INERTIA IN LABOR MARKETS

GRAHAM PYATT*

1. Introduction

The model presented in this paper is an attempt to characterize the short-run equilibrium of a firm which is faced with a firm-specific and unionized labor force. The starting point is the formulation provided by McDonald and Solow [5], which is generalized here in three main respects.

First, and most importantly, in the McDonald and Solow analysis the firm is faced by a unionized labor force of a given size, and it is unable to recruit from any other source. In contrast, the approach here assumes that additional labor is available externally in infinitely elastic supply at a wage which is exogenous to the firm.

Secondly, McDonald and Solow assume that the firm will always operate on its production function boundary, i.e., that it will maximize output, given the level of employment. By relaxing this condition, it is shown that circumstances can exist under which it will be optimal for the firm to produce inside the production boundary, i.e., for the firm to be x-inefficient.

Thirdly, in common with McDonald and Solow, the present analysis treats the determination of wages and employment for unionized labor as a bargaining problem and, more specifically, as a cooperative game. Their specific results depend on assuming the Nash [3] solution, although they note that other solution algorithms are likely to give similar results. Here, no specific algorithm is to be adopted and the results obtained are dependent only on the notion of a Pareto efficient solution, i.e., on a solution which could not be improved either for the firm or for the union without the other party being made worse off.

The main result of the analysis is that the level of employment is largely determined independently of the wage in this model. In consequence, changes external to the firm, e.g., in product demand, may have no effect on the number of workers which the firm employs.

And with respect to wages, it is shown that, contrary to the statement by McDonald and Solow [2], the wage will not necessarily exceed the marginal revenue product of labor either in their version of the model or in its generalized form as presented here.

One advantage of the present approach is that by not adopting any specific solution algorithm, the results obtained can be related to those for the labor managed firm as set out, for example, in Brew and Browning [2] and Steinheir and Thorne [5].

*University of Warwick, Coventry, England.

The author is indebted to numerous friends and colleagues for comments on earlier drafts, and especially to Chris Bell, Chal Swaminathan and Malcolm Zaidi. More recently, comments from Robert Solow and a supporting correspondence have been unusually helpful. In thanking these friends and colleagues, I must also absolve them from any responsibility, together with the World Bank, where I was previously Senior Adviser in the Development Research Department.
Finally, it is suggested that the present results apply not only to the case in which there is a firm-specific union but also more generally. The model is relevant whenever external labor has a supply price which is greater than the reservation wage of internal labor. This could be due to search or training costs, for example. Adopting this broader interpretation, the inertia explained by the present analysis can be seen as analogous to that discussed by Oi [4] in his treatment of labor as a quasi-fixed factor.

II. The Scope for Cooperation

Let $P$ denote the profits of the firm, so that

$$ P = R(n) - en $$

where $R(n)$ is revenue expressed as a function of employment, $n$, and $e$ is the wage rate. For simplicity, it is assumed for now that the firm always operates on its production frontier, so that output is maximized as a function of employment, $n$. Hence the partial derivative of $R(n)$ with respect to $n$, to be denoted $r(n)$, is the marginal revenue product of labor. It is assumed that $r(n)$ is a diminishing function of $n$, as shown in Figure 1.

The firm wishes to maximize its profits. It has available to it a firm-specific (internal) pool of labor of size $n$, and has also an additional supply of external labor, which is infinitely elastic at a wage rate $e_1$. If the firm were to use only external labor, then it would employ $n_1$ workers and be at point $B$ in Figure 1. Its profits in this case can be denoted $P(n_1)$.

Obviously, the firm would like to earn profits in excess of $P(n_1)$. And it would do so if

$$ R(n_1) - en > P(n_1) $$

or, by rearrangement,

$$ e < \frac{R(n_1) - P(n_1)}{n_1} = x(n_1) $$

The schedule $x(n_1)$ defined by (3) is also shown in Figure 1, its general shape having been previously derived by McDonald and Sollow.

