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Efficient Contracts are on the Labour Demand Curve: Theory and Facts"

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Efficient Contracts are on the Labour Demand

Curve: Theory and Facts

1. Introduction

The concept of an efficient labour contract goes back at least to Wassily Leontief's well-known 1946 paper in the Journal of Political Economy. Its main contribution was to point out that an efficient agreement between a firm and a group of workers requires that the wage and employment levels be set cooperatively. Three decades later, in the implicit contract literature begun by Baily (1974) and Azariadis (1975), the same idea emerged in a different setting. With uncertainty about product demand, and state-contingent contracts linking choice variables to the price of the firm's output, these authors showed that in an optimal agreement the wage rate would be greater than the value of the marginal product of labour. It was soon realised that this result depends on the assumption that there is no private unemployment insurance (Bryant (1978), Akerlof and Miyazaki (1980), Grossman and Hart (1981)), but empirical evidence that such insurance is widely available has not been presented.^{1/} More recently, especially in the work of Calvo and Phelps (1977), Hall and Lilien (1979), Grossman and Hart (1981), Azariadis (1983) and Green and Kahn (1983), attention has switched to the theory of labour contracts under asymmetric information. Firms here are assumed to be able to observe variables like product demand; workers and their representatives are less well informed. Models of this sort can explain inefficient under-employment, although not involuntary unemployment, and again predict that the wage will differ from marginal product. Research in the area is still thriving.

There are at least two rather natural criticisms of this influen-

tial literature. First, no attempt seems to have been made to compare these theoretical models of labour contracts with real life contracts. This is a little surprising, because U.S. examples of the latter are widely available. Second, there have been few attempts to test the models against data on labour markets: the closest is the recent work by Brown (1982), Ashenfelter and Brown (1983) and MaCurdy and Pencavel (1983). The purpose of this paper is to pursue the first direction, to argue that current theory does not fit the facts, and to present an alternative model.

The paper begins by studying some aspects of current American labour contracts. For the unionized sector it is easy to obtain information on these, because collective agreements are printed documents containing the details of the negotiated wage rates, work practices and job conditions. A small sample of contracts was collected as part of the project. Some official published data also exist, although the Bureau of Labor Statistics has recently decided to stop gathering figures on major collective bargaining agreements. One immediately obvious fact which emerges from an examination of real labour contracts is the importance of seniority provisions. Collective agreements in U.S. manufacturing industry, for example, typically include a clause which states that lay-offs will be done in the order of inverse seniority within the firm. There is also reliable evidence that 'last in, first out' practices are common throughout the non-union sector. The theoretical literature, however, almost entirely ignores this feature of the world.^{2/} One of the paper's objectives is to attempt to show why that

may be a serious omission.

The traditional approach to the economics of trade unions - associated especially with the work of Dunlop (1944) - has been to think of a union as choosing a wage rate constrained by the demand for its members' labour. But there is a well-known objection to this. One way to capture its logic is to think of the following conceptual experiment. Consider a trade union which gets utility both from higher wages and greater employment, and imagine it fixing its optimal wage - employment combination somewhere on the firm's labour demand curve. Then consider the effect of a first-order wage reduction from that equilibrium. By the definition of an optimum, that change leaves the union's utility unaltered (it was already at a turning point). Yet the same is not true for the employer: a first-order fall in workers' pay raises profits. Hence, because it possible to generate a Pareto improvement, the original equilibrium cannot have been efficient.

Figure 1 sketches a monopoly equilibrium, e^m , and an efficient wage bargain, e^b , for a conventional form of static model. Similar constructions are used in Leontief (1946) and McDonald and Solow (1981). The union has a quasi-concave utility function, with indifference curves I^0 , I^1 . The firm's preferences are represented by iso-profit contours π^0 and π^1 . Point e^b is on a contract curve (not drawn) in wage-employment space. In this world an efficient bargain or contract lies to the north east of the conventional labour demand function: the wage is greater than the marginal product of labour. The usual way to provide a rationale for the union's quasi-concave utility function is to

assume that lay-offs are by random draw. Then the expected utility of the representative union worker - hence of the union itself - is

$$EU = \frac{n}{m} u(w) + (1 - \frac{n}{m})u(b), \quad (1)$$

where n is employment, m is total membership of the labour pool, $u(\cdot)$ is an individual's utility, w is the wage, and b is unemployment benefit or an alternative wage. If the value of the firm's marginal product is $pf'(n)$, an efficient wage contract sets

$$w = pf'(n) + \frac{u(w) - u(b)}{u'(w)}. \quad (2)$$

The same formula occurs when there is uncertainty and state-contingent contracts.

It has often been argued - Leontief (1946), Farber (1984), among others - that an efficient labour contract requires that the parties negotiate over employment as well as over the wage rate. The usual argument is that if only the wage is agreed in the bargain then it will be rational for the employer to set a point on its labour demand curve, which is not Pareto efficient. For a static model in which there is no uncertainty this view seems to be correct. More generally, however, things are less clear. If there are many time periods, and a lasting relationship between employer and employees, an efficient contract might be sustained by wage negotiation alone. The firm in the relationship would be expected to set the jointly efficient number of jobs (that is, more employment than would be unilaterally optimal). This contract would then be enforced by some kind of implicit threat: the employees would punish the employer in period $t+1$ if in period t it failed to

set the appropriate employment level. It is much harder, unfortunately, to make this argument fully rigorous. At the very least one might wonder why, in an efficient labour contract, it would be necessary or desirable to rely on a complicated implicit arrangement of this kind. Why not expect to see negotiation simultaneously over both variables, or, if only one is to be agreed explicitly by the two parties, why should not the level of employment be the one so agreed? These questions have not been addressed in the literature.

