

# The Decision Whether to Hire Managers in a Mixed Duopoly with State-Owned and Labor-Managed Firms

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## Abstract

This paper considers a mixed duopoly model in which a state-owned firm competes with a labor-managed firm. The timing of this game is as follows. In the first stage, each firm decides whether or not to hire a manager. In the second stage, the firms that hired managers select incentive parameters for them. In the third stage, firms compete in Cournot fashion. The paper presents the subgame perfect equilibrium of this model.

**Keywords:** Cournot model, managerial delegation, mixed duopoly, labor-managed firm, state-owned firm.

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## Introduction

The analyses by Sklivas (1987), Fumas (1992), Basu (1995) and Kräkel (2002) consider two-stage delegation games in which in the first stage, profit-maximizing owners choose the incentive schemes they will give to their managers, and in the second stage, each manager chooses the strategy that maximizes his utility, given his incentive scheme and his rival's behavior. Each study demonstrates that owners use the incentive schemes that influence their managers' behavior and alters the equilibrium outcome. These studies investigate strategic decisions of managerial incentive contracts in private oligopoly markets.

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A few papers are published on the study of mixed oligopoly models comprising state-owned and capitalist firms. For instance, White (2001) considers managerial incentives in a market where a state-owned welfare-maximizing public firm competes against profit-maximizing capitalist firms with profit objectives, and demonstrates that in equilibrium only capitalist firms hire managers. Fernández-Ruiz (2009) examines firms' decisions to hire managers when a state-owned firm competes against a foreign capitalist firm, and shows that in equilibrium both firms hire managers. Bárcena-Ruiz (2009) considers a mixed duopoly market in which there are state-owned and capitalist firms, and demonstrates that at equilibrium under price competition with heterogeneous goods, both firms hire managers. In addition, Ohnishi (2018) examines a mixed duopoly market in which a state-owned firm competes on price against a foreign capitalist firm, and shows that there is a subgame perfect Nash equilibrium in which only the foreign capitalist firm hire a manager.

We consider the managerial incentive contract when a state-owned firm competes with a labor-managed firm. The following situation is considered. In stage one, each firm chooses whether or not to hire a manager. In stage two, the firms that hired managers select incentive parameters for them. In stage three, firms simultaneously and independently choose their output levels. We present the equilibrium of the mixed duopoly model and find that the managerial incentive contract is not profitable for the firms.

### Model

Let us consider a mixed duopoly model comprising a state-owned firm (firm S) and a labor-managed firm (firm L). Throughout this paper, subscripts S and L denote firm S and firm L, respectively. Each firm can hire one manager to make its production decision. There is no possibility of entry or exit. The duopolists produce perfectly substitutable commodities. The market price is determined by the inverse demand function  $P(Q) = a - Q$ , where  $a > Q = q_S + q_L$ .

Firm L's profit per worker is given by

$$\phi_L(q_S, q_L) = \frac{P(Q)q_L - m_L q_L - f}{l_L} - M_L = \frac{P(Q)q_L - m_L q_L - f}{q_L} - M_L \quad (1)$$

where  $m_L \in (1, \infty)$  denotes firm L's constant marginal cost,  $f \in (1, \infty)$  is the fixed cost,  $l_L$  is the amount of labor employed by firm L, and  $M_L$  is firm L's manager's payoff (if hired). Firm L aims to maximize (1).

Economic welfare, which is the sum of consumer surplus and producer surplus, is given by

$$W(q_S, q_L) = \frac{Q^2}{2} + P(Q)q_S - m_S q_S - M_S + P(Q)q_L - m_L q_L - M_L \quad (2)$$

where  $m_S \in (1, \infty)$  denotes firm S's constant marginal cost and  $M_S$  is its manager's payoff (if hired). Firm S seeks to maximize (2). We assume that firm S is less efficient than firm L, i.e.,  $0 < m_L < m_S$ . This assumption is justified in Gunderson (1979) and Nett (1993; 1994), and is often used in literature studying mixed markets (George and La Manna, 1996; Mujumdar and Pal, 1998; Pal, 1998; White, 2001; Ohnishi, 2008; Fernández-Ruiz, 2009). If firm S is equally or more efficient than firm L, then firm S produces a quantity such that price equals marginal cost. Therefore, firm L has no incentive to operate in the market, and firm S supplies monopolistically in the market.

