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The Effects of Unionization on Wages, Employment and Hours of Work

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Ⅰ. Introduction

Most theoretical union models have focused on how wages and employment are determined under unionism. An implicit or explicit assumption underlying those models is either that working hours per employee are fixed or that they are determined according to the labour supply schedule.[1] Both assumptions are unrealistic. First, one of the important roles of trade unions has been to influence

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1) For example, Oswald(1982) assumes that workers in the unionized establishments choose hours of work according to their labour supply curves.

the length of workday and workweek (see, for example, Hannicutt[1984], Rees [1989], Clark and Oswald[1993]).2) Second, from the theoretical point of view it may be suboptimal for unions to choose only wages and let hours to be determined according to their members' labour supply curves when unions can influence both wages and hours.

Recently, a few researchers including Earle and Pencavel(1990), Pencavel(1991), Dinardo(1991) and Johnson(1990) have extended the existing union models by allowing employers and unions to negotiate over hours as well as wages and employment in the collective bargaining process. Focussing on the efficient contracts model, these researchers have obtained several valuable results. For example, Earle and Pencavel(1990) showed that under a "rent-max" form of the union's objective function the optimal hours and employment are independent of the wage rate, which can be interpreted as a contract curve being vertical in both wage-employment and wage-hours spaces.3) Dinardo(1991) showed that under a union's objective function in which the worker's preferences are represented by the Cobb-Douglas utility function, unions reduce hours of work. With a similar union's objective function Johnson(1990) showed that the negotiated hours lie to the left of the each union member's labour supply curve. In other words, each union member would like to work more hours at the negotiated wage rate.

What is not fully addressed in the literature, however, is the shape of the contract curve in the three variable case in which the two parties bargain over wages, employment and hours.4) Another related issue not fully examined in the literature is the effects of unionization on wages, hours and employment. If hours are fixed, we expect that the wage rate is higher, but the level of employment can be higher or lower or even unaffected under unionism. In the case where hours are determined by collective bargaining, we know little about the union effects on those

2) In Clark and Oswald's survey of union leaders' views in Great Britain, 53 out of 57 union leaders say yes to the question, "Does your union usually negotiate over hours of work per week?" On the other hand, very few union leaders said that unions negotiate over employment.

3) The "rent-max" union objective function is shown in section 3.

4) Pencavel(1991) showed that the slope of the contract curve in wage-employment space can be positive, negative or vertical, holding hours constant at the equilibrium. This is not a desirable way to find out the slope of the contract couve since the optimal hours should adjust along the contract curve in wage-employment space.

variables.

In this paper I show how to characterize the contract curve when wage, hours and employment are jointly determined by collective bargaining. Although it is not possible to determine the shape of the contract curve under the most general specification of the union's objective function, I am able to show, in some special cases where the union's objective function takes a "rent-max" form, that the contract curve is downward-sloping in wage-hours space and upward-sloping in wage-employment space. This may in turn imply that as the bargaining power of the union increases, wages and employment rise, but hours fall.

The organization of this paper is as follows. Section II sets up the basic model without unions and describes optimal nonunion outcomes. In section III, I introduce unions in the firm and examine the effects of unionization on wages, employment and hours under three different union bargaining models, i.e., the monopoly union, right to manage and efficient contracts models. Section IV discusses a possible extension of our results. Section V summarizes the main results of this paper.

II. A Simple Model Without Unions

The model presented in this section is a special case of the model in Donaldson and Eaton(1984). Workers are assumed to be homogeneous.[5] Firms are assumed to be competitive in the product market and assumed to produce a single consumption good. More importantly, firms are assumed to be utility takers in this model. That is, a firm has to meet its workers' ongoing or reservation utility level when

5) The assumption of homogeneous workers is not necessary here, but it is almost inevitable in the model with unions. The reason is that when union members vote for more than two subjects a union's utility function is bound to be ill-defined. Oswald(1982) shows that a well-behaved utilitarian union utility function can be constructed even when workers are heterogeneous in the two variable case (wage and employment). One of the assumptions he made is that workers are equally productive and hence receive the same wage despite of heterogeneity. Unfortunately, having this kind of heterogeneity does not add much to the model. For this reason, I assume that workers are homogeneous.

choosing wages and hours. Finally, I assume that workers and hours are perfect substitutes in production and there are no person-specific costs or quasi-fixed costs of employment.[6)]

Given the assumption above, a firm's problem can be written as

$$\max_{W,H,N} \Pi(W,H,N)=G(HN)-WHN \quad \text{(1)}$$

$$\text{s.t. } U(WH,T-H)\geq \bar{U} \quad \text{(2)}$$

where W is wage rate, H hours per worker, N number of workers and T total available time for work. The production function G is assumed to be strongly concave in total labour (HN) and the utility function U is assumed to be strongly quasi-concave in income (WH) and leisure (T-H). Finally, the output price is normalized to be unity.

