

Union Wage Policy and Entry Deterrence

Jaeki Lee¹⁾
Economics Major

<Abstract>

By using a three-stage game-theoretic model, this paper explicitly introduced a strategic wage policy of labor union on entry deterrence model. An interesting result is that labor union voluntarily cooperates with the management when an entry threat exists in the product market. This happens when a monopoly outcome is not available and the gain to the labor union from setting the wage level higher than the limit-wage level is more than offset by the loss from the reduction of the employment level.

노동조합의 임금정책과 진입저지문제

이재기
경제학전공

<요약>

이 논문은 3단계 게임모형을 이용하여 노동조합의 전략적 임금정책이 진입저지 문제에 미치는 영향을 명시적으로 분석하였다. 이론적 분석결과 밝혀진 흥미있는 결과는 생산물시장에서 진입의 위협이 존재할 때, 노동조합은 자발적으로 낮은 임금을 요구함으로써 기업(경영)이 신규진입을 저지할 수 있도록 협조할 수 있다는 것이다. 이러한 경우는 노동조합이 노동의 독점적 공급자로서 독점가격을 설정하는 것이 가능하지 않거나(신규기업의 진입에 따라), 진입저지 임금수준 이상으로 임금을 설정할 경우 높은 임금으로 인한 후생증가효과보다 고용저하로 인한 후생감소효과가 더 큰 경우에 발생한다.

1) This paper was written while the author visited Griffith University in Australia for one year. I gratefully acknowledge the aids from University of Ulsan and Griffith University.

1. Introduction

Labor unions are often considered to be responsible for the wasteful phenomenon of involuntary unemployment. If the union acts as a monopolist, it will raise the price of labor above the market-clearing level. Moreover, under some assumptions²⁾, the equilibrium wage is not sensitive to external shocks. However, this result can be modified when we consider product market structure and strategic interactions of firms and unions.

A recent development of literature on entry deterrence and union behavior deals with strategic interactions of labor union with imperfect product market structure. Entry deterrence literature such as Dixit(1979, 1980), and Ware(1984) focused on the analysis of strategic interactions between incumbent monopolist and potential entrant firms. The possibility of entrance, however, affects the behavior of the labor union in the incumbent firm since such an entry may reduce the output and employment level of the incumbent firm. This paper analyzes the impact of the wage-setting behavior of labor union on entry deterrence.

It is often observed that labor unions concede to the management or decide not to go on strike when profitability of firms is weakened by the increased domestic or international competition. Furthermore, some empirical studies show the relationship between the wage level and concentration ratio of the firms in an industry. Brander and Spencer(1988) and Mezzetti and Dinopoulos(1991) analyzed the strategic interactions among firms in an unionized oligopoly, but their main concern is to investigate how the unionization affects the Cournot competition among the firms and international trade policies. This paper, on the other hand investigates entry deterrence in a unionized oligopoly. In particular, this paper focuses on the effect of union wage policy on the entry decisions of prospective entrant firm. The paper tries to clarify how entry threat benefits the management of the incumbent firm by influencing the response of the union.

In this paper, three stage game is adopted. In the first stage, the labor union of the incumbent firm decides the wage level to ask for the management. In the second stage, the entrant firm decides whether or not to enter the product market. In the last stage, the incumbent and the entrant (if it enters) choose their output (employment) levels. In a subgame perfect equilibrium, there is a case where it is optimal for the union to lower its wage demand and maintain a high level of employment as a result of deterring entry. This behavior of union results in higher profits for the incumbent firm and lower utility for the union compared with an equilibrium in a model with no entry threat. In other words, by proposing lower wage level, the union helps the management to deter entry at the cost of its own utility when a threat of entry exists in the product market.

2) For example, see McDonald and Solow(1981), and Oswald(1985).

In section 2, the basic model is presented. In section 3, equilibrium strategy is specified. Section 4 concludes the paper and suggests the direction for further extensions.

2. Basic Model

Consider a monopolistic market in which an incumbent firm is facing a potential entrant. There is a labor union in the incumbent firm. The game structure is assumed as follows. In the first stage, the labor union of the incumbent firm sets the wage level w , which is usually assumed in the monopoly union model.³⁾ In the second stage, the entrant firm observes the wage level and decides whether or not to enter the product market. In the third stage, both the incumbent and the entrant firm choose the employment levels simultaneously according to the Cournot-Nash strategies if the potential entrant actually enters. If the potential entrant decides not to enter, the incumbent firm chooses a monopoly employment level. In the model, we assume that the labor union unilaterally decides the wage level and the management of the incumbent firm accepts it and just chooses the employment level.

