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Managerial Delegation and Conflicting Interest in Unionized Duopoly with Firm Heterogeneity

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Abstract: This paper utilized a three-stage dynamic game to analyze the conflicts of interest between stakeholders caused by firm heterogeneity. We show that the higher the degree of heterogeneity, the higher the sales delegation incentive given. The firm's heterogeneity scale will cause industry profit, union utility, consumer surplus and manager bonus conflicts of interest. Furthermore, the intensity of conflict is lower between the industry and the union than between the industry and consumer and between the industry and manager if the degree of heterogeneity is relatively small.

Keywords: unionized oligopoly; firm heterogeneity; managerial delegation; stakeholders

MSC: 91A10; 91A25; 91B38; 91B54

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1. Introduction

Petroleum is a highly homogeneous product, and quantity competition is a common strategy. Meanwhile, increasing market share by establishing management contracts is widely adopted in the industry. Notably, in North America, the United Steelworkers Union (USW) negotiates with companies on behalf of workers in various industries. After two rounds of negotiations in January and February 2022, USW had considerable bargaining power after a series of protests outside refineries across the United States, prompting oil companies to raise wages for union members. Wage negotiations led by labor unions may lead to adjustments in the market competition strategy of firms.

Le Pape and Wang [1,2] proposed a formal definition of conflicting/conciliating relationships and a measurement of the intensity of the conflicts between stakeholders (shareholders, consumers and employees). They investigated the relationship between the main stakeholders with/without the weight put on consumer surplus in its altered objective function and when the wage-bargaining power of the firm facing the intervention of labor union altered, and also compared the extent of the conflict between Cournot competition and Bertrand competition. However, their analysis was based on a homogeneous firm framework and ignored labor heterogeneity.

The well-known result is that wages can be set centrally by an industry-wide union or by decentralization by a firm-level union [3]. The centralization argument argues that workers are generally better off if workers are identical and substitutable [4,5]. Strand [6] also showed that when productivity differences between workers are small, a centralized union-firm wage-bargaining solution is more stable than a possible individual bargaining solution. Accordingly, with identical workers, the industry-wide union setting is usually

adopted in a unionized oligopoly (see, e.g., [6–11]). Bastos et al. [11] introduced firm heterogeneity in a unionized oligopoly, showing that the degree of firm heterogeneity will systematically affect the average wage buffer and the wage floor in the industry. They claim that with identical labor skills, managerial differences lead to firm heterogeneity, which varies productivity. In practice, managerial style affects workers' efficiency and firm productivity. However, they set the heterogeneity parameter as constant, and the link between firm heterogeneity and managerial efforts is missing. In a unionized industry, Buccella and Fanti [12] investigated the bargaining agenda selection with decentralized bargains (right to manage (RTM) and efficient bargaining (EB)) for different market competition structures.

By what method and how might the unions affect the managerial delegation of the owners? In this paper, we endogenize firm heterogeneity with the managerial delegation mechanism. Consequently, we take into account Vickers [13], Fershtman and Judd [14] and Sklivas [15], hereafter referred to as VFJS, for managerial delegation in a unionized duopoly. VFJS argued that the owners must put some weight specifically attached to dimensional variables in the managerial contracts, such as sales revenue, as this will enhance the firm's profit even though the behavior of managers deviates from purely profit-maximizing objectives in the equilibrium. They showed that a firm's output decision is delegated to the manager, and the equilibrium results in higher output and lower profits than those obtained in the Cournot–Nash equilibrium, the so-called "Prisoner's Dilemma". (In addition to the sales delegation case, the literature considers different managers' objective functions. Jansen et al. [16] and Ritz [17] analyzed the case of market share delegation, while Miller and Pazgal [18] adopted the relative-performance delegation case. For an extended discussion of the delegation game, see, e.g., [19–21]). Although there has been a proliferation of studies on managerial delegation, no literature considered the firm heterogeneity led by managerial delegation. A further question is whether a conflict of interest exists between the main stakeholders in a unionized duopoly.