The constraint (2) implies that the firm has to meet the worker's ongoing utility level $\bar{U}$. At the equilibrium, (2) will hold with equality. Hence, it may be rewritten as

$$Y \equiv W H = y(T - H, \bar{U}) \quad \text{(3)}$$

Since the utility function is assumed to be strongly quasi-concave in income and leisure, function y is strongly convex in leisure and it is true that $y_1=\partial y/\partial (T-H)<0$, $y_{11}=\partial^2 y/\partial (T-H)^2>0$. Substituting (3) into the profit equation (1) and maximizing the substituted profit equation with respect to H and N yield the following two first order conditions.

$$G'(HN) + y_1 = 0 \quad \text{(4)}$$

6) The assumption of perfect substitution between workers and hours is used to simplify our analyses. Donalson and Eaton(1984) allow the case where the total labour takes a form of $A(H)N$, where $A(H)$ can be a strongly concave function of H. Also, I can allow some kind of quasi-fixed costs of employment in the model. Having fixed costs in the model will affect the optimal wage rate, hours and employment. For example, the employer will increase the number of hours per worker but reduce the number of workers in the presence of fixed costs. However, having fixed costs in the model will not change the main predictions on union effects as long as the size of fixed costs in the union sector is similar to that in the nonunion sector. The role of fixed costs in measuring union impact is discussed in the next section in detail.

$$y_1 H + y = 0 \quad \cdots\cdots (5)$$

Using (3), equations (4) and (5) can be rewritten as

$$W = G'(HN) \quad \cdots\cdots (6)$$

$$W = -y_1 \quad \cdots\cdots (7)$$

Equation (6) looks very familiar. It states that the optimal wage rate should be equal to the value of marginal product of total labour (*HN*). On the other hand, equation (7) states the optimal wage rate should also be equal to the marginal rate of substitution of income for leisure at the utility level $\bar{U}$. The above two equations and (3) determine the optimal *W*, *H* and *N*.

In order to understand why equation (7) holds at the equilibrium, we need some preliminary results. Note that equation (3) can be rewritten as

$$W = W(H, \bar{U}) \quad \cdots\cdots (8)$$

Equation (8) is nothing but the expression for an indifference curve in wage-hours space at $U=\bar{U}$. This indifference curve has the same features as appeared in Altonji and Paxson (1988). That is, the indifference curve (8) has a *U*-shape and the associated labour supply curve goes through the bottom of the indifference curve. Figure 1 in Appendix B depicts a family of the indifference curves ($U^1 > U^0$) and the associated labour supply curve (*LS*). Note that at the bottoms of indifference curves, i.e., where $\frac{dW}{dH}=0$, wage rates are minimized while maintaining certain utility levels and also at the bottoms of indifference curves wage rates are equal to the marginal rate of substitution of the income for leisure.[7]

With these results, I can now explain why equation (7) must be true in equilibrium. Since hours and employment are perfect substitutes in production, any combination of *H* and *N* such that the product of *H* and *N* is a constant will yield the same revenue to the firm. Therefore, the whole problem is reduced to minimizing the labour costs, $W(H,\bar{U})HN$, while keeping *HN* an optimal level. It is then obvious that in order to minimize the labour costs, *H* has to be chosen such

7) The slope of an indifference curve can be shown as $\frac{dW}{dH} = \frac{U_2 - WU_1}{HU_1}$, $H \neq 0$. Hence, $\frac{dW}{dH}=0$ if and only if $W = \frac{U_2}{U_1}$.

that W is minimized keeping the utility level at $\bar{U}$ since N can be always adjusted to maintain HN to be a constant. We know from the properties of the indifference curve, the minimum W is achieved at the bottom of the indifference curve $\bar{U}$ and at that point it must be true that the wage rate is equal to the marginal rate of substitution of the income for leisure. Therefore, the optimal W and H will satisfy equation (7).

In sum, if hours and employment are perfect substitutes in production and if there are no quasi-fixed costs for employment, the optimal hours per worker for the firm are the hours that each worker would have supplied at the chosen wage rate if the worker had maximized his or her utility at that wage rate. Put differently, the optimal combination of the wage rate and hours for the firm is in accordance with the worker's labour supply curve. The optimal level of employment for the firm is then determined by the labour demand curve, equation (6)

Ⅲ. Effects of Unionization on Wages, Hours and Employment

This section considers the monopoly union, right to manage and efficient contracts models to see how unionization might affect the wage rate, hours per worker and the level of employment of a firm. However, since the right to manage model is more general than the monopoly union model, I focus on analyzing the right to manage model and examine the monopoly union model as a special case.