The inverse demand function of the product market is

$$(1) \quad p(q_1, q_2) = a - b(q_1 + q_2),$$

where a and b are positive numbers, and p is the market price, and q_1 and q_2 are outputs or quantities demanded of the incumbent firm and the potential entrant firm (if enters) respectively.

Production technology is assumed $q_1 = n_1$ for the incumbent firm, and $q_2 = cn_2$ for the entrant, where $c > 0$, n is employment level. The output level of the incumbent firm is equal to employment level n , so a constant return to scale technology is assumed. The entrant firm also assumed to have a CRS technology, but it can have a cost advantage if $c \in (0, 1)$ and a disadvantage if c is greater than 1.

The utility function of the labor union of the incumbent firm is represented by

$$(2) \quad U_1 = U(w_1, n_1),$$

where w_1 is the wage level set by the union itself and n_1 is the employment level chosen by the incumbent firm. The followings are assumed on the utility function of

3) In the monopoly union model, the union is assumed to set the wage level unilaterally, subject to the firm's labor demand curve. Once the wage is set by the union, the firm then simply reads off from the labor demand curve the number of workers to hire at that wage. In unilaterally choosing the wage, the union understands how the firm will behave in response to the wage. The monopoly union model has been criticized by some people as being excessively simple (Booth, 1995).

the labor union.

Assumption 1: $U(w, n)$ is twice differentiable, strictly monotonic and strictly quasi-concave. $U(w, 0) = U(0, n) = 0$ for any $w > 0$ and $n > 0$. In addition, $\partial U(0, n)/\partial w = \infty$ for any $w > 0$, and $\partial U(w, 0)/\partial n = \infty$ for any $n > 0$.

The assumption that the objective function of the labor union is increasing with respect to both wage and employment level is quite popular in the literature.

Finally, we assume that the entrant firm which is firm 2 faces wage level v given exogenously. This assumption can be justified if the incumbent is a domestic firm and the entrant is a foreign one.⁴⁾ Entering firm has fixed cost F as a disadvantage to the incumbent.

3. Equilibrium Strategies

Third Stage Game

As a tradition to solve a sequential game by backward induction, we first need to find equilibrium in the third stage game. For the time being, we assume $c = 1$, which means both firms have a same CRS technology. Thus the only difference in production cost is the additional fixed cost F to the entrant firm. Under this assumption, profit functions of the incumbent firm and entrant firm are as follow.

$$(3) \quad \Pi_1 = [a - w - b(q_1 + q_2)]q_1$$

$$(4) \quad \Pi_2 = [a - v - b(q_1 + q_2)]q_2 - F$$

The Nash equilibrium output(employment) pair of the third stage game (q_1^N , q_2^N) can be determined by solving the first order conditions of profit maximization for each firm.:

$$(5) \quad a - 2bq_1 - bq_2 - w = 0$$

$$(6) \quad a - bq_1 - 2bq_2 - v = 0$$

The Nash equilibrium output levels and other related values in the above Cournot game are as follow.

$$q_1^N = (a - 2w + v)/3b, \quad q_2^N = (a + w - 2v)/3b$$

4) If the entrant is also a domestic firm, we can think of several possible cases of interactive wage determination. Specify.

$$\begin{aligned}\Pi_1^N &= (a-2w+v)2/9b & \Pi_2^N &= (a+w-2v)^2/9b \\ p^N &= (a+w+v)/3\end{aligned}$$

To ensure the stability of Nash equilibrium in the third stage Cournot game when the potential entrant firm actually enters, we need several assumptions on inverse demand function. The inverse demand $p(Q)$ where Q is industry output is a twice differentiable function with $p(Q) > 0$ and $p'(Q) < 0$ for $Q > 0$. Furthermore, we need to assume that the inverse demand satisfies the Hahn-Novshek condition such that $p'(Q) + q_i p''(Q) < 0$ for any $q_i < Q$, where q_i is the output of the firm i ($i = 1, 2$). In our model, these conditions are easily satisfied since we assume a linear demand in the product market