2. Some Facts

It is natural to ask whether conventional theory fits the facts. There are at least two issues on which one might focus.

- (i) Do real labour contracts have lay-offs by random draw?
- (ii) Is there any evidence of bargaining over the employment level (as well as over wages)?

One of the most obvious features of unionized U.S. labour markets is that there are formal written agreements between employers and employees. A typical industrial union contract is a little over one hundred pages long, is small enough to fit into the hip pocket and describes an agreement which lasts for three years. Craft contracts, however, tend to be much shorter - perhaps less than ten pages. The latter are now rare, except in the construction trades, and will not be considered in detail here. An ordinary industrial union contract contains carefully designed clauses on topics like management and union rights, disciplinary procedures, pay and promotion, leaves of absence, grievances, seniority, apprenticeship and training programmes, holiday

arrangements and hours of work. A succinct summary of normal contract structure is given in Moore and Elkin (1983).

Formal contracts provide a certain amount of evidence on both of questions (i) and (ii). The second, however, is covered much less fully, so it seemed valuable for this project to organize a survey of major unions asking whether or not they negotiate with employers over jobs as well as pay. The results are reported towards the end of the section.

Even the briefest examination of union contracts makes it clear that lay-offs are almost never decided randomly. In practice workers are dismissed according to their length of service with the firm: lay-offs are by (inverse) seniority.^{3/} This rule is apparently ubiquitous in the U.S. industrial union sector; it is certainly contained in each of the fifty or sixty current contracts which are held in Princeton's Industrial Relations Section library. It is unfortunately the case, however, that there is no source of information based on a really large sample of contracts. The excellent (but recently discontinued) BLS publication Characteristics of Major Collective Bargaining Agreements gives various tables on certain aspects of seniority, such as whether seniority rights are retained during absence from work, but does not document the extent of lay-offs by seniority. One interpretation of this is that such rules are invariably used in major collective agreements, but that can only be a conjecture.

It may be useful to summarize some conventional clauses on seniority drawn from recent labour contracts. The 1983 contract between the Hughes Tool Company and the United Steelworkers of America, for

example, states that

"Plant seniority will be the only recognized seniority ... Plant seniority will be an employee's continuous service with the Company. (p.8)

Seniority shall cease:

- (a) Upon justifiable discharge.
- (b) Upon voluntary quitting.
- (c) Upon retirement.
- (d) If, after being laid off, an employee does not return to work within 5 days ... after written notice is sent to the address appearing on the records ...
- (e) If an employee is laid off and not recalled within 3 years. (p.9)

In the making of promotions, selection of qualified applicants from eligible employees shall be made by the appropriate supervisory employee on the basis of ability, physical fitness, and seniority. Where fitness and ability are relatively equal, seniority shall prevail. (p.11)

Except as otherwise provided herein, lay-offs, scheduling off, and recall shall be on the basis of plant seniority for all employees in the bargaining unit, except that employees in those jobs designated as crafts in this contract in Labor Grade 10 or above may be retained on their jobs out of seniority order, as long as their services on those jobs are necessary to the efficient operation of the plant, and there are no other qualified employees available with greater seniority. (p.13)

In establishing seniority rights for employees who have the same seniority, the order of seniority will be determined by chance drawings in the presence of all concerned; however, when applicable, time stamp seniority will be used." (p.14).

These clauses are probably representative of union contracts in U.S. manufacturing industry. As another example, the 1983 agreement between

Ingalls Shipbuilding and the Metal Trades Department requires that

"Each employee who is on the active payroll of the company as of the date of this Agreement shall have seniority status in accordance with his length of continuous service ... In all cases of reduction of the working force, whenever skill, ability and efficiency are relatively equal, length of service shall be the determining factor ... The Company shall notify the business representative of the Union prior to any layoff which deviates from seniority, stating the reason for such deviation and providing the Union an opportunity to discuss the matter." (pp. 21-22)

Similarly, New Jersey Bell Telephones and the Communication Workers of America, in their 1983 contract, agree to "lay-off regular employees of more than one year of net credited service in the inverse order of seniority" (p.65). In the 1982 agreement between Rockwell International Corporation and the International Union, UAW, "Employees will be laid-off and recalled in accordance with the local seniority agreements" (p.34). An interesting and more expansive statement can be found in the 1982 General Motors - UAW contract:

"Both parties agree that it is desirable to give employees high annual earnings. It is recognized and agreed that there are times when ... not enough work is available to give all employees with seniority a full week's work ... It is mutually recognized that to operate a plant at a schedule which gives employees less than 32 hours per week for more than a month is unsatisfactory to both employees and the Corporation ... Operation of a plant or any part thereof on a schedule of employment of less than an average of twenty-four (24) hours per week for a period of more than two consecutive weeks ... shall only be by local written agreement with the Shop Committee ... Employees shall be laid-off and rehired in accordance with local seniority agreements".
(Pages 54-55)

This information is drawn wholly from the unionized sector of the U.S. economy. There is, however, a little evidence for the non-union sector in the U.S. and for the British economy. Although, to take the latter first, there appear to be no recent data for Britain, a 1974 survey of the redundancy policies of 350 companies attempted to discover the extent of lay-offs by seniority. The British Institute of Management publication, Smith (1974), reveals that only 14% of firms employing less than one hundred workers use 'last in, first out', but that between 60% and 70% of companies employing more than one hundred people use the criterion of seniority. However, firms were allowed to respond to the questionnaire by selecting more than one criterion for selecting individual workers for lay-offs. Smith records that the most common order of priority was: (1) those over normal retiring age, (2) voluntary redundancy and (3) last in, first out.

