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THE IMPACT OF PRODUCT MARKET OLIGOPOLY ON UNION FORMATION

JAEKI LEE*

1. INTRODUCTION

The structure of collective bargaining outlines the arena where labor and management are expected to interact and negotiate. Thus a bargaining structure must be evaluated according to its effectiveness as a means for the parties to engage each other in decision making on the issues that affect the irvital interests.

We can observe a variety of patterns in the practice of wage bargaining under trade unionism. In some firms, the bargaining is at the firm level, in other firms at the industry level; in some cases, the union is organized at the firm level, and in other cases the whole work force in an industry is organized by a single union. The literature on industrial relations has discussed extensively possible explanations for the differences in bargaining structures.

Empirical studies attempt to relate patterns of bargaining to variables such as firm size and the degree of industry concentration.[1] [Hendricks and Kahn (1982), and Mishel(1986)] The problems in this approach are the lack of convincing explanations for how and why these variables should affect bargaining structure. This essay tries to explain these problems by relating firms' strategic behavior in the product market and unions' strategic behavior in the labor market by using a simple noncooperative game.

In mid−1980s, many U.S. employers were pressing for decentralization of the formal and informal stuctures of bargaining. An example is the course of collective bargaining in the steel industry. In 1986, bargaining for new national agereements at the major integrated steel mills took place on a company−by−company basis, in sharp contrast to the long tradition of coordinated national bargaining between the United Steel Workers(USW) and major steel coopera-

* Department of Economics , The University of Ulsan.

1) According to Rees (1989), it is important to classify industries as competitive or monopolistic by their market structure under non−union condition, since one of the effects of unions in such industries as the building trades and local service industries may be to create effective cartels in the product market.

tions. The result of change in bargaining structure is the decrease of compensation and the increase of employment opportunity. But there is no theoretical explanation why decentralized bargaining results in lower wages and higher employment security. This essay provides some explanation for these observations.

The previous theoretical literature suggests several explanations for the differences in bargaining structures by using strategic considerations.[2] Most studies in this area discuss the patterns of unionization in a single firm. Jun (1989) analyzes the union formation process in a firm when workers are composed of two groups distinguished by different sizes and different productivity. By using the Perfect Equilibrium concept in Rubinstein (1982), he shows that workers form a joint union when the size or productivity of the groups are similar and form separate unions otherwise. Horn and Wolinsky (1988) also develop a bargaining model for the case in which two groups of workers face a single employer. Similar to Jun, by using Rubinstein's Perfect Equilibrium concept, they show that when the two types of workers are substitute factors they will be benefit from forming a joint union, and when they are complements they will be better off by organizing separate unions.

A weakness in this game theoretic literature is that most studies deal with the interactions between a single employer and the multi−groups of employees. As we see in Hendricks and Kahn (1982), and Mishel (1986), however, the structure of the product market like the degree of industry concentration also affects the pattern of unionization and bargaining structure.[3] Similar to this essay, the effect of product market structure on bargaining is considered by Davidson(1988). He develops a model of wage determination in unionized oligopolistic industries and compares the outcome of collective bargaining structures−one in which the workers of each firm are represented by separate and independent unions and the other in which a single union represents all workers in the industry. He shows that industry−wide bargaining results in higher wages. However, he does not consider the effect of strategic actions by oligopolistic firms on collective bargaining.

This essay tries to relate the strategic behaviors of trade unions in the labor market with those of firms in the product market by developing a simple game theoretic model. We assume that there are two unionized firms in an industry and each union (firm) has two strategic choices, 'collude' or 'not collude', with the other union (firm). By using several simplifying assumptions, we show that it is a dominant strategy for both unions and firms to collude. That is, in equi-

2) Another popular approach in this area which is not discussed in this paper is legal and institutional approach. Explanations of this approach try to show how legal and institutional environments may affect union formation and consequent bargaining structures. An example is that in United States, unionization procedure is regulated by NLRB which can affect the scope of a union under certain circumstances, This implies that the underlying balance of political power which shapes NLRB and its regulations may affect the pattern of unionization.

3) Mishel[1986] considers the structure of product market as a key determinant in wage determination and other labor market outcomes generally because it is considered to be closely related to the firm's ability to pay.

librium, firms form a cartel and unions form a single industry union. However, payoffs from this equilibrium are Pareto inferior to the case where both firms and unions are non−collusive. Here we confront a situation which is analogous to the Prisoner's Dilemma in a two−person noncooperative game.[4] By considering the model in a repeated game context, we argue how the Pareto efficient outcome can be sustained and how the situation analogous to that of Prisoner's Dilemma can be avoided. This argument can shed some light on the efficiency of the bargaining structure in major U.S. industries. It also can provide a solid explanation for the recent trend of decentralization in collective bargaining in major U.S. industries confronted with decreased demand and increased foreign competition.

The rest of essay is organized as follows. In Section 2, the basic structure of model is presented. In Section 3, the payoffs to each combination of strategies are analyzed. In Section 4, equilibrium of the bargaining game and its properties are investigated. The variations of oligopoly model when the labor market is unionized are considered in Section 5. In Section 6, we analyze the sustainability of the efficient outcome in a dynamic context. Section 7 concludes the essay and suggests some possible extensions.

