Do Profit Maximizers Maximize Profit?: Divergence of Objective and Result in Oligopoly*

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Abstract

This paper presents an n-firm Cournot oligopoly model in which each firm's objective is to maximize the weighted average of profit and another factor such as revenue. Firms whose realized profits are the largest are not generally those that have the profit maximization objective. The basic model is extended to a two-stage delegation game in which firm owners in the first stage set goals for managers to pursue and the managers in the second stage compete for the given goals. The divergence of objective and result occurs even at the level of owners in this delegation game. In other words, the profit maximization objective is no longer justified at the root level of the firm. Thus, Friedman's as if logic is not only consistent with the managerial theory of the firm, but also supportive of its further study.

Keywords: firm objective, as if profit maximization, non-profit maximization, managerial theory of the firm, delegation game

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1 Introduction

The firm and its hypothesized mode of behavior constitute the foundation of the production side of economic models. Standard in economic theory is to model firms as profit maximizing entities in order to derive the qualitative and quantitative characterizations of the production equilibrium. The acceptance of profit maximization, as a first approximation of firm behavior, has not been without debate.

The managerial theory of the firm has proposed that firms in reality do not necessarily act to maximize profits.[1] The basic tenet was that given the separation of management from ownership, the complexity of organization, and the uncertainty of the states, the firm's manager maximizes his own utility function rather than profit.

On the other hand, the long-run viability of non-profit maximizing firms has been doubted. Alchian (1950) explicated that in the long-run, natural selection results in the survival of just the profit maximizers. Friedman (1953, pp. 21-22) argued that regardless of how actual firms may behave and the constraints on rationality they may be subject to, the surviving firms are those that attained the highest profits, so the economist can model firms *as if* they maximized profit. The strength of these arguments, we contend, has lead to the current acceptance of the profit maximization hypothesis.

The profit maximization hypothesis and the managerial theory of the firm seemed to have been irreconcilable until Vickers (1985) and Fershtman and Judd (1987) presented a two-stage delegation game in which profit maximizing owners in the first stage set goals for managers to pursue, and managers in the second stage compete for the given goals. They showed that the profit maximizing owners set non-profit objectives for their managers. They justify the managerial theory, while keeping the profit maximizing objective at the level of owners.[2]

The present paper proposes another reconciliation, not by separating ownership and management, but by distinguishing profit as an objective and

[1] Managerialism as an antithesis to the classical profit maximizing firm in pure competition began with Berle and Means (1932). Baumol (1959), Cyert and March (1963), Marris (1964), and O. Williamson (1964) mark the key developments. A review of the literature is provided in the appendix.

[2] We refer to these papers as they are the closest to ours. Some make the same point by using the theory of principal-agent relationship. See, for example, the introductory chapter of Tirole (1988).

profit as a result. We present an n-firm Cournot oligopoly model in which each firm's objective is to maximize the weighted average of profit and another factor.[3] In this setting, firms whose realized profits are the largest are not generally those that have the profit maximization objective. Once profit as an objective and profit as a result are distinguished, the justification of modeling firms as having the profit maximization objective cannot be based on Friedman's *as if* logic. Instead, the *as if* logic will allow us to model objective functions other than profit, and yet be consistent with resultant profit guiding firm survival.

One might argue that our games are just subgames of a delegation game in which managers are not given profit as their objectives, while the owners still have the profit maximization objective. To respond to this criticism, we extend, albeit for a limited case, the above model to a two-stage delegation game. We then show that the divergence of profit as an objective and as a result, and thus our claim, carry over even to the level of the firm owner in this delegation game. Firm owners whose realized profits are maximized are not those owners with the profit maximization objective. This acts as a rationale to model objective functions other than profit even at the level of owners in the delegation game.

The logic behind the divergence of objective and result is not novel in itself, and can be explained intuitively for the case of the objective function being the weighted average of profit and revenue. The more weight a firm puts on revenue, the less it cares about cost, and the further its reaction function shifts outward forcing other firms to produce less given the strategic interaction between the firms. This leads to an increase in the profit of the firm in question at the expense of others.

The novelty of our paper is in showing that the profit maximization objective is no longer justified at the root level of the firm.

One might also argue that the credibility of the objective function is no longer guaranteed if the firm's objective at the root level is not profit. Once profit as an objective is distinguished from profit as a result, the credibility of the profit maximization objective is at stake as much as other objectives. If, like in the United States, the shareholders are the primary stakeholders of the firm, the profit maximization objective may be credible. However, if, as in

[3] This factor is represented by a function F that satisfies some regularity conditions, and its examples are revenue, market share, cost, and profit per worker. Its generality allows us to address the criticism against the managerial theory of the firm, that it is ad hoc.

	U.S.	Japan
Return on Investment	8.1	4.1
Share Price Increase	3.8	0.1
Market Share	2.4	4.8
Improve Product Portfolio	1.7	2.3
Rationalization of Prod. & Dist.	1.5	2.4
Increase Equity Ratio	1.3	2.0
Ratio of New Products	0.7	3.5
Improve Company's Image	0.2	0.7
Improve Working Conditions	0.1	0.3

291 Japanese companies and 227 U.S. companies ranked factors weighted 10, for first importance, to 1, for least importance.
source: Abegglen and Stalk (1985).
original source: Economic Planning Agency (Japan) survey 1980/81.

