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TACIT COLLUSION IN A LABOR-MANAGED OLIGOPOLY MARKET

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ABSTRACT: This paper considers a two-stage price-setting oligopoly model with labor-managed income-per-worker-maximizing firms. In the first stage, each firm non-cooperatively decides whether to offer a donative most-favored-nation policy as a strategic instrument. In the second stage, each firm non-cooperatively chooses its actual price. At the end of the second stage, the market opens and each firm sells at its actual price. The paper shows the role of the donative most-favored-nation policy as a practice facilitating coordination in the labor-managed oligopoly model.

KEYWORDS: Donative most-favored-nation pricing, Labor-managed firm

JEL classification: C72, D21, L13

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Introduction

Labor-managed firms have existed in Western economies since the advent of the factory system. The oldest surviving labor-managed firms in the United Kingdom and Italy appeared in the nineteenth century (Bonin et al., 1993). Furthermore, after the Second World War, the right to manage the firm in the former Yugoslavia was, within the limits determined by law, in the hands of its employees (Furubotn and Pejovich, 1970).

The labor-managed firm in all Western European countries grew significantly between the early 1970s and the early 1980s, for example, from 4,370 firms in 1970 to 11,203 in 1982 in Italy and from 522 to 933 firms in France over the same period. Furthermore, in the United Kingdom the number of labor-managed firms rose by almost 1,000% and employment by 133% between 1976 and 1981 (Estrin, 1985). In the United States, the most notable presence of labor-managed firms is in the plywood industry in the Pacific Northwest where they have been in existence since 1921, and during the 1950s, they contributed as much as 25 percent of the industry's total output (Bonin et al., 1993). In China, the market-oriented economic reform has given much greater autonomy to state and collective enterprises' managers to make production, investment and marketing decisions. Meng and Perkins (1998) find that the state and the collective sectors behave like labor-managed firms in their wage determination, while private-sector firms behave more like profit-maximizing firms.

The first theoretical analysis of a labor-managed firm was done by Ward (1958). Since then, many economists have studied the behavior of labor-managed firms.[1] For example, Laffont and Moreaux (1985) examine the welfare properties of free-entry Cournot equilibria in labor-managed economies and show that Cournot equilibria are efficient provided that the market is sufficiently large. Okuguchi (1986) compares the Bertrand and Cournot equilibrium prices for the labor-managed oligopoly under product differentiation and shows that the Cournot equilibrium prices are not lower than the Bertrand ones. Zhang (1993) and Haruna (1996) apply Dixit (1980) and Bulow et al., (1985) frameworks of entry deterrence to labor-managed industries and show that labor-managed incumbents have greater incentive to hold excess capacity to deter entry than corresponding profit-maximizing incumbents. Okuguchi (1993) examines two models of duopoly with product differentiation and with only labor-managed firms, in one of which two firms' strategies are outputs (labor-managed Cournot duopoly) and prices become

[1] See Ireland and Law (1982), Stephan (1982), Bonin and Putterman (1987), and Putterman (2008) for excellent surveys of labor-managed firms.

strategic variables in the other (labor-managed Bertrand duopoly). He shows that reaction functions are upward-sloping under general conditions in both labor-managed Bertrand and Cournot duopolies with product differentiation. Lambertini and Rossini (1998) analyze the behavior of labor-managed firms in a two-stage Cournot duopoly model with capital strategic interaction and show that labor-managed firms choose their capital commitments according to the level of interest rate, unlike what usually happens when only profit-maximizing firms operate in the market. Lambertini (2001) examines a spatial differentiation duopoly model and shows that if both firms are labor-managed, there exists a (symmetric) subgame perfect equilibrium in pure strategies with firms located at the first and third quartiles, if and only if the setup cost is low enough. There are many further studies, such as Hill and Waterson (1983), Neary (1984, 1988), Sertel (1991), Drago and Turnbull (1992), Kamshad (1997), Kihlstrom and Laffont (2002), and Bar-Shira et al., (2006).

We consider a price-setting oligopoly model in which labor-managed firms can offer donative most-favored-nation (MFN) policies.[2] This policy is that a firm agrees to make donations to nations or to charities for social services if it lowers its price in the future.[3] We consider the following situation. In the first stage, each firm non-cooperatively decides whether to offer a MFN policy. In the second stage, each firm non-cooperatively chooses its actual price. At the end of the second stage, the market opens and each firm sells at its actual price. This paper shows the role of the MFN policy as a practice facilitating coordination in the labor-managed oligopoly model.

The Model

Let us consider a price-setting model with n labor-managed income-per-worker-maximizing firms, producing substitute goods. There is no possibility of entry or exit. Firm i 's income per worker is given by

$$\omega^i = \frac{(p^i - m^i)q^i(p^1, p^2, ..., p^n) - f^i}{l^i(q^i(p^1, p^2, ..., p^n))}, (i = 1, 2, ..., n), \tag{1}$$

[2] For details of the MFN policy, see Ohnishi (2010b).