2. THE MODEL

In order to explain the effect of firms' and unions' strategic behaviors on the outcomes of collective bargaining, we need to make some simplifying assumptions. We assume that there exist two firms in an industry producing homogeneous goods with the same technology. We also assume that workers in the industry are all identical; so workers are completely substitutable in the produciton process both at the firm and industry level. Each firm has two strategies in the determination of output; to collude or not to collude with the other firm. If they choose to collude, their function in the product market is the same as that of a cartel or monopoly playing the Cournot−Nash strategies in the product market. Similarly, each union has two strategic choices in the formation of union structure. If they collude they form a single industry union, but if they don't the result will be two separate firm−level unions in the labor market.

We assume that the wage is set non−cooperatively by the union and the employment level is determined by the firm on its labor demand curve.[5] The reason for this assumption is that even if the firm and union choose wages and employment level on the contract curve through efficient bargaining, the former has an incentive to abrogate the agreement and to decrease employment level

4) This situation in the present paper looks like that of Prisoners' Dilemma. However, strictly speaking, we can not use that terminology because the game in this paper is a restricted four-person game.

5) The equilibrium on labor demand curve satisfies the condition for Nash equilibrium.

to a point on the demand curve.[6]

The game structure here is a restricted four−person two−stage game.[7] At the first stage, union i and firm i (i=1, 2) simultaneously decide their strategic actions, s_{ui} and s_{fi} against the other union and firm, where $s \in \{C, N\}$. Here, C and N are labels of two strategies, 'collude' and 'not collude' respectively. At the second stage, unions offer wages, and then observing unions' wage offers firms decide employment level under the given choices of actions at the first stage of the game. If the game is truncated at the end of the first stage, paryoffs for union i and firm i are defined as

$$(1)\quad U_i = U_i(s_{ui}, s_{uj}; s_{fi}, s_{fj}),\ i \neq j,$$

and

$$(2)\quad \Pi_i = \Pi_i(s_{ui}, s_{uj}; s_{fi}, s_{fj}),\ i \neq j,$$

respectively. Hereafter, we ignore subscripts of payoff functions because those functions are symmetric. Since each strategic action has two possibilities, we have sixteen different combinations of actions. However, we only need to focus on four different bargaining structures (C,C; C,C), (N,N; C,C), (C,C; N,N) and (N,N; N,N), since

$$U(C, N; a_{fi}, a_{fj}) = U(N,C; a_{fi}, a_{fj}) = U(N, N; a_{fi}, a_{fj})$$

for any given a_{fi} where i = 1, 2, and

$$U(a_{ui}, a_{uj}; C,N) = U(a_{ui}, a_{uj}; N,C) = U(a_{ui}, a_{uj}; N,N)$$

for any given a_{ui} where i = 1, 2. We can apply the same reasoning to firms' payoffs.

In the first case, (C,C; C,C), firms form a cartel and unions form a joint industry union. So we can apply the monopoly bargaining model to this case. In the second case (N,N; C,C), firms form a cartel, but unions form separate firm −level unions. Since all workers are assumed to be identical, it is pausible to assume that each union uses the Bertrand conjecture for the other union's

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6) There are two differnt approaches−monopoly union model and efficient contract model− on the determination of wage and employment in the unionized labor market. Monopoly union model is adopted in the paper since most of collective bargaining in the United States and other advanced countries seem to grant firms considerable discretion over the level of employment. Empirical works done in this area [MaCurdy and Pencavel(1986) and Brown and Ashenfelter(1986)] do not give us a decisive conclusion about the validity of two models.

7) The game is restricted since we exclude possibilities of cooperation between firm and union. We can find incumbent firm−union cooperation to deter entry in the Pennington case. Thus, if we allow possibilities of cooperation between union and firm, we can analyze entry deterrence when the labor market is unionized. For details of this issue, refer to Kim(1988) and williamson(1968).

wage offer. The third case(C,C; N,N) implies that unions form a joint union, but firms play Cournot−Nash strategies in the product market. In the last case (N,N; N,N,), since both firms and unions choose not to collude they function as a bilateral duopoly. Firms play Cournot−Nash strategies against each other in the product market and unions play Cournot−Nash strategies for their wage offers.