Table 1: Ranking of Corporate Objectives: U.S. and Japan

Japan, the stakeholders of the firm are believed to be more diversified among shareholders, managers, employees, suppliers, etc, then objectives other than profit may be more credible.[4]

Given our view, observations such as those presented in Table 1 take on a new meaning. Here, Japanese firms have objectives other than return on investment that can be considered as a proxy for profit. If one has a preconception that a firm's ultimate objective ought to be profit, then one may attempt to interpret these observations using the frameworks of delegation games or principal-agent theory. On the other hand, if one contends that profit need not be the objective at the root level of the firm, these observations may be explained by some other factors such as the composition of stakeholders of the firm.

Note that modeling non-profit maximizing firms has nothing to do with bounded rationality. Firms are rational given their objectives. In this sense, our model is in contrast to the evolutionary models in which agents are bounded rational including Nelson and Winter (1982) and Vega-Redondo

[4]See Chapter 11 of Aoki (2001) for the comparison between the shareholder approach and the stakeholder approach.

(1997).

One may suggest that this model be extended to a repeated situation where long-run survival may not coincide with expected profit maximization as shown by Blume and Easley (1992). We do not take such a course since our model does not contain uncertainty or risk. If the model is deterministic, the larger the profit a firm attains, the larger its size becomes unless we consider the issue of dividends and reinvestment as in Dutta and Radner (1999).

The following section presents the model. Sections 3 presents the results and some examples. Section 4 extends the model to the delegation game, provides a limit result, and considers price competition. Section 5 concludes. Given that an implication of our paper is to renew the significance of the theories of firms with non-profit maximization objectives, we attach an appendix that reviews the literature.

2 Model

Consider an oligopoly market with homogenous goods. There are n firms indexed by $i = 1, \ldots, n$. The firms simultaneously choose their own output. The output level of firm i ($i = 1, \ldots, n$) is denoted by $x_i \geq 0$. The inverse demand function is given by $p = P(X)$ where p is the price, and $X = \sum_{i=1}^{n} x_i$ is the total output of the market. We assume that P is continuous, and there exists $\bar{X} > 0$ such that $P(X)$ is twice continuously differentiable with $P'(X) < 0$ for all $X < \bar{X}$, and $P(X) = 0$ holds for all $X \geq \bar{X}$. The profit of the ith firm is

$$\pi_i(x_1, \ldots, x_n) = \pi(X, x_i) = P(X)x_i - C(x_i),$$

where $C(\cdot)$ is the cost function, identical across firms. We assume that C is twice continuously differentiable, $C(0) \geq 0$, and $C'(\cdot) > 0$ is bounded away from zero.

Unlike standard oligopoly models, the objective functions can be different across firms. Each firm tries to maximize the weighted average of its profit and some other objective, i.e., the objective function of firm i ($i = 1, \ldots, n$) is given by

$$g_i(x_1, \ldots, x_n) = (1 - \theta_i)\pi(X, x_i) + \theta_i F(X, x_i), \tag{1}$$

where $\theta_i \in [0, 1)$ is the weight firm i puts on the objective other than profit. Note that $\theta_i = 0$ implies that firm i is a profit maximizer. We assume without loss of generality that $\theta_1 \leq \theta_2 \leq \cdots \leq \theta_n$ holds.

We further assume some regularity conditions. First, it is assumed that for all $X < \bar{X}$, $P''(X)X + P'(X) < 0$. This implies that the marginal revenue, $P'(X)x_i + P(X)$, is strictly decreasing in x_i. Second, for all $X < \bar{X}$ and all $x_i < X$,

$$P''(X)x_i + 2P'(X) - C''(x_i) < 0, \tag{2}$$

holds. The third regularity condition states that for all $X < \bar{X}$ and all $i = 1, 2, \ldots, n$, there exists $\varepsilon > 0$ such that

$$P'(X) - C''(x_i) < -\varepsilon \tag{3}$$

holds for all $x_i \leq X$. Conditions (2) and (3) imply that the cost function does not exhibit too strong a decreasing marginal cost. Note that these conditions hold whenever the firms' marginal cost is non-decreasing in the presence of decreasing marginal revenue.

As for the other objective, F, we assume that $F_1 = \partial F/\partial X \leq 0$, $F_{12} + F_{22} < 0$, and $F_{11} + 2F_{12} + F_{22} < 0$ where we write $F_2 = \partial F/\partial x_i$, $F_{12} = \partial^2 F/\partial X \partial x_i$, and so on. The first condition implies output choices are strategic substitutes. The second and third conditions imply that $dF/dx_i = F_1 + F_2$ is strictly decreasing in x_i if X is kept constant (the second condition), or if X moves as x_i (the third condition). We further assume $\lim_{x_i \to \infty} F_1 + F_2 \leq 0$. These regularity conditions guarantee the unique existence of Nash equilibrium (see Gaudet and Salant (1991) and Novshek (1985)).

Several examples that deserve attention are in order.

1. Revenue: $F(X, x_i) = P(X)x_i$

2. Market share: $F(X, x_i) = x_i/X$

   Note that these two specifications satisfy the above conditions on F in the presence of the regularity conditions on the profit function.

3. Negative of cost: $F(X, x_i) = -C(x_i)$

   This specification corresponds to cost minimization and satisfies the regularity conditions if $C'' > 0$ holds.

4. Profit per worker: $F(X, x_i) = \dfrac{P(X)x_i - C(x_i)}{N(x_i)}$

$N(x_i)$ is the number of workers needed to produce x_i.[5] This formulation corresponds to the labor managed firm. One may add the wage rate to F as well. The regularity conditions put a restriction on the shape of N as well as on P and C.