Second Stage Game

Before analyzing the second stage game, it is helpful to consider the breakeven condition (zero profit condition) for the entrant firm in addition to conditions (5) and (6).

$$(7) \quad [a - v - b(q_1 + q_2)] q_2 - F = 0$$

If we solve the system of equations (5)-(7) simultaneously, we can get the following solutions denoted by $q_1^*(v, F)$, $q_2^*(v, F)$ and $w^*(v, F)$.

$$(8) \quad q_1^*(v, F) = (a-v)/2 - 2(F/b)^{1/2}$$

$$(9) \quad q_2^*(v, F) = (F/b)^{1/2}$$

$$(10) \quad w^*(v, F) = (2v-a) + 3(bF)^{1/3}$$

For the equation (8) and (9), we can easily check that $q_1^*(v, F) = q_1^N(w^*(v, F), v)$ and $q_2^*(v, F) = q_2^N(w^*(v, F), v)$. Equation (10) can be called the limit wage function for the incumbent firm. The limit wage level is increasing with respect to both v and F which are wage level and fixed entering cost of the entrant firm.

Proposition 1: The entrant firm will enter the product market if and only if the wage level of the incumbent firm is greater than the limit wage level, $w^*(v, F) = (2v-a) + 3(bF)^{1/3}$.

Proof: First, we show that the equilibrium profit of the entrant firm is increasing with respect to the wage level of the incumbent firm. Differentiating Π_2^N with respect to w , we get $\partial \Pi_2^N / \partial w = 2(a+w-2v)/(9b) > 0$.

We know that $\Pi_2^N(q_1^N, q_2^N) = 0$ if $w = w^*(v, F)$. Thus the entrant firm earns positive profit by entering the market if and only if $w > w^*(v, F) = (2v-a) + 3(bF)^{1/3}$.

In addition to the above result, we need to consider the possibility that the limiting

wage level is negative. In such a case, the entrant firm will always enter the product market at the second stage of the game. In order to analyze this case, let us rephrase equation (5) and (6) as explicit functions of q_1 and q_2 respectively. In fact these are the reaction functions of the incumbent and entrant firm in the third stage of the game.

$$(5)' \quad q_1 = R_1(q_2 ; w) = (a - bq_2 - w) / 2b$$

$$(6)' \quad q_2 = R_2(q_1 ; v) = (a - bq_1 - v) / 2b$$

In addition, we can denote the monopoly output level of the incumbent firm by using the relationship in (5)'.

$$(11) \quad q_1^m(w) = R_1(0 ; w) = (a - w) / 2b$$

Proposition 2: Suppose $F = 0$, and let $R_2^{-1}(q_2 ; v)$ be the inverse function of $q_2 = R_2(q_1 ; v)$ for a given v .⁵⁾ Then, we have

$$(i) \quad w^*(v, 0) = 2v - a \geq 0 \text{ if and only if } q_1^m(0) = a/2b \geq R_2^{-1}(0 ; v) = (a - v)/b$$

$$(ii) \quad w^*(v, 0) = 2v - a < 0 \text{ if and only if } q_1^m(0) = a/2b < R_2^{-1}(0 ; v) = (a - v)/b$$

Proof: Note that $R_2^{-1}(0 ; v) = q_1^m(w^*(v, 0))$ since $q_2^N(w^*(v, 0)) = 0$. Moreover, $dq_1^m(w)/dw = -1/2b < 0$. These together prove the result.

If proposition 2 (ii) holds, then $w^*(v, F) < 0$ holds for some $F > 0$. By combining proposition 1 and 2, we can find some case that the entrant firm will enter the product market regardless of the wage level the union in the incumbent firm sets.

First Stage Game

Now we proceed to the first stage game. At this stage, the union in the incumbent firm decides the wage level. According to the proposition 1, the equilibrium output level (or employment level) of the incumbent firm for the given wage level w can be defined as follows.

$$(12) \quad q_1^E(w, v, F) = q_1^N(w, v) = (a - 2w + v) / 3b \quad \text{if } w > w^*(v, F) = (2v - a) + 3(bF)^{1/3}$$

$$= q_1^m(w) = (a - w) / 2b \quad \text{if } w \leq w^*(v, F) = (2v - a) + 3(bF)^{1/3}$$

The optimal wage strategy for the union in the incumbent firm at the first stage of the game can be defined as follows;

$$(13) \quad w^E(v, F) = \operatorname{argmax}_w U(q_1^E(w, v, F), w)$$

5) Note that $R_2^{-1}(q_2 ; v) = (a - 2bq_2 - v) / b$.

