Social Inefficiency of Entry under Imperfect Competition: A Consistent Explanation*

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Abstract

We consistently explain the excess entry theorem from the standpoint of the difference between the social planner's objective and each firm's one under standard oligopoly model. We introduce industry cost function which is derived from fitting-in function, and establish as follows: (1) Under second-best regulation, the real objective discrepancy results in the social inefficiency of entry from the first-best viewpoint. (2) Under no intervention the fictitious objective discrepancy generates entry bias from the second-best viewpoint, and both discrepancies generate this bias from the first-best one.

Key Words : Excess entry theorem, Real objective discrepancy, Fictitious objective discrepancy

JEL Classifications Numbers: C43, L13

1. Introduction

Recently some advanced high-tech industries (software, biomedical, and network service) belong to information and technology. These industries have a common cost structure, which consists of high fixed setup cost and low variable production cost. A firm must pay enormous expenditure on the development of "information goods" or the building of network, but after the setup stage, it can supply "information goods" with low production cost[1]. Economy of scale exhibits in these industries. The similar cost structure appears in telecommunication, electricity, airline industries and so on.

* We thank to Shingo Ishiguro (Osaka University), Toru Kikuchi (Kobe University), Tetsuya Kishimoto (Kobe University), Ei-ichi Miyagawa (Columbia University), Ryoichi Nagahisa (Kansai University), Noritsugu Nakanishi (Kobe University), Masao Oda (Kansai University), Tadashi Sekiguchi (Kyoto University), Koji Shimomura (Kobe University), Hajime Sugeta (Kansai University) for valuable comments. Of course, any remaining errors are in ours.

1) See Shapiro and Varian (1999) about the definition of "information goods."

The typical market structure in these industries become oligopoly by large fixed setup cost. In quantity-setting oligopoly with fixed setup cost, von Weizsäcker (1980), Perry (1984), Mankiw and Whinston (1986), and Suzumura and Kiyono (1987) analyzed whether free-entry equilibrium brings about social efficient outcome. They examined two types of government intervention: (1) First-best entry regulation: In order to maximize social surpluses, a social planner determines the number of operating firms, and sets their outputs. (2) Second-best entry regulation: the planner can only determine the number of firms, and cannot intervene firm's behavior. They also investigated free-entry case (no intervention), which each firm engages in the two stage game: at the first stage, each entrant determines whether it enters the market or not, and at the second stage it behaves as a quantity-setting oligopolist.

Mankiw and Whinston (1986) and Suzumura and Kiyono (1987) compared the outcomes under government intervention with that under no intervention. By assuming the quasi-competitiveness and a zero-profit condition, they established *excess entry theorem*: (1) In the sense of first-best, firms enter the market excessively. (2) In the sense of second-best, if business-stealing (business-augmenting) effect prevails, then entry is excessive (insufficient). Business-stealing (Business-augmenting) effect means that the increase in the number of firms reduces (enhances) each incumbent's output.

In the second-best case, Mankiw and Whinston (1986) explained inefficient entry as follows: An imperfectly competitive firm produces at a less output level than the efficient one, and cannot fully exhaust the scale economy at the free-entry equilibrium. Business-stealing effect produces the divergence between the planner's marginal evaluation of entry and entrant's one, because the planner calculates business-stealing effects but the entrant does not. They, therefore, concluded that imperfect competition and business-sterling effect result in entry bias, and that perfect competition achieves the efficient allocation. In the first-best case, however, no previous researchers have tried to explain the cause of entry bias.

The purpose of this paper is to explain the entry inefficiency consistently from the standpoint of difference between the social planner's objective and each firm's one. We adopt an analytical method called "fitting-in" function by Selten (1973) and Szidarovsky and Yakowitz (1977). By this method, we can clearly compare three interventions: the first-best entry regulation, the second-best one, and no intervention[2]. By this fitting-in function, we can regard the effect of entry as *a marginal change in the total output*. We also define "industry marginal cost", that is, the increment in the total industry cost associated with the marginal change.