3 Results

The first order condition of the ith firm ($i = 1, \ldots, n$) is given by

$$\frac{\partial g_i(x)}{\partial x_i} = (1-\theta_i)\frac{d\pi(X, x_i)}{dx_i} + \theta_i \frac{dF(X, x_i)}{dx_i}$$
$$= (1-\theta_i)\left[P'(X)x_i + P(X) - C'(x_i)\right] + \theta_i\left[F_1(X, x_i) + F_2(X, x_i)\right] \leq 0, \tag{4}$$

and (4) holds with equality if $x_i > 0$. The second order condition is satisfied due to the regularity conditions.

3.1 Output

This subsection compares firms with different objectives, i.e., different weights on profit and the other objective. Our first result is key to understanding the subsequent arguments. It states that a firm that puts a smaller weight on profit produces no less output than another firm that puts a larger weight, provided that dF/dx_i is positive if the marginal profit is non-negative.

Lemma 1 *Suppose that* $\frac{d\pi}{dx_i}(X, x_i) = P'(X)x_i + P(X) - C'(x_i) \geq 0$ *implies* $\frac{dF}{dx_i}(X, x_i) = F_1(X, x_i) + F_2(X, x_i) > 0$. *Then for any Nash equilibrium* $x^* = (x_1^*, \ldots, x_n^*)$, *we have*

$$x_1^* \leq x_2^* \leq \cdots \leq x_n^*.$$

Moreover, $\theta_i < \theta_j$ *and* $x_j^* > 0$ $(i, j = 1, \ldots, n)$ *imply* $x_i^* < x_j^*$.

Proof. Take two firms i and j with $i < j$. If $x_i^* = 0$, then $x_i^* \leq x_j^*$ necessarily holds. Suppose $x_i^* > 0$. Then the first-order conditions for i and j are

$$(1-\theta_i)\left[P'(X^*)x_i^* + P(X^*) - C'(x_i^*)\right] + \theta_i \left[\frac{dF}{dx_i}(X^*, x_i^*)\right] = 0, \tag{5}$$

[5] We may assume that the production function is of Leontief type to make the example consistent.

and

$$(1-\theta_j)\left[P'(X^*)x_j^* + P(X^*) - C'(x_j^*)\right] + \theta_j \left[\frac{dF}{dx_j}(X^*, x_j^*)\right] \leq 0, \tag{6}$$

respectively. Dividing (5) and (6) by $1-\theta_i$ and $1-\theta_j$, respectively, and subtracting the former from the latter, we obtain

$$\begin{aligned} &P'(X^*)(x_j^* - x_i^*) - (C'(x_j^*) - C'(x_i^*)) \\ &+\frac{\theta_j}{1-\theta_j}[\frac{dF}{dx_j}(X^*, x_j^*)] - \frac{\theta_i}{1-\theta_i}[\frac{dF}{dx_i}(X^*, x_i^*)] \leq 0. \end{aligned} \tag{7}$$

Now, suppose the contrary, i.e., that $x_j^* < x_i^*$ holds. Since $P'(X^*)x_k - C'(x_k)$ is decreasing in x_k, keeping X^* constant, the term $P'(X^*)(x_j^* - x_i^*) - (C'(x_j^*) - C'(x_i^*))$ is positive. Also, since $\theta_j \geq \theta_i$ and $\frac{dF}{dx_j}(X^*, x_j^*) > \frac{dF}{dx_i}(X^*, x_i^*) \geq 0$ under our assumptions, the rest of the terms in (7) is positive. Thus, the left hand side of (7) is positive, which is a contradiction.

To prove the second statement, note first that the assumption of the lemma implies that in (5), the first term is negative, while the second term is positive. Note next, in the above argument, that if $\theta_i < \theta_j$ and $x_j^* \leq x_i^*$ hold, then we can repeat the same argument to show that (7) is positive, and therefore, a contradiction. ∎

Lemma 1 compares firms with different objectives in terms of their outputs. The intuition is fairly transparent. If dF/dx_i is positive whenever the marginal profit is non-negative, then the greater θ_i is, the further outward is the reaction curve, leading to a larger output in equilibrium.

The next lemma deals with the opposite case, i.e., the case in which dF/dx_i is negative whenever the marginal profit is non-positive. In this case, a weight on F has an output reducing effect since the reaction curve shifts inward. The proof of this lemma is essentially the same as that of Lemma 1 except that we change some inequalities, and therefore, we omit it.

Lemma 2 *Suppose that $P'(X)x_i + P(X) - C'(x_i) \leq 0$ implies $F_1(X, x_i) + F_2(X, x_i) < 0$. Then for any Nash equilibrium $x^* = (x_1^*, \ldots, x_n^*)$, we have*

$$x_1^* \geq x_2^* \geq \cdots \geq x_n^*.$$

Moreover, $\theta_i < \theta_j$ and $x_j^* > 0$ $(i, j = 1, \ldots, n)$ imply $x_i^* > x_j^*$.

Examples of objective functions that have output increasing effects and output decreasing effects are given below:

1. Revenue: $F(X, x_i) = P(X)x_i$

   Since the marginal cost is always positive, i.e., $C'(\cdot) > 0$, $P'x_i + P - C' > 0$ implies $dF/dx_i = P'x_i + P > 0$. Thus, this objective function has an output increasing effect.

2. Market share: $F(X, x_i) = x_i/X$

   We have $dF/dx_i = 1/X - x_i/X^2 = (\sum_{j \neq i} x_j)/X^2 > 0$. Thus, this objective function has an output increasing effect.

3. Negative of cost: $F(X, x_i) = -C(x_i)$

   We have $dF/dx_i = -C'(x_i) < 0$. Thus, it has an output decreasing effect.

