i.e. not just the labour demand curve or efficient bargain) are allowed for. On the basis of this, they reject both models in favour of a more general alternative (the major drawback being that they use aggregate data). Also discussing identification, Oswald (1988) notes that the labour demand curve and efficient bargaining models are identical if lay-offs by seniority occur.
Nevertheless, the main point here is these tests are based on static bargaining models. The major exception is Card's (1986) study of employment determination for US airline mechanics. In his model, a forward-looking element is introduced as a dynamic Nash bargain takes place. However, he uses the assumption that future wages are

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[7] See McDonald and Solow (1981) for a formalisation of the efficient bargaining model.

[8] Abowd (1989) also presents an interesting test of strong efficiency, basing his test on the division of the value of the enterprise between workers and shareholders. Christofides and Oswald (1991a) use Canadian contract data and are also unable to reject efficiency of labour contracts. See also Christofides and Oswald (1991b) for an interesting empirical study of contract wage determination where they find support for rent-sharing type models.

determined in today's bargain which means that the tests used in static models are essentially valid as the time path of wages is independent of employment. Card then derives a general bargaining model and tests it using US data on airline mechanics : the more general bargain cannot be rejected in favour of the labour demand curve or the efficient contract model.

2.3 UNIONS AND DYNAMIC MODELS OF EMPLOYMENT DETERMINATION

In this section we consider the empirical implications of a dynamic Nash bargain in which the firm maximises profits subject to a union constraint. The pay-off to the employer at date t (substituting out hires H_t) is given by the profit function $\Pi_t(L_t,W_t,L_{t-1})$, where the dependence on W_t makes explicit that the wage is endogenously determined by the collective bargain. The pay-off to the union at date t is given by the utility function $U_t(L_t,W_t,L_{t-1}|\bar{W}_t)$ where the dependence on L_{t-1} can be rationalised in terms of union membership dynamics (Blanchard and Summers (1986)). The value functions for the firm and the union are

$$\text{Firm} \quad V_t^F(L_{t-1}) = \Pi_t(L_t,W_t,L_{t-1}) + \beta_F E_t\, V_{t+1}^F(L_t) \tag{2.7a}$$

$$\text{Union} \quad V_t^U(L_{t-1}) = U_t(L_t,W_t,L_{t-1}|\bar{W}_t) + \beta_U E_t\, V_{t+1}^U(L_t) \tag{2.7b}$$

2.3.1 Wage and Employment Determination

We assume that we can represent union-firm bargaining by the model proposed in Manning (1987). In this model, there is first a bargain about wages, followed by a bargain about employment. The relative bargaining strength of the two parties at the two stages may differ. This model has the advantage that it encompasses the most popular trade union models. For example, the right-to-manage model is the case where the union has no direct influence over employment, and the efficient bargain where it has the same influence over wages and employment. Initially, our chosen bargaining model is as follows. In the second stage, given the negotiated wage W_t, employment is assumed to be chosen to maximise :

$$V_t^F(L_{t-1}) + \mu_t^1 V_t^U(L_{t-1}) \tag{2.8}$$

which, when solved, would lead to an employment equation of the form $L_t = L_t(W_t,L_{t-1})$. In (2.8) μ_t^1 represents the relative bargaining strength over employment and in general it will be a function of all exogenous variables.[9]

At the wage determination stage, the wage is chosen to maximise

$$V_t^F(L_{t-1}) + \mu_t^w V_t^U(L_{t-1}) \tag{2.9}$$

subject to the constraint $L_t = L_t(W_t, L_{t-1})$. This will lead to a solution of the form $W_t = W_t(L_{t-1})$.

The Euler equation for employment in this model is (see Appendix A for a formal derivation)

$$\begin{aligned}&(\partial\Pi_t/\partial L_t) + \mu_t^1(\partial U_t/\partial L_t) + \beta_F[(\partial\Pi_{t+1}/\partial L_t)\\ &+ \mu_{t+1}^1(\partial U_{t+1}/\partial L_t)] + \beta_F[(\partial\Pi_{t+1}/\partial W_{t+1})\\ &+ \mu_{t+1}^1(\partial U_{t+1}/\partial W_{t+1})](\partial W_{t+1}/\partial L_t)\\ &+ (\beta_U\mu_t^1 - \beta_F\mu_{t+1}^1)(\partial V_{t+1}^U/\partial L_t) = 0\end{aligned} \tag{2.10}$$

Equation (2.10) does not provide a directly estimatable equation because of the unobservable nature of the marginal benefit to the union in period t+1 of employment in period t $(\partial V_{t+1}^U/\partial L_t)$ and of union bargaining power over employment (μ_{t+1}^1, μ_t^1). Yet we can impose restrictions on (2.10) to generate Euler representations of the employment path corresponding to alternative (simpler) bargaining models. In particular, the right-to-manage model is the case where the union has no power at the employment determination stage $(\mu_t^1 = 0)$. The efficient bargaining model is obtained when the relative bargaining strengths are equal at the two stages of the bargain $(\mu_t^1 = \mu_t^w)$.

2.3.2 *The Right-to-Manage Model*

If the employer has unilateral control over employment, we will have $\mu_t^1 = 0$ for all t. Imposing this condition, we can write (2.10) as :

$$\begin{aligned}&(\partial\Pi_t/\partial L_t) + \beta_F(\partial\Pi_{t+1}/\partial L_t)\\ &+ \beta_F(\partial\Pi_{t+1}/\partial W_{t+1})(\partial W_{t+1}/\partial L_t) = 0\end{aligned} \tag{2.11}$$

The first two terms are familiar from the analysis of the Euler equation in a competitive labour market (see equation (2.3) above);

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[9] We might represent a bargaining solution by a very general function. For example, we could say that L_t is chosen to maximise $B_t(V_t^F, V_t^U)$ where $B_t(\cdot)$ is some bargaining solution. This would lead to a solution $V_t^U = \bar{V}_t^U$. This means we can mimic the bargaining solution by the following constrained optimisation problem : MAX V_t^F s.t. $V_t^U \geq \bar{V}_t^U$ which would lead to an objective function of the form $V_t^F + \mu_t V_t^U$ where μ_t is the Lagrange multiplier on the constraint. So, this illustrates that we can convert any general bargaining solution into a linear one of this form although, of course, μ_t should not be treated as exogenous.

the third term arises as the employer recognises that the employment level chosen today will affect the negotiated wages tomorrow and that this affects future profits.

Let us consider this third term in more detail. The term $(\partial \Pi_{t+1}/\partial W_{t+1})$ will, for a standard specification of the profit function, be equal to $-L_{t+1}$, so the third term in (2.11) will introduce another term involving L_{t+1} to the equation. It will be multiplied by $(\partial W_{t+1}/\partial L_t)$. In most dynamic models, where wages are determined by bargaining within the firm, this will be non-zero. For example, Lockwood and Manning (1989) present a model in which there are costs of adjusting employment but no dynamics in the union utility function (which is additively separable across time). They show that in this case $\partial W_{t+1}/\partial L_t > 0$. Conversely, the insider-outsider model of Blanchard and Summers (1986), in which there are no employment adjustment costs but there are dynamics in the union utility function, has the feature that $\partial W_{t+1}/\partial L_t < 0$. From this discussion it should be apparent that although it is unlikely that $\partial W_{t+1}/\partial L_t = 0$ it is not possible to sign it a priori on theoretical grounds.