In order to analyze the decision of the union in the incumbent firm, it is convenient to derive the possible cases of output and wage combination, which is the constraint over which the union decides its wage requirement.

According to the demand condition of the product market and cost condition of the entrant firm, we can categorize four possible cases about the limit wage level for the union in the incumbent firm; (i) $w^*(v, F) = (2v-a)+3(bF)^{1/3} \geq p(0) = a$, (ii) $p(0) = a \geq w^*(v, F) = (2v-a)+3(bF)^{1/3} > p(R_2(0; v)) = (a+v)/2$, (iii) $p(R_2(0; v)) = (a+v)/2 \geq w^*(v, F) = (2v-a)+3(bF)^{1/3} \geq 0$ (iv) $w^*(v, F) = (2v-a)+3(bF)^{1/3} < 0$.

The above four cases are depicted in Figures 1-4.

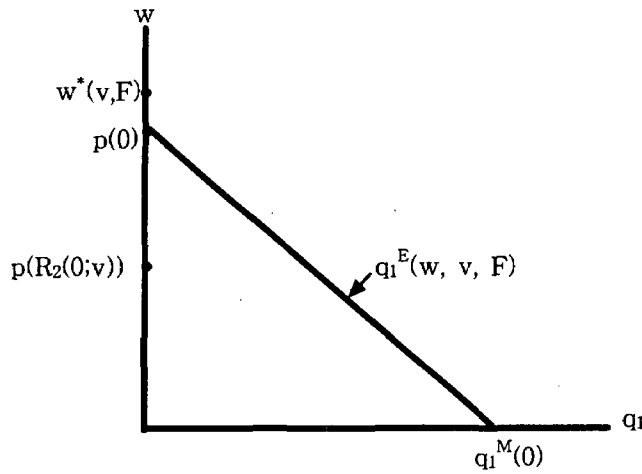


Figure 1

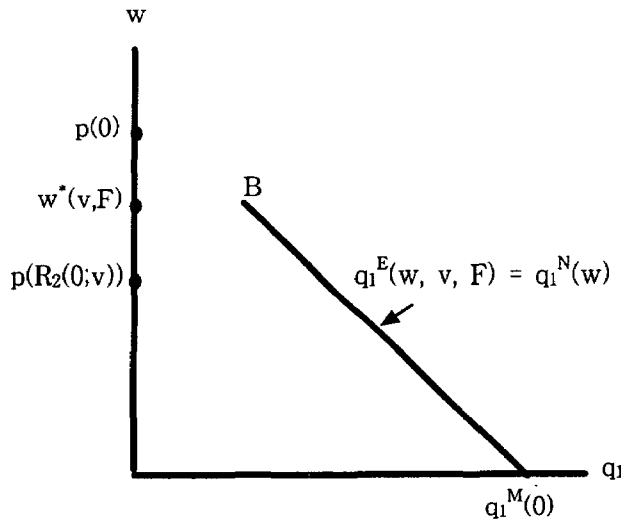


Figure 2

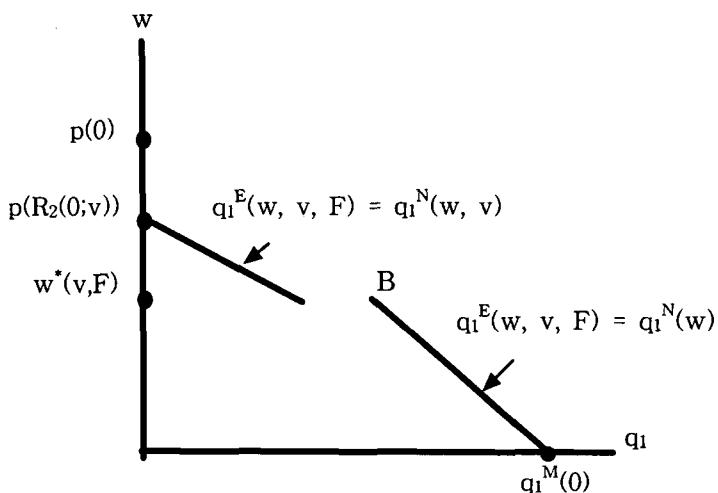


Figure 3

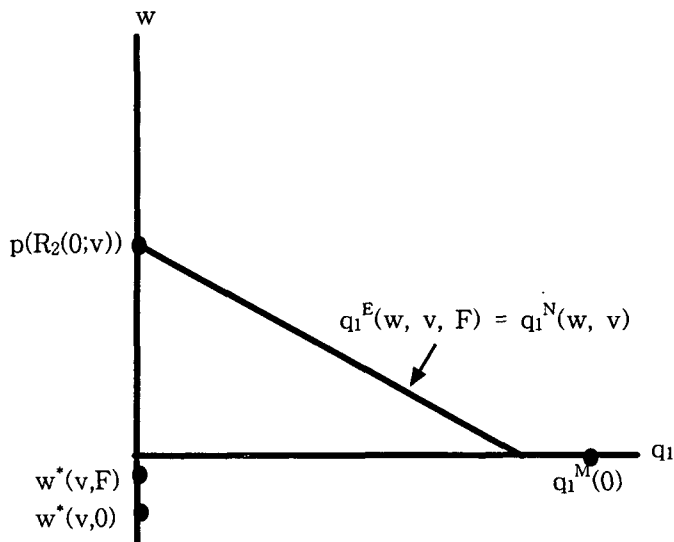


Figure 4

The last case may occur when proposition 2 (ii) holds.

The labor union in the incumbent firm chooses the optimal wage level $w^E(v, F)$ according to (13). That is, at the point $(q_1^E(w^E(v, F), w^E(v, F)), w^E(v, F))$, the labor union attains its highest utility level.

In order to characterize the equilibrium strategy of the labor union, we need to define w^M and $w^N(v)$ as follows;

$$w^M \equiv \operatorname{argmax}_w U(q^M(w), w),$$

$$w^N \equiv \operatorname{argmax}_w U(q^N(w, v), w).$$

When assumption 1 holds and demand function is linear, we can find w^M and w^N uniquely determined.