[3] Ohnishi (2010a) examines the equilibrium of two-period competition where labour-managed firms are allowed to offer retroactive most-favoured-customer policies as a strategic instrument. Under the retroactive most-favoured-customer policy, the seller promises to give its first period customers a rebate of the price difference if its second period price is below its first period price. For details of the retroactive most-favoured-customer policy, see for example Cooper (1986) and Neilson and Winter (1992).

where $p^i \in (0,\infty)$ is firm i 's price, $m^i \in (0,\infty)$ is firm i 's constant marginal cost for output, $q^i : \Re^n_{++} \to \Re_{++}$ is firm i 's demand function, $f^i \in (0,\infty)$ is firm i 's fixed cost, and l^i is the amount of labor in firm i .

We assume that there is a unique Bertrand equilibrium and each firm's price, output and income per worker are positive in the equilibrium. In addition, the following assumptions are made.

Assumption 1. q^i is twice continuously differentiable with bounded derivatives, $\partial q^i / \partial p^i \equiv q^i_i < 0$, and $\partial q^i / \partial p^j \equiv q^i_j > 0 \;\; (i, j = 1, 2, ..., n; i \neq j)$.

Assumption 2. $\left|q^i_i\right| > \sum_{j \neq i} \left|q^i_j\right|$.

Assumption 3. $q^i_{ij} = 0$.

Assumption 4. $l_i' > 0$ and $l_i'' \geq 0$.

These assumptions are fairly standard in Bertrand games. Assumption 1 means that demand is downward-sloping and the goods are substitutes. Assumption 2 means that firm i 's own effects of price on demand exceed firm j 's cross effects. Assumptions 1 and 3 mean that q^i is smooth. Assumption 4 states that the marginal quantity of labor used is positive and non-decreasing.

The two stages of the model run as follows. In the first stage, each firm simultaneously and independently decides whether to offer a MFN policy. If firm i offers the policy, then it chooses a price $\overline{p}^i \in [0,\infty)$ and a number $z^i \in [0,\infty)$, and advertises that if it sells goods to its customers at a lower price p^i than $\overline{p}^i$, then it will donate the amount of z^i times the difference $(\overline{p}^i - p^i)$ to nations or to charities for social services. In the second stage, each firm i simultaneously and independently chooses its actual price p^i . At the end of the second stage, the market opens and each firm i sells at its actual price p^i . If $p^i < \overline{p}^i$, then firm i denotes the amount $(\overline{p}^i - p^i)z^i$ to nations or to charities for social services.

Therefore, firm i 's income per worker changes as follows:

$$\hat{\omega}^i(\overline{p}^i, z^i, p^1, p^2, ..., p^n) = \begin{cases} \omega^i(p^1, p^2, ..., p^n) & \text{if } p^i \geq \overline{p}^i, \\ \omega^i(p^1, p^2, ..., p^n) - (\overline{p}^i - p^i)z^i & \text{if } p^i \leq \overline{p}^i. \end{cases} \quad (2)$$

On the other hand, unless firm i offers an MFN policy, its income per worker is (1). We use subgame perfection as an equilibrium concept.

We state firm i 's best reaction function. If firm i does not adopt an MFN policy, then its reaction function is defined by

$$R^i(p^{-i}) = \arg\max_{p^i} \omega^i(p^1, p^2, ..., p^n), \quad (3)$$

where $p^{-i} = (p^1, p^2, ..., p^{i-1}, p^{i+1}, ..., p^n)$. On the other hand, if firm i adopts an MFN policy and rebates $(\overline{p}^i - p^i)z^i$ to its customers, then its reaction function is defined by

$$\overline{R}^i(p^{-i}) = \arg\max_{p^i} [\omega^i(p^1, p^2, ..., p^n) - (\overline{p}^i - p^i)z^i] \quad (4)$$

Therefore, if firm i adopts an MFN policy, then its best response is shown as follows:

$$\hat{R}^i(p^{-i}) = \begin{cases} R^i(p^{-i}) & \text{if } p^i > \overline{p}^i, \\ \overline{p}^i & \text{if } p^i = \overline{p}^i, \\ \overline{R}^i(p^{-i}) & \text{if } p^i < \overline{p}^i. \end{cases} \quad (5)$$

The adoption of MFN policy by firm i creates kinks in the best response at the level of $\overline{p}^i$. In the next section, we discuss the equilibrium of the model.

Equilibrium

The following lemma provides a characterization of MFN policies as a strategic instrument.