In general, there is no closed form solution for $(\partial W_{t+1}/\partial L_t)$ which raises the issue of identification in this type of model. We model $(\partial W_{t+1}/\partial L_t)$ assuming it to be a function of union presence. The specific functional form we adopt for the extra term in (2.11) is $-L_{t+1}(\theta_0 + \theta_1 UNION_{t+1} + \theta_2 UNION_{t+1}/L_{t+1})$ so that the estimating equation is

$$L_{t+1} = \psi_{21}L_t + \psi_{22}L_{t-1} + \psi_{23}(Q/L)_t + \psi_{24}W_t$$
$$+ \psi_{25}(UNION{*}L)_{t+1} + \psi_{26}UNION_{t+1} + \nu_{2t+1} \qquad (2.12)$$

where UNION is unionisation.

The underlying structural parameters are related to the parameters in (2.12) as

$$\psi_{21} = \gamma[\beta_F(1-\delta)^2 + 1]/\beta_F[\gamma(1-\delta) - \theta_0]$$

$$\psi_{22} = -\gamma(1-\delta)/\beta_F[\gamma(1-\delta) - \theta_0]$$

$$\psi_{23} = -\alpha/\beta_F[\gamma(1-\delta) - \theta_0]$$

$$\psi_{24} = 1/\beta_F[\gamma(1-\delta) - \theta_0]$$

$$\psi_{25} = \theta_1/[\gamma(1-\delta) - \theta_0]$$

$$\psi_{26} = \theta_2/[\gamma(1-\delta) - \theta_0]$$

In this case, the structural parameters are unidentified and theory merely restricts the signs and possibly the range of ratios of coefficients. Hence, we can state that $\psi_{21}/\psi_{22} < -2$ and $-1 < \psi_{23}/\psi_{24} < 0$. Neither the long run nor the short run coefficient on the wage rate can be signed a priori, but the wage coefficient ψ_{24} must have the same sign as ψ_{21}, the coefficient on lagged employment. On the coefficients ψ_{25} and ψ_{26}, we should also note, from the previous discussion, that there are no a priori views regarding their signs. However, despite the reduced form nature of the model specification, there are still testable implications for the optimal employment path.

2.3.3 *The Efficient Bargaining Model*

To derive the Euler equation for the efficient contracting model we can use the first order conditions for the wage (see Appendix A equation (A4)) put forward one period to eliminate the term $(\partial\Pi_{t+1}/\partial W_{t+1})$ from (2.10) and we set $\mu_s^1 = \mu_s^w$, (s = t, t+1). This gives

$$(\partial\Pi_t/\partial L_t) + \mu_t^1(\partial U_t/\partial L_t) + \beta_F[(\partial\Pi_{t+1}/\partial L_t) + \mu_{t+1}^1(\partial U_{t+1}/\partial L_t)] + (\beta_U\mu_t^1 - \beta_F\mu_{t+1}^1)(\partial V_{t+1}^U/\partial L_t) = 0 \qquad (2.13)$$

Moreover note that the first order conditions for the wage rate imply

$$\mu_t^1 = \mu_t^w = -(\partial\Pi_t/\partial W_t)/(\partial U_t/\partial W_t) \qquad (2.14)$$

which permits us to substitute out the unobservable relative union strength terms.

There are some important differences relative to the labour demand curve model. Firstly, the term $\partial W_{t+1}/\partial L_t$ does not enter explicitly.[10] Secondly, new terms appear which reflect the fact that the unions have some power over employment decisions (i.e. because $\mu_t^1 > 0$).

To make the model operational, we need to specify union preferences. Initially, we let union preferences be additively separable across time with respect to employment and wages. Below we also discuss the consequences of allowing for union membership dynamics by including lagged employment in the utility function.

In the first case, the period union utility function is assumed to be $U_t = (W_t - \bar{W}_t)L_t^\theta$ $(\theta \geq 0)$. For this specification $\mu_t^1 = L_t^{1-\theta}$. At this point we also use the approximation $\partial V_{t+1}^U/\partial L_t = \partial U_{t+1}/\partial L_t$ which is zero in the absence of union membership dynamics. Hence the empirical Euler equation becomes

$$L_{t+1} = \psi_{31}L_t + \psi_{32}L_{t-1} + \psi_{33}(Q/L)_t + \psi_{34}W_t + \psi_{35}\bar{W}_t + \nu_{3t+1} \qquad (2.15)$$

where

$$\psi_{31} = [\beta_F(1-\delta)^2 + 1]/\beta_F(1-\delta)$$

$$\psi_{32} = -1/\beta_F$$

$$\psi_{33} = -\alpha/\beta_F(1-\delta)$$

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[10] In the efficient bargain, where $\mu_t^1 = \mu_t^w$ for all t, the wage and employment outcomes can be viewed as the outcomes of the same optimisation problem. Hence, an envelope theorem applies to make $\partial W_{t+1}/\partial L_t$ disappear.

$\psi_{34} = (\theta-1)/\beta_F(1-\delta)$

$\psi_{35} = \theta/\beta_F(1-\delta)$

Equation (2.15) is the Euler equation corresponding to the efficient bargain. Under strong efficiency (i.e. a risk neutral utilitarian union) $\theta = 1$ and employment does not depend directly on the negotiated wage.
Generalising the union utility function to

$$U_t = (W_t - \bar{W}_t)L_t^{\theta 1}L_{t-1}^{\theta 2} \quad (\theta_1 > 0)$$

allows for union membership dynamics (Blanchard and Summers (1986), Nickell and Wadhwani (1991)). The implied time path of employment for this specification of union preferences and with the same assumptions as above is given by

$$L_{t+1} = \psi_{41}L_t + \psi_{42}L_{t-1} + \psi_{43}(Q/L)_t + \psi_{44}W_t + \psi_{45}\bar{W}_t + \psi_{46}(W_{t+1} - \bar{W}_{t+1})L_t^{\theta 2-\theta 1}L_{t+1}^{\theta 1}/L_{t-1}^{\theta 2} + \nu_{4t+1} \qquad (2.16)$$

There are two important characteristics of equation (2.16) *vis-à-vis* earlier versions of the model. The first is that the model becomes non linear in current and lagged employment. The second is the change in the lag structure of the wage and alternative wage variables. We test for the importance of these extra considerations in the empirical section.

2.3.4 *Identification*

In a static model the closed form nature of the employment and wage equations make identification issues clear. In the right-to-manage model the employment equation is identified *vis-à-vis* the wage equation by the absence of both union power and alternative wage measures. The efficient bargain model is identified by the exclusion of union power measures which affect the wage.
In a dynamic context, the right-to-manage model contains the last term in (2.11) which will depend upon the term $\partial W_{t+1}/\partial L_t$ for which no closed form solution can be found and hence has to be proxied. This model is identified by the exclusion of *current* (t) dated union power and the alternative wage from the employment equation : these current dated terms should not enter $\partial W_{t+1}/\partial L_t$ conditional on variables dated t+1. This is sufficient to distinguish the employment equation of the right-to-manage model from the wage equation. The identification of the employment rule in the efficient bargain is achieved by the exclusion of variables that determine the union bargaining position (μ_t^W). In the dynamic context this requires that the approximation for the term $\partial V_{t+1}^U/\partial L_t$ does not depend on union power variables.