There is no general agreement on the specification of a union's objective function. Therefore, the most general specification for a union's objective function may take the form

$$V = V(Y, H, N; \bar{U}) \quad \cdots\cdots (9)$$

where $Y=WH$, $V_1=\partial V/\partial Y>0$, $V_2=\partial V/\partial H<0$, $V_3=\partial V/\partial N>0$, and $\bar{U}$ is a worker's non-union utility level.[8] I use the union's objective function (9) when characterizing the outcomes of the monopoly union, right to manage and efficient contracts models. However, it is very difficult to predict union effects on the wage rate, hours and employment with the union's objective function (9). Therefore, in order to obtain possible predictions I consider a special case

$$V(WH, H, N; \bar{U}) = N[U(WH, T-H) - \bar{U}] \quad \cdots\cdots (10)$$

The objective function (10) can be seen as an extension of a "rent-max" union's objective function in the two variable (wage and employment) case. Also, the union's objective function (10) is more general than the special union's objective function considered by Earle and Pencavel(1990).[9] Finally, the firm's objective function is assumed to be the same as before.

1. The Right to Manage Model

The right to manage model(Nickell, 1981) in the two variable case (wage and employment) assumes that a union and a firm bargain over a wage rate and given the negotiated wage rate, the firm determines the level of employment unilaterally. In the three variable case, there can be several possible situations.[10] In our problem, the firm is indifferent between hours and employment, so it is not possible to distinguish between the case where the two parties negotiate over wage and hours and the case where they negotiate over wage and employment. However, as mentioned in the introduction, unions and firms seem to frequently negotiate over hours but not over employment. Therefore, it is more reasonable to think that the union and firm negotiate the wage rate and hours and the firm determines the level of employment unilaterally in the right to manage model. Following Manning (1987), this problem can be written as[11]

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8) This union's objective function is used by Earle and Pencavel(1990).

9) The special union objective function considered by Earle and Pencavel(1990) takes the form, $N[Y+f(H)-\bar{Y}]$, where $Y=WH$, $f'<0$ and $f''<0$.

10) For example, the union and the firm negotiate over the wage rate and the firm unilaterally chooses hours and employment, or the two parties negotiate over the wage rate and hours and the firm unilaterally chooses the employment, or the two parties bargain over the wage rate and employment and the firm chooses hours unilaterally.

11) An alternative approach is to maximize $\Omega = V(WH, H, N; \bar{U}) + \beta\Pi(W, H, N)$ subject to $G'(HN)-$

$$\max_{W,H,N} \quad \theta \ln V(WH,H,N;\bar{U})+(1-\theta)\ln \Pi(W,H,N) \qquad (11)$$

$$\text{s.t.} \quad G'(HN)-W=0 \qquad (12)$$

where θ $(0<\theta<1)$ represents the union's bargaining power. Note that if $\theta=1$ in (11), the right to manage model degenerates to the monopoly union model where, in this case, the union chooses the wage rate and hours, and the firm chooses the level of employment at the negotiated wage rate and hours. From the first order conditions for (11) and (12) one can show that

$$\frac{dW}{dH}\Big|_V = G''N \cdot \frac{1}{1+\frac{(1-\theta)\alpha_1}{\theta}} \qquad (13)$$

$$\frac{dW}{dN}\Big|_V = G''H \cdot \frac{1}{1+\frac{(1-\theta)\alpha_2}{\theta}} \qquad (14)$$

where

$$\alpha_1 = -\frac{G'HN^2V}{(V_1W+V_2)\Pi} \qquad (15)$$

$$\alpha_2 = -\frac{G'H^2NV}{V_3\Pi} \qquad (16)$$

It is straightforward to show from the first order conditions that $\alpha 1$ and $\alpha 2$ are positive. Thus, $\frac{dW}{dH}|_V \geq G''N$ and $\frac{dW}{dN}|_V \geq G''H$. This implies that in general, the union's indifference curves are flatter than the labour demand curves at the equilibrium in wage-hours and wage-employment spaces respectively. Note that if $\theta=1$ in (13) and (14), the slopes of the indifferences are equal to the slopes of the labour demand curves, which is the equilibrium conditions for the monopoly union model.

The solutions (13)-(16) are too general to predict the effects of unionization on the wage rate, hours and employment. Thus, I consider a special case where the

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$W=0$, where β is nonnegative. I follow the specification used by Manning(1987) simply because his specification is more commonly seen in the bargaining models. The results of the two specifications do not differ qualitatively.

union's objective function takes the form of (10). I also impose $\theta=1$ to make points clear.[12] Under these assumptions, the first order conditions are summarized as follows:

$$WU_1 - U_2 = -NHU_1G'' > 0 \quad (17)$$
$$U - \bar{U} = -NH^2U_1G'' > 0 \quad (18)$$
$$W = G' \quad (19)$$

The above three equations determine the optimal wage, hours and employment. The main implication of (17) is that optimal hours are not on the worker's labour supply curve.[13] Therefore, the assumption used by Oswald(1982) that hours in unionized establishments are determined by a worker's labour supply decision is not appropriate. Furthermore, at the equilibrium, union workers work fewer hours than they would like to work at the equilibrium wage rate since $W>\frac{U_2}{U_1}$. Equation (18) states that union workers attain a higher utility level than nonunion workers and equation (19) represents the labour demand curve.