4. Profit per worker: $F(X, x_i) = \pi_i/N(x_i)$

   We have two cases for this objective function. To begin with, we have

   $$\frac{dF}{dx_i} = \frac{\partial \pi_i}{\partial x_i}\frac{1}{N(x_i)} - \frac{\pi_i}{N(x_i)^2}N'(x_i).$$

   The second term is positive if and only if $\pi_i > 0$ holds. Thus, this objective function has an output increasing effect if and only if the equilibrium net profit is positive.

3.2 Profit: Case of non-increasing marginal costs

Whether or not firms with larger weights on F earn more profit than those with smaller weights is a different question. If marginal costs are weakly decreasing, then Lemma 1 leads to the result that the firm with the larger weight earns more profit than the one with the smaller weight provided that they earn positive profits. The following theorem is a formal statement of this relationship.

Theorem 1 *Suppose that $P'(X)x_i + P(X) - C'(x_i) \geq 0$ implies $F_1(X, x_i) + F_2(X, x_i) > 0$. Assume $C''(\cdot) \leq 0$. Let $x^* = (x_1^*, \ldots, x_n^*)$ be a Nash equilibrium. Suppose that $\pi_i(x^*) > -C(0)$ holds for some i. Then for all $j < i$,*

$\pi_j(x^*) \leq \pi_i(x^*)$ holds, and $\theta_j < \theta_i$ implies $\pi_j(x^*) < \pi_i(x^*)$. Also, for all $j = i, i+1, \ldots, n-1$, $\pi_j(x^*) \leq \pi_{j+1}(x^*)$ holds, and $\theta_j < \theta_{j+1}$ implies $\pi_j(x^*) < \pi_{j+1}(x^*)$.

The next theorem is the mirror image of Theorem 1.

Theorem 2 *Suppose that $P'(X)x_i + P(X) - C'(x_i) \leq 0$ implies $F_1(X, x_i) + F_2(X, x_i) < 0$. Assume $C''(\cdot) \leq 0$. Let $x^* = (x_1^*, \ldots, x_n^*)$ be a Nash equilibrium. Suppose that $\pi_i(x^*) > -C(0)$ holds for some i. Then for all $j > i$, $\pi_j(x^*) \leq \pi_i(x^*)$ holds, and $\theta_j > \theta_i$ implies $\pi_j(x^*) < \pi_i(x^*)$. Also, for all $j = 1, 2, \ldots, i-1$, $\pi_j(x^*) \geq \pi_{j+1}(x^*)$ holds, and $\theta_j < \theta_{j+1}$ implies $\pi_j(x^*) > \pi_{j+1}(x^*)$.*

We present the proof of Theorem 1 only since the proof of Theorem 2 is a mirror image of that of Theorem 1.

Proof of Theorem 1. First of all, we have

$$\pi_j(x^*) = \pi_i(x^*) + \int_{x_i^*}^{x_j^*} [P(X^*) - C'(y)]\, dy. \tag{8}$$

Inequality

$$P(X^*) - C'(x_i^*) > 0 \tag{9}$$

follows $\pi_i(x^*) > -C(0)$; for if not, $C''(\cdot) \leq 0$ implies $P(X^*) - C'(y) \leq 0$ for all $y \leq x_i^*$, which implies $\pi_i(x^*) \leq -C(0)$. Let $\bar{y} = \sup\{y \in [0, x_i^*] | P(X^*) - C'(y) \leq 0\}$ if it exists, and let $\bar{y} = 0$ if it does not exist. Since $C''(y) \leq 0$ for all y, we have $P(X^*) - C'(y) \leq 0$ for all $0 < y \leq \bar{y}$, and $P(X^*) - C'(y) \geq 0$ for all $y \geq \bar{y}$. Note also that $x_i^* > \bar{y}$.

Take any $j < i$. From Lemma 1, $x_j^* \leq x_i^*$ holds. If $x_j^* \leq \bar{y}$ holds, then we have $\pi_j(x^*) \leq -C(0)$, and therefore, $\pi_j(x^*) < \pi_i(x^*)$. If, on the other hand, $x_j^* > \bar{y}$ holds, then we have $P(X^*) - C'(y) > 0$ for all $y \in [x_j^*, x_i^*]$ Therefore, from (8), we have $\pi_j(x^*) \leq \pi_i(x^*)$. In particular, if $\theta_j < \theta_i$ holds, then Lemma 1 implies $x_j^* < x_i^*$, which in turn implies $\pi_j(x^*) < \pi_i(x^*)$.

Next, take any $j = i, i+1, \ldots, n-1$. Then from (8), $\bar{y} \leq x_i^* \leq x_j^* \leq x_{j+1}^*$ implies $\pi_j(x^*) \leq \pi_{j+1}(x^*)$. In particular, if $\theta_j < \theta_{j+1}$ holds, then Lemma 1 implies $x_j^* < x_{j+1}^*$. Thus, from (8) and (9), we have $\pi_j(x^*) < \pi_{j+1}(x^*)$. ∎

The profit maximizer chooses an output level at which price is above marginal cost, and therefore, from the viewpoint of competition across firms, it tends to "underproduce." If the alternative objective function has an output increasing effect, it leads to a higher profit provided that the marginal cost is nonincreasing.

In order to validate Theorems 1 and 2, we need to keep the assumptions in the statements (though one can weaken them to some degree). Indeed, the theorems do not hold if some assumptions are violated. Examples 1 and 2 are counterexamples. In these examples, we use revenue as the alternative objective, i.e., $F(X, x_i) = P(X)x_i$. Example 1 shows that even if $\pi_i^* > 0$ holds for some i, it does not necessarily imply that the profit is ordered in the same way as θ_j's.