Proposition 3: At the first stage of the game, the optimal strategy for the labor union in the incumbent firm, $w^E(v, F)$, is;

- (i) $w^E(v, F) = w^M$ if $w^M \leq w^*(v, F)$,
- (ii) $w^E(v, F) = w^*(v, F)$ if $w^M > w^*(v, F)$ and $U(q^M(w^*(v, F)), w^*(v, F)) \geq \max_{w \geq w^*(v, F)} U(q^N(w, v), w)$,
- (iii) $w^E(v, F) = w^N(v)$ if $w^M > w^*(v, F)$ and $U(q^M(w^*(v, F)), w^*(v, F)) < \max_{w \geq w^*(v, F)} U(q^N(w, v), w)$.

If $w^M \leq w^*(v, F)$, the point $(q^M(w^M), w^M)$ is on the locus $(q^E(w, v, F), w)$. Thus the labor union chooses $w^E(v, F) = w^M$ which brings the highest level of utility. If $w^M > w^*(v, F)$, then the point $(q^M(w^M), w^M)$ is not on the locus $(q^E(w, v, F), w)$. Thus the indifference curve of the labor union that gives the highest utility level touch the locus $(q^E(w, v, F), w)$ at the point where $w \geq w^*(v, F)$. More specifically, the indifference curve touches the locus $(q^E(w, v, F), w)$ either at the point $(q^M(w^*(v, F)), w^*(v, F))$ which is point B in figure 2 and figure 3 or at the point $(q^N(w^N(v)), w^N(v))$ which is the point somewhere on DB' of figure 3 or DB'' of figure 4. the former holds when $U(q^M(w^*(v, F)), w^*(v, F)) \geq \max_{w \geq w^*(v, F)} U(q^N(w, v), w)$. In this case, the labor union chooses $w^E(v, F) = w^*(v, F)$. The latter holds when $U(q^M(w^*(v, F)), w^*(v, F)) < \max_{w \geq w^*(v, F)} U(q^N(w, v), w)$. In this case, the labor union chooses $w^E(v, F) = w^N(v)$.