3. STOCHASTIC SPECIFICATION AND ESTIMATION

The models we consider all have the general form

$$L_{it+1} = \alpha L_{it} + \beta L_{it-1} + \gamma' x_{it} + \delta' z_{it+1} + f_i + u_{it+1}$$

where i is a firm index, t is a time index and x_{it} and z_{it+1} contain all other right hand side variables suggested by the various Euler equations described in Section 2. To allow for various time-invariant unobservables, we incorporate a firm-specific fixed effect f_i. In addition to this, we have two further sources of stochastic variation. Firstly, because of the formulation of the dynamic optimisation problem, all variables dated t+1 are potentially correlated with the error term u_{it+1} (which, at least partially, reflects expectational errors). This includes the alternative wage since : (i) there are industry-specific temporal shocks that may affect both employment and the industry wage, and (ii) some firms have a large market share and hence wage negotiations in such a firm may have an important impact on the average industry wage.[11]

Secondly, u_{it+1} may reflect stochastic shocks to the parameters of the model. Such shocks may be serially correlated and theory itself provides no guidance for the structure of such serial correlation. Hence the appropriate timing of instruments is ultimately an empirical question.

To control for fixed effects we estimate the model in first differences, with the error term $\Delta u_{it+1} = u_{it+1} - u_{it}$ implying that all variables dated t are probably endogenous. To estimate the model we rely on fixed T (time) - large N (firms) asymptotics and use a Method of Moments estimator as developed by Arellano and Bond (1991) and Holtz-Eakin, Newey and Rosen (1988). This utilises all permissible orthogonality conditions of the form $E(\Delta u_{it} | x_{it-k}, z_{it-k}, L_{it-k}) = 0$, for appropriate k. An intuitive interpretation of this instrumental variables estimator is as follows : in every year of data a different reduced form is estimated for each of the endogenous (right-hand side) variables using all valid instruments available in that period. Thus if the data runs from 1977 to 1986 and we intend to use instruments lagged at least three periods, the first period of estimation will be 1980 and the reduced form will contain variables dated 1977. In the next period (1981) the reduced form contains variables from 1977 and 1978 and so on. To implement the estimator we use lags of employment, the wage, the alternative wage and unionisation (by itself and interacted with employment) as instruments. We use the same general instrument set for all our estimated models and report results with the instruments lagged at least three periods (and, in an Appendix, also at least four periods lagged). The reported standard errors take account of heteroscedasticity both across firms and across time and we also present Sargan tests of the overidentifying restrictions.

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[11] Take, as a classic example of this, the importance of the annual pay settlement at Ford for UK car workers.

4. DATA DESCRIPTION

The data we use is drawn from the Datastream databank of company accounts. This data source covers UK Stock Exchange quoted companies and contains employment and wage cost data from 1976 onwards. Until June 1982, UK companies were required to report the number of UK employees and remuneration in their accounts. After this date, the requirement changed to cover total group employees. However, some companies (mostly, but not entirely, those without overseas subsidiaries) did continue to report UK employment, so for these companies, we have series on UK employment and wage costs up to 1986. Our basic analysis draws on those companies which reported UK employee data for at least 8 continuous years. Hence, we have panel data on 232 companies, with the structure of the panel given in Table 1. The intertemporal behaviour of firm-level employment and wage data (for the full sample and across broad industry groups) is illustrated in Tables 2A and 2B. Figures 1 and 2 give plots for the industry subgroups. Their behaviour over time is consistent with aggregate trends (falling employment in the early 1980s, rising real wages through the 1980s), but also exhibits some cross-sectional variation even when aggregated to the 1-digit industry-level.

TABLE 1 :
Structure of the Panel

Number of Companies	Number of Records
51	8
44	9
89	10
48	11

Note.
1. This is the number of records on each company which reported the number of UK employees with at least 8 continuous records.

TABLE 2A :
Average Employment for Firms Across Manufacturing Industries

Year	All	Chemicals	Engineering	Other Manufacturing
1977	2504	2770	4055	1226
1978	2462	2735	4058	1527
1979	2655	2669	3906	1473
1980	2632	2494	3800	2059
1981	2468	2117	3741	1939
1982	2272	1833	3487	1818
1983	2205	1816	3314	1783
1984	2042	1675	2844	1782
1985	2100	1528	3149	1770
1986	2340	1728	3867	1759

TABLE 2B :
Average Real Wages (1980 Prices) for Firms Across Manufacturing Industries

Year	All	Chemicals	Engineering	Other Manufacturing
1977	5660	6204	6035	5200
1978	5843	6290	6142	5472
1979	6017	6499	6434	5558
1980	6216	6753	6643	5725
1981	6370	6831	6749	5942
1982	6628	7077	7079	6166
1983	6657	7097	7095	6208
1984	6753	7298	7290	6227
1985	7020	7614	7670	6466
1986	7401	7935	8022	6903

FIGURE 1 :
Average Employment

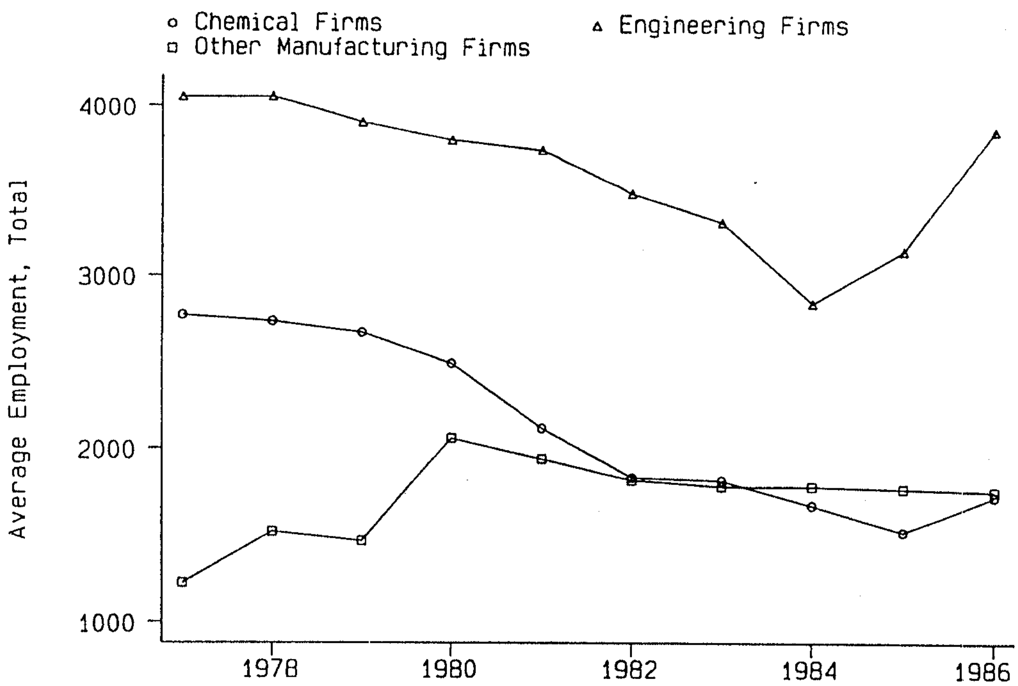
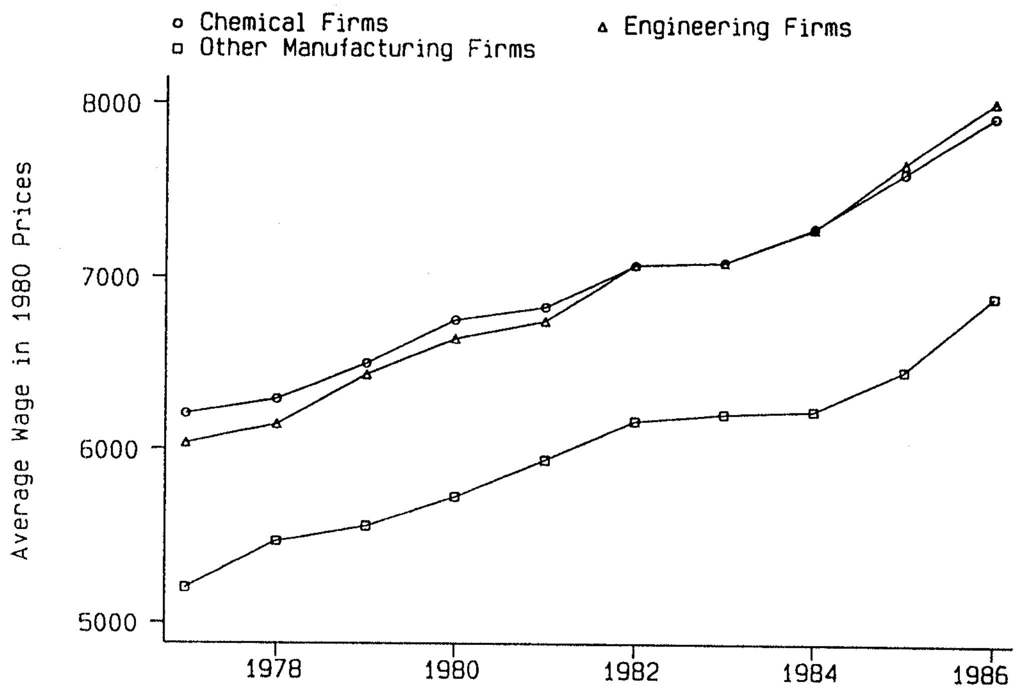