Example 1 *Suppose $n = 3$ with $\theta_1 = 0$, $\theta_2 = \varepsilon$, and $\theta_3 = 1$. Let $P(X) = 1 - X$, and $C(x_i) = c\left(x_i - \frac{1}{2}(x_i)^2\right)$ where $c = \frac{1}{2-\varepsilon}$. In this setup, $\varepsilon > 0$ is sufficiently small. After tedious calculation, the solution is:*

$$\begin{aligned} x_1^* &= 0, \\ x_2^* &= \tfrac{\varepsilon}{4-\varepsilon}, \\ x_3^* &= \tfrac{1}{2}\left(1 - \tfrac{\varepsilon}{4-\varepsilon}\right). \end{aligned} \tag{10}$$

Then the profits are:

$$\begin{aligned} \pi_1^* &= 0, \\ \pi_2^* &= \left[\tfrac{1}{2}\left(1 - \tfrac{\varepsilon}{4-\varepsilon}\right) - c + c\tfrac{\varepsilon}{4-\varepsilon}\right] x_2^* \\ &\propto -\tfrac{1}{2}\left(1 - \tfrac{\varepsilon}{4-\varepsilon}\right) < 0, \\ \pi_3^* &= \left[\tfrac{1}{2}\left(1 - \tfrac{\varepsilon}{4-\varepsilon}\right) - c + c\tfrac{1}{2}\left(1 - \tfrac{\varepsilon}{4-\varepsilon}\right)\right] x_3^* \\ &\propto \tfrac{1}{2}\left(1 - \tfrac{\varepsilon}{4-\varepsilon}\right) - \tfrac{1}{2-\varepsilon}\left(1 + \tfrac{\varepsilon}{4-\varepsilon}\right), \end{aligned} \tag{11}$$

where the last expression is positive if ε is sufficiently close to zero. Thus, we have $\pi_1^* = 0, \pi_2^* < 0, \pi_3^* > 0$. In particular, $\pi_1^* > \pi_2^*$ holds in spite of $\pi_3^* > 0$.

3.3 Profit: Case of increasing marginal costs

If the marginal costs of these firms are increasing, then $\pi_i^* > 0$ for all i does not necessarily imply that the profit is ordered in the same way as θ_j's. Example 2 shows this point.

Example 2 *Suppose $n = 3$ with $\theta_1 = 0$, $\theta_2 = \frac{1}{2}$, and $\theta_3 = 1$. Let $P(X) = 1 - bX$ with $b > 1$, and $C(x_i) = x_i^2$. The solution is:*

$$x_1^* = \frac{b+1}{4b^2 + 9b + 4}, x_2^* = \frac{b+2}{4b^2 + 9b + 4}, x_3^* = \frac{(b+1)(b+2)}{b(4b^2 + 9b + 4)},$$

$$\pi_1^* = \frac{(b+1)^3}{(4b^2+9b+4)^2}, \pi_2^* = \frac{b(b+2)^2}{(4b^2+9b+4)^2}, \pi_3^* = \frac{(b-1)(b+1)^2(b+2)^2}{b^2(4b^2+9b+4)^2},$$

and we have $0 < \pi_1^* < \pi_3^* < \pi_2^*$ *iff* $b+1 > b^2 > 2$.

The above example shows that if a firm puts too much weight on F, then it may overproduce compared to the profit maximizing quantity. However, if the weight on F is not too large, its profit exceeds that of a profit maximizer. The following theorem states that this is the case.

Theorem 3 *Suppose that* $P'(X)x_i + P(X) - C'(x_i) \geq 0$ *implies* $F_1(X, x_i) + F_2(X, x_i) > 0$. *Let* $\theta_i = 0$. *Then there exists* $\bar{\theta} > 0$ *such that for all* $\theta_j \in (0, \bar{\theta})$, $\pi_i(x^*) > -C(0)$ *implies* $\pi_j(x^*) > \pi_i(x^*)$.

Proof of Theorem 3. Assume $\theta_i = 0$ and $\pi_i(x^*) > -C(0)$. From the first order condition, this implies $P(X^*) - C'(x_i^*) > 0$. By the continuity of C', there exists a sufficiently small $\bar{\delta} > 0$ such that for all $\delta \in (0, \bar{\delta})$, $P(X^*) - C'(x_i^* + \delta) > 0$ holds. For a sufficiently small $\bar{\theta}$, if $\theta_j \in (0, \bar{\theta})$, then from the Theorem of Maximum and Lemma 1 $x_j^* \in (x_i^*, x_i^* + \delta)$ holds. Therefore, we have

$$\pi_j(x^*) - \pi_i(x^*) = \int_{x_i^*}^{x_j^*} [P(X^*) - C'(x)]dx > 0.$$

∎

4 Extension and Discussion

4.1 Delegation Games

We extend our model, albeit for a limited case, to a two stage delegation game in order to demonstrate the crucial difference between our claim and those of Vickers (1985) and Fershtman and Judd (1987).

Suppose that there are two firms, each of which is an owner-manager pair. In the first stage, each owner endows her manager with an objective function. The objective functions of managers are weighted averages of profit and revenue, and the firm owners specify the weights in the first stage. In the second stage, the managers Cournot-compete, maximizing their respective objectives. In Fershtman and Judd, the objective of the firm *owners* is to maximize profit, and the equilibrium choice of the weights is the solution. We show below that in this framework, the firm owner whose objective is not profit can attain a larger profit than the firm owner whose objective is profit.

