

A Three-Stage Labour-Managed Cournot Duopoly with Lifetime Employment as a Strategic Commitment

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Abstract

This paper studies the effectiveness of lifetime employment as a strategic commitment in a three-stage Cournot model with two identical labour-managed income-per-worker-maximizing firms. In the first stage, one labour-managed firm is allowed to offer lifetime employment. In the second stage, the other labour-managed firm is allowed to offer lifetime employment. In the third stage, both firms simultaneously and independently choose and sell actual outputs. The paper then finds that the introduction of lifetime employment into the analysis of the quantity-setting labour-managed duopoly model is profitable for both firms.

Keywords: Labour-managed firm; Three-stage Cournot model; Lifetime employment

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1 - Introduction

Studies of labour-managed firms have received considerable attention over the past 30 years.¹ Enterprises of this type have existed in Western European countries at least since the Industrial Revolution. The oldest surviving labour-managed firms in the UK 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)]. Between 1970 and the early 1980s in many industrialized European countries and the US the number of labour-managed firms formed and the amount of new employment rose annually [Ben-Ner (1988)]. 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 UK the number of labour-managed firms rose by almost 1,000% and employment by 133% between 1976 and 1981 [Estrin (1985)]. In the US, 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 collective enterprises' managers to make production, investment and marketing decisions. Meng and Perkins (1998) find that the state and the collective sectors behave like labour-managed firms in their wage determination.

The following studies provide practical examples of differences between labour-managed and capitalist firms. Jones and Backus (1977) examine the experience of British labour-managed firms in the footwear industry and show that the failure to pay a scarcity-reflecting remuneration for the use of collectively owned capital is responsible for the frequently short life-span of labour-managed firms. They find that if variation in the degree of employee collective ownership and participation among labour-managed firms is ignored, then during the post-war period, labour-managed firms are always producing in the zone of increasing returns to scale and, compared to capitalist firms, at a relatively low scale of output and size, and both under investing and using less capital per worker.

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

Furthermore, Bartlett et al. (1992) examine the differences between the behaviour of capitalist firms and that of labour-managed firms in a matched sample of the two organizational types in North-Central Italy and find that the labour-managed firms apparently have higher productivity, more labour-intensive production methods, lower income differentials and a more tranquil industrial relations environment than the capitalist firms.

The first theoretical analysis of a labour-managed firm was done by Ward (1958). Since then, many researchers have studied the behaviour of labour-managed firms. 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. (1985) 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 a corresponding 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 (1984, 1988), Sertel (1991), Drago and Turnbull (1992), Haruna (1996), Kamshad (1997), Kihlstrom and Laffont (2002), Bar-Shira et al. (2006) and Ohnishi (2009). However, there are few studies that examine sequential strategic choice Cournot competition with labour managed firms.

Therefore, we consider a three-stage quantity-setting model with two identical labour-managed income-per-worker-maximizing firms. We consider the following situation. In the first stage, one labour-managed firm is allowed to offer lifetime employment. In the second stage, the other labour-managed firm is allowed to offer lifetime employment. In the third stage, both firms simultaneously and independently choose and sell actual outputs. If a firm offers lifetime employment, then it chooses an output level and enters into a lifetime employment contract with the number of employees necessary to achieve the output level.² This paper is the first study that examines the equilibrium of three-stage Cournot competition in which labour-managed firms are allowed to offer lifetime employment as a strategic commitment.

The main purpose of the paper is to show the effectiveness of lifetime employment as a strategic commitment by using the three-stage labour-managed Cournot model. The paper finds that the introduction of lifetime employment into the analysis of three-stage quantity competition is profitable for the labour-managed firms.

The remainder of the paper is organized as follows. In Section 2, we describe the model. Section 3 gives supplementary explanations of the model. Section 4 presents the results of the model. Finally, Section 5 concludes the paper.

2 - The model

Let us consider a three-stage model with two identical labour-managed income-per-worker-maximizing firm, firm 1 and firm 2. In the remainder of this paper, subscripts 1 and 2 denote firm 1 and firm 2, respectively. In addition, when i and j are used, they should be understood to refer to 1 and 2 with $i \neq j$. There is no possibility of entry or exit. The market price is determined by the inverse demand function $P(Q)$, where $Q = q_1 + q_2$. We assume that $P' + P''q_i < 0$ and $P'' \geq 0$. This assumption means that the inverse demand function is linear or convex.