FIGURE 2 :
Average Real Wages (1980 Prices)



As a further way of summarising our data and learning about its dynamic structure, we also present matrices of autocorrelations and autocovariances (with standard errors) for the changes in the log of employment ($\Delta \ln L_t$) and wages ($\Delta \ln W_t$) as suggested by Abowd and Card (1989).[12] Since we have panel data, autocovariances can be computed separately for every pair of years. We consider the time series structure of the differences rather than the level to net out the correlations due to fixed effects. The results for employment and wages are presented in Tables 3A and 3B. The diagonal contains the cross sectional variance of the change in logs, whilst above the diagonal we present the autocovariances and below the autocorrelations.

Consider first the behaviour of employment. It is apparent from the year-to-year variances and autocovariances that the rate of change of employment is non-stationary. The first order autocovariances in Table 3A are often significant but the corresponding autocorrelations are quite small. In some years the autocorrelations cut off after one or two lags while in others they persist somewhat longer. The data seems to be consistent with an MA(2) or an ARMA process with relatively small autoregressive coefficients.

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[12] The results we obtain for the change in levels (rather than the change in logs) are essentially the same.

TABLE 3A :
*Covariances (x100) and Correlations of the Change in log (Employment)**

1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
4.588	0.748	-0.959	0.387	-0.766	0.732	0.273	0.260	1.351	0.364
(1.905)	(0.500)	(0.990)	(0.383)	(0.829)	(0.688)	(0.243)	(0.237)	(0.767)	(0.306)
0.191	1.498	0.240	0.178	0.054	-0.064	-0.038	0.272	0.147	-0.238
	(0.357)	(0.291)	(0.077)	(0.163)	(0.139)	(0.115)	(0.127)	(0.199)	(0.317)
-0.213	0.140	1.914	0.220	0.387	0.188	-0.065	0.321	0.292	0.209
		(0.581)	(0.094)	(0.124)	(0.157)	(0.204)	(0.203)	(0.219)	(0.161)
0.100	0.121	0.134	1.372	0.615	0.097	-0.148	0.141	0.279	0.137
			(0.274)	(0.159)	(0.134)	(0.168)	(0.248)	(0.238)	(0.130)
-0.137	0.025	0.163	0.311	2.863	0.457	0.096	0.801	0.443	-0.420
				(0.621)	(0.234)	(0.123)	(0.541)	(0.236)	(0.400)
0.151	-0.035	0.092	0.057	0.184	2.156	0.300	0.603	0.413	0.485
					(0.392)	(0.453)	(0.429)	(0.450)	(0.195)
0.048	-0.017	-0.027	-0.072	0.032	0.117	3.044	1.079	0.440	-0.018
						(1.295)	(0.381)	(0.301)	(0.204)
0.037	0.097	0.099	0.051	0.200	0.174	0.262	5.111	1.172	-0.238
							(1.338)	(0.330)	(0.576)
0.209	0.048	0.083	0.092	0.101	0.109	0.097	0.209	5.087	0.239
								(1.803)	(0.407)
0.079	-0.081	0.062	0.047	-0.100	0.133	-0.004	-0.044	0.049	3.471
									(0.914)

* Elements below the diagonal are correlations, the diagonal represents the variance of the rate of change in the relevant period and the elements above the diagonal are the covariances. Standard errors in parentheses.

TABLE 3B :
*Covariances (x100) and Correlations of the Change in log (Wages)**

1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
1.305	-0.023	0.071	-0.090	-0.305	0.169	0.133	0.053	0.013	0.026
(0.613)	(0.112)	(0.152)	(0.045)	(0.252)	(0.184)	(0.101)	(0.076)	(0.056)	(0.072)
-0.019	0.489	-0.023	-0.023	-0.099	0.053	-0.066	0.008	-0.144	-0.027
	(0.087)	(0.038)	(0.059)	(0.053)	(0.042)	(0.037)	(0.047)	(0.085)	(0.056)
0.067	-0.053	0.373	-0.077	-0.042	0.019	-0.074	0.086	0.069	0.031
		(0.063)	(0.059)	(0.043)	(0.028)	(0.041)	(0.040)	(0.070)	(0.038)
-0.057	-0.036	-0.140	0.802	-0.138	-0.077	0.074	-0.052	-0.006	-0.013
			(0.254)	(0.041)	(0.061)	(0.083)	(0.037)	(0.069)	(0.129)
-0.196	-0.155	-0.077	-0.174	0.779	-0.331	0.082	-0.124	0.010	0.095
				(0.136)	(0.117)	(0.055)	(0.054)	(0.046)	(0.068)
0.108	0.083	0.035	-0.096	-0.419	0.799	-0.314	-0.004	-0.094	-0.180
					(0.167)	(0.087)	(0.051)	(0.088)	(0.123)
0.084	-0.102	-0.134	0.092	0.103	-0.391	0.808	-0.232	0.027	-0.008
						(0.115)	(0.096)	(0.064)	(0.081)
0.036	0.013	0.155	-0.063	-0.152	-0.005	-0.280	0.776	-0.064	-0.031
							(0.148)	(0.153)	(0.064)
0.008	-0.185	0.099	-0.005	0.010	-0.092	0.026	-0.066	0.998	-0.027
								(0.306)	(0.115)
0.022	-0.033	0.042	-0.012	0.090	-0.168	-0.008	-0.031	-0.026	0.810
									(0.156)

* Elements below the diagonal are correlations, the diagonal represents the variance of the rate of change in the relevant period and the elements above the diagonal are the covariances. Standard errors in parentheses.