Rather more is known about the lay-off policies of non-unionized American companies. Foulkes (1980) cites employee handbooks that state, for example, that the employees "will be demoted or laid-off according to their length of company service and qualifications" (p. 101). The author also describes case studies in which seniority was used to determine on whom lay-offs would fall. More systematic data are available in Medoff and Abraham (1981). The authors collected statistics, by conducting a postal survey of union and non-union employers, about the role of seniority at U.S. work places. They received 561 usable responses. One of the most interesting conclusions was that seniority appears to play a more important role in unionized plants than in non-unionized ones.

Nevertheless, 70% of employers operating without unions indicated that seniority in and of itself receives substantial weight in termination decisions.

These various kinds of evidence, when combined, seem to suggest that lay-offs by seniority are prevalent throughout the U.S. and British economies. It would clearly be desirable to have more data on the precise extent of this 'last-in, first-out' rule, and to discover whether it is widely used in other industrialized economies. Nevertheless, for British and American labour markets, especially but not exclusively unionized markets, the existence of lay-offs in inverse order of seniority can reasonably be taken to be a stylised fact. The model developed in the next section builds upon this fact.

Do unions bargain over the aggregate number of jobs? Again formal contracts may give some insight into this, although the evidence can only be suggestive. The typical labour contract has a 'management rights' clause which - at least ostensibly - allows the firm to make lay-off decisions unilaterally. The 1977 agreement between Kaiser Aluminum and Chemical Corporation and the United Steelworkers of America, for example, specifies that

"The Management of the works and plant and the direction of the working forces, including the right to hire, suspend or discharge for proper cause or transfer, and the right to relieve employees from duty because of lack of work, ... is vested exclusively in the Company." (p. 87)

Similarly, the International Brotherhood of Electrical Workers and the

New Jersey Bell Telephone Company in 1983 agreed that "the Company will decide the necessity for and will determine the extent of any required force adjustments" (p. 22), while the 1982 contract between the same union and the RCA Corporation states that the Company has "the right to manage the plants and direct the working forces" and "the right to lay-off employees for lack of work". (p. 2) The existence of these clauses appears to be a weak form of evidence that firms set employment unilaterally, but cannot be thought of as any more than that. Hence a survey of major trade unions was carried out to try to discover the extent of any bargaining over the number of jobs as well as over wages and conditions. Letters were sent in the winter of 1983/4 to the thirty largest American unions and the thirty largest British unions. The response rate was reasonable (about 50%), so a second batch of letters was sent in the spring of 1984. One hundred and twenty letters were sent in total, and they were divided equally between Britain and the USA. The preliminary survey results are given in Tables 1 and 2.

The survey suggests that trade unions do not normally negotiate over the total number of jobs. Although the rate of pay and many of the other factors which impinge on workers' lives are discussed, and often written into the collective agreement, the employer seems to be seen, by both sides, as having the right to set employment unilaterally. But there are a few exceptions. A small proportion of trade unions who responded to the survey did say that they bargained over jobs, and this appeared to be slightly more prevalent in the British case. Furthermore, unions do negotiate over crew size or the equivalent.

Table 1

Preliminary Survey Results (on June 19)

The largest American unions were asked the following questions.

	<u>Number of unions replying</u>		
	<u>No</u>	<u>Yes</u>	<u>No Answer/Unclear</u>
1. Does your union normally negotiate over the number of jobs as well as over wages and conditions?	16	2	1
2. Is employment set unilaterally by the employer?	2	10	7
3. Are crew size and manning decisions written into the labour contract?	7	10	2
4. Are total employment levels written into the labour contract?	14	2	3
5. Are there normally unwritten agreements on employment levels?	6	2	11

Table 2

Preliminary Survey Results (on June 19)

The largest British unions were asked the following questions.

	<u>Number of unions replying</u>		
	<u>No</u>	<u>Yes</u>	<u>No Answer/Unclear</u>
1. Does your union normally negotiate over the number of jobs as well as over wages and conditions?	10	3	5
2. Is the employment set unilaterally by the employer?	1	7	10
3. Are crew size and manning decisions written into the labour contract?	2	6	10
4. Are total employment levels written into the labour contract?	8	1	8
5. Are there normally unwritten agreements on employment levels?	3	2	13

There is some other evidence that trade unions bargain over work rules and crew levels. Table 3 reports BLS published data for major contracts in the union sector.