If the firm is to cooperate with its union rather than depend entirely on external labor, then the union must be prepared to accept wage and employment levels such that $w$ is less than $x(n_1)$ as required by (3). As is evident from Figure 1, this implies a wage less than $e_1$, which is the supply price of external labor. Why members of a firm-specific union might agree to a wage which is less than the supply price of external (non-union) labor is a question we shall return to after considering the objectives and preferences of the union.

The members of the internal labor force (or union) are assumed to bargain collectively. Their preferences are given by a welfare function which is (some monotonic transform of)

$$ W = \mu u(e) + (1 - \mu) u(v_0) $$

where

$$ \mu = \min(1, n/n_1) $$

The notation is to be interpreted as follows. Firstly, $u(\cdot)$ is a utility function for a typical member of the union with the usual properties that

$$ 0 > u' > 0 $$

Hence, $u(\cdot)$ is the typical workers’ utility level if they are employed by the firm at wage $e$. If such a worker is not employed by the firm then their resulting utility level can be denoted $u(v_0)$. With the inference that $e_1$ is a measure (in wage units) of how well off the worker would be if not employed by the firm. Clearly, $e_1$ will depend on many considerations, such as the chances of getting another job, wages offered by other firms and social security levels.

With these interpretations, the welfare level $W$ defined by equations (4) and (5) can be interpreted as the typical or average expected utility of a union member, taking into account the ex ante possibility that each union member may or may not be offered a job by the firm.

The wage level $v_0$ is shown in Figure 1. It can be regarded as the reservation wage for members of the union: unless the firm pays them at least this much, then they will leave the firm and seek employment elsewhere. Consequently, if the firm and the union are to cooperate then, from the union’s point of view, the firm must pay a wage at least as great as $v_0$, so that the welfare level of workers does not fall below $u(v_0)$.

Combining the respective attitudes of the firm and its labor union implies that they could agree to cooperate if the wage and employment level were to correspond to some point in the area ABD of Figure 1: at all such points not only does the wage exceed the reservation wage $v_0$, but also, from previous arguments, profits exceed the level $P(n_1)$ which the firm could obtain by using labor exclusively.

It follows from the construction of Figure 1 that an area for cooperation, such as ABD, can exist only if $e_1 > v_0$.

The difference between $e_1$ and $v_0$ can be interpreted in several ways. One interpretation is that it is a measure of the power of union restrictive practices. According to this interpretation, external workers may be no different from internal workers in so far as both are prepared to work for the firm for a wage of $e_1$. The premium $e_1 - v_0$ then measures the extra cost per worker to the firm of recruiting from outside the union due to restrictive practices, i.e., to union practices which qualify or restrict the free access of the firm to external labor.

An alternative interpretation would be that $e_1 - v_0$ measures training or search costs. This possibility is discussed in a final section of the paper. For the present, however, it
is convenient to assume that the scope for a cooperative bargaining solution, as given by $c_1 - c_0$, can be attributed to the power of the union since, with this interpretation, the McDonald and Solow formulation of the bargaining problem can be regarded as an extreme case of the present one. McDonald and Solow do not allow any external recruiting at all. Accordingly, their results correspond to the special case of the present formulation in which restrictive practices are so powerful as to push $c_1$ up to such a level that the firm would not want to recruit externally under any circumstances. In this case, $P(n)$ is zero, and it would not be profitable for the firm to engage in production given such a high external supply price for labor if external labor was the only source.

In general, with $c_1$ greater than the reservation wage $c_0$, there is scope for the union to negotiate some outcome in the area ABD of Figure 1. As we have seen, this requires a wage greater than $c_0$, so that the union members gain some advantage from the situation: they are better off working for the firm than they would be otherwise. Equally, the outcome will be a wage less than $c_1$; otherwise, there would be no advantage to the firm in negotiating with the union, since it could do just as well by hiring only external labor.