TABLE 3C :
*Change in log (Wages) Versus Change in log (Employment) - Covariances (x100)**

1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
-0.472	-0.033	0.068	-0.004	-0.325	-0.252	0.099	-0.363	-0.259	-0.240
(0.688)	(0.139)	(0.214)	(0.107)	(0.294)	(0.312)	(0.216)	(0.238)	(0.375)	(0.153)
-0.192	-0.054	-0.108	0.026	0.056	0.069	-0.002	0.075	0.103	0.093
(0.225)	(0.115)	(0.135)	(0.046)	(0.068)	(0.068)	(0.052)	(0.113)	(0.111)	(0.155)
-0.196	0.066	-0.330	0.053	-0.046	-0.101	0.128	0.058	-0.051	-0.012
(0.333)	(0.067)	(0.128)	(0.046)	(0.053)	(0.078)	(0.088)	(0.084)	(0.115)	(0.114)
0.029	0.107	0.187	0.020	-0.015	0.035	0.186	0.231	0.023	0.440
(0.163)	(0.108)	(0.164)	(0.087)	(0.140)	(0.095)	(0.116)	(0.237)	(0.104)	(0.236)
0.562	-0.084	-0.085	0.038	0.050	0.110	-0.143	-0.130	0.081	-0.132
(0.300)	(0.091)	(0.089)	(0.082)	(0.124)	(0.117)	(0.208)	(0.197)	(0.112)	(0.133)
-0.089	0.079	-0.061	-0.034	-0.262	-0.207	-0.085	-0.477	0.132	0.275
(0.099)	(0.059)	(0.053)	(0.075)	(0.197)	(0.110)	(0.080)	(0.275)	(0.139)	(0.239)
-0.226	-0.144	0.156	0.144	0.132	-0.020	-0.250	0.009	-0.020	-0.126
(0.279)	(0.085)	(0.134)	(0.071)	(0.100)	(0.108)	(0.139)	(0.149)	(0.117)	(0.181)
-0.075	0.112	-0.089	-0.018	-0.063	-0.010	0.187	0.171	0.070	0.155
(0.146)	(0.065)	(0.066)	(0.070)	(0.107)	(0.105)	(0.150)	(0.235)	(0.268)	(0.213)
-0.019	0.129	-0.011	0.149	0.119	-0.064	-0.149	0.139	-0.531	0.442
(0.107)	(0.102)	(0.078)	(0.072)	(0.102)	(0.083)	(0.086)	(0.246)	(0.262)	(0.411)
-0.088	0.035	-0.192	-0.148	0.222	-0.043	-0.037	-0.196	-0.295	-0.333
(0.124)	(0.086)	(0.122)	(0.082)	(0.220)	(0.134)	(0.098)	(0.253)	(0.249)	(0.251)

* Element (i,j) is the covariance of Δ ln (Employment) in period j with Δ ln (Wages) in period i. Standard errors in parentheses.

TABLE 3D :
*Change in log (Wages) Versus Change in log (Employment) - Correlations**

1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
-0.193	-0.016	0.028	-0.002	-0.109	-0.098	0.032	-0.096	-0.075	-0.097
-0.086	-0.063	-0.110	0.031	0.046	0.065	-0.002	0.047	0.058	0.055
-0.098	0.086	-0.391	0.072	-0.044	-0.111	0.119	0.041	-0.033	-0.008
0.010	0.095	0.149	0.019	-0.010	0.026	0.119	0.109	0.010	0.198
0.193	-0.075	-0.069	0.037	0.034	0.085	-0.093	-0.062	0.036	-0.060
-0.030	0.070	-0.049	-0.032	-0.173	-0.157	-0.055	-0.226	0.057	0.124
-0.076	-0.128	0.124	0.137	0.087	-0.015	-0.160	0.004	-0.009	-0.056
-0.027	0.102	-0.071	-0.016	-0.041	-0.007	0.116	0.086	0.032	0.074
-0.007	0.094	-0.007	0.111	0.061	-0.038	-0.074	0.056	-0.235	0.205
-0.040	0.025	-0.117	-0.105	0.110	-0.024	-0.018	-0.076	-0.125	-0.198

* Element (i,j) is the correlation of Δ ln (Employment) in period j with Δ ln (Wages) in period i.

We now consider the behaviour of $\Delta \ln W_t$ (Table 3B) and its relationship with $\Delta \ln L_t$ (Tables 3C and 3D). From Table 3B, it is apparent that, like $\Delta \ln L_t$, $\Delta \ln W_t$ is variance non stationary. Its serial correlation structure seems to be an MA(1) (or AR with a low autoregressive coefficient) with most of the more distant correlations being very small.

The Euler equations discussed above contain a lagged wage (in our notation, W_t). However, the small autocovariances after t-1 in Table 3B suggest that wages lagged more than two periods may prove to be inadequate instruments for the wage. On the other hand, as some of the relatively large covariances below the diagonal of Table 3C indicate, lagged changes in employment seem to be better correlated with the wage. In our empirical work, we use employment lagged at least three periods as an instrument and experiment with instruments containing the wage lagged two and then three periods. Finally, note that there is some contemporaneous negative correlation between wages and employment. This is more significant in 1979, 1982, 1983 and 1985.

Two other important data related issues are pertinent.

First, in the labour demand curve model, we need a measure of union power. Unfortunately, firm-specific union data is not available for these firms, so we use industry-level data. Of course, since we control for fixed effects this is reasonable given that, over the estimation period, changes in recognition were rare at firm level (ACAS (1987), Claydon (1989)). Any variations over and above this can be reasonably assumed to be picked up by industry variations in union presence. We make use of two alternative time-varying 2-digit industrial union variables :

(i) A measure of industrial union density initially taken from Price and Bain (1983), but then updated. This measure is based on union membership as reported by unions.

(ii) The proportion of workers covered by major industry-level agreements.[13] This measure does not capture firm level agreements but has the potential advantage that it is reported by employers.

Plots of these two variables are given in Figure 3. Note that movements in union density are more or less in line with aggregate movements, peaking around 1980 then falling sharply. The importance of industry-level agreements falls throughout the estimation period, adequately illustrating the moves towards decentralised collective bargaining agreements in UK manufacturing since the 1970s (Millward and Stevens (1986) and Brown and Walsh (1991)).

A second important issue concerns the definition of an alternative wage, for use in the efficient contracting model. Its role is important since this variable identifies the efficient bargain *vis-à-vis* the labour demand model. In an ideal world we would observe transitions between industries, across industries, and into unemployment. This could be used to construct the expected wage of

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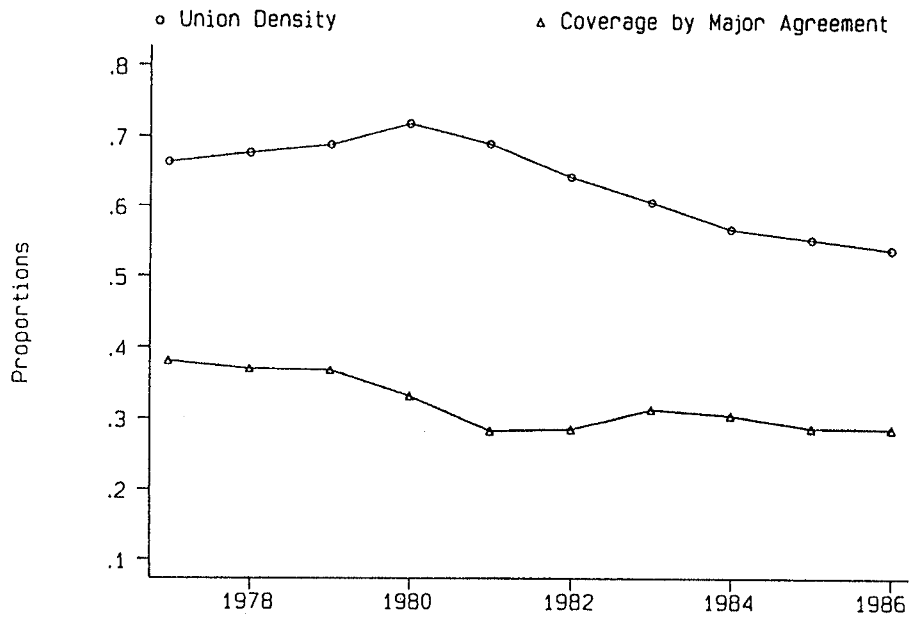
[13] This is unpublished data from the New Earnings Survey : it is the proportion of *all* workers in a given industry who are covered by a major industry-level collective bargaining agreement.