Firm  $i$  ( $i = S, L$ ) can hire a manager to make its production decision. Firm  $i$ 's manager chooses  $q_i$  to maximize the following function:

$$M_i = \alpha_i [\beta_i (Pq_i - m_i q_i) + (1 - \beta_i) Pq_i] + t_i = \alpha_i [(P - \beta_i m_i) q_i] + t_i \quad (3)$$

where  $\beta_i \in [0, 1]$  can be interpreted as a discount factor on  $m_i$ , while firm  $i$  chooses  $\alpha_i \in (0, \infty)$  and  $t_i \in (0, \infty)$  so that manager  $i$  gets only his opportunity cost.

We follow White (2001) and Fernández-Ruiz (2009) and consider the following three-stage game. In the first stage, each firm decides whether or not to hire a manager. In the second stage, the firms that hired managers select incentive parameters for them. In the third stage, firms compete in Cournot fashion. We adopt subgame perfection as an equilibrium concept and solve the game by backward induction.

## Results

We first examine a subgame in which neither firm hires a manager. In the third stage, firm S will maximize economic welfare given by (2), while the firm L will maximize (1). The simultaneous solution of these problems yields:

$$q_S^N = a - m_S - \sqrt{f}, \quad q_L^N = \sqrt{f} \quad (4)$$

where the superscript N denotes that neither firm hires a manager. These output choices imply:

$$W^N = \frac{1}{2} (a - m_S)^2 + (a - m_L - \sqrt{f}) \sqrt{f}$$

$$\phi_L^N = m_S - m_L - \sqrt{f}$$

Second, we consider a subgame in which only firm S hires a manager. In the third stage, firm S's manager maximizes the objective function given by (3), while firm L maximizes (1). These lead to the following output functions:

$$q_S^S = a - \beta_S m_S - \sqrt{f}, \quad q_L^S = \sqrt{f} \quad (5)$$

where the superscript S denotes that only firm S hires a manager.

In the second stage, firm S choose the incentive parameter  $\beta_s$  to maximize economic welfare. We obtain:

$$\beta_s^S = 1 \tag{6}$$

$$W^S = \frac{1}{2}(a - m_s)^2 + (a - m_L - \sqrt{f})\sqrt{f} - t_s$$

$$\phi_L^S = m_s - m_L - \sqrt{f}$$

Third, we consider a case in which only firm L hires a manager. In the third stage, firm S maximize (2), while firm L's manager maximizes (3). These lead to the following output functions:

$$q_s^L = a - m_s - \sqrt{f}, \quad q_L^L = \sqrt{f} \tag{7}$$

where the superscript L indicates that only firm L hires a manager. We see that firm L's output is independent from  $m_L$ . These result in:

$$W^L = \frac{1}{2}(a - m_s)^2 + (a - m_L - \sqrt{f})\sqrt{f} - t_L$$

$$\phi_L^L = m_s - m_L - \sqrt{f} - t_L$$

Fourth, we consider a case in which both firms hire managers. The simultaneous maximization of the managers' objective functions leads to the following output at the third stage:

$$q_s^B = a - \beta_s m_s - \sqrt{f}, \quad q_L^B = \sqrt{f} \tag{8}$$

where the superscript B indicates that both firms hire managers.

In the second stage, firm S choose  $\beta_s$  to maximize economic welfare given by (2). Since  $q_L^B$  is independent from  $m_L$ , firm L does not need to choose the incentive parameter  $\beta_L^B$ . Both firms anticipate stage-three output quantities given by (8). Therefore, the following choice of incentive parameter is led:

$$\beta_s^B = 1 \tag{9}$$

This results in:

$$W^B = \frac{1}{2}(a - m_s)^2 + (a - m_L - \sqrt{f})\sqrt{f} - t_s - t_L$$

$$\phi_L^B = m_s - m_L - \sqrt{f} - t_L$$

Finally, we state the results of this paper. From the above discussion, we can present the following proposition.

**Proposition:** *In the mixed duopoly model comprising state-owned and labor-managed firms, the equilibrium coincides with the Cournot solution without managerial delegation.*

This proposition states that neither firm needs to hire a manager. This means that the managerial incentive contract is not profitable for the firms in the mixed duopoly model.

## Conclusion

We have examined firms' decisions whether to hire managers when a state-owned firm competes with a labor-managed firm. We have shown that in equilibrium neither firm hires a manager. As a result, we conclude that the introduction of managerial delegation into the analysis of mixed duopoly competition comprising state-owned and labor-managed firms is profitable for neither firm.

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