This paper has three main contributions. First, the most related paper is by Bastos et al. [11] who find a negative relationship between firm heterogeneity and wages. However, we find that if the union decides on the wage first and the owner then chooses his managerial incentive scheme with the firm heterogeneity, the relationship between firm heterogeneity and wage is positive instead of negative. Second, more importantly, we show that the higher the degree of heterogeneity, the higher the sales delegation incentive given. Third, the firm's heterogeneity scale will cause industry profit, union utility, consumer surplus and manager bonus conflicts of interest. Furthermore, the intensity of conflict is lower between the industry and union than between the industry and consumer and between the industry and manager, if the degree of heterogeneity is relatively small.

The remainder of this article is organized as follows. The basic model is presented in Section 2. In Section 3, subgame perfect equilibriums are computed by backward induction and the outcomes are analyzed. Section 4 analyzes the conflicts of interest between the stakeholders in a unionized duopoly. The final section presents the concluding remarks.

2. Basic Model

In a Cournot duopoly, two firms produce homogeneous goods and face a linear inverse demand function, $P = a - Q$, where P is the market price, a is the market scale, and Q is the quantity of demand in the market. The supply function in the market is given by $Q = \sum q_i$, and q_i denotes the firm i's output, $i = 1, 2$. Labor, l_i $(i = 1, 2)$, is the only factor of each firm to produce goods in a technology with constant returns to scale. Assuming a firm requires $\frac{1}{\phi(1+\varphi_i)}$ units of labor to produce one unit of product, we have the following production functions (The literature does not consider different labor productivity as a firm's heterogeneity and sets a unit of labor to produce a unit of product, i.e., $q = l$; see, e.g., [7,8,22–26]. Haucap and Wey [3] assumed a firm requires α units of labor to produce

one unit of product, i.e., $l = \alpha q$. Bastos et al. [11] introduced a heterogeneous firm's production function as $q_i = \phi(1 \pm s)l_i$, $i = 1, 2$, in which s is fixed and arbitrary),

$$q_i = \phi(1 + \varphi_i)l_i, \ i = 1, \ 2. \tag{1}$$

Here, heterogeneity among firms is introduced, the workers are ex ante identical, but the labor productivity is different due to managerial differences among firms. In other words, heterogeneity among firms is reflected by differences in managerial delegation and labor productivity. The average productivity is given by ϕ in the intra-industry, and $\varphi_i \in [0, \overline{\varphi}]$ measures the degree of firm heterogeneity that represents the productivity spread among the firms.

The wages paid to its workers by a firm reflect the firm-level rent sharing as the crucial assumption. The profit of a firm is given as $\pi_i = R_i - wl_i = Pq_i - wl_i$, $i = 1, \ 2$. As in the USW, we consider that an industry-wide union in this intra-industry unilaterally sets wages to maximize its Stone–Geary-type utility function, $U = (w - w)^{\alpha}(l_1 + l_2)^{\beta}$, where $\overline{w}$ is reservation wage level and assumed to be zero for simplicity. Due to a neutral union, we set $\alpha = \beta = 1$ for simplicity without the loss of generalization.

Regarding the sales delegation, a linear incentive scheme with "take it or leave it" is offered to their managers by the owners. Each firm has only one manager, manager i. Let the real reward for manager i be of the form $A_i + B_i M_i$ for constants A_i and B_i. We assume $B_i > 0$, and M_i is a linear combination of firm profits and sales [13–17]. A_i is selected by the owner and normalized to zero, assuming that the manager only gets his reserving utility. Following [14], the risk attitude of the managers is neutral. We maximize the objective function as $M_i = \lambda_i \pi_i + (1 - \lambda_i)R_i$, where π_i and R_i are the firm i's profits and sales revenue, respectively. $\lambda_i \in [0, 1]$ denotes the profit–incentive weight for the manager, which the owner of the firm i chooses. Assuming $q_i = \phi(1 - (\lambda_i - 1)\overline{\varphi})l_i$; in particular, if $\lambda_i = 1$, no incentive delegation is offered, and thus the manager does nothing for labor productivity. Hence, the production function is $q_i = \phi l_i$. However, if $\lambda_i = 0$, the production function is $q_i = \phi(1 + \overline{\varphi})l_i$, and delegation results in higher productivity. We assume that firms commit the incentive schemes, and the delegation contract is observable.