In order to find an equilibrium, we need to consider payoffs for each combination of actions. An important point to note here is that if unions form a joint union, the joint union offers a single wage to it's bargaining counterpart. A justification of the single wage offer can be found from the political consideration of union's decision making process. This single wage offer excludes the possibility of wage discrimination by a monopoly union which is similar to price discrimination by a monopoly firm in the product market, and also excludes the possibility of redistribution of wage bill in the union[8]

To go further and analyze payoffs we need several simplifying assumptions about market demand, production technology and objective functions of union and firm. The inverse market demand for homogeneous good is assumed to be a linear functional of the form:

$$(3)\quad p=a-b(Q_1+Q_2),$$

where p is the price of the good and Q_i is the output of firm i, i=1, 2.
Production technology is represented by a constant return to scale production function:

$$(4)\quad Q_i=L_i,\ i=1,\ 2,$$

where L_i is the level of employment in firm i. As usual, we assume that firms maximize profits and unions maximize their total wage−bills. At the second stage, under the given choices of strategies at the first stage, we can construct the firm's profit function and the union's objective function as follows.

$$(5)\quad \Pi_i=pQ_i-w_iL_i,\ i=1,2,$$

$$(6)\quad U_i=w_iL_i,\ i=1,\ 2,$$

where w_i is the wage level for workers in union i. The objective function(46) implies that union i is a wage−bill−maximizer. If we assume the alternative wage for worker is zero, then w_i is the wage differential between unionized and

8) It is well known that a product market monopolist can discriminate among consumers with private information by implementing a nonuniform price schedule. This nonuniform pricing model is applied to the labor market by Kuhn(1988).

non−unionized workers and the union can be considered as a rent maximizer.

3. BARGAINING STRUCTURE AND PAYOFFS

In order to find equilibrium strategies and outcomes we need to calculate and compare payoffs for both firm and union in each combination of strategies. This section enables us to calculate and compare the bargaining results for four different bargaining structures. Even if the arguments about determination of wage and employment in this section is mechanical and also well know, they are worth while to pursue, The reason is that almost all previous theoretical studies of unionization and resulting bargaining outcomes assume the produst market is either monopolistic or competitive, they thereby ignore the possibility of interactions between firms and unions that may affect the outcomes of collective bargaining.

3.1 Bargaining between a Joint Union and a Cartel

Since both bargaining units choose to collude, firms act as a cartel or a monopolist in the product market and unions act as a monopoly union in the labor market. In this situation, we can apply a simple monopoly bargaining model. Firms maximize a joint profit by solving

$$(7)\ \underset{L}{\text{Max}}\ \Pi = (a-bL)\,L - wL.$$

From the first order condition, firms' labor demand function is given by

$$(8)\ L(w) = (a-w)/2b.$$

In the case of industry−wide bargaining like this, the industry union is assumed to maximize the sum of utilities. This assumption simplifies the analysis, but is not essential for our results. Hence we assume that the industry−wide union maximizes a joint wage bill and solves

$$(9)\ \underset{w}{\text{Max}}\ wL(w) \text{ subject to } (48).^{9}$$

Note that here w implies a single wage offered by the industry−wide union. By assumption, both firms and unions are symmetric; hence, solving (9) gives the optimal wage offer for the monopoly union. All bargaining outcomes are as

9) In this essay, we use the backwards induction to solve the two−stage game. Especially, in this section analyzing the second stage game, the adoption of the backwards induction method implies that we implicitly assume unions are Stackelberg leaders and know firms' reaction functions for their wage offers.

follows:

(10.1) $w(C,C;C,C,) = a/2$

(10.2) $L(C,C;C,C,) = a/8b$

(10.3) $\Pi(C,C;C,C,) = a^2/32b$

(10.4) $U(C,C;C,C,) = a^2/16b$

(10.5) $P(C.C;C,C,) = 3a/4$

Equations(10.1)−(10.5) show how the wage rate, employment level, payoffs to the firm and union, and output price are determined in a bilaterally monopolistic industry. Note that total payoffs to the cartel and industry union are divided equally to the initial individual firms and unions. Thus (10.2), (10.3) and (10.4) represent the employment level and payoffs to those individual units. Under given choice(C,C;C,C) at the first stage game, these results imply that there exists a unique Nash equilibrium at the second stage.

3.2 Bargaining between a Cartel and Two Separate Unions.

Similar to the first case, firms behave as a cartel or monopolist. Then they maximize their joint profit by solving

(11) $\underset{L_1,L_2}{\text{Max}}\ \Pi = (a-bL)L - w_1 L_1 - w_2 L_2$ subject to $L_1 + L_2 = L$.

Then the inverse labor demand for union i is given by

(12) $w_i = a - 2b(L_1 + L_2)$, $i = 1, 2$.

If union i's wage offer is higher than the other union's offer union i will lose whole market. Since there is wage competition between two unions, two unions' wage offers must be equal at equilibrium. Thus equilibrium wage and resulting labor demand are $w_1 = w_2 = 0$ and $L_1(w_1,w_2) = L_2(w_1, w_2) = a/4b$. Here note that the competitive wage level is assumed to be zero.

From the above argument, we can easily find the following bargaining outcomes.

(13.1) $w(N,N;C,C) = 0$

(13.2) $L(N,N;C,C) = a/4b$

(13.3) $\Pi(N,N;C,C) = a^2/8b$

(13.4) $U(N,N;C,C) = 0$

(13.5) $p(N,N;C,C) = a/2$

In contrast to the previous case, the wage competition between two unions lowers the wage level to that in the competitive labor market but increases employment level to that in the competitive market. So this case is equivalent to a monopoly firm with a competitive labor market. Unions cannot get any rent and all monopoly rents belong to the two collusive firms.