Using equations (17)-(19) one can see the union effects on wage, hours and employment. Figure 2 in Appendix B depicts some possible equilibrium outcomes. Note that any equilibrium wage rate and hours must lie on the left hand side of the labour supply curve (LS) since $W>\frac{U_2}{U_1}$. Since the nonunion equilibrium is at the bottom of $\bar{U}$ (point b), it is obvious that at any point on U^* where $U^*>\bar{U}$ the union wage rate is greater than the nonunion wage rate. However, the hours can increase (point a_3), decrease (point a_1) or remain at the same level (point a_2). The union effects on hours depend on the shape of the labour supply curve. For example, if the labour supply curve is strongly backward bending, then hours will decrease as a result of unionization. Since G is strongly concave and since the wage rate increases after unionization, what is not possible is the situation in which both hours and employment increase after unionization. Otherwise, any other combinations of hours and employment are possible as long as they satisfy equations (17)-(19).

Finally, it is worthwhile to note that if hours are assumed to be determined by

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12) This, of course, is the monopoly union case. The main predictions on union effects are not affected even if $\theta<1$.

13) Remember that the labour supply curve is represented by $WU_1-U_2=0$.

the worker's labour supply decision, i. e., $H=H(W)$, then our monopoly union's problem becomes exactly the same problem that is in Oswald (1982).[14] Notice, however, that his assumption ($H=H(W)$ or $WU_1-U_2=0$) is adhoc and the solution of the monopoly union's problem is suboptimal because the union can attain a higher utility level by setting $WU_1-U_2>0$. In addition, the union effects on hours and employment obtained from his results are different from ours. In our case, those effects are ambiguous if the labour supply curve has a positive slope. But, in his case, hours must increase if the labour supply curve has a positive slope, and employment must decrease due to the strongly concave production function given that the wage rate rises after unionization.

2. The Efficient Contracts Model

In the efficient contracts model it is assumed that the union and the firm bargain over wages, employment and hours and therefore, unlike the monopoly union and right to manage models, the outcomes of the efficient contracts model are pareto optimal. Formally, the optimal wage rate, hours and employment in this bargaining problem are the solution of the following problem:[15]

$$\max_{W,H,N} \quad \Omega = \theta \ln V(WH, H, N\,;\, \bar{U}) + (1-\theta)\ln \Pi(W,H,N) \qquad (20)$$

From the first order conditions of (20), one can obtain the following two relationships:

$$\frac{V_3}{HV_1}\Big|_V = \frac{W-G}{N}\Big|_\Pi \qquad (21)$$

$$\frac{WV_1 + V_2}{HV_1}\Big|_V = \frac{W-G}{H}\Big|_\Pi \qquad (22)$$

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14) The union utility function in Oswald(1982) has the same ordering as our union utility function (10). Oswald also assumed that hours and employment are perfect substitutes in production. Therefore, if we assume, as he did, that hours are determined by the worker's labour supply decision, our problem becomes exactly the same as his.

15) Again, I employ the specification used by Manning(1987) for the similar reason presented earlier.

Equations (21) and (22) are obtained by equating the slopes of the indifference curve with the slopes of the isoprofit curve in wage-employment space and wage-hours space respectively. Note that equations (21) and (22) determine optimal combinations of wage, hours and employment, and characterize a contract curve in wage-hours-employment space. Like McDonald and Solow (1981) and many others, one can find the slopes of the contract curve by taking total differentials of (21) and (22) and solving for $\frac{dH}{dW}$ and $\frac{dN}{dW}$ simultaneously.

Under the most general specification of the union's objective function (9), we cannot sign $\frac{dH}{dW}$ and $\frac{dN}{dW}$.[16] In other words, the contract curve can take any shape. Also, it is impossible for us to predict the union effects on the wage rate, hours and employment since the relationship between the union's objective function and the worker's utility function is unclear. Thus, I adopt (10) as the union's objective function in order to obtain possible qualitative results.

Under the union's objective function (10), equations (21) and (22) become

$$\frac{U-\bar{U}}{HNU_1} = \frac{W-G'}{N} > 0 \quad \cdots\cdots (23)$$

$$\frac{WU_1 - U_2}{HU_1} = \frac{W-G'}{H} > 0 \quad \cdots\cdots (24)$$

Equations (23) and (24) characterize pareto optimal combinations of wage, hours and employment on the contract curve. Taking total differentials of the above two equations, we obtain the following results (see Appendix A for derivations).

$$\frac{dH}{dW} = \frac{H(U_{21} - U_{11}W)}{U_{11}W^2 - 2U_{12}W + U_{22}} \quad \cdots\cdots (25)$$

$$\frac{dN}{dW} = \frac{-NU_1^2G''(U_{21} - U_{11}W) + (WU_1 - U_2)(U_{11}U_{22} - U_{12}^2)}{U_1^2G''(U_{11}W^2 - 2U_{12}W + U_{22})} \quad \cdots\cdots (26)$$

It can be shown that $\frac{dH}{dW}<0$ and $\frac{dN}{dW}>0$, and hence $\frac{dH}{dN}<0$[17]. The intuition for the

16) This is true even in the two variable (wage and employment) case. See, for example, Gunderson and Riddell(1993).