A three-stage sequential game is established to solve the problem of wage setting, delegation and market competition, as Figure 1 shows. In the first (wage) stage, the union sets the wage. Subsequently, the owner decides on the manager's incentive contract to maximize profit in the second (delegation) stage. Notice that the delegation causes the firm's heterogeneity while the firms produce. In the third (output) stage, conditional on the wage and delegation, the manager chooses output to maximize his objective. The concept of subgame perfect Nash equilibrium (SPNE) is used with backward induction.

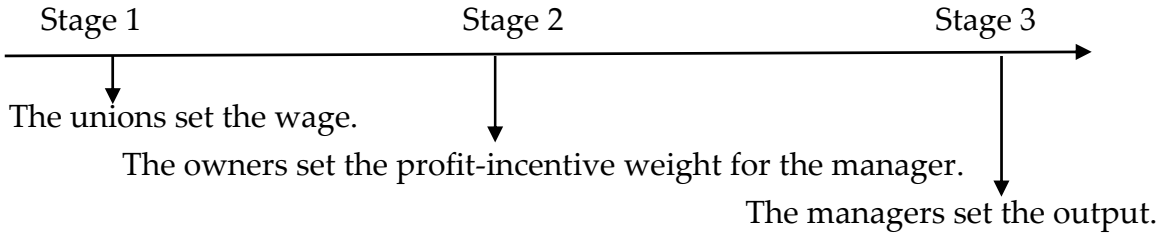

Figure 1. Decision order of the game.

3. Equilibrium Outcomes

In the third stage, the manager chooses output and decides how many workers to hire for maximizing the objective function. The labor-demand function in terms of λ_i and w is given by

$$l_i = \frac{a\phi\left(1 + \left(1 - \lambda_j\right)\overline{\varphi}\right)\left(1 + (1 - \lambda_i)\overline{\varphi}\right) + \left(\lambda_j - 2\lambda_i\right)w(1 + \overline{\varphi}) + w\lambda_j\lambda_i\overline{\varphi}}{3\phi^2\left(1 + \left(1 - \lambda_j\right)\overline{\varphi}\right)\left(1 + (1 - \lambda_i)\overline{\varphi}\right)^2}; i, j = 1, 2, i \neq j. \tag{2}$$

To simplify the model, and without the loss of generality, hereafter we assume $\phi = 1$. We then have

$$l_i = \frac{a\left(1+\left(1-\lambda_j\right)\overline{\varphi}\right)\left(1+(1-\lambda_i)\overline{\varphi}\right)+\left(\lambda_j-2\lambda_i\right)w(1+\overline{\varphi})+w\lambda_j\lambda_i\overline{\varphi}}{3\left(1+\left(1-\lambda_j\right)\overline{\varphi}\right)\left(1+(1-\lambda_i)\overline{\varphi}\right)^2} \tag{3}$$