Lemma 1. If firm i offers an MFN policy and an equilibrium is achieved, then at equilibrium $\overline{p}^i = p^i$.

Lemma 1 means that at equilibrium firm i does not donate $(\overline{p}^i - p^i)z^i$ to nations.

The main result of this study is described by the following proposition.

Proposition 1. There is an equilibrium in which at least one labor-managed firm offers an MFN policy. At equilibrium, each labor-managed firm's income per worker is higher than in the Bertrand game with no MFN policies.

Proposition 1 means that there is no equilibrium in which none of the labor-managed firms offer the MFN policy in the equilibrium of the labor-managed oligopoly model. Our results indicate that the introduction of MFN pricing into the analysis of labor-managed oligopoly competition is profitable for all labor-managed firms. The intuition behind Proposition 1 is as follows. If none of the firms offer the MFN policy, then the equilibrium occurs at the Bertrand solution. From (3), (4) and (5), we see that prices cannot be below the Bertrand prices because the MFN policy limits only price reductions. Since the model is the case of strategic complements in which goods are substitutes, each firm has an incentive to raise its price. If firm i offers an MFN policy, then its best response changes to (5). If $\overline{p}^i > p^i$, firm i must donate $(\overline{p}^i - p^i)z^i$ to nations or charities for social services. Therefore, firm i does not want to choose the Bertrand price. If firm i chooses a price higher than the Bertrand price, then the other firms' demand increases. Even if the other firms choose the Bertrand prices, they can earn more than in the Bertrand game with no MFN policies. Since the optimal strategies raise prices, firm i 's demand and income per worker also increase.

Conclusion

We have examined a price-setting oligopoly model in which labor-managed firms can offer donative MFN policies as a strategic instrument. We have shown that there is an equilibrium in which at least one labor-managed firm offers an MFN policy and at equilibrium each labor-managed firm's income per worker becomes higher than in the Bertrand game with no MFN policies. We have found that the introduction of MFN pricing into the analysis of labor-managed oligopoly competition is profitable for all labor-managed firms. Since the MFN policy enables all labor-managed firms to earn more in a noncooperative setting, we can say that it facilitates tacit collusion.

Appendix

We begin by proving Lemma 1.

Proof of Lemma 1

First, consider the possibility that $\overline{p}^i > p^i$ at equilibrium. From (2), if $\overline{p}^i > p^i$, firm i must donate $(\overline{p}^i - p^i)z^i$ to nations or charities for social services. That is, firm i can increase its income per worker by reducing $\overline{p}^i$, and the equilibrium point does not change in $\overline{p}^i \geq p^i$. Hence, $\overline{p}^i > p^i$ does not result in an equilibrium.

Next, consider the possibility that $\overline{p}^i < p^i$ at equilibrium. From (1) and (2), we see that firm i's marginal cost is m^i. It is impossible for firm i to change its output in equilibrium because such a strategy is not credible. That is, if $\overline{p}^i < p^i$, MFN pricing does not function as a strategic commitment. Q.E.D.

We present the following supplementary lemmas in order to prove Proposition 1.

Lemma 2. Suppose labor-managed oligopoly competition with no MFN policies. Then each firm's Stackelberg leader price is higher than its Bertrand price.

Proof.

If firm i is the Stackelberg leader, then it maximizes its income per worker $S(p^i, R^j(p^i))$ with respect to p^i. Therefore, firm i's Stackelberg leader price satisfies the first-order condition:

$$\omega_i^i + \omega_j^i R_i^j = 0. \qquad (6)$$

Since our model is the case of strategic complements in which goods are substitutes, ω_j^i and R_i^j are both positive. To satisfy (6), ω_i^i must be negative, and thus Lemma 2 follows. Q.E.D.

Lemma 3. Suppose that at least one labor-managed firm offers an MFN policy. Then each labor-managed firm's income per worker becomes higher than in the Bertrand game with no MFN policies.

Proof.

Suppose that firm i offers the MFN policy. From (3), (4) and (5), we see that prices cannot be below the Bertrand prices because the MFN policy limits only price reductions. If none of the firms offer the MFN policy, then the equilibrium occurs at the Bertrand solution. We can rewrite (4) as

$$\overline{R}^i(p^{-1}) = \arg\max_{p^i}\left[\frac{(p^i - m^i)(q^i + z^i l^i) - f^i - (\overline{p}^i - m^i)z^i l^i}{l^i}\right].$$

Here, f^i and $(\overline{p}^i - m^i)z^i l^i$ are irrelevant as far as marginal choices are concerned, and everything is as if firm i faced demand $q^i + z^i l^i$. l^i is the amount of labor in firm i, and z^i is a variable which can take values of zero and above. Therefore, firm i's price rises according to the value of z^i. $\overline{p}^i$ is also a variable which can take values of zero and above. From Lemmas 1 and 2, firm i's income per worker becomes higher than in the Bertrand game with no MFN policies.