FIGURE 3 :
Industry-level Unionisation



someone leaving the current firm. Such data is unavailable. So we have to make do with a simpler measure.
We initially use the convex combination $(1 - U)W^i + UB$, where W^i is the real industrial wage, U the aggregate unemployment rate and B is aggregate benefits (measuring the outside opportunity available). We also discuss this in more detail below, recognising that it may be industry-wide and/or aggregate wages which form a more appropriate measure of outside opportunities.

5. RESULTS

5.1 ESTIMATED EULER EQUATIONS FOR EMPLOYMENT

Table 4 presents Generalised Method of Moments estimates of Euler equations for employment using instruments lagged at least three periods (i.e. in our timing dated t-2 or earlier, where the dependent variable is dated t+1). In Appendix B, we also present first differenced results based on taking the instruments back further one period. Comparing the results from these two tables it is quite clear that there are no significant differences between the two sets. As a further validation of the instruments, Sargan tests for the validity of the overidentifying restrictions are reported at the bottom of the table. For all first differenced models these are acceptable.
Turning now to the parameter estimates. The first column presents the Euler equation for employment which would be valid in the absence of bargaining. Although the signs of the coefficients on L_t, L_{t-1} and

TABLE 4 :
The Euler Equation for Employment

	(1)	(2)	(3)	(4)	(5)	(6)
	(		FIRST DIFFERENCES		)	LEVELS
L_t	0.949 (0.095)	0.561 (0.077)	0.666 (0.028)	0.949 (0.094)	0.563 (0.077)	0.842 (0.138)
L_{t-1}	-0.088 (0.044)	-0.083 (0.040)	-0.177 (0.028)	-0.088 (0.044)	-0.084 (0.040)	0.038 (0.120)
$(Q/L)_t$	0.004 (0.001)	0.000 (0.002)	-0.001 (0.002)	0.004 (0.001)	0.0005 (0.002)	0.0002 (0.0003)
W_t	-0.082 (0.052)	-0.116 (0.043)	-0.036 (0.037)	-0.094 (0.122)	-0.054 (0.062)	-0.021 (0.008)
$\bar{W}_t$				0.019 (0.124)	-0.010 (0.070)	
$(DEN*L)_{t+1}$		0.251 (0.013)			0.252 (0.013)	0.176 (0.030)
DEN_{t+1}		-0.527 (0.119)			-0.556 (0.123)	-0.184 (0.130)
$(COV*L)_{t+1}$			0.932 (0.044)			
COV_{t+1}			-1.022 (0.359)			
SARGAN	158 (122)	140 (120)	142 (120)	157 (121)	153 (119)	204 (156)
2nd SC	0.307	0.265	0.628	0.306	0.403	0.426

Notes :

1. Dependent variable is L_{t+1}. Employment is measured in thousands of workers and the wage in thousands of pounds per annum. All models are estimated on data from 232 companies giving a total sample size of 1294.
2. Heteroscedastic consistent standard errors in parentheses.
3. All estimates are Generalised Method of Moments estimates. The first five columns are specified in first differences and use instruments lagged at least three periods; column (6) is in levels with lagged levels as instruments, using instruments lagged two periods.
4. The Sargan tests are tests of the validity of instruments with the degrees of freedom given in parentheses.
5. Second SC is an N(0,1) test for second order serial correlation.

$(Q/L)_t$ are as predicted by the theory, the basic property of the model implying that employment is stable forward is violated. In addition, the theoretical Euler equation introduced earlier implies a negative long run relation between L_t and W_t, but a positive short run impact of W_t on L_{t+1}. However, despite implying a negative long run effect of wages on employment, the results in column (1) contradict the above short run theoretical predictions (since the coefficient on W_t is estimated to be negative). This is attributable to the original violation of the dynamic specification.

In a static framework, given the wage, it is not possible to distinguish the standard competitive labour demand model from a right-to-manage model where the union negotiates over the wage (but not over employment). We have shown, however, that in a dynamic context these two models are distinguishable. We thus turn to the results presented in column (2) of Table 4 where we have added two extra regressors to the previous equation, namely the $(UNION*L)_{t+1}$ and $UNION_{t+1}$ terms which come in with oppositely signed significant coefficients (the UNION measure used here, DEN, is the density variable). The results correspond to equation (2.12). They suggest that negative union effects on employment are present, but only in small firms, and that in large firms union employment effects may actually be positive (the effect is zero for a firm with 2100 employees, and positive/negative for larger/smaller firms).

Including the union variables reduces the estimated coefficient on the lagged dependent variable. However, the estimated lag structure now conforms with the one implied by the theoretical specification (if $\theta_0 \neq 0$ in (2.12)) since the ratio of the coefficients on L_t and L_{t-1} is less than -2. The long run wage effect is estimated to be negative and a function of unionisation. At the sample average of union density the estimated long run wage elasticity is -0.98. Raising the value of density by 1.5 standard deviations produces an estimated elasticity of -1.20; lowering it by 1.5 standard deviations yields a long run wage elasticity of -0.80.

The results reported so far use union density in the industry as the measure of union presence. We also carried out some experiments using a measure of industry-wide collective agreements (see column (3)). The results proved very similar in qualitative terms but the actual size of the long run wage effect is a little smaller at the sample means. For example, the average long run wage elasticitiy was estimated to be -0.65 with coverage, as compared to the -0.98 reported above for density.

In the model just described the union does not negotiate over employment. An alternative bargaining structure is the efficient bargain where the union and the firm decide jointly on a complete wage-employment package. Given a measure for the alternative wage and a form for union preferences, such as the one presented in earlier sections, this model is distinguishable from both the right-to-manage model (columns (2) and (3) in Table 4) and the standard labour demand model (column (1) in Table 4). The estimated efficient bargaining model (equation (2.15)) is presented in column (4) of the same table. In this model the alternative wage enters with a positive sign, but the standard error is too large for inference to be made with any degree of confidence.[14] Note that time dummies and the constant term (in the first differenced equations) are not significant and hence have been excluded; it is not the presence of the time dummies that is taking away the alternative wage effects. We have tried including in the instrument set the wage and the alternative wage lagged only two periods relative to t+1 (rather than three) but neither the parameters nor the precision changed much.

This result has a variety of interpretations. First, the alternative wage may not be measured well by the industry wage based measure. In fact the latter may be correlated highly with the firm-specific wage when the firm is large and may not represent well the wages in alternative employment. If the appropriate alternative wage measure only varies with time it may be better to simply use an aggregate wage variable. We estimated such a model using aggregate wages to measure the alternative wage : again the results were not very different (coefficient = 0.32, standard error = 0.42). Moreover, the other coefficients did not change much.[15] Finally, it may be a combination of both that is required : this also made no difference to the reported results as the coefficients on both the industrial and aggregate wage were very imprecisely determined.