The market will be modelled by means of following three-stage game. In the first stage, firm 1 decides whether to offer lifetime employment. In the second stage, firm 2 decides whether to offer lifetime employment. In the third stage, both firms simultaneously and independently choose and sell actual outputs $q_1 > 0$ and $q_2 > 0$. If

² For details of lifetime employment as a strategic commitment, see Ohnishi (2001, 2002, 2011).

firm i offers lifetime employment, then it chooses an output level $q_i^* > 0$ and enters into a lifetime employment contract with the number of employees necessary to achieve q_i^* .

Therefore, firm i 's income per worker is given by

$$\omega_i = \begin{cases} \frac{P(Q)q_i - rq_i - f}{l(q_i)} & \text{if } q_i > q_i^*, \\ \frac{P(Q)q_i - rq_i - f}{l^*(q_i^*)} & \text{if } q_i \leq q_i^*, \end{cases} \quad (1)$$

where $r > 0$ is the unit cost of capital, l is the labour input function, and $f > 0$ is the fixed cost. We assume that $l' > 0$ and $l'' > 0$. This assumption means that the marginal labour input is increasing. We use subgame perfection as our equilibrium concept.

3 - Supplementary explanations

First, we derive firm i 's best response from (1). If firm i does not offer lifetime employment, then its reaction function is defined by

$$R_i^n(q_j) = \arg \max_{q_i} \left[\frac{P(Q)q_i - rq_i - f}{l(q_i)} \right], \quad (2)$$

and if firm i offers lifetime employment and produces $q_i \leq q_i^*$, then its reaction function is defined by

$$R_i^l(q_j) = \arg \max_{q_i} \left[\frac{P(Q)q_i - rq_i - f}{l^*(q_i^*)} \right]. \quad (3)$$

Therefore, if firm i selects q_i^* and offers lifetime employment, then its best response is shown as follows:

$$R_i(q_j) = \begin{cases} R_i^n(q_j) & \text{if } q_i > q_i^*, \\ q_i^* & \text{if } q_i = q_i^*, \\ R_i^l(q_j) & \text{if } q_i < q_i^*. \end{cases} \quad (4)$$

We now state the following lemma:

Lemma 1. Under Cournot competition, $R_i^n(q_j)$ is upward sloping, whereas $R_i^l(q_j)$ is downward sloping.

Proof. The Cournot equilibrium occurs where each firm maximizes its objective with respect to its own output, given its rival's output. Firm i aims to maximize its income per worker with respect to its own output, given firm j 's output. The Cournot equilibrium must satisfy the following conditions: If firm i does not offer lifetime employment, then the first-order condition is

$$(P'q_i + P - r)l - (Pq_i - rq_i - f)l' = 0, \quad (5)$$

and the second-order condition is

$$(P''q_i + 2P')l - (Pq_i - rq_i - f)l'' < 0. \quad (6)$$

If firm i offers lifetime employment and produces $q_i \leq q_i^*$, then the first-order condition is

$$P'q_i + P - r = 0, \quad (7)$$

and the second-order condition is

$$P''q_i + 2P' < 0. \quad (8)$$

Furthermore, we have

$$R_i^n'(q_j) = -\frac{P''q_i l + P'(l - q_i l')}{(P''q_i + 2P')l - (Pq_i - rq_i - f)l''} \quad (9)$$

and

$$R_i^l'(q_j) = -\frac{P''q_i + P'}{P''q_i + 2P'}. \quad (10)$$

From $l'' > 0$, we have $l - q_i l' < 0$, so that $P''q_i l + P'(l - q_i l')$ is positive. On the other hand, $P''q_i + P'$ is negative. Q.E.D.

Next, we present the following lemma, which provides a characterization of

lifetime employment as a strategic commitment.

Lemma 2. If firm i offers lifetime employment, then in equilibrium $q_i = q_i^*$.

Proof. First, consider the possibility that $q_i < q_i^*$ in equilibrium. If $q_i < q_i^*$, firm i must employ extra employees necessary to produce $q_i^* - q_i$. That is, firm i can increase its income per worker by reducing q_i^* , and the equilibrium point does not change in $q_i \leq q_i^*$. Hence, $q_i < q_i^*$ does not result in an equilibrium.