17) See Appendix A for the proof.

results is as follows. Suppose that the wage rate increases. Since the firm is indifferent between hours and employment, the union can determine hours. As the wage rate rises, each union member may want to work less or more hours depending on whether income effects dominate substitution effects. However, because of the diminishing marginal utility of income and leisure, the union will try to substitute employment for hours whenever possible.[18] Put differently, the return to an increase in income through an increase in hours will be relatively smaller than the return to an increase in employment. Consequently we expect $\frac{dH}{dW}$ to be negative but $\frac{dN}{dW}$ to be positive.

Using $\frac{dH}{dW}<0$ and $\frac{dN}{dW}>0$, we can draw the contract curve in $(W-H-N)$space. Figure 3 in Appendix B depicts the contract curve (CC). Note that the curves represented by CwCh, CwCn and ChCn are the projections of the contract curve CC in $(W-H)$, $(W-N)$ and $(H-N)$ space respectively.

Union impacts on the wage rate, employment and hours are depicted in figure 4 in Appendix B. Point b represents "before unionization" and point a represents "after unionization". In $(W-H)$ space, point b must be at the bottom of the indifference curve $\bar{U}$ since that point represents the optimal outcomes of the firm's maximization problem without unions. Point a, however, must be on the decreasing portion of the indifference curve U^* since $WU_1-U_2>0$. Finally, movement from b to a implies that both the wage rate and employment increase, but hours decrease after unionization.

Finally, consider a case where the union worker is risk-neutral in income. In particular, let us assume the union's objective function to be

$$V(WH,H, N) = N[WH + f(H) - \bar{Y}]^k \quad\text{.......}\quad (27)$$

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18) In general, this argument will depend upon whether or not there are fixed costs of employment. If there are fixed costs of employment, the union may not successfully substitute employment for hours. I have somewhat generalized the firm's objective function as $\Pi=G\ [A(H)N]-WHN-cN$, where $A(H)$ is a concave function of H and c is fixed costs of employment per worker. In this case the slope of dH/dW includes $A(H)$ and c terms, but the predictions are not so different from those obtained from the simpler model. However, if the fixed costs, c, is higher in the unionized firm than it is in the nonunionized sector, then the predictions will change, In this case the unionized firm will have an incentive to substitute hours for workers and hence the sign of dH/dW will depend on the size of the fixed costs. If fixed costs increases by a large amount after unionization, it is possible that dH/dW can even be positive.

where $f'<0$, $f''<0$ and $k>0$. The union's objective function (27) appears in Pencavel(1991). With this union's objective function and our firm's objective function, we obtain the following two conditions for an efficient bargaining:

$$G'H=(1-\frac{1}{k})WH+\frac{1}{k}(f-\overline{Y}) \quad \text{......} (28)$$

$$G'N=-f'N \quad \text{......} (29)$$

Pencavel refers equation (28) as an efficient contracts employment condition and equation (29) as an efficient contracts hours condition. The employment condition states that the marginal revenue product of employment is the weighted sum of income and opportunity costs $(f-\overline{Y})$ and the hours condition states that the marginal revenue product of hours is equal to the disutility(f') of work of union members. The way that Pencavel finds the slope of the contract curve in wage-employment space is to obtain $\frac{dN}{dW}$ from (28) holding hours constant. In this case, it can be shown that

$$\frac{dN}{dW}=-\frac{(1-k)}{G''H} \quad \text{......} (30)$$

From (30), we can say that if the union cares relatively more about income than employment ($k>1$), the contract curve has a negative slope and if the union cares more about employment than income ($k<1$), the contract curve has a positive slope. If $k=1$, the optimal employment is independent of the wage rate.

Obviously, equation (30) cannot represent the true slope of the contract curve in wage-employment space since hours will not be held constant along the contract curve. The correct slopes of the contract curve can be found by solving (28) and (29) simultaneously. Using the method described earlier, we obtain

$$\frac{dH}{dW}=-\frac{(1-k)H}{(1-k)(W+f')-kHf''} \quad \text{......} (31)$$

$$\frac{dN}{dW}=\frac{(1-k)(NG''+f'')}{(1-k)(W+f')G''-kHf''G''} \quad \text{......} (32)$$

We know that $G''<0$ and $f''<0$ from our assumptions. Also, it can be shown that $W+f'>0$ from (28) and (29).[19] With these signs, we can show that if $k<1$, $\frac{dN}{dW}>0$

and $\frac{dH}{dW}<0$, if $k=1$, both $\frac{dN}{dW}$ and $\frac{dH}{dW}$ are independent of the wage rate, and if $k>1$, both $\frac{dN}{dW}$ and $\frac{dH}{dW}$ are indeterminate. Note that if $k>1$, we have $\frac{dN}{dW}<0$ from (30), whereas it is ambiguous in (32). Also, even though the signs of $\frac{dN}{dW}$ are same in both equations (30) and (32) when $k<1$, their magnitudes may be quite different. Since union effects on wage rate and employment depend not only on the sign of $\frac{dN}{dW}$ but also on its magnitude, it is important to recognize the difference between the two methods.