Alternatively it may simply be the case that the data does not support the efficient bargain. In fact, when we estimate the encompassing model (column (5)) it becomes clear that the preferred model is the right-to-manage model, since we are unable to reject the hypothesis that the alternative wage coefficient is zero while the coefficients on the union variables are still jointly (and individually) significant. The same pattern of results held when the aggregate wage was used or if time dummies were included.

The evidence we have presented points to the right-to-manage model as the best representation of this data. It also points to important union effects on the employment path. However, before we conclude, we also report on a series of additional experiments and robustness checks using the right-to-manage model as a bench-mark.

5.2 ESTIMATES USING LEVELS INFORMATION

We re-estimated the right-to-manage model in levels to see if fixed effects really matter. To make the model compatible with the timing assumptions of the differences estimator we use instruments lagged two

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[14] Card (1990) and Nickell and Wadhwani (1991) also report positive alternative wage effects. The interpretation offered by Card is "this positive correlation is consistent with the hypothesis that higher average industry wages leads to improvements in the firm's competitive position and increases in employment" (Card (1990) p.685). Note, however, that here the coefficient is very small and statistically insignificant.

[15] Using the aggregate convex combination of wages and benefits (weighted by the unemployment rate) also produced similar results.

periods. The results are presented in column (6) of Table 4. Fixed effects appear to be important and some clear differences emerge : the coefficient on the lagged dependent variable increases significantly, the coefficient on the second lag on employment changes sign but is insignificantly different from zero while the wage effect becomes smaller (in absolute terms).

5.3 *RESPECIFICATION OF THE EULER EQUATION*

Despite the fact that the Euler equation may theoretically be written using any of the (endogenous) variables as dependent variable, one may think that it is a little unorthodox to have $(UNION*L)_{t+1}$ on the right-hand side of an equation with dependent variable L_{t+1}. Respecification of the Euler equation to have a different dependent variable made no difference to the results. Estimating the model $L_t = \Phi(L_{t+1}, L_{t-1}, (Q/L)_t, W_t, (DEN*L)_{t+1}, DEN_{t+1})$ using the same dated (t-2 or before) instrument set produced identical short run and long run results to those reported above. The long run wage elasticity remained unaffected by this respecification.

5.4 *GENERALISING THE DYNAMIC SPECIFICATION*

If we have aggregated different groups of workers who are subject to different adjustment costs then further lags may be important (Nickell (1986)). To explore this possibility, we included a further lag in employment and the wage rate.[16] A $\chi^2(2)$ test statistic of their joint significance was 9.2 and the coefficient estimates are presented in column (1) of Table 5. The rejection of the test is driven by the lagged wage and not from the third lag in employment which seems to be unimportant. However, the implied average long run wage elasticity is almost identical at -0.97 to the -0.98 derived from column (2) of Table 4 and the dynamics remain largely unaffected.

In column (2) of Table 5 we also present an encompassing model including a set of extra lags; they are jointly significant - $\chi^2(4) = 14$ - but only the t-1 wage is significant individually. We then removed the lagged density term and the third lag in employment and the χ^2 statistic for the remaining two extra terms was 11.1 (which is significant at the 0.4% level). Again, however, the long run properties of the model remained very similar to the right-to-manage model presented earlier.

5.5 *UNION MEMBERSHIP DYNAMICS*

Up to now, the efficient bargaining model assumes that there are no membership dynamics in the union utility function.

Allowing for union membership dynamics introduces a non linear term defined as $(W_{t+1} - \bar{W}_{t+1})\, L_t^{\theta 2-\theta 1} L_{t+1}^{\theta 1}/L_{t-1}^{\theta 2}$ (see equation (2.16)). To see

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[16] The conditions under which aggregation over different skills will be reflected in more elaborate dynamics are discussed in Bresson, Kramarz and Sevestre (undated).

TABLE 5 :
Testing the Lag Specification

	FIRST DIFFERENCES (1)	FIRST DIFFERENCES (2)
L_t	0.575 (0.065)	0.768 (0.177)
L_{t-1}	-0.115 (0.035)	-0.198 (0.074)
L_{t-2}	0.035 (0.048)	0.047 (0.038)
$(Q/L)_t$	0.003 (0.002)	0.0011 (0.0018)
W_t	-0.050 (0.045)	-0.034 (0.046)
W_{t-1}	-0.080 (0.028)	-0.078 (0.026)
$(DEN*L)_{t+1}$	0.250 (0.010)	0.260 (0.008)
DEN_{t+1}	-0.570 (0.120)	-0.540 (0.147)
$(DEN*L)_t$		-0.071 (0.053)
DEN_t		-0.073 (0.150)
SARGAN	123 (118)	125 (117)

Notes :
1. As for Table 4.

whether this generalisation improves the performance of the efficientbargaining model we set $\theta_2 = \theta_1 = \theta$ and performed a grid search to estimate θ. Then we tested for the significance of the coefficient of the nonlinear term given the value of θ (which was estimated to be approximately 0.5) in an encompassing model including the union term of the dynamic right-to-manage model. This process was then repeated for the alternative assumption of $\theta = \theta_1 = -\theta_2$ (θ was

estimated to be 0.6 in this case).[17]
Conditional on the values of θ the $\chi^2(2)$ statistics of the null hypothesis that the extra terms originating from the efficient bargain can be excluded were 3.8 and 6 respectively. Hence, we cannot reject the dynamic labour demand model even when we allow for union membership dynamics.

6. CONCLUSIONS

In this paper we have developed dynamic models of employment determination in the presence of unions. In contrast to previous contributions to the literature, we present a model in which wages are not committed in advance but are negotiated each year. This means that current decisions taken by the firm will generally affect future wage negotiations and that this should be taken into account in the theory of employment determination. We show how it is possible in this framework to develop tests based on Euler equations of the standard models, particularly the right-to-manage and efficient bargaining models. These tests do differ from those used in the usual static framework : for example, union power will affect employment conditional on the current wage in the dynamic right-to-manage model.
We go on to implement these models using a panel of 232 UK companies over the period 1980-86. Whilst the estimates are subject to the use of industry-wide union measures (in the absence of firm-specific union data) and to our measure of the alternative wage, the results suggest that the dynamic version of the right-to-manage model best describes the data.

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[17] In this case the union utility function can be interpreted as a per capita union utility with the term (L_t/L_{t-1}) reflecting the probability of an insider being reemployed in period t.