Let $n = 2$, $P(X) = a - bX$, and $C(x_i) = cx_i$, where $a > 3c > 0$ and $b > 0$. Let the ith manager's objective function ($i = 1, 2$) be:

$$(1-\theta_i)\left(P\left(X\right)-c\right)x_i+\theta_i P\left(X\right)x_i.$$

In the Cournot-Nash equilibrium of the second stage, the profit of firm i is:

$$\frac{1}{9b}\left(a-c-c\theta_i-c\theta_{3-i}\right)\left(a-c+2c\theta_i-c\theta_{3-i}\right) \tag{12}$$

and the revenue of firm i is:

$$\frac{1}{9b}\left(a+2c-c\theta_i-c\theta_{3-i}\right)\left(a-c+2c\theta_i-c\theta_{3-i}\right) \tag{13}$$

for $i = 1, 2$.

If, as in Vickers and Fershtman and Judd, both firm owners' objectives are profit, then the subgame perfect equilibrium choice of weights by the owners in the first stage is $\theta_1^* = \theta_2^* = \frac{1}{5c}\left(a-c\right)$, and managers choose outputs $x_1^* = x_2^* = \frac{2}{5b}\left(a-c\right)$ to attain profits $\pi_1^* = \pi_2^* = \frac{2}{25b}\left(a-c\right)^2$.

Now, consider a firm owner whose objective is not profit but a convex combination of profit and revenue. Suppose that firm 1 is the same as before, i.e., firm 1 owner chooses θ_1 to maximize profit, (12). Suppose, on the other hand, that the owner of firm 2 chooses θ_2 to maximize the weighted average of profit and revenue, (12) and (13), with respective weights of $(1-\eta)$ and η. The solution to this problem is $\theta_1^{**} = \frac{1}{5c}\left(a-c-2\eta c\right)$, $\theta_2^{**} = \frac{1}{5c}\left(a-c+8\eta c\right)$, $x_1^{**} = \frac{2}{5b}\left(a-c-2\eta c\right)$, $x_2^{**} = \frac{2}{5b}\left(a-c+3\eta c\right)$, $\pi_1^{**} = \frac{2}{25b}\left(a-c-2\eta c\right)^2$, and $\pi_2^{**} = \frac{2}{25b}\left(a-c-2\eta c\right)\left(a-c+3\eta c\right)$. It is verified that $\pi_2^{**} > \pi_1^{**}$ if $0 < \eta \leq 1$.[6]

The literature on strategic delegation has provided reconciliation between the profit maximization hypothesis and the non-profit maximizing managerial behavior through the separation of ownership and management: owners

[6] Although our intention is not to have any entity choosing η, one may be interested in the following: the largest value of π_2^{**} is attained when $\eta = \frac{1}{12c}\left(a-c\right)$; the largest value of $\pi_2^{**} - \pi_1^{**}$ is attained when $\eta = \frac{1}{4c}\left(a-c\right)$.

with the profit maximization objective do not necessarily set profit as their managers' objectives. However, here, we demonstrate that even at the level of owners, a non-profit maximization objective leads to a larger resultant profit than the profit maximization objective. In other words, the separation of ownership and management alone cannot justify the profit maximization objective, and the distinction of profit as an objective and as a result is essential in understanding the nature of the problem at the root level of the firm.

4.2 The Limit Result

This subsection shows the limit result for the case of F having the output increasing effect: profit maximization as an objective leads to profit maximization as a result if there are sufficiently many firms under the assumption of increasing marginal costs. We assume that firms have non-negative profit constraints[7], i.e., firm i's problem is written as:

$$\max_{x_i \geq 0} g_i(x) \quad s.t. \quad \pi_i(x) \geq -C(0).$$

Now, we have the following statement.

Theorem 4 *Suppose that $P'(X)x_i + P(X) - C'(x_i) \geq 0$ implies $\frac{dF}{dx_i}(X, x_i) > 0$. Assume that $P(0) > C'(0) > 0$ holds, and $C''(y) > 0$ holds for all $y \geq 0$, and that firms operate under the non-negative profit constraint. Take the inverse demand function P as given. For all $\bar{\theta} > 0$, there exists $\bar{n}$ such that $n \geq \bar{n}$ implies that in an oligopoly market with n firms, for all $\theta = (\theta_1, \theta_2, \ldots, \theta_n)$ with $\theta_1 = 0$, $\pi_1^*(\theta) > \pi_i^*(\theta)$ holds for all i with $\theta_i > \bar{\theta}$.*

The logic behind this result, in the presence of the other results in the previous section, is roughly as follows. As the number of firms increases, the equilibrium price approaches $C'(0)$ from above. This implies that, under increasing marginal costs, the maximal output at which profit is non-negative converges to zero. On one hand, a firm with a positive weight θ on revenue still faces a residual demand that is strictly above its "adjusted" marginal cost curve $(1 - \theta)C'(\cdot)$ in the neighborhood of zero output. Therefore, its

[7]We can prove the same result for the case of no constraint on profit. However, the outcome is unrealistic since in that case, firms with positive weights on revenue will earn negative profit if the number of firms is sufficiently large.

output is either bounded away from zero, leading to negative profit in the limit, or equal to the amount at which the non-negative profit constraint is binding, inducing zero profit. On the other hand, a profit maximizer can always attain a positive profit if the equilibrium price is above $C'(0)$. Thus, a profit maximizer attains a larger profit than the firm with $\theta > 0$ in the limit as the number of firms tends to infinity. The formal proof is given below.