Ⅳ. Extension

In this section I briefly discuss how one can extend our results to the sequential bargaining(Manning, 1987). Manning(1987) considers a bargaining situation where the union and firm negotiate over wages and employment sequentially. In particular, he shows that conventional union models such as the monopoly union, right to manage and efficient contracts models are special cases of the sequential bargaining model, by assigning a particular value to the bargaining power of the union at each stage of the bargaining process. For example, if the union has all the power in negotiating wages and the firm has all the power in negotiating employment, the sequential bargaining model is reduced to the monopoly union model. On the other hand, if both parties have the same bargaining power in negotiating wages and employment, the sequential bargaining model is reduced to the efficient contracts model.

The sequential bargaining model can be also employed in our case where the union and firm negotiate over wages, hours and employment. For example, let us assume that union and firm bargain over a wage rate at the first stage, hours at the second stage and employment at the third stage.[20] Under this scenario the

19) This condition is analogous to $WU_1-U_2>0$ in our earlier results.

20) It is important to assume that both parties negotiate a wage rate first, but it is not important to assume that hours are negotiated before employment in our model since they are perfect

sequential bargaining problem can be written as follows, using backward induction:

$$\max_{N} \ \theta_3 \ln V(WH, H, N) + (1-\theta_3) \ln \Pi(W, H, N) \quad (33)$$

$$\max_{H} \ \theta_2 \ln V[WH, H, N(W, H)] + (1-\theta_2) \ln \Pi[W, H, N(W, H)] \quad (34)$$

$$\max_{W} \ \theta_1 \ln V[WH(W), H(W), N(W)] + (1-\theta_1) \ln \Pi[W, H(W), N(W)] \quad (35)$$

Using the definition for Π it is straightforward to show that (1) if $\theta_1=1$, $0<\theta_2\leq 1$, and $\theta_3=0$, the solutions of (33)-(35) are identical to those of the monopoly union model, (2) if $0<\theta_1<1$, $0<\theta_2\leq 1$ and $\theta_3=0$, the solutions are identical to those of the right to manage model, and (3) if $\theta_1=\theta_2=\theta_3=\theta$, the solutions are identical to those of the efficient contracts model. The main difference between the monopoly union model and right to manage model is that in the right to manage model unions have no longer monopoly power in setting wages. This is reflected by $\theta_1<1$.

V. Conclusion

This main purpose of this paper was to examine the effects of unionization on wages, employment and hours. To do that, I have characterized the nonunion outcomes and compared them with the outcomes obtained under the monopoly union, right to manage and efficient contracts models without assuming fixed hours of work. Under the most general union objective function, union impacts on hours and employment are found to be ambiguous while the union impact on wages is found to be positive. However, if some reasonable structures are imposed on the union's objective function, I have been able to show that the wage rate increases, hours decrease, and employment increases as a result of unionization.

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substitutes in production. Our results will be unaffected even if employment is negotiated before hours.

The shapes of labour supply, labour demand and contract curves are some of the important factors determining union impact on hours of work. In the monopoly union model union impact on hours of work will mainly depend upon the shape of labour supply curves. On the other hand, in the efficient contracts model union impact on hours of work will depend upon the firm's production technology as well as the worker's taste for work.

In this paper I have also shown the slope of the contract curve in wage-employment space without assuming fixed hours. The slope obtained in this paper is quite different form the one obtained by fixing hours. In particular, if the union cares relatively less about employment than the utility gains of its members, I have shown that the contract curve does not necessarily have a negative slope in contrast to the one shown in Pencavel(1991).

Like Johnson(1990) and DiNardo(1991), I have also obtained the result that at the equilibrium union workers would like to work more hours at the negotiated wage rate. The implication of this finding is twofold. First, it means that the usual assumption of fixed working hours or the assumption that workers can choose the number of hours they would like to work may be inappropriate in the union sector. Second, it also means that some of the higher wages that union workers receive could be "compensating wage differentials" for the unsatisfactory hours set by unions and firms. Figure 5 in Appendix B depicts an equilibrium under the efficient contracts models. Under the contract curve (C_wC_h) the total union-nonunion wage differential is denoted by (a-b). It can be decomposed as the sum of the compensating differential (a-c) and the pure union-nonunion wage differential (c-b). This notion that union workers might receive compensating wage differentials for their restrictive work was empirically tested by Duncan and Stafford(1980).