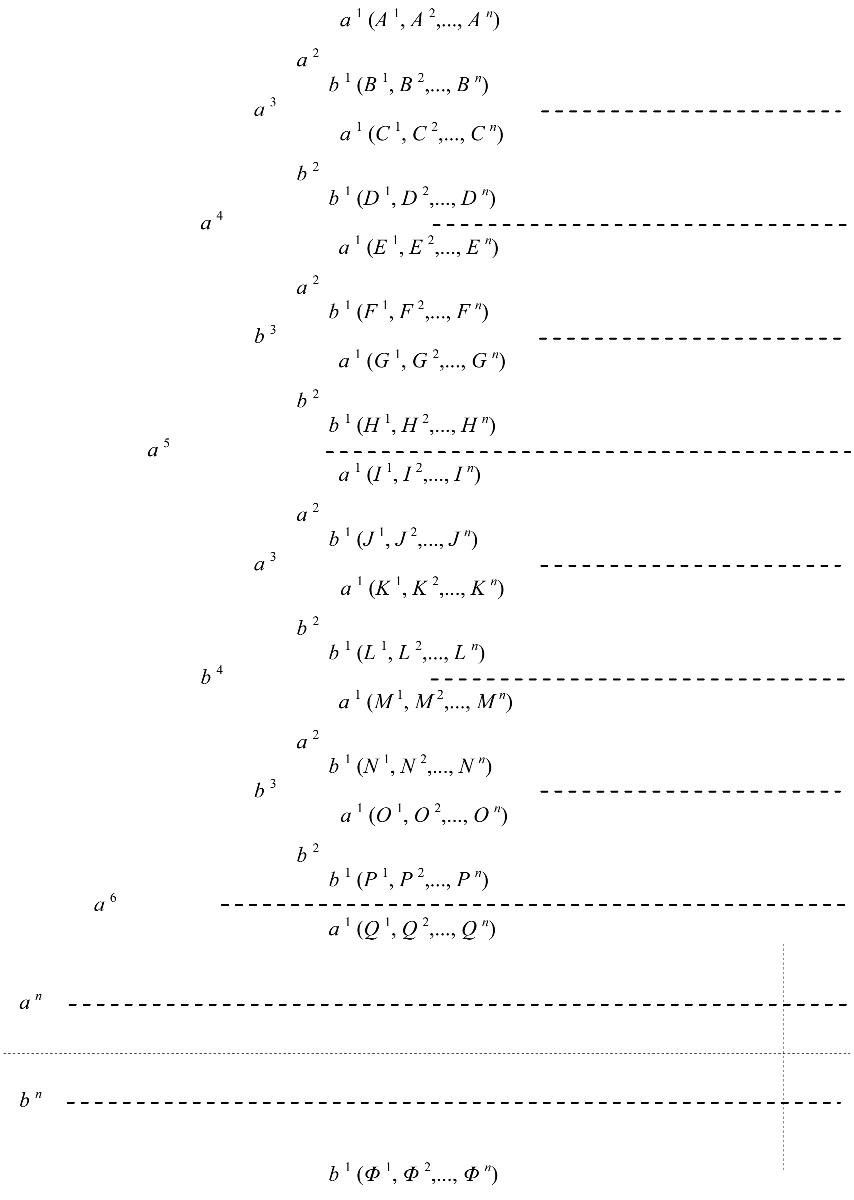
When firm i chooses a price higher than the Bertrand price, the other firms' demand increases. Even if the other firms choose the Bertrand prices, they can earn more than in the Bertrand game with no MFN policies. The optimal strategies must yield at least these payoffs, and thus Lemma 3 follows. Q.E.D.

Proof of Proposition 1

In the first stage, if firm i offers a MFN policy, then it chooses $\overline{p}^i$ and declares to make donations to nations or to charities for social services if its actual price is less than $\overline{p}^i$. In the second stage, each firm simultaneously and independently chooses its actual price p^i. At the end of the second stage, the market opens and each firm sells at p^i. If $p^i < \overline{p}^i$, then firm i donate $(\overline{p}^i - p^i)z^i$ to nations or charities for social services. Each firm's income per worker is decided. Our equilibrium concept is the subgame perfect Nash equilibrium, all information is common knowledge. Hence, we can consider the payoff matrix in Figure 1.[4] In this figure, a^i denotes an adoption of the MFN policy and b^i no adoption. From Lemma 3, we see that $\Phi^i < A^i, B^i, C^i, D^i, E^i, \ldots$ Thus, Proposition 1 follows. Q.E.D.

[4] For this figure, see Ohnishi (2007).

Figure 1. An *n*-player game with two action sets (a^i and b^i)



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