Proof. Let $\theta_1 = 0$. Take $\bar{\theta}$ as given. Consider a firm, call firm i, with $\theta_i > \bar{\theta}$. We would like to show that $\pi_1^* > \pi_i^*$ holds for a sufficiently large n no matter what the distribution of θ_j's may be. If $P(X^*) \leq C'(0)$, then $C''(0) > 0$ and the non-negative profit constraint imply $x_j^* = 0$ for all j, which is a contradiction since we have $P(0) > C'(0)$. So assume $P(X^*) > C'(0)$. This implies $x_1^* > 0$ from the first-order condition, and thus $\pi_1^* > 0$. Lemma 1 is easily extended to oligopoly games with the non-negative profit constraint, so we have $x_1^* < x_i^*$. Moreover, x_1^* tends to zero as n goes to infinity; for if not, $X^* \geq nx_1^*$ goes to infinity, and our regularity conditions imply that $P(X^*)$ falls below $C'(0)$. Therefore, the first order condition for firm 1 implies that $P(X^*)$ tends to $C'(0)$ as n goes to infinity. This in turn implies that x_i^* tends to zero as n goes to infinity due to the non-negative profit constraint and $C''(\cdot) > 0$.

Now, suppose the contrary, i.e., that $\pi_i^* \geq \pi_1^* > 0$. This implies

$$(1-\theta_i)\left[P'(X^*)x_i^* + P(X^*) - C'(x_i^*)\right] + \theta_i\left[F_1(X^*, x_i^*) + F_2(X^*, x_i^*)\right] = 0,$$

since the non-negative profit condition is not binding. As n goes to infinity, $x_i^* \to 0$ implies that both the first and the second term tend to zero, i.e.,

$$\frac{d\pi_i(X^*, 0)}{dx_i} = 0, \tag{14}$$

and

$$F_1(X^*, 0) + F_2(X^*, 0) = 0, \tag{15}$$

where (14) comes from the first order condition of firm 1, the profit maximizer. But the assumption of the theorem states that (14) and (15) cannot hold at the same time. A contradiction. ∎

4.3 Price Competition

Although the driving force of our main result is the strategic effect between oligopolistic firms, it does not depend upon the specific mode of competition (strategic substitute or complement). This subsection shows, by a simple example of price-setting duopoly with differentiated products, that a similar result holds under price competition.

Suppose that if firms i and j ($i = 1, 2$; $j \neq i$) choose prices p_i and p_j, respectively, then the quantity demanded for good i is given by

$$x_i = a - p_i + \lambda p_j,$$

where we have $0 < \lambda < 1$, and firm i's profit is given by

$$\pi_i = (p_i - c)x_i,$$

where $c \in (0, a)$ is the constant marginal cost. Let firm i's objective function be

$$(1 - \theta_i)\pi_i + \theta_i p_i x_i \;=\; (p_i - (1 - \theta_i)c)x_i.$$

In an interior equilibrium, we have the first order condition:

$$a - p_i + \lambda p_j - (p_i - c(1 - \theta_i)) = 0.$$

Summing the first order conditions of the two firms, we obtain

$$2a - (2 - \lambda)(p_i + p_j) + c(2 - \theta_i - \theta_j) = 0.$$

Also, subtracting one firm's first order condition from the other, we obtain

$$(2 + \lambda)(p_j - p_i) + c(\theta_j - \theta_i) = 0.$$

Solving the above system of equations, we obtain

$$p_i^* = \frac{2a + 2c - c(\theta_i + \theta_j)}{2(2 - \lambda)} + \frac{c(\theta_j - \theta_i)}{2(2 + \lambda)}.$$

From this solution, we have

$$\pi_j^* - \pi_i^* \;=\; c(\theta_j - \theta_i)\beta,$$

where

$$\beta = \frac{a\lambda - c\lambda + c\lambda^2}{(2 + \lambda)(2 - \lambda)} > 0.$$

Therefore, $\pi_j^* > \pi_i^*$ if and only if $\theta_j > \theta_i$. In other words, the firm with the larger weight on revenue earns more profit than the one with the smaller weight.

5 Conclusion

The neo-classical formulation to model firms to have the profit maximization objective is the norm in economic theory, supported by the survival criterion and the *as if* rationale. Our contribution is in indicating the consistency of non-profit maximizing objectives of the firm with the *as if* rationale by distinguishing the resultant profit from the profit maximization objective. This holds even at the root level of firm ownership. The following quote from Friedman (1953, pp. 21-22) serves to clarify Friedman's argument and how it can be consistent with objective functions other than profit:

> ... under a wide range of circumstances individual firms behave as if they were seeking rationally to maximize their expected returns ... and had full knowledge of the data needed to succeed in this attempt; as if, that is, they knew the relevant cost and demand functions, calculated marginal cost and marginal revenue from all actions open to them, and pushed each line of action to the point at which the relevant marginal cost and marginal revenue were equal. Confidence in maximization of returns hypothesis is justified by evidence of a very different character. ... unless the behavior of businessmen in some way or other approximated behavior consistent with the maximization of returns, it seems unlikely that they would remain in business for long. Let the apparent immediate determinant of business behavior be anything at all - habitual reaction, random chance, or whatnot. Whenever this determinant happens to lead to behavior consistent with rational and informed maximization of returns, the business will prosper and acquire resources with which to expand; whenever it does not, the business will tend to lose resources ... The process of "natural selection" thus helps to validate the hypothesis...