The intuition behind the comparative-static result is straightforward, $\frac{\partial l_i}{\partial \lambda_i} = \frac{a\overline{\varphi}(1+(1-\lambda_i)\overline{\varphi})\left(1+\left(1-\lambda_j\right)\overline{\varphi}\right)+w\left(-2-2\overline{\varphi}(2+\lambda_i+\overline{\varphi}+\lambda_i\overline{\varphi})+\lambda_j\overline{\varphi}(3+(3+\lambda_i)\overline{\varphi})\right)}{3(1+(1-\lambda_i)\overline{\varphi})^3\left(1+\left(1-\lambda_j 1\right)\overline{\varphi}\right)} > 0$. When sales delegation is weak, that is, the firm's owner does not want the manager to enlarge sales revenue except for maximum profit, the manager does not change his managerial efforts to raise labor unit productivity. Instead, the manager hires more workers to compensate for the disadvantage in productivity to maximize M, which is the firm's profit when a no-sales delegation contract is offered. On the other hand, if the rival firm j's owner does not consider sales delegation, firm i's manager hires more workers, $\frac{\partial l_i}{\partial \lambda_j} = \frac{w(1+\overline{\varphi})}{3\left(1+\left(1-\lambda_j\right)\overline{\varphi}\right)^2(1+(1-\lambda_i)\overline{\varphi})} > 0$. Further analytical inspection reveals that $\frac{\partial^2 l_i}{\partial \lambda_i \partial \lambda_j} = \frac{w\overline{\varphi}(1+\overline{\varphi})}{3\left(1+\overline{\varphi}-\lambda_j\overline{\varphi}\right)^2(1+\overline{\varphi}-\lambda_i\overline{\varphi})^2} > 0$; accordingly, the labor demand is the highest when both owners do not adopt sales delegation, but the total output is the lowest. The intuition behind this result is straightforward. The lowest labor productivity produces the lowest output, even though the number of workers is abundant.

Table 1 shows that the delegated manager will produce more but demand less work due to firm heterogeneity. An increase in total output pushes up the wage payment, and the output-substitution effect reflects the profit-shifting effects between firms in a unionized Cournot duopoly.

Table 1. The strategic delegation, labor demand, and output.

λ_2 \ λ_1	**0 (Delegation)**	**1 (No Delegation)**
0 (delegation)	$l_1 = l_2 = \frac{a}{3+3\overline{\varphi}}$; $q_1 = q_2 = \frac{a}{3}, Q = \frac{2a}{3}$	$l_1 = \frac{a-2w}{3}, l_2 = \frac{a+w}{3+3\overline{\varphi}}$; $q_1 = \frac{a-2w}{3}, q_2 = \frac{a+w}{3}, Q = \frac{2a-w}{3}$
1 (no delegation)	$l_1 = \frac{a+w}{3+3\overline{\varphi}}, l_2 = \frac{a-2w}{3}$; $q_1 = \frac{a+w}{2}, q_2 = \frac{a-2w}{3}, Q = \frac{2a-w}{3}$	$l_1 = l_2 = \frac{a-w}{3}$; $q_1 = q_2 = \frac{a-w}{3}, Q = \frac{2(a-w)}{3}$

We obtain the following Lemma 1.

Lemma 1. *The labor demand is the highest when no sales delegation is adopted by either firm, but the total output is the lowest. On the other hand, the labor demand is the lowest when both firms adopt sales delegation, and the total output is the highest.*

Proof.

(i) $Q(\lambda_1 = 0, \lambda_2 = 0) - Q(\lambda_1 = 0, \lambda_2 = 1) = Q(\lambda_1 = 0, \lambda_2 = 0) - Q(\lambda_1 = 1, \lambda_2 = 0) = \frac{2a}{3} - \frac{2a-w}{3} = \frac{w}{3} > 0$;

(ii) $Q(\lambda_1 = 1, \lambda_2 = 1) - Q(\lambda_1 = 0, \lambda_2 = 1) = Q(\lambda_1 = 1, \lambda_2 = 1) - Q(\lambda_1 = 1, \lambda_2 = 0) = \frac{2(a-w)}{3} - \frac{2a-w}{3} = \frac{-w}{3} < 0$

From (i) and (ii), we have

$$Q(\lambda_1 = 0, \lambda_2 = 0) > Q(\lambda_1 = 0, \lambda_2 = 1) = Q(\lambda_1 = 1, \lambda_2 = 0) > (\lambda_1 = 1, \lambda_2 = 1). \ \square$$

In the second stage, the owner decides on incentive contracts for his manager to maximize his own profit. The profit–incentive weight is derived as,

$$\lambda_i = \frac{(1+\overline{\varphi})(a-6w+4a\overline{\varphi})}{a\overline{\varphi}(1+4\overline{\varphi})-w(5+2\overline{\varphi})}; i = 1, 2. \tag{4}$$

We have the following Lemma 2.