3.3. Bargaining between a Joint Union and Two Separate Firms

If firms choose not to collude, they play a Cournot Nash strategies in the product market.[10] Each firm maximizes its own profit under the assumption that the other firm's output is fixed. For firm i(i = 1,2), the optimization problem is

(14) $\underset{L_i}{\text{Max}}\ \Pi_i = [a - b(L_i + L_j)]L_i - wL_i$

From the first order conditions, we can derive labor demand functions for two firms playing Cournot-Nash strategies as follows:

(15.1) $L_1(w_1, w_2) = (a - 2w_1 + w_2)/3b$,

(15.2) $L_2(w_1, w_2) = (a + w_1 - 2w_2)/3b$,

The sbove two equations give us $L_1 = L_2$ since collusive unions set the same wage rate.[11] Then the industry-wide union solves the following problem;

(16) $\underset{w}{\text{Max}}\ wL(w)$ subject to $L(w) = 2(a - w)/3b$.

Solving (16), we have the bargaining outcomes as follows.

(17.1) $w(C,C; N,N) = a/2$

(17.2) $L(C,C; N,N) = a/6b$

(17.3) $\Pi(C,C; N,N) = a^2/36b$

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10) We can assume that they play a Bertrand game. Then all surplus goes to the joint union and individual firm's profit will be zero. The adoption of this assumption does not change the qualitative properties of results. We will consider this case in later section in which conjectural variations with the unionized labor market are discussed.

11) This assumption is appropriate because two unions are cooperative and their members are all identical. If unions are composed of heterogeneous workers we can allow the possibility of wage differential which seems to be associated with two-tier wage system.

(17.4) $U(C,C;N,N) = a^2/12b$

(17.5) $p(C,C;N,N) = 2a/3$

In this case, the wage level is equal to the first case in which bargaining occurs between a joint union and a cartel, regardless of the differences of the situation in the product market. The reason is that the industry-wide union sets the wage level where wage elasticity of labor demand is equal to one.

3.4 Bargaining between a Firm and a Union in Bilateral Duopoly

Since both bargaining units choose not to collude, firms play Cournot-Nash stategies in the product market and firms play Bertrand strategies to determine their optimal wage offers. It is important to note that wage offers between two separate unions can be different at off-equilibrium state, even if they are equal at equilibrium. Firms' strategies can be represented by the reaction functions(15.1) and (15.2). Therefore, union 1 solves

(18) $\underset{w_1}{\text{Max}}\ w_1L_1(w_1,w_2)$ subject to(55.1).

By solving (18), we can get the following reaction function of union 1,

(19) $(a-4w_1+w_2)/3b = 0.$

Similarly, by solving for union 2 we can get the reaction function of the second union,

(20) $(a+w_1-4w_2)/3b = 0$

By solving (15.1), (15.2), (19) and (20) simultaneously, we will get the followingresults.

(21.1) $w(N,N;N,N) = a/3$

(21.2) $L(N,N;N,N) = 2a/9b$

(21.3) $\Pi(N,N;N,N) = 4a^2/81b$

(21.4) $U(N,N;N,N) = 2a^2/27b$

(21.5) $p(N,N;N,N) = 5a/9$

An interesting point worthwhile to mention here is the possibility of cheating in cartel. It is well known that there is strong incentive of cheating for each

firm in the cartel. In our model, the possibility of cheating also exists,[12] but we can infer that the possibility of cheating may be smaller than the case in which labor market is competitive since the extra profit from cheating will be shared by unions.

The wage level is highest when unions are collusive and employment level is highest when unions are non collusive but firms are collusive. If firms are collusive, the employment level is determined on the industry labor demand for monopolist regardless of unions' strategies, but if they are not, then, employment level is outside of the industry demand.

4. EQUILIBRIUM AND EFFICIENCY

So far we have investigated payoffs and other bargaining outcomes for each combination of strategies. By using the results in the previous section, we can determine the equilibrium strategic actions at the first stage. By comparing (10.3), (13.3), (17.3) and (21.3), we arrive at the following proposition.

Proposition 1. It is a weakly dominant strategy for each firm to choose C.

Proof: If firm 1 chooses C, it's payoff $\Pi(s_{11}, s_{12}; C, s_{22})$ is not dominated by strategy N for any s_{11}, s_{12} and s_{22}. That is,

$$\Pi(s_{11}, s_{12}; C, s_{22}) \geq \Pi(s_{11}, s_{12}; N, s_{22}).$$

The same argument is true for firm 2. Q.E.D.

Also by comparing(10.4), (13.4), (17.4) and (21.4), we can derive a similar result for unions.

Proposition 2. For each union, it is a weakly dominant strategy to choose C.

Proof: If union 1 chooses C, it's payoff is $U(C, s_{12}; s_{21}, s_{22})$. For any s_{12}, s_{21} and s_{22},

$$U(C, s_{12}; s_{21}, s_{22}) \geq U(N, s_{12}; s_{21}, s_{22}).$$

The same argument applies to union 2. Q.E.D

By combining the previous two propositions, we find that (C,C;C,C) is a dominant strategy equilibrium.[13]

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12) In the first two cases, (C,C;C,C) and(N,N;C,C), we can easily check the existence of incentives to cheat in the cartel. At equilibrium employment level, individual firm's marginal revenue is greater than marginal cost, which is equal to wage here.