We establish the followings. (1) Second-best regulation: Social inefficiency is only caused by "real objective discrepancy," that is, the difference between social planner's objective

2) Previous researches regarded the number of firms as the fundamental variable.

and each firm's one in the sense of first-best. (2) No intervention (Free-entry): The free-entry equilibrium can be regarded as a second-best equilibrium in which the social planner holds a "fictitious" objective, which is different from the planner's true one. Social inefficiency appears because of both real and fictitious objective discrepancies in the sense of first-best. On the other hand, the inefficiency is invoked by only "fictitious objective discrepancy" in the sense of second-best.

The rest of papers is organized as follows: In section 2, we present an oligopoly model after Mankiw and Whiston (1986). We show preliminary results by introducing fitting-in function, an industry marginal and an average cost functions. Section 3 offers an explanation from the standpoint of real and fictitious objective discrepancies. Concluding remarks are given in the section 4.

2. The model and analysis

We begin with examining no intervention case. Following Mankiw and Whinson (1986), we construct a two stage game: At the first stage, each potential entrant decides whether it enters a market or not. At the second stage, each identical firm behaves as a quantity-setting and profit-maximizing oligopolist in a homogenous good market. The profit of firm i is

$$\pi_i = p(Q)q_i - c(q_i), \tag{1}$$

where Q is industry output, $p(Q)$ shows a inverse demand function with, $p'(Q)<0$, q_i is quantity supplied by firm i, $c(q_i)$ represents an identical cost function. We impose the following:

Assumption 1: $c(q_i)$ is convex with $c(0)>0$.

Assumption 1 specifies economies of scale and implies that firm i's average cost curve, $c(q_i)/q_i$ has downward sloping in $[0, \bar{q}]$, where $\bar{q}$ is the minimum efficient scale.

Mankiw and Whinston (1986) did not explicitly specify a market structure in the post-entry stage. They considered imperfect competition as a competitive mode where price exceeds marginal cost. Then, we assume the following:

Assumption 2: $P(Q) - c'(q_i) \geq 0$ for all q_i and Q.
Assumption 3: An increase in the number of operating firms enhances total output[3].

3) See Ruffin (1971) and Okuguchi (1973). Mankiw and Whinston (1986) assumed this property.

Assumption 3 implies that quasi-competitiveness holds.

We solve the subgame perfect equilibrium of this game. Suppose that n identical firms compete in the market at the second stage. The profit-maximizing condition of each firm is given by

$$p(Q) + \phi(q_i, Q) = c'(q_i), \tag{2}$$

where $\phi(q_i, Q) \leq 0$ from Assumption 2. It means a reduction of each firm's marginal revenue through strategic interactions among firms. If each firm behaves in Cournot fashion, then $\phi(q_i, Q) = -p'(Q)q_i$. The LHS of (2) shows a private marginal benefit of production and the RHS is its marginal cost. We focus on the symmetric equilibrium, $q_i = q$. At the first stage, each firm's profit is driven down to zero in a long-run (free-entry) equilibrium, that is

$$p(Q) - c(q)/q = 0. \tag{3}$$

Next consider two types of entry regulation: first-best entry regulation and second-best one. A social planner has an objective function TS consisting of total surpluses, i.e. the sum of consumers' surpluses, a representative firm's profit, and its rivals' ones:

$$TS = \left[\int_0^Q p(s)ds - p(Q)Q\right] + \pi_i + \sum_{j \neq i} \pi_j. \tag{4}$$

Under the first-best entry regulation, the planner can determine not only the number of operating firms but also quantity supplied by each firm. By Harris (1981) and Suzumura (1995), we formulate the first-best entry regulation as a two-stage single decision problem: At a first stage, the planner sets the number of entrants. At the second stage, given the number of firms, she assigns each entrant's output. Under the second-best entry regulation, she can only decide the number of entrants at the first stage. She plays the following two-stage game against firms: At a first stage, the planner selects the number of firms. At the second stage, each firm behaves as a quantity-setting oligopolist.