Table 3

The Extent of Limitations and Regulations on Crew Size

<u>Year</u>	<u>Sample Size</u>	<u>% of Agreements</u>		<u>% of Workers</u>	
		<u>Manuf.</u>	<u>Nonmanuf.</u>	<u>Manuf.</u>	<u>Nonmanuf.</u>
1970	252	4.8%	19.8%	1.9%	16.1%
1975	1514	13.2%	33.8%	8.8%	35.1%
1980	1550	9.9%	33.5%	6.4%	35.6%

Source: various issues of
Characteristics of Major Collective
Bargaining Agreements (Bureau of
Labor Statistics)

Sample size refers to the number of collective agreements studied. The figures show up an interesting difference between the manufacturing and non-manufacturing sectors. It is unfortunate that this source contains no figures on the number of contracts which specify total levels of employment, rather than only these data on variables more like capital-labour ratios, but this may well be because such clauses are rare.

3. The Main Ideas

The earlier sections of the paper have tried to show that there is a significant difference between union contracts in theory and union contracts in practice. Real contracts, in particular, have lay-offs by seniority, whereas the usual assumption in the theoretical literature is that unemployment is by random draw. This section discusses the effects of correcting the conventional assumption. The model which

emerges has a prediction - exactly in line with the second main stylised fact reported in the previous section - that it will be optimal for workers to allow the employer to set the employment level unilaterally.

Consider a trade union which agrees with the employer that reductions in the labour force will be by inverse seniority within the firm. What form of contract will this produce? The key to this question lies in the structure of the union's preferences. Say we begin by thinking of behavior as being determined by a median voter rule.^{4/} The median individual is in this case the person with median seniority (setting aside, as a simplification, any differences in tastes), who is, by definition, half way down the employment roster.

Figure 2 describes the trade union's preferences in a world of this kind.^{5/} Wages and employment are on the axes, and the diagram assumes that all workers get the same wage rate. The employment level n^s is the median voter's seniority position. In other words, for employment points above n^s , this median individual always has a job; but for all employment points below that one the median voter is necessarily unemployed. Hence region A, the unbounded rectangle above the horizontal line segment On^s , is an indifference zone. The trade union (whose interests here are exactly represented by those of this particular member) does not care which wage rate, w , or amount of employment, n , holds within the A region. To the right of n^s there are horizontal indifference curves, because the median person is always employed and therefore cares only about the rate of pay. Line I_2 denotes a higher utility than line I_1 . For employment levels above n^s this kind of

union is obviously indifferent about the total number of jobs.

It is natural now to study the form of a Pareto-efficient contract. Assume that - to keep the analytical structure in line with Section 2 - there is no uncertainty and only a single period. A sensible assumption about the employer's preferences is that they can be depicted as concave iso-profit contours (McDonald and Solow (1981), for example). By definition, then, there is a normal labour demand curve, dd' , given by the locus of the turning points of these curves. If profits are always driven down to some minimum level ($\bar{\pi}$, say), perhaps by costless entry or the threat of entry, the efficient equilibrium is where union utility is maximised subject to that amount of entrepreneurial profit.

An efficient outcome can then take two possible forms, and they are described geometrically, as e and e' , in Figures 3 and 4. The more plausible case, the former, is where the union's indifference curves are tangent to the appropriate iso-profit contour. It is likely to be a Pareto-optimal outcome only in the partial equilibrium sense (one agent's utility is maximised against the other's), but in conventional terminology is an efficient contract. The contract's principal feature is that it is on the labour demand curve. The trade union is locally indifferent to the level of employment; the firm's profits are affected by employment; hence an efficient agreement will allow the employer to pick exactly that number of jobs which would have been chosen, given the wage, in an atomistic labour market.

Figure 4 is the other type of outcome. Equilibrium employment here is at n^s , the median voter's seniority position. It is clear that only

a startling market shock could produce an allocation like the one in the figure, because the initial employment level was necessarily twice as high. Could n^s be a long run equilibrium in a model with many periods? Obviously it could not. At the start of the next period there would be a new median voter, at a point equidistant between 0 and n^s , who would wish to impose a much lower number of jobs. With the iso-profit curve $\bar{\pi}$ unchanged, in fact, a point like h would be set, which takes us back to the structural form in Figure 3.

The only papers in the theoretical literature to discuss models with lay-offs by seniority are Grossman (1983) and Blair and Crawford (1983). Neither, however, studies efficient contracts. Instead the authors focus on inefficient monopoly models in which the existence of lay-offs by seniority modifies the union's preferences. Hence the conclusions are quite different from those derived from the framework considered above.

The comparative statics of the simplest version of the model are worth considering. First, a rise in the price of output (an improvement in product demand) leads to an increased equilibrium wage rate. Second, equilibrium employment is reduced by a rise in the output price, which is a result that is formally identical to the famous 'perverse' employment behaviour documented in the theoretical literature on labour managed firms (Vanek (1970), for example). Figure 5 shows the change in the $\bar{\pi}$ iso-profit contour, from $\bar{\pi}_a$ to $\bar{\pi}_b$, after an increase in the price of output.

To check these predictions, write the model in simple form as

$$\begin{array}{ll} \text{Maximise} & u(w) \\ & w, n \end{array} \quad (3)$$

$$\text{s.t. } pf(n) - wn > \bar{\pi} \quad (4)$$

$$n - n^s > 0, \quad (5)$$

where p is the product price, w is the wage rate, n is employment, $f(n)$ is output and $\bar{\pi}$ is the exogenously fixed market rate of profit.