A more challenging task in this area is to analyze union effects on wages, hours and employment in a general equilibrium setting. Some researchers like Diewert(1974) and Khun (1988) have examined union effects on wages and employment in general equilibrium models. However, to my knowledge, no one has shown how wages, hours and employment are determined in a unionized economy in a general equilibrium model. This remains an important future research agenda among labour economists.

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Appendix A: Proof of $\frac{dH}{dW}<0$ and $\frac{dN}{dW}>0$

First, I show how to obtain $\frac{dH}{dW}$. Equations (23) and (24) can be simplified as follows:

$$G' = \frac{U_2}{U_1} \quad \text{(A1)}$$

$$U - \bar{U} = U_1 H(W - G') \quad \text{(A2)}$$

Substituting (A1) into (A2), we obtain

$$U - \bar{U} = H(U_1 W - U_2) > 0 \quad \text{(A3)}$$

The inequality of the right hand side of (A3) is very important to determine the signs of $\frac{dH}{dW}$ and $\frac{dN}{dW}$. Let F be the function such that

$$F(W, H; \bar{U}) = U(WH, T-H) - \bar{U} - U_1(WH, T-H)WH + U_2(WH, T-H)H \quad \text{(A4)}$$

Using the implicit function theorem, we can compute

$$\frac{dH}{dW} = -\frac{F_W}{F_H} \quad \text{(A5)}$$

where

$$F_H = -H(U_{11}W^2 - 2U_{12}W + U_{22}) \quad \text{(A6)}$$

and

$$F_w = H^2(U_{12} - WU_{11}) \quad \text{(A7)}$$

Hence,

$$\frac{dH}{dW} = \frac{H(U_{21} - U_{11}W)}{U_{11}W^2 - 2U_{12}W + U_{22}} \quad \text{(A8)}$$

To obtain $\frac{dN}{dW}$, we take total differential of equation (A1) and obtain

$$G''HdN = \left[\frac{U_1(WU_{12} - U_{22}) - U_2(WU_{11} - U_{12})}{U_1^2} - G''N\right]dH + \frac{H(U_1U_{21} - U_2U_{11})}{U_1^2}dW \quad \text{(A9)}$$

Then, after dividing (A9) by dW and rearranging terms, we obtain

$$\frac{dN}{dW}=\left[\frac{U_1(WU_{12}-U_{22})-U_2(WU_{11}-U_{12})}{G'HU_1^2}-\frac{N}{H}\right]\frac{dH}{dW}+\frac{U_1U_{21}-U_2U_{11}}{G'U_1^2} \quad \text{.........(A10)}$$

By substituting the results for $\frac{dH}{dW}$ into (A10) and rearranging the terms, we obtain

$$\frac{dN}{dW}=\frac{-NU_1^2G''(U_{21}-U_{11}W)+(WU_1-U_2)(U_{11}U_{22}-U_{12}^2)}{U_1^2G''(U_{11}W^2-2U_{12}W+U_{22})} \quad \text{.................................(A11)}$$

Now, we prove $\frac{dH}{dW}<0$ and $\frac{dN}{dW}>0$. From the assumption of the concavity of U we know that $U_{11}U_{12}-U_{12}^2\geq 0$. The production function G is assumed to be strongly concave, so $G''<0$. We also know that $WU_1 - U_2 > 0$ from (A3). Therefore, we only need to know the signs of $U_{11}W^2 - 2U_{12}W + U_{22}$ and $U_{21} - U_{11}W$ to determine the signs of $\frac{dH}{dW}$ and $\frac{dN}{dW}$.

Recall that the worker's labour supply curve is characterized by

$$WU_1(WH,T-H) - U_2(WH, T-H) = 0 \quad \text{.........(A12)}$$

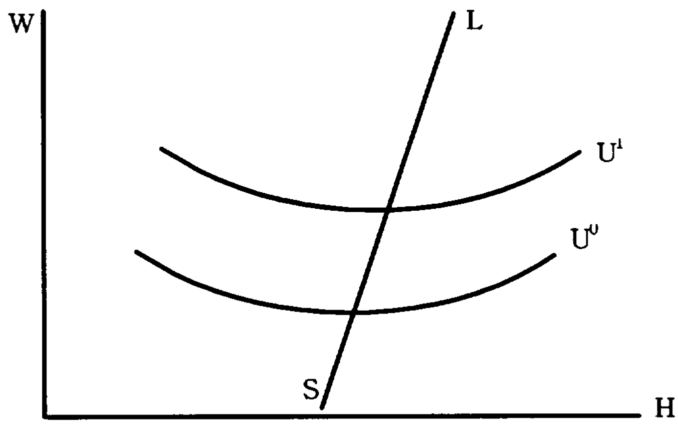
Applying the implicit function theorem to (A12), one can show

$$\frac{dH}{dW}=\frac{-U_1}{W^2U_{11}-2WU_{12}+U_{22}}+\frac{H(U_{12}-WU_{11})}{W^2U_{11}-2WU_{12}+U_{22}} \quad \text{.........(A13)}$$