Appendix: A Literature Review

The questioning of the profit maximization objective and suggestions of alternative modes of firm behavior has a long history. The work of Berle and Means (1932) marks the beginning of the managerial theory of the firm by pointing out the decreasing role of shareholders and accompanying shift of managerial functions to the administrators of the firm.[8]

Major developments in the managerial theory of the firm took place in the 1950's and 1960's along with the advent of large corporations in the U.S. economy. It was argued that in an environment of uncertainty and organizational complexity, given the management-ownership (shareholder) separation, it is more realistic to hypothesize that managers pursue objectives other than profit. Cyert and March (1956) contend that the objective of the firm is to attain an acceptable level of profit where this level is a norm defined by past experience and outside standards. Baumol (1959) analyzes the firm that maximizes revenue subject to a minimum profit constraint (pp. 45-72). This is extended to maximization of the growth rate of revenue in Baumol (1962). In Cyert and March (1963), firms are adaptive organisms that cope with problems as they arise instead of maximizing any objective. Oliver Williamson (1963, 1964) formulates the utility function of the manager (maximized subject to a minimum profit constraint) that contains as arguments staff expenditure and managerial emoluments. These arguments are means by which the manager's goals are achieved: size of staff expenditure being related to the manager's promotion, salary, security, power, prestige, and professional achievement, and emoluments including perquisites such as discretionary expense account and office size. In Marris (1963), managers maximize the growth rate of firm size subject to a minimum profit constraint, where firm size is defined by the amount of corporate capital (fixed assets, inventory, and cash reserves). John Williamson (1966) provides a comparison of profit maximization, growth rate maximization, and discounted revenue maximization. These authors typically argue that the minimum profit constraint come from the job security interest of the managers: a low profit level (thus share price) increases the likelihood of takeovers. Yarrow (1976) is critical of the ad hoc nature of managerial theories and suggests standardization by the use of the same constraint on the managers across models.

Another class of models that does not assume profit maximization is that of the labor managed firm. Dreze (1976) and Meade (1972) represent the initial contributions. Based on the recognition that employees play a role in the firm's decision making, the labor managed firm is viewed to be a maximizer of employee welfare. In Ward (1958), firms maximize net revenue (revenue net of non-labor costs) per employee. Miyazaki (1984) and Miyazaki and

[8]Boulding (1942) gives an analysis of the developments in the 1930's.

Neary (1983, 1985) define welfare of each employee as utility from wage and leisure weighed by the probability of losing the job.[9] Aoki (1980) takes this further to let the firm's objective be the Nash bargaining solution between shareholders and employees. In Aoki (1983), he proposes to model the firm as a coalition of shareholders, employees, and business partners.

As discussed in the introduction, theories that hypothesize firms that have objectives other than profit have been criticized in regard to the long-run viability of the firm (Alchian, 1950): since surviving firms act *as if* they maximized profit, we can model firms as having the profit maximization objective (Friedman, 1953). Enke (1951) is critical of profit maximization for the short-run, but supports the *as if* rationale for the long-run. Scherer (1970, p.34)[10] states that the profit maximization objective is promoted by (1) disappearance of firms that depart too far from the profit maximization objective and survival of those that conform to it knowingly or unknowingly, and (2) adaptation of behavior of surviving firms by other firms.

The managerial theorists were aware of the profit-for-survival criterion. Marris (1963), Kaysen (1966), and Scherer (1970, p. 36) argue that although firms in highly competitive markets are constrained to maximize profits, firms in less competitive markets earn enough profits to pursue goals other than profit maximization.[11]

Peterson (1965) provides a counter-argument that profit margins are not large even for firms with market power, and in a world of constant change and uncertainty, firms still need to maximize profits for survival.[12] Cyert and Hedrick (1972) summarize the debate, stating that there is evidence of unease of the neo-classical profit maximization hypothesis but no displacement of it. They are critical of the *as if* rationale that it ignores the internal workings of individual firms.

These were followed by the strategic delegation literature in which stage

[9] Kaneda (2000) models competition between profit maximizing and profit-per-employee maximizing firms in a monopolistic competition market.

[10] Chapter 2 of Scherer's text contains a survey that helped us greatly.

[11] Note that in our model it is the less competitive market in which there can be a divergence between profit as the objective and the resulting profit, due to the strategic effects. Moreover, although there is recognition in the managerial theory literature that non-profit maximization objectives are more likely in less competitive markets, none of the papers realize that such objectives can give rise to profits higher than that attained by the profit maximization objective.

[12] This view was disagreed by Berle (1965) and Kaysen (1965) in the same symposium issue.

1 players with the profit maximization objective endow stage 2 players with non-profit objectives. Brander and Spencer (1983), Vickers (1985), Brander and Lewis (1986), Fershtman and Judd (1987), and Sklivas (1987) mark the early contributions. These papers were followed by Bolton and Scharfstein (1990), Reitman (1993), Basu (1995), and Barcena-Ruiz and Espinosa (1996).

Attention also shifted reflecting theoretical advances in three areas, transaction cost economics, agency theory, and evolutionary game theory. Cyert and March (1992, Chapter 9) identify and survey these developments. We refrain from digressing on the literature of transaction costs and agency theory, as the focus of these are on the internal organization of the firm, while our attention is on viability of firms with non-profit maximizing objective functions.

The profit maximization hypothesis has also been questioned in the field of evolutionary game theory.[13] Vega-Redondo (1997) considers an infinite repetition of n-firm Cournot oligopoly and applies a stochastic evolutionary dynamic to it. In this model, the greater the profit of a firm is, the more likely is its behavior to be imitated. He then shows that the total output converges to the Walrasian outcome where the price equals the marginal cost. This implies that those who survive in the long run are not profit maximizers.[14]

[13]Not only this hypothesis, but also rationality has been questioned in this field. In Blume and Easley (1992), they consider an evolutionary process in an asset market in which people accumulate wealth through portfolio choices, and show that fit rules need not be rational.

[14]See also Rhode and Stegeman (1995).

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