13) Notice that (C,C;C,C) is dominant strategy equilibrium at the first stage game. Actually the game in this paper is defined as a two stage game, so the equilibrium concept will be subgame perfect or sequential equilibrium. However, since our main interest is the determination of bargaining structure we restrict our concern at the first stage game and use the concept of dominant strategy or Nash equilibrium.

Proposition 3. It is a dominant staregy equilibrium for each union and firm to collude against each other.

For each union, to collude to form a joint industry union is a weakly dominant strategy. Similarly, it is also a weakly dominant strategy for each firm to collude and form a cartel. As a result, (C,C; C,C) is a dominant strategy equilibrium. A union has higher payoffs by choosing to collude with the other union whatever choices the other union and firms make. Whatever choices the unions and the other firm make, a firm gets higher payoffs by choosing to collude with the other firm. This result is an extension of the result in Horn and Wolinsky(1989) to the industry level. In Horn and Wolinsky, it is profitable for workers to form a joint union when they are substitutable factors in a single firm. Our result supports that of Horn and Wolinsky at the industry level

An important weakness of this equilibrium is that even if it is a dominant strategy equilibrium, it is strictly dominated by the outcomes from playing (N, N; N,N) since

$$U_i(C,C;C,C) = a^2/16b < U_i(N,N;N,N) = 2a^2/27b,$$

and

$$\Pi_i(C,C;C,C) = a^2/32b < \Pi_i(N,N;N,N) = 4a^2/81b$$

for any $i=1,2$. This result implies that we have a situation which is analogous to the well-known Prisoner's Dilemma in a two-person game. Since the game structure in this essay is a restricted four-person game we cannot define the situation here as Prisoner's Dilemma.[14] However, it is surprising that we can find a situation analogous to the Prisoner's Dilemma in multiple firms and unions bargaining game. For both unions and firms, choosing not to collude gives higher payoffs than playing equilibrium strategies. This intersting result arises from the behavioral differences of unions in the wage it is the equilibrium wage or not. In non-collusive case, however, wage offers can be different between two unions though they are equal at equilibrium.[15]

Mishel(1986) studies union wages in the United States 1968-72 and finds

14) Prisoner's Dilemma problem in a game with more than two players is not investigated in economics even if multi-person game is important in the real world. For example, many interesting problems of public goods provision can be explained better by multi-person game than two-person game. The application of the multi-person Prisoner's Dilemma to public goods provision is found in a political scientist's work.[Taylor(1987)]

15) According to our model, regardless of unions' strategic choices at the first stage of game, the observed wage level in the industry will be equal. But the difference in union structure causes different union wage effects. Thus, empirical studies of union/nonunion wage gap will be misleading if they do not consider this structural factor.

16) Mishel(1986)'s explanation of effects of union concentration is based on the presumed weakness of plant-level unions bargaining with a multi-plant employer who can use inventories and overtime in other plants to minimize the cost of strike in a single plant.

that wages tend to be higher in industries where union concentration is high and where bargaining is centralized.[16] Davidson(1988) also shows that an industry-wide union is able to win higher wages than union organized independently at the level of firm when the product market is oligopolistic. These finding are consistent with the result in the present essay. However, they do not consider the strategic interactions between product market and labor market. By considering these interactions, this paper suggests that an industry-wide union may result in a welfare loss even if it ensures higher wage to workers.

The finding that a centralized bargaining may cause welfare loss even if it ensures higher wages provides some rationale for the recent trend toward decentralization of formal and informal bargaining structure in major U.S. industries and resulting wage concessions. A good example is the U.S. steel industry. Until 1986, the United Steel Workers (USW) had normally negotiated collectively with the five largest steel makers, and the other small steel makers followed the agreement between the USW and the big five.[17] We can infer that this situation is similar to the bargaining between an industry-wide union and a cartel discussed at subssection III.1. In 1986 the steel makers refused to negotiate collectively. Instead, they proposed separate wage negotiations in individual firms. This decentralized bargaining may corresponds to the firm level bargaining discussed at subsection III. 4. The change of bargaining structure resulted in substantial wage concessions and increased job security. This observation in the steel industry is consistent with the predictions of our model. In an industry experiencing recession and foreign competition, the choice of decentralized bargaining can bring higher payoffs to both parties by lowering wage but raising employment opportunity.

We can think of two issues related with the situation analogous to the Prisoner's Dilemma. With regard to policy issue, the effect of economic policy in the product market such as antitrust regulation must be reevaluated. According to our model, the regulation in the product market only gives incentives for unions to collude and extract revenue. This situation will hurt the possibility of obtaining Pareto efficient outcomes. Here we can find needs for regulation in the labor market.