Lemma 2. *The higher the wage the owner pays, the lower the sales delegation incentive given.*

Proof. $\frac{\partial \lambda_i}{\partial w} = \frac{a\left(5+21\overline{\varphi}-16\overline{\varphi}^3\right)}{\left(a\overline{\varphi}(1+4\overline{\varphi})-w(5+2\overline{\varphi})\right)^2} > 0$. □

In terms of wages set by an industry-wide union, the profit–incentive weight is increasing in w and decreasing in $\overline{\varphi}$, i.e., $\frac{\partial \lambda_i}{\partial w} > 0$, which implies that the higher the wage the owner needs to pay, the lower the incentive provided by the owner. The reasoning is that high wages increase the firm's marginal cost when the union has full bargaining power. The owner hence has less incentive (higher λ_i) to reward the manager.

In the first stage, the union maximizes its utility by setting the following optimal wage

$$w^* = \frac{a\left(5+3\overline{\varphi}+4\overline{\varphi}^2\right)}{2(5+2\overline{\varphi})} \tag{5}$$

We have the following Lemma 3.

Lemma 3. *The higher the degree of heterogeneity given, the higher the wage the owner pays.*

Proof. $\frac{dw^*}{d\overline{\varphi}} = \frac{5a+40a\overline{\varphi}+8a\overline{\varphi}^2}{2(5+2\overline{\varphi})^2} > 0$. □

Lemma 3 points out that the higher the degree of firm heterogeneity, the higher the productivity spread among the firms, leading to a higher wage paid by the owner. It means that the higher productivity spread causes a higher derived demand for labor, thus the owner has to pay a higher wage. Bastos et al. [11] examined the relationship between wage difference and firm heterogeneity, and this is found to be negative because the effect of heterogeneity on the wage floor in the industry dominates the effect on the wage buffer. Of note, in their model, the firm heterogeneity is exogenously given. The industry-wide union thus sets the wage to maximize its utility. However, if the union decides on the wage first and the owner then chooses his managerial incentive scheme implying the level of heterogeneity, the relationship between firm heterogeneity and wage is positive instead of negative.

Proposition 1. *The higher the degree of heterogeneity given, the higher the sales delegation incentive given.*

Proof. $\frac{\partial \lambda_i}{\partial \overline{\varphi}} = -\frac{(a-w)\left(18w+a(1+4\overline{\varphi})^2\right)}{\left(w(5+2\overline{\varphi})-a\overline{\varphi}(1+4\overline{\varphi})\right)^2} < 0$ and $\frac{d\lambda_i}{d\overline{\varphi}} = \frac{\partial \lambda_i}{\partial \overline{\varphi}} + \frac{\partial \lambda_i}{\partial w}\frac{dw}{d\overline{\varphi}} = -\frac{18}{(5+2\varphi)^2} < 0$. □

Proposition 1 shows the direct effect of the degree of firm heterogeneity, $\frac{\partial \lambda_i}{\partial \overline{\varphi}} < 0$, which implies that there is a positive effect on the incentive $(1-\lambda_i)$ provided by the owner. The reasoning is that a higher degree of firm heterogeneity leads to higher productivity spread; the owner hence has more incentive to reward the manager and gets a larger market share. However, we have $\frac{\partial \lambda_i}{\partial w}\frac{dw}{d\overline{\varphi}} > 0$, which implies a negative indirect effect that increases the wage and leads to a lower incentive (larger λ_i) provided by the owner. The total effect of the degree of firm heterogeneity on the incentive provided by the owner is positive, which implies that the higher the degree of firm heterogeneity, the higher the incentive (lower λ_i) provided by the owner.

Conditional on an optimal wage set by an intra-industry union, the optimal profit–incentive weight and labor demand are, $\lambda_1 = \lambda_2 = \frac{4-2\overline{\varphi}}{5+2\overline{\varphi}}$ and $l_1 = l_2 = \frac{a(1+\overline{\varphi})}{5+\overline{\varphi}(3+4\overline{\varphi})}$, respectively.

