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Inventories in a Labour-Managed Economy

Kazuhiro Ohnishi*

Abstract: This paper considers a two-period model in which two labour-managed firms can use inventory investment as a strategic device. In the first period, each firm simultaneously and independently chooses how much it sells in the current market and the level of inventory it holds for the second-period market. The paper shows the reaction curves in the model with inventories. The paper finds that inventories may be used by labour-managed firms to facilitate tacit collusion.

Keywords: labour-managed firm, inventory investment, two-period model

JEL Classification: C72, D21, L13, L31

Introduction

Labour-managed firms have existed in Western economies since the advent of the factory system. The oldest surviving labour-managed firms in the United Kingdom and Italy appeared in the nineteenth century (Bonin et al. 1993). 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 labour-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 labour-managed firms rose by almost 1,000% and employment by 133% between 1976 and 1981 (Estrin, 1985). In the United States, the most notable examples of labour-managed firms are 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). Furthermore, in China, the market-oriented economic reform has given much greater autonomy to state and

* Kazuhiro Ohnishi is at Osaka University and Institute for Basic Economic Science, Osaka, Japan.

collective enterprises' managers to make production, investment and marketing decisions. Meng and Perkins (1998) find that the state and the collective sectors behave more like labour-managed firms in that they try to maximize income per worker rather than profit.

The pioneering work on a theoretical model of a labour-managed firm was conducted by Ward (1958). Since then, many economists have studied the behaviour of labour-managed firms.[1] For example, Laffont and Moreaux (1985) examine the welfare properties of free-entry Cournot equilibria in labour-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 labour-managed oligopoly under product differentiation and shows that the Cournot equilibrium prices are not lower than the Bertrand ones. Zhang (1993) applies a Dixit (1980)-Bulow et al. (1985a) framework of entry deterrence to a labour-managed industry and shows that a labour-managed incumbent has a greater incentive to hold excess capacity to deter entry than corresponding a profit-maximizing incumbent. Okuguchi (1993) examines two models of duopoly with product differentiation and with only labour-managed firms, in one of which two firms' strategies are outputs (labour-managed Cournot duopoly) and prices become strategic variables in the other (labour-managed Bertrand duopoly). He shows that reaction functions are upward-sloping under general conditions in both labour-managed Bertrand and Cournot duopolies with product differentiation. Lambertini and Rossini (1998) analyse the behaviour of labour-managed firms in a two-stage Cournot duopoly model with capital strategic interaction and show that labour-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 labour-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 (1988), Drago and Turnbull (1992), Haruna (1996), Kamshad (1997), Kihlstrom and Laffont (2002) and Ohnishi (2009). However, there are few models in which labour-managed firms manage inventories as a strategic device.

Therefore, we study a two-period model in which two labour-managed firms are allowed to hold inventories as a strategic device.[2] In the first period, each labour-managed firm simultaneously and independently chooses how much it sells in the current market and the level of inventory it holds for the second-period market. We show the reaction curves in the model with inventories. We then find that inventories may be used by labour-managed firms to facilitate tacit collusion.

The Model

Let us consider a two-period model with two labour-managed profit -per-worker-maximizing firms, firm 1 and firm 2. In the remainder of this paper, when *i* and *j* are used to refer to firms in an expression, they should be understood to refer to 1 and 2 with $i \neq j$. In addition, the subscript denotes the firm, and the superscript denotes the period. There is no possibility of entry or exit. The price of each period is determined by $P(S^t)$, where $S^t = \sum_{i=1}^{2} s_i^t$ denotes the aggregate sales of each period. We assume that P' < 0 and P'' > 0 .

The game runs as follows. In the first period, each firm simultaneously and independently chooses its first-period production $q_i^1 \in [0, \infty)$ and its first-period sale $s_i^1 \in [0, q_i^1]$. Firm i 's inventory I_i^1 becomes $q_i^1 - s_i^1$. At the end of the first period, each firm observes the behaviour of the other firm. In the second period, each firm simultaneously and independently chooses its second-period production $q_i^2 \in [0, \infty)$. At the end of the second period, each firm sales $s_i^2 = I_i^1 + q_i^2$ and holds no inventory. For notational simplicity, we consider the game without discounting.

Since $\sum_{t=1}^{2} q_i^t = \sum_{t=1}^{2} s_i^t$, firm *i* 's profit per worker is

$$\pi_i = \sum_{i=1}^{2} \frac{P(S^t)s_i^t - c_i q_i^t - f_i}{l_i(s_i^t)} = \sum_{t=1}^{2} \frac{P(S^t)s_i^t - c_i s_i^t - f_i}{l_i(s_i^t)} \tag{1}$$

where $c_i \in (0, \infty)$ is firm *i*'s constant marginal cost, $f_i \in (0, \infty)$ is firm *i*'s fixed cost, and l_i is the amount of labour in firm *i*. We assume that l_i is the function of s_i^t with $l_i' > 0$ and $l_i'' > 0$. This assumption means that the marginal quantity of labour used is increasing.

We define

$$\pi_i^t = \frac{P(S^t)s_i^t - c_i s_i^t - f_i}{l_i(s_i^t)} \tag{2}$$

We use subgame perfection as our equilibrium concept.