In proposition 3, the most interesting case is (ii) $w^E(v, F) = w^*(v, F)$ where equilibrium wage is equal to the limiting wage. This case is depicted in Figure 5

In Figure 5, the labor union obtains its maximum utility level U^E when the wage level is set at w^* and entry is deterred. Note that the union can require wage level higher than the limiting wage level w^* . Any wage level, however, which is even slightly higher than the limiting wage, $w^*(v, F)$ would greatly reduce the employment level by causing the entrance of the new firm to the product market. Since the loss of utility from the reduction in the employment is greater than the gain from the increase of wage, the labor union voluntarily chooses a lower wage which is equal to the limiting wage level.

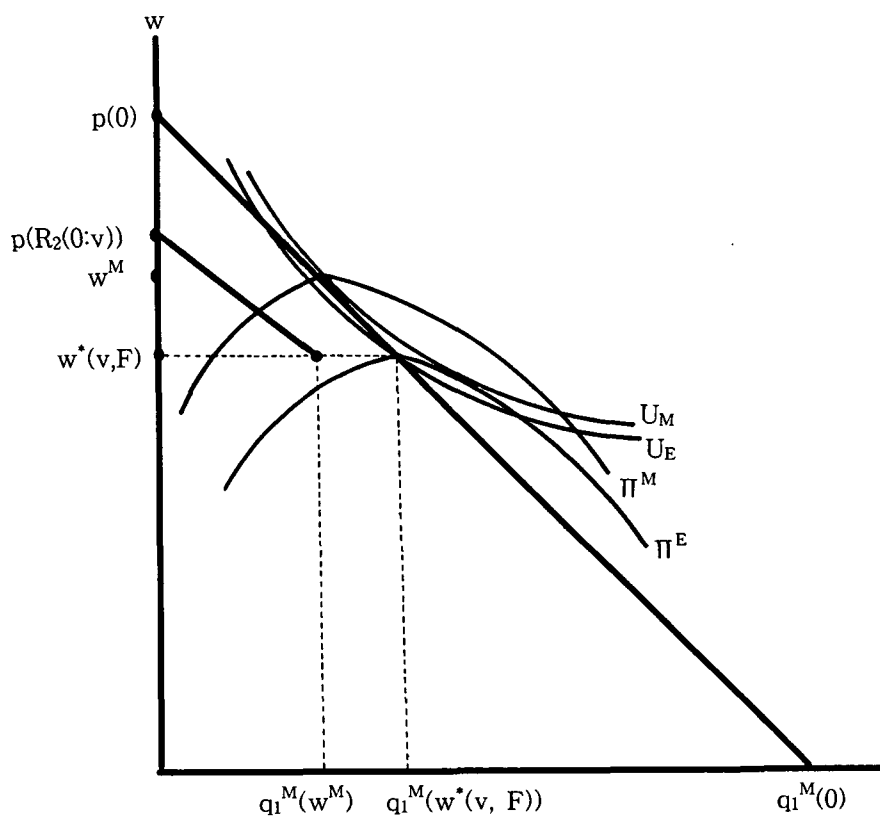


Figure 5.

If there is no threat of entry, the incumbent firm behaves as a monopolist. The indifference curve of the labor union and the isoprofit curve of the incumbent firm in the monopoly outcome are denoted by U^M and Π^M in Figure 5 respectively. It is obvious that the monopoly outcome brings a higher level of utility to the labor union, but a lower level of profit for the incumbent firm compared with the equilibrium occurring when the threat of entry exists. In the monopoly outcome, the wage level is set high enough so that the gain from higher wage compensates for the loss resulting from the reduction of the employment level. Under the threat of entry in a product market with sufficiently low fixed cost for the entrant, the monopoly outcome is not attainable for the incumbent firm. The threat of entry into the product market benefited the incumbent firm and hurts the labor union in the incumbent firm. This result is quite paradoxical that a more competitive market caused by the existence of potential entrant brings a higher profit to the incumbent firm.

4. Conclusion

This paper explicitly introduced a strategic wage policy of labor union on entry deterrence. The most interesting result is that labor union voluntarily cooperates with the management when an entry threat exists in the product market. This happens when a monopoly outcome is not available and the gain to the labor union from setting the wage level higher than the limit-wage level is more than offset by the loss from the reduction of the employment level.

In this paper, labor union unilaterally decides the wage level and management solely decides the employment level. The introduction of different bargaining structure such as efficient bargaining or some noncooperative bargaining process is left for future research.

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