Aside from the policy issue, a natural subsequent question is how to move from the Pareto inferior dominant strategy equilibrium to the Pareto efficient outcome. An interesting point is that there is no explicit way for both players to coordinate their actions. The Prisoner's Dilemma problem in a two person game has provoked a lot of controversies as to what is a reasonable way to play the game. The answer seems to depend on whether the players areplaying a one shot game or whether the game is to be repeated an infinite number of

17) This is an example of pattern bargainging which is an informal means for spreading the terms and conditions of employment negotiated in one formal bargaining structure to another. Pattern bargaining is an informal substitute for centralized bargaining aimed at taking wages out of competition.

times. In Section 6, by applying the recent results in game theory literature, we can show how to solve the analogous Prisoner's Dilemma in our model.

5. OLIGOPOLY MODELS REVISITED WHEN LABOR MARKET IS UNIONIZED

This section extends the previous analysis in section 3 by considering the other possibilities of firm behavior (Stackelberg and Bertrand game) in the product market. This will make it possible to reconstruct the conjectural variation argument in an oligopoly in which labor is unionized. In addition, we can discuss unions' optimal behavior when firms play the Stackelberg or the Bertrand game[18]

First, consider the Stackelberg case in which firm 1 is a Stackelberg leader and the unions are non−cooperative. Since firm 1 is a Stackelberg leader, it knows firm 2's reaction function and solves

$$(22)\ \underset{L_1}{\text{Max}}\ \Pi_1 = [a - b(L_1 + L_2)]L_1 - w_1L_1$$

subject to $L_2(L_1) = (a - w_2 - bL_1)/2b$.

From the first order condition and the constraint of(22), we get labor demand function for the Stackelberg leader and follower:

$$(23.1)\ L_1(w_1,w_2) = (a - 2w_1 + w_2)/2b,$$

$$(23.2)\ L_2(w_1,w_2) = (a + 2w_1 - 3w_2)/4b.$$

The non−collusive union maximizes its wage bill $w_iL_i(i=1, 2)$ by setting optimal wage rate. This gives us reaction functions of the two unions as follows:

$$(24.1)\ a - 4w_1 + w_2 = 0,$$

$$(24.2)\ a + 2w_1 - 6w_2 = 0.$$

Solving (23.1)−(24.2) simultaneously gives the following bargaining outcomes for the Stackelberg case when unions are non−collusive. Here S and F represent Stackelberg leader and follower respectively.

$$(25.1)\ w_1(N,N;S,F) = 7a/22 \qquad W_2(N,N;S,F) = 3a/11$$

$$(25.2)\ L_1(N,N;S,F) = 7a/22b \qquad L_2(N,N;S,F) = 9a/44b$$

$$(25.3)\ \Pi_1(N,N;S,F) = 49a^2/968b \qquad \Pi_2(N,N;S,F) = 40.5a^2/968b$$

$$(25.4)\ U_1(N,N;S,F) = 49a^2/484b \qquad U_2(N,N;S,F) = 27a^2/484b$$

18) For simplicity the possibility of unions' behavior like this is ignored

(25.5) $p(N,N;S,F) = 21a/44$

These results imply that the union in the firm with information advantage can get a higher wage rate and a higher employment level than the union in the firm with information disadvantage. Thus, information asymmetry in the product market can be a source of wage differential for identical workers.[19]

If unions are collusive, they will set a common wage since workers are all identical. Then, from the Stackelberg game we have

(23.1') $L_1 = (a-w)/2b$,

(23.2') $L_2 = (a-w)/4b$.

The joint union solves

(26) $\underset{w}{\text{Max}}\ w(L_1 + L_2)$ subject to(23.1') and(23.2').

The outcomes of bargaining in which firms play the Stackelberg game and unions are collusive are summarized as follows:

(27.1) $w_1(C,C;S,F) = w_2(C,C;S,F) = a/2$

(27.2) $L_1(C,C;S,F) = a/4b$ $\quad L_2(C,C;S,F) = a/8b$

(27.3) $\Pi_1(C,C;S,F) = a^2/32b$ $\quad \Pi_2(C,C;S,F) = a^2/64b$

(27.4) $U_1(C,C;S,F) = a^2/8b$ $\quad U_2(C,C;S,F) = a^2/16b$

(27.5) $p(C,C;S,F) = 5a/8$.

Proposition 4. If firms play a Stackelberg game in the product market, unions have incentives to collude and form a joint union.

Proof: From(25.4) and (27.4), a collusive strategy gives higher payoffs to both unions.

This result is consistent with our previous argument that it is a dominant strategy for unions to play collusively regardless of firms' strategies in the product market. If two firms play a Bertrand game, the output price is equal to the marginal cost, which is the wage rate in this case. At equilibiium, the wage rate for two unions must be equal; otherwise, the firm with higher wage rate will be

19) There have been different explanations on this issue since Adam Smith. Traditional explanation originated by Smith says that wage differentials are required to equalize or compensate the total monetary and nonmonetary advantages and disadvantages among work activities and among worker themselves. Even if its clarity of exposition, this theory can not explain why there is permanent wage differentials among firms or industries for seemingly identical workers. Efficiency wage hypothesis is a plausible explanation for this problem.

kicked out from the market. Moreover, there will be wage competitions between two unions. At equilibrium, the wage offer will be zero, which is the wage level in the competitive market, Here we can find the possibility of cooperation between a firm and its union to drive out the other firm.