Define a maximum profit function

$$\pi(w, p) = \max_n pf(n) - wn, \quad (6)$$

which is homogeneous of degree one in (w, p) , convex, decreasing in w and increasing in p . Assume it is appropriately differentiable. Then the problem can be reformulated as that of

$$\begin{array}{ll} \text{Maximise} & u(w) \\ & w \end{array} \quad (7)$$

$$\text{s.t. } \pi(w, p) > \bar{\pi} \quad (8)$$

$$n - n^s > 0. \quad (9)$$

As long as the first constraint binds, as we should expect, there is only a single wage which will satisfy that constraint. Let it be w^* . Then it follows immediately that, as long as we can ignore corners at $n = n^s$,

$$\frac{dw^*}{dp} = - \frac{\pi_p}{\pi_w} > 0, \quad (10)$$

which establishes the result that wages rise as product prices improve.

The perverse employment prediction can be proved in a number of

ways. To use the maximum profit function we need to show that

$$\frac{dn^*}{dp} = \frac{d}{dp} (-\pi_w) \Big|_{\pi = \bar{\pi}} \quad (11)$$

$$= -\pi_{wp} + \pi_{ww} \frac{\pi_p}{\pi_w} \quad (12)$$

is negative. Because $\pi(w,p)$ is homogeneous of degree one,

$$p\pi_p + w\pi_w = \pi \quad (13)$$

$$p\pi_{pw} + w\pi_{ww} = 0, \quad (14)$$

so that, after substitution, and for profit fixed at $\bar{\pi} > 0$,

we find that

$$\frac{dn^*}{dp} = \pi_{ww} \left[\frac{w}{p} + \frac{\pi_p}{\pi_w} \right] < 0. \quad (15)$$

Employment falls as the product price increases.

This is an extreme result. It need not hold good when there are other inputs, when there are monopoly rents to be shared between the two sides to the agreement or when there is uncertainty about prices. The first caveat is unsurprising, but the other two are worth exploring more fully.

The previous model assumes that profits are always bid down to $\bar{\pi}$. Although this makes sense in a competitive labour market, it need not if there are rents to be shared between a union and a firm. We might hope to be able to derive comparative static predictions for this case, and one way to analyse such a bargaining model is to use the

well-known Nash (1950) solution to a two person cooperative game. Define the fixed threat or fall-back positions of the agents as u^0 and π^0 . The Nash outcome is derived from the maximisation of the product

$$\Omega = (u - u^0)(\pi - \pi^0) . \quad (16)$$

For the model with lay-offs by seniority an interior solution requires that the wage be chosen to

$$\underset{w}{\text{Maximize}} \quad \log[u(w) - u(w^0)] + \log[\pi(w, p) - \pi^0] , \quad (17)$$

where u^0 is defined as $u(w^0)$, and w^0 is the fall-back wage. The first order condition for a Nash optimum is

$$w : [u(w) - u(w^0)]^{-1} u'(w) + [\pi(w, p) - \pi^0]^{-1} \pi_w = 0 \quad (18)$$

and the negativity of the second order condition means that the main comparative static result for this model is as follows:

$$\text{sign} \frac{dw}{dw^0} = \text{sign} [u(w) - u(w^0)]^{-2} u'(w^0) u'(w) > 0 \quad (19)$$

$$\text{sign} \frac{dw}{d\pi} = \text{sign} [\pi(w, p) - \pi^0]^{-2} \pi_w < 0 \quad (20)$$

$$\begin{aligned} \text{sign} \frac{dw}{dp} = & - [\pi(w, p) - \pi^0]^{-2} \pi_p \pi_w \\ & + [\pi(w, p) - \pi^0]^{-1} \pi_{wp} \gtrless 0 . \end{aligned} \quad (21)$$

Hence, as we might expect, the wage outcome is raised by an increase in the union's fall-back wage rate or by a decrease in the employer's fall-back profit level, and is ambiguously affected by a change in the

product price.

Trade unions are often accused of implementing inefficient work rules and restrictive practices. There have been some attempts by economists to construct models which might account for 'make-work' or featherbedding rules (Ashenfelter and Brown (1983), MaCurdy and Pencave (1983), McDonald and Solow (1981) and Nguyen and Rea (1981) can all be interpreted in this way), but they typically involve the conventional and previously discussed notion of an efficient employment level to the north-east of the atomistic labour demand curve. In the real world the usual form of a work rule is, at least superficially, slightly different from this. Casual inspection and anecdotal evidence suggests that unions and firms agree to fix variables like the ratio of workers to machines rather than the total number of employees, and the earlier results of the survey are consistent with this.

One of the classic references is the study by Slichter, Healy and Livernash (1960), who cite many kinds of work rules. These include the following.

1. Restrictions on the amount of materials that can be handled by a worker (the number of bricks in a construction worker's hod, for example), or the number of machines to be tended.
2. Demarcation limits, where workers of one type cannot do the job of some other kind of employee.
3. Apparently needless repetition (for instance, the printers' insistence on the resetting of newspaper type for adverts placed in another paper).

4. Unnecessary extra work, such as that three coats of plaster be used in house building.
5. Requirements that crews be unreasonably large (that a fireman be present on diesel trains, say).
6. Restrictions on the adoption of new technology and modern tools.
7. Rules governing a worker's maximum speed of work and the use of excessive relief time (for cleaning up, for example).