Furthermore, we have the firm's profit and industry profit as follows:

$$\pi_1 = \pi_2 = \frac{a^2(1+\overline{\varphi})(1-2\overline{\varphi})}{2(5+2\overline{\varphi})^2},\ V = \frac{a^2(1+\overline{\varphi})(1-2\overline{\varphi})}{(5+2\overline{\varphi})^2} \tag{6}$$

where V refers to the industry profit. Notably, $\overline{\varphi} \in \left(0, \frac{1}{2}\right)$ ensures the non-negativity of the firm's profit.

4. Conflicting Interest in Unionized Duopoly

In this section, we analyze the conflicts of interest between the major stakeholders in a unionized duopoly.

The manager's compensation, union utility and consumer surplus are

$$M_i = \frac{a^2(1+\overline{\varphi})^2}{(5+2\overline{\varphi})^2},\ U = \frac{a^2(1+\overline{\varphi})}{5+2\overline{\varphi}},\ CS = \frac{2a^2(1+\overline{\varphi})^2}{(5+2\overline{\varphi})^2} \tag{7}$$

We take comparative static analysis and have

$$\frac{\partial V}{\partial \overline{\varphi}} = -\frac{9a^2(1+2\overline{\varphi})}{(5+2\overline{\varphi})^3} < 0, \tag{8a}$$

$$\frac{\partial M_i}{\partial \overline{\varphi}} = \frac{6a^2(1+\overline{\varphi})}{(5+2\overline{\varphi})^3} > 0, \tag{8b}$$

$$\frac{\partial U}{\partial \overline{\varphi}} = \frac{3a^2}{(5+2\overline{\varphi})^2} > 0, \tag{8c}$$

$$\frac{\partial CS}{\partial \overline{\varphi}} = \frac{12a^2(1+\overline{\varphi})}{(5+2\overline{\varphi})^3} > 0. \tag{8d}$$

It indicates that the firm heterogeneity scale will affect the manager's compensation, industry profit, union utility and consumer surplus. According to Lemma 1, when both firms adopt sales delegation, the total output is the highest because the manager will behave aggressively. Moreover, the "Prisoner's Dilemma" occurs in Cournot competition: the owner's profit decreases, while the manager's compensation, union utility and consumer surplus increase. Hence, a change in the firm heterogeneity scale will create conflicts of interest between the whole industry and other stakeholders.

As [2] define the measure of conflicts of interest, they said that the relationship between stakeholder and stakeholder is in conflict if an increase in $\overline{\varphi}$ favors $s1$ but at the same time damages $s2$, i.e., $\eta_{s1/s2,\,\overline{\varphi}} = \frac{\partial(s1/s2)}{\partial \overline{\varphi}} \frac{\overline{\varphi}}{(s1/s2)} < 0$. The greater the absolute value, the more intensive the conflict between stakeholders $s1$ and $s2$. We find that the conflicts of interest between the stakeholders are

$$\eta_{V/U,\,\overline{\varphi}} = \frac{\partial(V/U)}{\partial \overline{\varphi}} \frac{\overline{\varphi}}{(V/U)} = \frac{12\overline{\varphi}}{4\overline{\varphi}(2+\overline{\varphi})-5} < 0, \tag{9a}$$

$$\eta_{V/CS,\,\overline{\varphi}} = \frac{\partial(V/CS)}{\partial \overline{\varphi}} \frac{\overline{\varphi}}{(V/CS)} = \frac{3\overline{\varphi}}{2\overline{\varphi}^2+\overline{\varphi}-1} < 0, \tag{9b}$$

$$\eta_{V/M_i,\,\overline{\varphi}} = \frac{\partial(V/M_i)}{\partial \overline{\varphi}} \frac{\overline{\varphi}}{(V/M_i)} = \frac{3\overline{\varphi}}{2\overline{\varphi}^2+\overline{\varphi}-1} < 0. \tag{9c}$$

where η stands for the extent of conflicts.