III. Pareto Efficient Solutions without Recruiting

All points in the area ABD in Figure 1 represent combinations of the wage, $w$, and employment, $n$, which are mutually attractive to the firm and its union members in the sense that profits exceed $P(e)$ and the union's welfare exceeds $u(e)$. However, not all these points are Pareto efficient, as McDonald and Solow have previously noted. In particular, it can be noted that when $n$ is less than $n_1$, so that some members of the union are at risk of being laid off, then it can be shown from (4) that the union will prefer a lower wage in exchange for more jobs provided that:

$$dr/dn > -(u(c) - u(c_0))/nu'(c)$$

Hence it can be established that profits can be increased by raising $n$ while keeping the union on the same indifference curve as long as:

$$r(n) > e - \frac{u(c) - u(c_0)}{nu'(c)}$$

McDonald and Solow have previously demonstrated that this last result is equivalent to the requirement that $e$ be larger than some function of $n$, which is shown as $g(n)$ in Figure 1. Two characteristics of the function $g(n)$ can be noted at this point. Firstly, it passes through the point $E$ in Figure 1. This is easily seen from (8). The right hand side of (8) has the value $c_0$ when $e$ is equal to $c_0$. Hence, if $g(n_0) = c_0$, as in Figure 1, then it must follow that $c_0$ is equal to $g(n_0)$.

Secondly, it can be noted that the right hand side of (8) is independent of $e$ when the utility function $u(.)$ is linear. This form of utility function can be thought of as the limiting case in which the union has no risk aversion. In this limit, then, the right hand side of (8) reduces to $c_0$ for all the values of $e$. Hence $n_0$ must be equal to $n_0$ for all $e$ and the graph of $g(n)$ becomes a vertical line at $n = n_0$.

An implication of the result (8) is that no point in the area CDE of Figure 1 can be Pareto efficient. For all points in this area, lowering $n$ would allow profits to be raised while maintaining the union at a constant level of welfare. Hence only points in the area ABEF can be attractive to both the firm and its union and, at the same time, Pareto efficient.

Assuming for the present that the union membership $n_1$ exceeds $n_1$, a second implication of the result (8) is that no point in the area CDE of Figure 1 can be Pareto efficient unless $n$ is equal to $n_1$ at that point. If $n$ is less than $n_1$, the result (8) requires that $n$ should be raised. And $n$ cannot exceed $n_1$ because the wage is less than $c_1$ at all points in BCFE, so that hiring non-union labor is impossible.

To formalize these conclusions, it is useful to introduce notation $n_2$ for the value of $n$ corresponding to point C in Figure 1. There are then three possible cases:

(i) if $n_1 < n_2 < n_0$ then $n = n_2$ and $r(n_2) > r(n_1)$

(ii) if $n_0 < n_1 < n_2$ then either $n = n_0$ and $r(n_0) > r(n_1)$ or $n < n_0$ and $w > y(n_1)$; and

(iii) if $n_1 > n_2$ then $n_2 > n_0$ and $e = y(n_1)$.

McDonald and Solow do not allow this full range of possibilities but rather restrict themselves to cases in which the condition $e > y(n_1)$ will characterize the solution. Hence they conclude that the bargain eventually struck will imply that not all union members are necessarily hired ($n < n_0$) and that the agreement reached will correspond to some point on the line CE in Figure 1. As can be seen from the figure, this in turn implies that the wage will exceed the marginal revenue product of labor, i.e., $e > r(n_0)$. But in fact result (9) makes it clear that this outcome is far from necessary. For example, if it is less than $n_1$ then the agreement reached cannot correspond to a point on CE; there will be no lay-offs, and the wage may equally well be above or below the marginal revenue product of labor.

It is interesting to note the result (9) simplifies when the union is not risk averse. In this case, it will be recalled, the function $y(n)$ is vertical so that $n_1$ and $n_2$ are equal. With this simplification, result (9) reduces to:

$$n = \min(n_0, n_1), \quad r(n) > e > c_0$$

IV. Pareto Efficient Solutions with Recruiting

The result (9) defines a set of Pareto efficient solutions when $n$ exceeds $n_1$. As has been noted earlier, in such cases there will be no recruiting because, once all union members are employed, the supply price of additional (external) labor exceeds its marginal revenue product. Moreover, there is no incentive to replace internal labor with external because the latter is cheaper.