There are many other examples of these types of practices. In the 1960's, for example, American Airlines had three pilots on planes designed for two. From 1960 to 1978, in a similar case, Conrail trains carried two brakemen rather than one (to which, with compensation to the union, they reverted in 1978). The West Coast longshore industry through the 1950's is also often claimed (Kochan (1980)) to have employed more workers than were needed after the invention of containers. In the 1970's the City of New York claimed that 'Five-Man Manning' on fire engines was unnecessary and cut squads to four men. Many other cases are documented in the industrial relations literature.

One way to incorporate work rules into the formal analysis is to treat them as techniques to limit the effort and intensity of work. Let a worker's utility function now be $u(w,e)$, where w is the wage or income level, and e is the degree of intensity of work. Hence e could be thought of as a proxy for speed of work, size of load or number of machines to be manned by an individual. Assume that the employer's production function is $f(n,e)$, concave and increasing in the two inputs.

An efficient contract here is one which specifies employment, pay and work intensity. Define

$$\pi(w,e,p) = \max_n pf(n,e) - wn, \quad (22)$$

and write the union's maximisation problem, assuming that profits are forced down to $\bar{\pi}$, and for simplicity ignoring the possibility of a corner at $n=n^s$, as

$$\begin{array}{ll} \text{Maximize} & u(w,e) \\ & w,e \end{array} \quad (23)$$

$$\text{s.t. } \pi(w,e,p) > \bar{\pi}. \quad (24)$$

Again this has as implicit the notion that the union is dominated by senior members who are indifferent to employment, and that the union wholly appropriates any monopoly rents. Whether or not there are rents, an interior optimum is characterized by

$$\frac{u_w}{u_e} = \frac{\pi_w}{\pi_e}, \quad (25)$$

the equality of the union's marginal rate of substitution between income and work intensity with that of the employer. Figure 6 sketches the equilibrium.

There are two broad conclusions from this. First, there is a natural but rarely stressed distinction between negotiating about the total level of employment and negotiating over work rules which influence the capital-labour ratio. 'Feather-bedding' in the real world is overtly of the latter kind; yet models in the economic literature typically study the former. If, as this section has suggested, one thinks of work-rules as

governing the worker's intensity of effort, it is natural that those rules as well as the wage should be discussed in collective bargaining. Moreover, when there are lay-offs by seniority, this kind of negotiation is perfectly consistent with the observation that firms set total employment unilaterally.

4. Uncertainty

The economic literature contains many examples of efficient labour contract models under uncertainty. Baily (1974) and Azariadis (1975), for example, study a framework where there are state-contingent contracts in which both sides - the firm and the employees - observe all relevant variables ex post. The second generation of theories, like that developed in Grossman and Hart (1981), assumes that workers cannot observe demand conditions in the employer's product market, so that a different form of labour contract is required. In that framework it is efficient to tie the wage to the level of employment set by the firm. Both strands in the literature use the expected utility formulation in which the ex ante utility of a worker is a convex combination of the utilities from working and being unemployed. The weights, following the idea that lay-offs are by random draw, are the proportions of the labour pool with and without work.

This section explores the implications for these kinds of models of the assumption that the representative worker is never laid off. Because senior workers dominate in any voting procedure, lay-offs are by inverse seniority, and for normal demand fluctuations the person with median seniority is sure of having a job, the traditional models may be

misleading.

Assume that the firm and workers have to decide on an optimal labour contract for the coming period. Let the probability density function of prices be $g(p)$, and assume that n^s is the level of employment at which the worker with median seniority will be laid off. The expected utility function in the usual literature is equation (1) in Section 1; but for the case to be studied here it is simply the expected utility of an employed individual, because the union's or group's preferences are given by those of the median individual, and each worker has the same wage rate.

Consider a framework of the sort in the conventional literature. Using the same notation as before, expected profits are

$$E\pi = \int \pi g(p) dp = \int [pf(n) - wn] g(p) dp . \quad (26)$$

For the sake of generality, however, assume that the firm may be risk averse, with a weakly concave utility function. The problem is

$$\begin{array}{ll} \text{Maximise} & \int u(w(p))g(p)dp \\ w(p), n(p) & \end{array} \quad (27)$$

$$\text{s.t.} \quad \int v(pf(n) - wn)g(p)dp > \bar{v} \quad (28)$$

$$n - n^s > 0 ,$$

where $u(w)$ and $v(\pi)$ are the utility functions of workers and firms respectively. We can simplify this, by noting that $n(p)$ will be chosen independently of worker preferences, and then using a duality

shortcut. Define a maximum value function for the firm's utility, $v(w,p)$, and a maximum profit function for profits, $\pi(w,p)$. Therefore let

$$v(w,p) = \max_n v(pf(n) - wn) \quad (29)$$

$$\pi(w,p) = \max_n pf(n) - wn. \quad (30)$$

Hence $v(w,p) = v(\pi(w,p))$, because the optimal choice of n is also independent of the concavity of the firm's utility function.