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APPENDIX A : DERIVATION OF EULER EQUATION FOR EMPLOYMENT IN SEQUENTIAL BARGAIN

STAGE 1 : EMPLOYMENT DETERMINATION

Wage and employment determination occurs in two stages.
The first order condition for the maximisation of (2.9), given the specification of the value functions in (2.7), can be written

$$(\partial \Pi_t/\partial L_t) + \beta_F(\partial V^F_{t+1}/\partial L_t) + \mu^l_t[(\partial U_t/\partial L_t) + \beta_U(\partial V^U_{t+1}/\partial L_t)] = 0 \qquad \text{(A1)}$$

The following re-arrangement of (A1) is useful

$$(\partial \Pi_t/\partial L_t) + \mu^l_t(\partial U_t/\partial L_t) + \beta_F[(\partial V^F_{t+1}/\partial L_t) + \mu^l_{t+1}(\partial V^U_{t+1}/\partial L_t)]$$
$$+ (\beta_U.\mu^l_t - \beta_F\mu^l_{t+1})(\partial V^U_{t+1}/\partial L_t) = 0 \qquad \text{(A2)}$$

STAGE 2 : WAGE DETERMINATION

The first order condition for wage determination is

$$[(\partial \Pi_t/\partial L_t) + \beta_F(\partial V^F_{t+1}/\partial L_t)](\partial L_t/\partial W_t) + (\partial \Pi_t/\partial W_t)$$
$$+ \mu^w_t[(\partial U_t/\partial L_t) + \beta_U(\partial V^U_{t+1}/\partial L_t)](\partial L_t/\partial W_t) + \mu^w_t(\partial U_t/\partial W_t) = 0 \qquad \text{(A3)}$$

We can use (A1) to simplify this to

$$[(\partial U_t/\partial L_t) + \beta_U(\partial V^U_{t+1}/\partial L_t)](\partial L_t/\partial W_t)(\mu^w_t - \mu^l_t)$$
$$+ (\partial \Pi_t/\partial W_t) + \mu^w_t(\partial U_t/\partial W_t) = 0 \qquad \text{(A4)}$$

This puts us in a situation to use the information in the employment equation (A2), the wage equation (A4) and the derivatives of the value functions in (2.7) to derive tests of different bargaining models.
The value functions in (2.7) and equation (A1) put forward one period can be used to eliminate the first term in square brackets in (A2) to derive the Euler equation for employment as

$$(\partial\Pi_t/\partial L_t) + \mu_t^1(\partial U_t/\partial L_t) + \beta_F[(\partial\Pi_{t+1}/\partial L_t) + \mu_{t+1}^1(\partial U_{t+1}/\partial L_t)]$$
$$+ \beta_F[(\partial\Pi_{t+1}/\partial W_{t+1}) + \mu_{t+1}^1(\partial U_{t+1}/\partial W_{t+1})](\partial W_{t+1}/\partial L_t) \qquad \text{(A5)}$$
$$+ (\beta_U\mu_t^1 - \beta_F\mu_{t+1}^1)(\partial V_{t+1}^U/\partial L_t) = 0$$

which appears as equation (2.10) in the main body of the paper.

APPENDIX B : RESULTS WITH INSTRUMENTS LAGGED AT LEAST 4 PERIODS

	(1)	(2)	(3)	(4)	(5)
	{		FIRST DIFFERENCES		}
L_t	0.929	0.554	0.666	0.928	0.557
	(0.095)	(0.077)	(0.077)	(0.084)	(0.077)
L_{t-1}	-0.084	-0.085	-0.171	-0.071	-0.086
	(0.041)	(0.044)	(0.044)	(0.042)	(0.044)
$(Q/L)_t$	0.006	-0.0007	-0.003	0.006	-0.0002
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)
W_t	-0.091	-0.120	-0.041	-0.127	-0.049
	(0.052)	(0.044)	(0.035)	(0.151)	(0.062)
$\bar{W}_t$				0.055	-0.011
				(0.160)	(0.061)
$(DEN*L)_{t+1}$		0.255			0.256
		(0.012)			(0.012)
DEN_{t+1}		-0.535			-0.561
		(0.136)			(0.138)
$(COV*L)_{t+1}$			0.904		
			(0.055)		
COV_{t+1}			-1.011		
			(0.327)		
SARGAN	136	127	157	132	131
	(110)	(108)	(108)	(109)	(107)
2nd SC	0.207	0.391	0.552	0.205	0.374

Notes :

1. Dependent variable is L_{t+1}. Employment is measured in thousands of workers and the wage in thousands of pounds per annum. All models are estimated on data from 232 companies giving a total sample size of 1294.
2. Heteroscedastic consistent standard errors in parentheses.
3. All estimates are Generalised Method of Moments estimates. All equations are specified in first differences and use instruments lagged at least four periods.
4. The Sargan tests are tests of the validity of instruments with the degrees of freedom given in parentheses.
5. Second SC is an N(0,1) test for second order serial correlation.

APPENDIX C : DATA SOURCES

The source of the data is the Datastream databank of company accounts, plus additional industry variables mapped in at (broadly) the 2-digit industry level and aggregate variables mapped in by year.

Employment (L) - total number of UK employees (Datastream item 216).
Real wages (W) - (total UK remuneration/total UK employees) deflated by the aggregate producer price index (Source : various issues of *Annual Abstract of Statistics*).
Output (Q) - total sales (Datastream item 104) deflated by aggregate producer price index.
Industry union density - number of union members in industry/total industry employment (Source : Price and Bain (1983), and then updated using the 1980 and 1984 Workplace Industrial Relations Surveys).
Industry union coverage - proportion of workers in firm's main operating industry covered by a major industry-wide collective bargaining agreement (Source : unpublished data from Department of Employment New Earnings Survey data tapes).
Industry real wages (W^i) - average wages in industry deflated by producer price index (Source : Census of Production, various issues).
Aggregate unemployment rate (U), standard unemployment benefit (B) (Source : *Annual Abstract of Statistics*).

Labor Demand and Equilibrium Wage Formation
J.C. van Ours, G.A. Pfann and G. Ridder

COMMENTS ON "DYNAMIC MODELS OF EMPLOYMENT BASED ON FIRM-LEVEL PANEL DATA" BY S. MACHIN, A. MANNING AND C. MEGHIR.

A. VAN SOEST

This paper is an interesting contribution to the growing empirical literature on dynamic labour market bargaining between employers and unions. Several bargaining models are compared, which share the characteristic that the bargaining process is repeated each year. This seems much more realistic than the static models and the model based on one bargain determining all future wages, which have been used in the existing literature. The employment equations of the various models are estimated using micro-data on firm level, and a clear empirical conclusion emerges. I shall first indicate what in my view are the paper's main points, and then add some more critical comments.

The following dynamic models are analyzed : First, the no bargaining or competitive labour demand model. Euler equation estimates for this model are unsatisfactory, in the sense that parameter estimates do not satisfy inequality restrictions implied by theory.

The second model is the right to manage model, in which unions and firms negotiate about the wage but the firm then chooses employment. In this model, the effect of current employment on future wages plays a role, since the firm takes account of future consequences of its current decision. Not considering wage equations at all, the authors replace this term by something which mainly depends on the level of unionisation. This model implies less stringent theoretical constraints on the parameter values, and thus is not as easily rejected. The unionisation variables enter significantly, so the authors conclude that the second model does better than the first.

In the third place, an efficient bargaining model is considered, in which unions and firms negotiate about wages and employment, with the same bargaining power in the two cases. The employment equation of this model is characterised by the presence of the alternative wage which enters the union's utility function. The authors try various alternative wage measures, but none of them turns out to play a significant role. This conclusion remains the same if an equation is estimated which nests both the right to manage model and the efficient bargaining model.

The authors thus conclude that the right to manage model best describes the data. This conclusion is particularly nice because it corresponds to direct evidence from completely different data sources: The authors refer to recent studies of actual UK labour contracts, which hardly ever include explicit employment agreements.

All equations estimated are empirical versions of an Euler equation for employment. These are derived by equating current profit (or utility) and expected future profits. The error term thus stems from future uncertainty.

The Euler equation represents just one relationship between period t+1 employment and period t variables. It is a structural equation in the sense that it is derived from a fully structural model and can often, if identification is guaranteed, be used to retrieve the structural