In contrast, when employment is less than $n_1$, the marginal revenue product of labor exceeds its external supply price. Hence the firm will always have incentive to recruit up to the level $n_1$. Accordingly,

$$n$ = new$ = n_1, e > c_0$$

IV. Pareto Efficient Solutions with $e$-inefficiency

The above results imply that, irrespective of the size of the union, $n_1$, the level of employment will be somewhere in the range $n_1$ to $n_2$. However, these results depend on assuming that the firm will always operate at full production efficiency. This is not necessarily so. Specifically, if the marginal revenue product of labor is negative, then the firm can obviously increase profits by producing less, while labor need be no worse off as a result. Accordingly, some $e$-inefficiency can be a characteristic of a Pareto efficient solution.
The marginal revenue product of labor is negative for values of n greater than n’ where n’ is defined by
\[ r(n’) = 0 \]  
(13)

As can be seen from Figure 1, it then follows from the slope of the functions x(n) and y(n) that n_2 will exceed n’ if and only if
\[ x(n’) > y(n’) \]  
(14)

Now, from (5), x(n’) is given by \( E(n’) - P(e_1)/n’ \) while y(n’) is the wage at which the right-hand side of (8) is zero:
\[ 0 = y(n’) - [u(x(n’))] - u’(y(n’)) \]  
(15)

Accordingly, n_2 will exceed n’ if and only if
\[ R(n’) - y(n’)/n’ > P(e_1) \]  
(16)

and this is a necessary and sufficient condition for x-inefficient solutions to be possible. It states that the profits which the firm could earn if it employed n’ workers at wage e’ must exceed P(e_1), i.e., the profits it would earn by employing n_2 (external) workers at wage e_1.

From (16) it follows that there are three conditions which are conducive towards x-inefficiency. The first is that P(e_1) should be small, and this corresponds to a powerful firm-specific union, able to drive up the entry price of external labor through restrictive practices. Second, x-inefficiency is most likely when y(n’) is small. From (15), there are two aspects to this. One is that y(n’) is positively related to e_1, so that x-inefficiency is more likely when employment prospects outside the firm are limited. The other is that y(n’) depends essentially on the curvature of the utility function u(.) in the more risk-averse the union the smaller y(n’) and hence the more likely x-inefficiency will emerge. The third factor conducive to x-inefficiency is that, when the marginal revenue product of labor, i.e., \( r(n’) \) is zero, the average revenue product \( R(n’)/n’ \) should be high. Again, there are two underlying possibilities. One is that product demand should be inelastic (monopoly) or kinked (oligopoly). The other is that, on the supply side, the marginal product of labor should fall rapidly at some point, as occurs when capital is fixed and largely supplementary to labor. Even when the condition (16) is satisfied, x-inefficiency is not an inevitable consequence. When it is less than n_2, there cannot be x-inefficiency. And when it lies above n_2, then whether x-inefficiency occurs or not will partly depend on bargaining strengths as well as on the size of N.

To explore the possibilities, it is necessary to reconsider the functions x(e) and y(n) for values of n above n’.

If firms are to employ labor in excess of n’ while maximizing profits, then they will hold back production so that revenue is equal to \( R(n’) \), i.e., they will choose to be x-efficient. The locus of points for which profits equal \( P(e_1) \) is, therefore, given by the graph of
\[ (R(n’) - P(e_1))/n = (x(n’)/n’ \]  
(17)

and this is shown in Figure 2.