The efficient contract must solve the following rewritten version of the original maximisation problem:

$$\text{Maximise}_{w(p)} \int u(w(p))g(p)dp \quad (31)$$

$$\text{s.t. } \int v(w(p),p)dp > \bar{v} \quad (32)$$

$$n - n^s > 0. \quad (33)$$

It is helpful to begin by neglecting corners at $n = n^s$. Assuming the problem is appropriately concave and differentiable, therefore, the solution is described by the following first-order condition (which holds for each p):

$$w(p) : u'(w(p)) + \lambda v_w(w(p),p) = 0, \quad (34)$$

where λ is a non-negative multiplier which is independent of prices. Small changes in price, p , lead to changes in the wage, w , according

to the equation

$$[u''(w(p)) + \lambda v_{ww}]dw + \lambda v_{wp}dp = 0 . \quad (35)$$

The term in square brackets is negative (by the second order condition), so that

$$\text{sign } w'(p) = \text{sign } v_{wp}, \quad (36)$$

which is positive or negative as

$$v_{wp} = \frac{\partial}{\partial p} [v_{\pi} \pi_w] \quad (37)$$

$$= v''(\pi) \pi_p \pi_w + v'(\pi) \pi_{wp} \quad (38)$$

is positive or negative. The first term in (38) is weakly positive, by the concavity of the firm's utility function. The second is negative, because the linear homogeneity of the maximum profit function implies that $\pi_{wp} < 0$. In general, then, we cannot say whether a rise in product price will increase or reduce the wage rate.

A more precise result is possible if we assume that the firm is risk neutral. Then $v'(\pi)$ can be set to unity without loss of generality, and therefore

$$\text{sign } w'(p) = \text{sign } \pi_{wp} < 0 , \quad (39)$$

so that the optimal wage function, contingent on prices, has a negative gradient, and produces a striking result. Wages fall in a boom. To see

the response of the number of jobs - in the risk neutral case again - to a change in product price, write the change in employment as

$$\frac{dn}{dp} = \frac{d}{dp} [-\pi_w(w(p), p)] \quad (40)$$

$$= -\pi_{ww}w'(p) - \pi_{wp} \quad (41)$$

$$> 0, \quad (42)$$

using the convexity of the profit function to sign the derivative. In conclusion, employment rises in a boom - partly because the wage falls and partly because of the product price effect. This accords with intuition and contrasts with the prediction of the simpler models presented in the previous section.

In a slump, when the price of output is at a reduced level, the median voter faces the possibility of a lay-off. This can be incorporated by extending the previous analysis. In the unconstrained case, where $n > n^s$, we know from the results given above that employment is an increasing function of p , so that there is an interval of low prices for which the earlier first-order conditions may fail. Let $\hat{p}$ be the greatest price at which this occurs. As $[\underline{p}, \bar{p}]$ is the whole support of the price distribution, the union, if dominated by the worker with median seniority, will set employment equal to n^s whenever $p \in [\underline{p}, \hat{p}]$. Define the wage function over this interval as $\omega(p)$. By definition it is the solution to the equation

$$n^s = -\pi_w(\omega(p), p), \quad p \in [\underline{p}, \hat{p}] \quad (43)$$

so that

$$\omega'(p) = - \frac{\pi_{wp}}{\pi_{ww}} > 0. \quad (44)$$

This makes good intuitive sense. When product prices are sufficiently low, and the union's senior workers' jobs are threatened, it is optimal for the union to accept a cut in pay. One possible form for the wage function over $[p, \bar{p}]$ is given in Figure 7a. The equivalent employment function over the interval of states of nature is shown in Figure 7b. Behavior of this type does not seem wholly different from the 'concession bargaining' (see Cappelli (1983a)) which occurred in the US in the early 1980's. Cappelli (1983b), for example, states that "it is difficult to think of a major example of concession negotiations that has not been accomplished by massive lay-offs of union members and - most importantly - threats of more to come." One interpretation of this is that major concessions and employment bargaining only occur when the median individual is threatened with the possibility of redundancy, which appears to be a testable proposition.

If we allow for the existence of asymmetric information over prices, as Calvo and Phelps (1977), Azariadis (1983) Grossman and Hart (1981), Hart (1983), Green and Kahn (1983) and others do, the analysis is changed quite significantly. Efficient contracts no longer lie on the conventional demand curve for labour, because there is an extra distortion caused by the existence of private information. As in the established literature on asymmetric information the contract cannot be one which links the wage rate to product price. If employment is observable, however, an optimal contract will make that the variable on which wages are conditioned. An efficient contract must specify a non-linear

wage schedule, $w(n)$.

Only the most basic ideas will be explored here. To get some feel for these, assume that the support $[p, \bar{p}]$ is such that efficient employment never falls to the point at which the person with median seniority will be laid off. This simplification means that corners can be neglected.

Define profit as

$$\pi = pf(n) - w(n)n, \quad (45)$$

where the wage is a function of employment. Let the firm's utility be $v(\pi)$. It will be useful to define a maximum value function

$$\phi(p) = \max_n v(\pi). \quad (46)$$

Using the same notation as before, the efficient contract is the solution to the problem

$$\begin{array}{ll} \text{Maximize} & \int u(w)g(p)dp \\ \phi(p), n(p) & \end{array} \quad (47) \quad \begin{array}{l} \text{Workers' preferences} \end{array}$$

$$\text{s.t. } \int \phi(p)g(p)dp > \bar{v} \quad (48) \quad \begin{array}{l} \text{Firm's minimum expected utility} \end{array}$$

$$\phi'(p) = v'(\pi)f(n(p)) \quad (49) \quad \begin{array}{l} \text{Envelope result for rational firm} \end{array}$$

The only unusual part is the final constraint, which ensures that employment is set optimally given the non-linear wage. This method - an adapted version of one originally developed by James Mirrlees for the mathematically equivalent problem of non-linear tax theory - uses only $\phi(p)$ and $n(p)$ as control variables. The wage rate is substituted out by using

equation (45), and the profit level is itself a function of $\phi(p)$, because the inverse of the employer's utility function can be expressed as $\pi(\phi(p))$.