The following is the bargaining outcomes for the case in which firms play a Bertrand game and unions are non−collusive, where B denotes Bertrand competition.

(28.1) $w_1(N,N;B,B) = w_2(N,N;B,B) = 0$

(28.2) $L_1(N,N;B,B) = L_2(N,N;B,B) = a/2b$

(28.3) $\Pi_1(N,N;B,B) = \Pi_2(N,N;B,B) = 0$

(28.4) $U_1(N,N;B,B) = U_2(N,N;B,B) = 0$

(28.5) $p(N,N;B,B) = 0$

It is not surprising that we have the bargaining outcomes which are equal to the competitive market equilibrium.

Finally, if unions are collusive, they will maximize their total wage bill by offering a single wage rate. This case is similar to the case in which an industry union bargains with all firms in a competitive market. The industry union solves the following problem:

(29) $\underset{w}{\text{Max}}\ wL$ subject to $L = (w-a)/b$

The results of bargaining in this case are

(30.1) $w_1(C,C;B,B) = w_2(C,C;B,B) = a/2$,

(30.2) $L_1(C,C;B,B) = L_2(C,C;B,B) = a/4b$,

(30.3) $\Pi_1(C,C;B,B) = \Pi_2(C,C;B,B) = 0$

(30.4) $U_1(C,C;B,B) = U_2(C,C;B,B) = a^2/8b$,

(30.5) $p(C,C;B,B) = a/2$.

By comparing(28.4) and (30.4), we can find that both unions have incentives to collude and form a joint union even when firms play a Bertrand game, In addition, our discussions in section 3 and in this section enables us to reformulate oligopoly models when the labor market is unionized. An interesting result is that regardless of firms' strategy, the wage level is higest when both unions choose to play collusively. As argued previously, this implies the fact that more centralized bargaining yields higher wages than more decentralized bar-

gaining does.

6. REPEATED BARGAINING IN LONG TERM RELATIONSHIP

When the bargaining units are engaged in repeated interactions the Pareto efficient result may be sustained in equilibrium by threats of reverting to a situation which is worse for both parties. As we see in proposition 3, there always exist incentives for both parties to deviate from non-collusive strategies which bring Pareto efficient outcomes, but if the future consequences of this deviation are bad enough and if the future is important enough, a deviation may be deterred. In this section, we formalize this idea by extending the previous model to a dynamic setting.

We assume, for simplicity, that there is no uncertainty in the demand for output; then, the inverse demand function in period t is

(3') $p_t = a_t - b_t(Q_{1t} + Q_{2t})$.

The production function of firm i (i=1,2) in period t is

(4') $Q_{it} = L_{it}$.

The decision variable for a firm is the level of employment which determines the level of output according to its choice of strategy to the other firm. The objective function of firm i is to maximize the discounted value of the infinite stream of profits

$$\sum_{t=0}^{\infty} \beta^t \Pi(w_{it}, L_{it}),$$

where β denotes a common discount factor for firms, w_{it} denotes the wage rate set its union, and

(5') $\Pi(w_{it}, L_{it}) = p_t Q_{it} - w_{it} L_{it}$.

Unions have the wage rates as their decision variable. The objective ofunion i is to maximize a concave utility function given as

$$\sum_{t=0}^{\infty} \beta_{it}^t U_{it} = \sum_{t=0}^{\infty} \beta_{it}^t w_{it} L_{it},$$

where β_{it} is a common discount factor for unions, To simplify the problem, we restrict ourselves to stationary paths, i.e., $[w_{it}, L_{it}] = [w_i, L_i]$ for all t. By this restriction, we will have the same bargaining outcomes as a one-shot game under the given strategic choices at the first stage for all. t.

It is important to notice that repetition alone is not enough to eliminate the

Pareto inferior static equilibrium since the one shot dominant strategy (also Nash) equilibrium is also a possible outcome of the repeated game. One could, however, argue that it is more reasonable to choose a Pareto efficient outcome among the possible equilibria. Unions and firms, therefore, can create an implicit mechanism that deters deviations from a Pareto efficient outcome and reach a bargaining structure and resulting wage employment combination which is Pareto superior to the one shot dominant strategy equilibrium. A possible mechanism to deter deviation is to use punishments against the parties who deviate from the agreement. This mechanism is possible even if the game in this essay is a kind of four person game. Only when two unions or two firms deviate simultaneously, will there be punishment from their bargaining counterparts. If only one firm or one union tries to deviate, Pareto efficient outcome is maintained and there is no need for punishment.[20] In addition, the punishment be severe enough to outweigh the gain from cheating in order to maintain an efficient outcome which is not sustainable in the one−shot game. We must, therefore, rule out threats which are not credible since each player acts in its own interest in all circumstances. This excludes punishments that are not credible and restrict us to subgame−perfect equilibria. According to Abreu(1986), we can use a simple punishment scheme. It is to revert to the one −shot dominant stragegy equilibrium forever whenever one party, both unions or both firms, deviates from the strategy which brings Pareto dfficient outcome.[21]

Now we apply the above arguments to our model and get the following result.