With respect to function \( y(n) \), it will be recalled that the right-hand side of the inequality (8) was previously identified as being the extra cost, i.e., the increase in the wage bill, needed to maintain labor at a constant utility level when employment increases marginally. From (15), this cost is zero when the wage is at \( y(n’) \); and it is not difficult to show that the cost is positive when \( e > y(n’) \) and negative when \( e < y(n’) \). Now, changing the level of employment has so effect on revenue when the firm is maintaining constant output such

---

**VI. Comment on the Results**

While the result obtained in the previous section appears to be quite complicated it can be noted that, in the absence of union risk aversion, it simplifies as previously shown in [12].

In this simple form, the main implications are readily identified. First, the level of employment is determined by Pareto-efficiency considerations. And secondly, of the three possible values for n, only two, namely n_1 and n_2 are influenced by product demand. Hence, changes
in product demand do not necessarily influence the level of employment. If \( n \) is below \( n_1 \),
the firm will recruit. If it is above \( n_0 \), then there will be layoffs. And as for as \( n \) lies
between \( n_1 \) and \( n_0 \), employment will be inert.

While employment is determined exactly in (12), the wage is indeterminate within set limits. Just
where it will fall within these limits must depend on the relative bargaining strengths of the firm and the union and,
as such, lies beyond the scope of this paper. However, two specific aspects of the question merit comment.

First, as we have seen, the wage may lie above or below the marginal revenue product of labor. And whether it is above or below depends on \( n \) as well as on bargaining power.

Second, it is relatively easy to extract from the general results obtained previously the implications for extreme cases. For example, the labor managed firm can be regarded as one in which the union has overwhelming bargaining strength to the extent that it can always squeeze profits down to the level \( P_e(x) \). In this special case, then, it follows from the general result that:

- If \( x(m^*) < y(n^*) \) then \( n = \text{median} \ (n_1, n_2, n_3) \) and \( e = x(n) \); and
- If \( x(m^*) > y(n^*) \) then \( n = \text{median} \ (n_1, n_2, n_3) \) and \( e = y(n) \).

\[
\epsilon = \begin{cases} x(n) & \text{if } n < n_1 \\ R(n^*) - P_e(x)/n & \text{otherwise.} \end{cases}
\]

The labor managed firm represents the extreme case of union power. However, as noted in the introduction, the results in this paper can instead be interpreted in a context in which there is no union. All this requires is, first, that the difference \( n_1 - n_0 \) be attributed to hiring costs (broadly interpreted to include search and training) and, second, that wages be determined (actually or as if) through a collective bargaining process. With this interpretation, the model is similar to that postulated by Oi [4] in his early attempt to explain the inelasticity of employment to product demand. And in this spirit it can be concluded that inertia in labor markets is not necessarily caused by restrictive practices but can also be explained by recruitment or training costs. And, in either case, the fact that there is inertia does not imply that wages are high or low relative to the marginal revenue product of labor but only that they are less flexible than marginal productivity theory would suggest.

References


I. Introduction

This paper presents a model of bargaining and strike activity based on rational behavior and incomplete information. We assume that both the union and the firm have private information about their own position and that both parties disguise their optimal wage when making wage offers. Both the firm and union bargain to extract information about the other's position.

Our model formally describes the effects of bargaining on strike costs in a Nash model. The model features uncertainty on both sides of bargaining and allows negotiations to occur during both the current contract and subsequent strike or lockout. These are realistic extensions of the incomplete information literature on bargaining as presented in Hayes [2] and Tracy [4].

II. Wage Offers

The basis of wage offers in our model are the union's labor supply and the firm's labor demand which are:

\[
I^u = e^u(w - p) + \alpha
\]

\[
I^f = e^f(w - p) + \beta.
\]

The model is in log-linear form. Both labor supply, \( I^u \), and labor demand, \( I^f \), are functions of the real wage. The supply and demand elasticities are \( e^u \) and \( e^f \), respectively. Following Mauro [3], private information is incorporated into the model through \( \alpha \), known only by the union, and \( \beta \), known only by the firm. The term \( \alpha \) might represent union tastes while \( \beta \) might represent technology.

*Federal Deposit Insurance Corporation, Washington D.C. and Fordham University, Bronx, New York, respectively.