The first order conditions for an optimal contract can be obtained in various ways. One is to write down a Lagrangean and integrate the second constraint by parts; another is to use a Hamiltonian. Let the multipliers on the constraints be λ and $\mu(p)$. Then the solution, regardless of method, is

$$\begin{aligned} \phi(p) : & [\lambda - u'(w)\pi'(\phi(p))/n(p)]g(p) - \mu'(p) \\ & - \mu(p)v'(\pi(\phi(p)))\pi'(\phi(p))f(n(p)) = 0 \end{aligned} \quad (50)$$

$$\begin{aligned} n(p) : & u'(w)[pf'(n(p)) - w]g(p)/n(p) \\ & - \mu(p)v'(\pi(\phi(p)))f(n(p)) = 0 \end{aligned} \quad (51)$$

$$\mu(\underline{p}) = \mu(\bar{p}) = 0 \quad (52)$$

The final condition is imposed by the transversality requirement.

There are three main conclusions. By equation (51), the wage w is in general different from the value of the marginal product of labour $pf'(n)$, because $\mu(p)v'(\pi)f(n)$ is not zero. If $\mu(p)$ is positive (negative) the wage is less (greater) than the marginal product. Second, under symmetric information, as the previous analysis showed, the wage is equal to the value of marginal product: in that case the envelope constraint does not apply and μ is zero. Third, even in the asymmetric price information case, $w = pf'(n)$ in the worst and best states of nature.

5. Conclusion

Research on the economics of labour contracts and trade unions has flourished over the last decade. In the literature on unions there is now an orthodox distinction - tested empirically by Ashenfelter and Brown (1983) and MaCurdy and Pencavel (1983) - between the union monopoly model and the efficient bargain model. Labour contract theory has attempted to generalize the latter, mainly by introducing the assumption that prices are uncertain. The most recent work has assumed that only the employer can observe prices in the product market.

The starting point for this paper has been the observation that lay-offs are not done randomly, as almost the whole of the literature assumes, but by inverse seniority within the firm. Evidence for this, both for Britain and the US, has been presented. The main source of information is real labour contracts themselves. Although widely available in the US, they have apparently not been studied in detail by economists.

The paper has set out a model of an efficient labour contract in which lay-offs are by seniority. Its main implication is that an optimal contract will be a wage-employment combination that lies on the labour demand curve. This is quite different from the conventional view, which is that in an efficient agreement the wage will exceed the value of the marginal product of labour, and the framework's comparative static predictions are not the same as those of the orthodox approach. Various models with lay-offs in the order of seniority have been discussed: the aim has been to study the effects of incorporating the seniority assumption into otherwise standard theoretical structures. They all have the characteristic

that in an efficient labour contract or wage bargain it will be optimal to allow the firm to set employment unilaterally. This is because senior workers, who dominate voting within the union, are indifferent - except in immense recessions - to the total number of jobs.

This suggests a new and rather unconventional way to think about what unions do. If there are rents to be shared between workers and the firm, and senior workers are insulated from lay-offs, the trade union will act as if it wished to raise the wage rate without any regard (subject to bankruptcy) to the consequences for employment. Hence the union will appear to maximize the wage; the firm will be seen to attempt to keep pay as low as possible; the efficient wage outcome, necessarily on the labour demand curve, will depend on the bargaining strengths of the parties.^{6/} Therefore those empirical monopoly models in the literature - like Farber (1978), Dertouzos and Pencavel (1981) Carruth and Oswald (1983) and Card (1984) - which estimate the curvature of a union's indifference curves, and hence calculate the implied degree of risk aversion of individual members, may be misleading.^{7/} Only a proper test will tell.

The paper has also reported the results of a survey of the largest US and British trade unions. Its principal function was to try to discover the extent to which unions bargain over the total number of jobs as well as over wages and conditions of work. The basic conclusion from the survey, which is consistent with the model developed in this paper, is that the vast majority of trade unions do not negotiate over employment levels.

Footnotes

1. Oswald (1983) summarizes published BLS data which suggest that most union workers cannot claim unemployment insurance from any private source.
2. Grossman (1983) was one of the first to construct a model in which seniority is important. The early papers by Shister (1943) and Simons (1944) and the book by Ross (1948) also discuss the effects of lay-offs by seniority.
3. The paper will not focus on why this might be. Gersuny (1982) describes the history of seniority provisions and speculates on the reasons for their popularity.
4. The results will be robust to changes in this, because all that is really required is that the union be locally indifferent to employment.
5. The same diagram would apply if some other generally known rule were used in determining the order of lay-offs. It is not crucial that the criterion for a lay-off be that of seniority.
6. Hence the model provides a rationale for the bargaining model in Nickell and Andrews (1983).
7. One corollary, exactly in line with the famous objections of Ross (1948) to such models, is that union leaders here should neither know nor care about the elasticity of demand for their members' labour.

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Figure 1

Monopoly and efficient equilibria

Figure 2

The union's preferences under lay-offs
by seniority.

Figure 3

An interior solution: an efficient contract on the labour demand curve.

Figure 4

A corner solution: employment equal to the median voter's seniority.

Figure 5

The effects of an increase in product price
(p_a to p_b).

Figure 6

Wages and work intensity

Figure 7a

Figure 7b