Comparing the extent of conflicts as mentioned above, we have the following Proposition 2.

Proposition 2. *The firm's heterogeneity scale will cause conflicts of interest among the industry profit, union utility, consumers surplus and manager bonus; moreover, the intensity of conflict is lower between the industry and union than it is between the industry and consumer and between the industry and manager if the degree of heterogeneity is relatively small.*

Proof. Due to $\overline{\varphi} \in \left(0, \frac{1}{2}\right)$, we have $4\overline{\varphi}(2+\overline{\varphi}) - 5 < 0$ and $2\overline{\varphi}^2 + \overline{\varphi} - 1 < 0$.

Thus $\left|\eta_{V/U,\,\overline{\varphi}}\right| = \frac{-12\overline{\varphi}}{4\overline{\varphi}(2+\overline{\varphi})-5}$, and $\left|\eta_{V/CS,\,\overline{\varphi}}\right| = \left|\eta_{V/M_i,\,\overline{\varphi}}\right| = \frac{-3\overline{\varphi}}{2\overline{\varphi}^2+\overline{\varphi}-1}$.

$\left|\eta_{V/U,\,\overline{\varphi}}\right| - \left|\eta_{V/CS,\,\overline{\varphi}}\right| = \left|\eta_{V/U,\,\overline{\varphi}}\right| - \left|\eta_{V/M_i,\,\overline{\varphi}}\right| = -\frac{3\left(\varphi-8\varphi^2+8\varphi^3\right)}{(-1+3\varphi^2)(-5+8\varphi+4\varphi^2)} < 0$, if $\overline{\varphi} < \frac{1}{4}\left(2-\sqrt{2}\right)$.

$\left|\eta_{V/U,\,\overline{\varphi}}\right| < \left|\eta_{V/CS,\,\overline{\varphi}}\right| = \left|\eta_{V/M_i,\,\overline{\varphi}}\right|$, if $\overline{\varphi} < \frac{1}{4}\left(2-\sqrt{2}\right)$. □

Proposition 2 reveals that a change in a firm's heterogeneity scale will cause conflicts of interest and that the intensity of conflicts depends on the degree of heterogeneity. When the degree of heterogeneity is relatively small, the intensity of conflict between the industry and union is the smallest, and the intensity of conflict between the industry and consumer and between the industry and manager is the same. Hence, it is argued that the conflicts between the industry and consumer and between the industry and manager stick out, while between industry and union, they ease up. This shows that the degree of heterogeneity would generate a greater welfare transfer between managers and consumers when the degree of heterogeneity is relatively small. The reasoning is that a lower degree of firm heterogeneity leads to lower productivity spread which causes a smaller increase in wages and the intensity of conflict between the industry and the union is the smallest.

5. Concluding Remarks

In a unionized Cournot duopoly, two firms implement different managerial delegation contracts leading to firm heterogeneity. The labor demand is the highest when no sales delegation is adopted by either firm, but the total output is the lowest. On the other hand, the labor demand is the lowest when both firms adopt sales delegation, and the total output is the highest. Bastos et al. [11] showed that the relationship between firm heterogeneity and wage is negative. While firm heterogeneity is incorporated, we show that the higher the degree of heterogeneity given, a positive direct effect leads to a higher incentive to reward the manager; a negative indirect effect increases the wage the owner pays, and a lower incentive is provided by the owner; the total effect of the degree of heterogeneity leads to a higher incentive provided by the owner. Importantly, we point out that there are conflicts of interest among the industry, union, consumers and managers, and the intensity of conflict between the industry and the manager and between the industry and the consumers depends on the degree of heterogeneity. However, the conflict between the industry and the union is moderate, if the degree of heterogeneity is relatively small.

Our analysis is based on the dynamic game of Nash equilibrium with the manager who cooperates. As [27,28] pointed out, the dynamic elements of the Prisoner's Dilemma are observed in sequential game interactions where the expectations and the punishments make each player's decisions. In future research, the case of an agent who does not cooperate could be considered.

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