Next, consider the possibility that $q_i > q_i^*$ in equilibrium. From (1) and (2), we see that firm i cannot change its output in equilibrium because such a strategy is not credible. That is, if $q_i > q_i^*$, lifetime employment does not function as a strategic commitment. Q.E.D.

Lemma 2 means that in equilibrium neither firm employs extra employees.

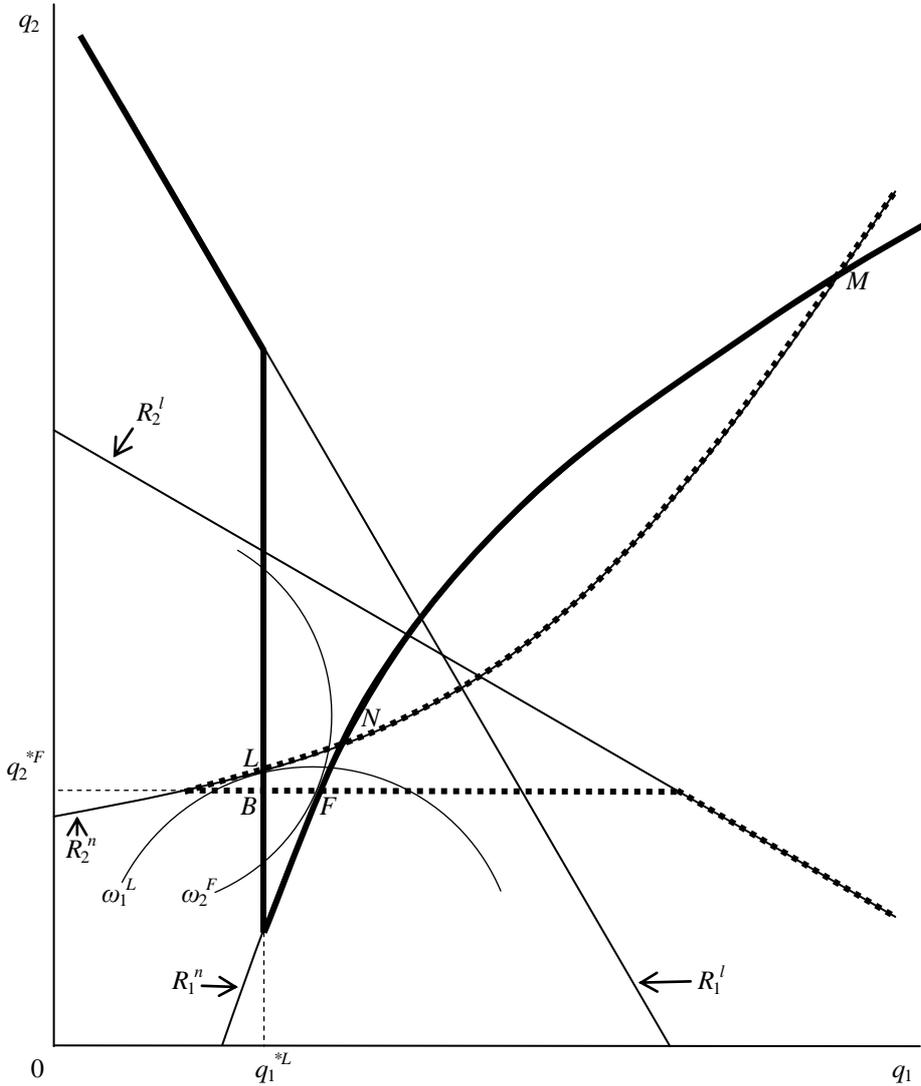
4 - Equilibrium

In this section, we analyse the equilibrium of the model described in Section 2. In our model, first firm 1 moves, then firm 2 observes firm 1's move, and subsequently firm 2 moves. Firm i aims to maximize its income per worker. Therefore, it is thought that firm i will offer lifetime employment if its income per worker increases by doing so, and firm i will not offer lifetime employment if its income per worker decreases by doing so.

The equilibrium is explained in Figure 1, where R_i^n is firm i 's reaction curve without lifetime employment, and R_i^l is firm i 's reaction function with zero marginal labour costs. R_i^n is downward sloping, whereas R_i^l is upward sloping.