Results

In this section, we show the reaction curves of the model described in the previous section. We derive firm *i*'s reaction functions from (2). In the first period, since there is no inventory available, firm i 's reaction function is defined by

$$R_i^1(s_j^1) \quad \arg\max_{s_i^1 \quad 0} \frac{P(S^1)s_i^1 \quad c_i s_i^1 \quad f_i}{l_i(s_i^1)} \tag{3}$$

In the second period, firm i's reaction function without inventory is defined by

$$R_i(s_j^2) \quad \arg\max_{s_i^2 \quad 0} \frac{P(S^2)s_i^2 \quad c_i s_i^2 \quad f_i}{l_i(s_i^2)} \tag{4}$$

and thus its best response is shown as follows:

$$R_i(s_j^2) \quad \begin{matrix} R_i(s_j^2) & \textit{if } s_i^2 \quad I_i^1 \\ I_i^1 & \textit{if } s_i^2 \quad I_i^1 \end{matrix} \tag{5}$$

When the inventory is zero, the first-order condition for firm i is

$$(P' s_i \quad P \quad c_i)l_i \quad (Ps_i \quad c_i s_i \quad f_i)l_i' \quad 0 \tag{6}$$

and the second-order condition is

$$(P'' s_i \quad 2P')l_i \quad (Ps_i \quad c_i s_i \quad f_i)l_i'' \quad 0 \tag{7}$$

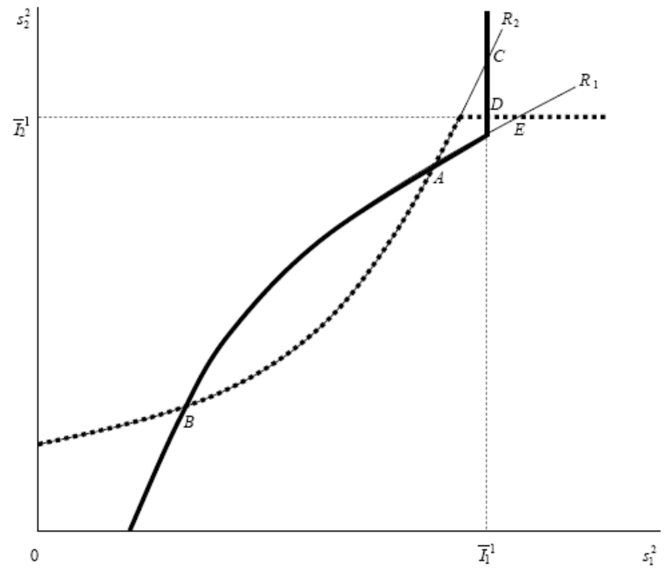
Furthermore, we have

$$R_i'(s_j) \quad \frac{P'' s_i l_i \quad P'(l_i \quad s_i l_i')}{(P'' s_i \quad 2P')l_i \quad (Ps_i \quad c_i s_i \quad f_i)l_i''} \tag{8}$$

Since $l_i'' \quad 0, l_i \quad s_i l_i' \quad 0$, so that $P'' s_i l_i \quad P'(l_i \quad s_i l_i')$ is positive; that is, $R_i(s_j)$ is upward sloping. This means that firm i treats s_i^t as strategic complements.[3]

Both firms' reaction curves are drawn in Figure 1. R_i is firm i's reaction curve with no inventory. Both firms' reaction curves are upward sloping. The equilibrium is decided in a Cournot fashion, i.e., the intersection of firm 1's and firm 2's reaction curves gives us the equilibrium of the game. The reaction curves cross twice. Only point B is a stable Cournot equilibrium, since in point A firm 2's reaction curve crosses firm 1's from above.

Figure 1:



Next, we consider the case with high inventories, which is drawn in Figure 2. By holding inventories, firm i's best response becomes (5). When firm 1 holds $\bar{I}_1^1$, its best response becomes the bold lines, and when firm 2 holds $\bar{I}_2^1$, its best response becomes the bold broken lines. The intersection of firm 1's and firm 2's reaction curves gives us the equilibrium of the game. Hence, we see that holding inventories changes the equilibrium of the game.

If only firm 1 holds inventories, then there are three Cournot Nash equilibria, namely A , B and C . Here, B and C are stable equilibria. From Figure 2, we can see easily that each firm's profit per worker is lower at C than at A . If only firm 2 holds inventories, then A , B and E are Cournot Nash equilibria. In addition, if each firm holds $\bar{I}_i^1$, then A , B and D are Cournot Nash equilibria. In this figure, B , C , D and E are stable equilibria. However, each firm's profit per worker is very low at the points C , D and E . Therefore, we see that high inventories are not profitable for each firm.

Finally, we consider the case with low inventories, which is drawn in Figure 3. By holding inventories, firm i's best response becomes (5). When firm 1 holds $\hat{I}_1^1$, its best response becomes the bold lines, and when firm 2 holds $\hat{I}_2^1$, its best response becomes the bold broken lines.

If only firm 1 holds inventories, then A , B and F are Cournot Nash equilibria. If firm 2's reaction curve and firm 1's isoprofit-per-worker curve come in contact with each other at F , then F is firm 1's Stackelberg leader point. From Figure 3, we can see that each firm's profit per worker is higher at F than at B .

Figure 2:

Figure 3

Furthermore, if both firms hold inventories, then A , B and G are Cournot Nash equilibria. In this figure, B , F , G and H are stable equilibria. Each firm's profit per worker is higher at G than at B . If both firms' isoprofit-per-worker curves come in contact with each other at G , then G is a collusive outcome. Therefore, we see that low inventories are profitable for both firms.

Conclusion

We have examined a two-period model in which two labour-managed firms are allowed to hold inventories as a strategic device. In the first period, each labour-managed firm simultaneously and independently chooses how much it sells in the current market and the level of inventory it holds for the second-period market. We have presented the reaction curves in the model with inventories. We have shown that low inventories are profitable for labour-managed firms, whereas high inventories are not. We have then found that inventories may be used by labour-managed firms to facilitate tacit collusion.

NOTES

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

[2] Matsumura (1999) considers a Cournot duopoly model in which profit-maximizing firms can hold inventories as a strategic device.

[3] The concept of strategic complements is introduced by Bulow et al. (1985b).

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