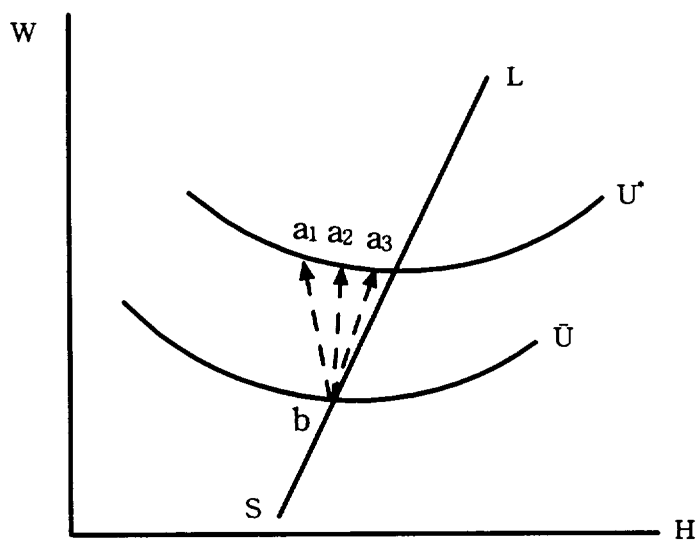
Equation (A13) is nothing but the Slutsky equation. The first part of the right hand side of (A13) is the substitution effect and the second part is the income effect. The denomination of the right hand side of (A13) is the second order condition of the worker's utility maximization problem, so it is negative. Hence, the substitution effect is positive as expected. We also know that if leisure is a normal good (hours are an inferior good), the income effect is negative. Therefore $U_{12} - WU_{11}$ must be positive. With these results, we obtain that $\frac{dH}{dW}<0$ and $\frac{dN}{dW}>0$.

Appendix B: Figures

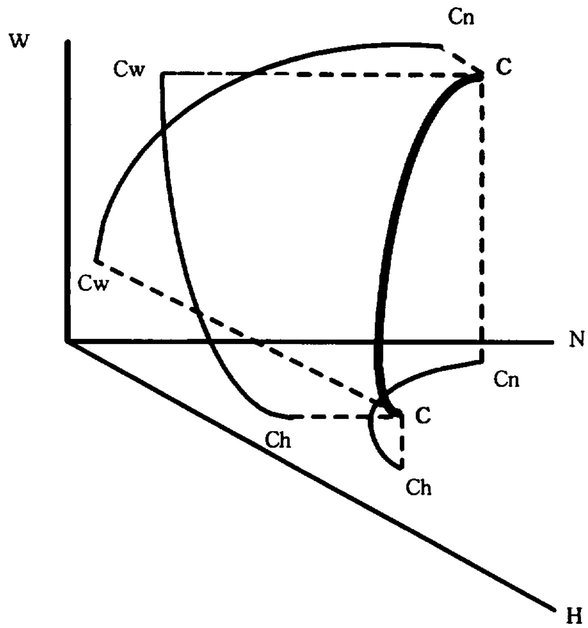
[Figure 1] Indifference Curves and The Associated Labour Supply Curve



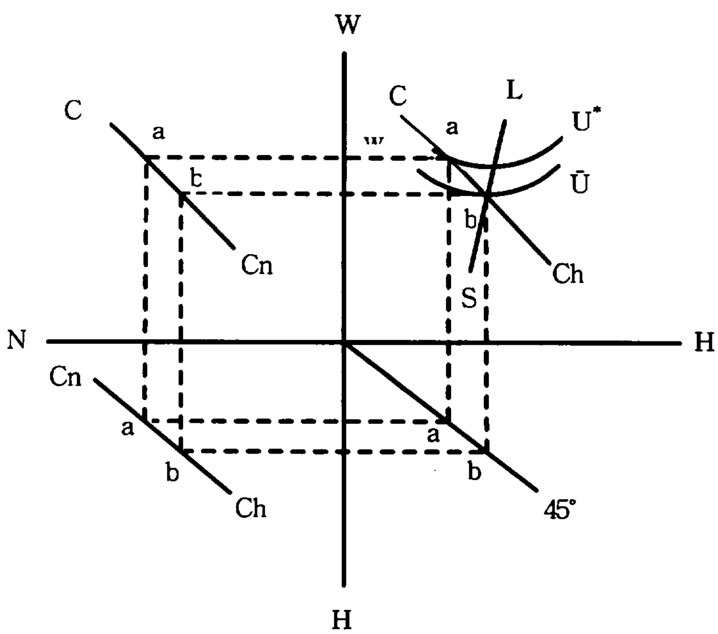
[Figure 2] Possible Equilibrium Outcomes under the Monopoly Union Model



〔Figure 3〕 A Representation of the Contract Curve in Wage-Hours-Employment Space



〔Figure 4〕 Optimal Outcomes under the Efficient Contracts Model



(Figure 5) Compensating Wage Differentials for Union Workers