By strategic choice of lifetime employment, firm 1's best response becomes (4). The offer of lifetime employment by firm 1 thus creates kinks in the reaction curve at the level of q_1^* . That is, if firm 1 chooses q_1^{*L} and offers lifetime employment, then its best response becomes the bold lines as in Figure 1. Furthermore, if firm 2 chooses q_2^{*F} and offers lifetime employment, then its best response becomes the bold broken lines.

Figure 1: Both firms' reaction curves



In the third stage, each firm independently chooses and sells its actual output. The equilibrium is decided in a Cournot fashion. If only firm 1 chooses q_1^{*L} and offers lifetime employment, then the reaction curves of both firms cross at L , N and M as in Figure 1. Lemma 2 states that if firm i offers lifetime employment, then in equilibrium $q_i = q_i^*$. That is, if $q_i < q_i^*$, firm i must employ the extra employees necessary to produce $q_i^* - q_i$ and can increase its income per worker by reducing q_i^* . In addition, if $q_i > q_i^*$, firm i cannot change its output because lifetime employment does not function as a strategic commitment. We see that each firm's income per worker is higher at L than at N and M . Therefore, firm 1 chooses $q_1 = q_1^{*L}$ and firm 2 chooses $q_2 = R_2^n(q_1^{*L})$. Hence, the solution is at L .

Furthermore, if firm 1 chooses q_1^{*L} in the first stage and firm 2 chooses q_2^{*F} in the second stage, then the reaction curves of both firms cross at L , B , F , N and M . The reaction curve of firm 1 will have a flat segment at q_1^{*L} . Firm 2's income per worker is lower at B and F than at L . If firm 2 offers lifetime employment, then its income per worker decreases. Hence, if firm 1 offers lifetime employment, then firm 2 has no incentive to do so.

If neither firm offers lifetime employment, then the solution occurs at M and N . If firm 2 unilaterally offers lifetime employment, then the reaction curves of both firms cross at F , N and M as in Figure 1. We can see easily that firm 2's income per worker is higher at F than at N and M . Hence, if firm 1 does not offer lifetime employment, then firm 2 has an incentive to do so. Therefore, it is thought that if firm 1's income per worker is higher at L than at F , then firm 1 offers lifetime employment in the first stage, whereas if firm 1's income per worker is higher at F than at L , then firm 1 does not offer lifetime employment in the first stage. From Figure 1, we see that firm 1's income per worker is higher at F than at L .

Since firm 1 does not offer lifetime employment in the first stage, its reaction curve is R_1^n . In the second stage, firm 2 offers lifetime employment and its reaction curve becomes the bold broken lines. Lemma 2 states that if firm i offers lifetime employment, then in equilibrium $q_i = q_i^*$; that is, the equilibrium occurs at the committed level of lifetime employment. Hence, F will be a possible equilibrium to the three-stage game. From Figure 1, we can see easily that each firm's equilibrium income per worker exceeds the Cournot income per worker without lifetime employment.

The equilibrium outcome can be stated as follows.

Proposition 1. In the three-stage labour-managed Cournot model with lifetime employment as a strategic commitment, there exists an equilibrium in which only firm 2 offers lifetime employment. In equilibrium, each firm's income per worker is higher than in the Cournot equilibrium without lifetime employment, and in addition firm 1's income per worker exceeds firm 2's income per worker.

Proposition 1 indicates that the introduction of lifetime employment into the analysis of the quantity-setting labour-managed duopoly model is profitable for both firms, and in addition firm 1 (first-mover) can gain advantage.

5 - Conclusion

We have considered a three-stage Cournot model in which two labour-managed income-per-worker-maximizing firms are allowed to offer lifetime employment as a strategic commitment. First, we have demonstrated that if the labour-managed firm does not offer lifetime employment, then its reaction function is upward sloping, whereas if it does, then its reaction function changes downward sloping. Second, we have demonstrated that there exists an equilibrium in which only the second-mover firm offers lifetime employment, and in equilibrium each firm's income per worker is higher than in the Cournot equilibrium without lifetime employment, and in addition the first-mover firm's income per worker exceeds the second-mover firm's income per worker. As a result, we have found that the introduction of lifetime employment into the analysis of the quantity-setting labour-managed duopoly model is profitable for both firms, and in addition the first-mover firm can gain advantage.

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