Proposition 5. The stationary strategy path(N,N;N,N) is sustainable in a subgame perfect equilibrium if it satisfies the following conditions.

(22) $U(N,N;N,N)-U(C,C;C,C) \geq 0$

(23) $\Pi(N,N;N,N)-\Pi(C,C;C,C) \geq 0$

(24) $U(C,C;N,N)-U(N,N;N,N) \leq \{U(N,N;N,N)-U(C,C;C,C)\}\beta_u/(1-\beta_u)$

(25) $\Pi(N,N;C,C)-\Pi(N,N;N,N) \leq \{\Pi(N,N;N,N)-\Pi(C,C;C,C)\}\beta_u/(1-\beta)$

Proof: Inequality(22) and(23) imply that a sustainable outcome gives higher payoffs to both union and firms than the one−shot dominant strategy equilibrium does. The left hand side of (24) implies the one period gain for a union from deviation, and the right hand side is the present valus of the loss by

20) If both bargaining parties deviate simultaneously, the result will be the dominant strategy equilibrium in the one− shot game. In this case, there is no need for punishment.

21) The punishment scheme needs not to be an optimal one. There are many other punishment schemes which decrease deviator's payoffs and therefore sustain efficient outcome. The punishment scheme adopted here is not renegotiation−proof. But we can construct a more sophisticated punishment scheme which is renegotiation−proof and also supports the efficient outcome.

reverting to the one-shot dominant strategy equilibrium forever after the deviation. Inequality(25) implies that the same situation holds for a firm. Thus if inequalities (24) and(25) hold, both parties have no incentive to deviate. Q.E.D

Notice that unions and firms have no incentive to deviate from any path that yields higher payoffs than those from choosing the one-shot dominant strategy equilibrium (C,C; C,C). It is not surprising that the Folk Theorem applies in this case. That is, if β and β_u approach 1 every path that yields higher utility and profit than the one-shot equilibrium can be sustained in a subgame perfect equilibrium of the repeated game.

If firms and unions have the same discount factor, i.e.$\beta=\beta_u$, we can derive the following proposition:

Proposition 6. For all $\beta\in[34/81,1]$, the fully efficent solution (N,N; N,N) is sustainable in a subgame perfect equilbrium of the repeated game. For all $\beta\in$ [8/45, 34/81), firms have incentives to deviate, and for $\beta\in[0, 8/45)$ both parties have incentives to deviate; so only the one-shot dominant strategy equilibrium,(C,C; C,C), is sustainable in these cases.

Proof: Use proposition 5.

As we see in proposition 6, if high interest rates prevail in an economy the bargaining structure of the economy tends to be centralized. Conversely, if low interest rates are prevalent it is more likely for the economy to have decentralized bargaining structures.[22] We need high enough discount factor(low enough interest rate) to ensure the Pareto efficient outcome. Finally, in our model firms are more likely to deviate and to form a cartel than unions do.

7. CONCLUSIONS AND REMARKS

This essay investigates the effect of interactions between product and labor market behavior on the collective bargaining outcomes. Under the simple game structure, we show that collusions-for firms to form a cartel and for unions to form a joint industry union-are dominant strategies for both players. However, this dominant strategy (also Nash) equilibrium in the one-shot game is not Pareto efficient. Interestingly enough, we have a situation analogous to Prisoner's Dilemma in the firm union bargaining game. For both players, it is profitable to

22) The dominance of decentralized bargaining in Japan can be justified, at least to some extent, by low real interest rate. According to Keizai Yoram(The Statistical abstract of Japanese Economy) by the Economic Planning Agency, the average nominal interest rate for one year deposits and the average growth rate of consumer price index are 5.8% and 5.4% respectively from 1952 to 1986, so the average real rate of interest is equal to 0.4%.

play non−collusively (firms play Cournot Nash strategies in the product market and unions form separate unions), but this result is not obtainable in the one−shot game. Since union and firm are engaged in repeated interactions, we can extend the game to the repeated one and show that it is possible to arrive at the Pareto efficient outcome under certain conditions.

It is worthwhile to note that our analysis can provide some rationale for recent decentralization of bargaining structures in major U.S. industries. According to this essay, decentralization and resulting wage concessions are natural tendencies toward efficient outcomes when an industry is confronted with recession and increased foreign competition. The implication of our analysis for economic policies is that the regulation in the product market such as antitrust act may not be effective if the policy is not accompanied by the regulation in the labor market.

The present essay also enables us to reformulate the oligopoly model when labor market is unionized. An interesting result is that wage rate is highest when unions choose the collusive strategy and form a joint union, regardless of firm's strategy. When unions form separate unions and firms play a Stackelberg game, there exists wage differential caused by the information asymmetry in the product market.

This essay is a start of research of union bargaining under oligopolistic structure. It is worth while to extend this model and to consider generalized product demand and technology. Another fruitful extension will be possible if we consider the heterogeneity of workers or the heterogeneity of technology between firms. These extensions will make it possible to understand the actual bargaining structure which is much more complicated than the results of this essay.

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