Let solve both the entry regulation problems. Under the first-best entry regulation, the planner assigns each firm's output to maximize her objective TS at the second stage. Note that when the planner determines the concerned firm's output, she regards the other firms' as given. The planner solves this problem under Cournot conjecture. The first order condition is

$$-p'(Q)Q + [p(Q) + p'(Q)q_i] + \sum_{j \neq i} p'(Q)q_j = c'(q_i). \tag{5}$$

The first term on the LHS of (5) shows an impact on consumers' surpluses caused by marginal increase in a concerned firm's output. The second term is marginal revenue of the concerned firms. The third term corresponds to the sum of changes of rivals' revenues. The LHS is the social marginal benefit of production, whereas the RHS is its social marginal cost. We rewrite (5) as

$$p(Q) = c'(q)^{4)}. \tag{5'}$$

Under second-best regulation, the first order condition at the second stage is the same as (2).

From (2) or (5)', we can define a "fitting-in" function originated by Selten (1973), which relates individual firm's output to the total output:

$$q = f_k(Q),\ k = FB \text{ or } SB, \tag{6}$$

where *FB* (*SB*) stands for first-best (second-best) entry regulation case. We obtain the equilibrium number of firms as a function of Q:

$$n_k = \frac{Q}{f_k(Q)} \equiv g_k(Q). \tag{7}$$

Assumption 3 ensures that

$$g_k'(Q) > 0, \text{ i. e., } f_k'(Q) < 1/n_k. \tag{8}$$

Mankiw and Whinston (1986) defined business-stealing (-augmenting) effect that each incumbent's output decreases (increases) as an entrant arrives at the market. From (6) and (8), we derive

Lemma 1: If and only if business-stealing (-augmenting) effect prevails, then $f_k'(Q)$ is negative (positive)[5].

We proceed to examining the first-stage problem. Taking account of (6) and (7), we define an *industry total cost* function, $ITC_k(Q)$ as

$$ITC_k(Q) = g_k(Q)c(f_k(Q)),\ k = FB, SB. \tag{9}$$

which means the sum of total cost which all operating firms have to pay if the total output is Q. From (6), (7), and (9), we rewrite the planner's objective (4) as

$$TS_k(Q) = \left(\int_0^Q p(u)du - p(Q)Q\right) + g_k(Q)p(Q)f_k(Q) - ITC_k(Q). \tag{10}$$

Because Q is an increasing function of n from Assumption 3, the maximization problem for

4) If the cost function is linear, we cannot define the fitting-in function, but directly solve the first-best problem. In this case, the planner allows only one firm to enter the market and forces marginal cost pricing to the firm.

5) Business-stealing (Business-augmenting) effect implies that strategic interaction among firms becomes strategic substitute (complement) named by Bulow, Geanakopolos, and Klemperer (1985).

the planner is modified as

$$\max_{Q}.\ TS_k(Q).$$

The planner maximizes $TS_k(Q)$, foreseeing the second stage equilibrium summarized by (6) and (7). The first-order conditions of the problem are given by

$$-p'(Q)Q + [p(Q) - c(f_k(Q))/f_k(Q)] + g_k(Q)p'(Q)f_k(Q)$$
$$+ \{[p(Q) - c'(f_k(Q))] - [p(Q) - c(f_k(Q))/f_k(Q)]\}\varepsilon_k(Q) = 0, \quad (11)$$

where $\varepsilon_k(Q) \equiv Qf_k'(Q)/f_k(Q)$, which is the each firms output elasticity of total output. Every term on the LHS of (11) means the marginal benefit and cost resulting from entry regulation: the first term is the impact on the consumers, and the second one shows entrant's profit, the third is a decrease in all incumbents' revenues through the change in the market price, and the last term indicates the incumbents' profits change originating from strategic interaction between incumbents and entrant. Because $g_k(Q)f_k(Q) = Q$, we can rearrange (11) as

$$p(Q) = IMC_k(Q), \quad (11)'$$

where

$$IMC_k(Q) = \frac{c(f_k(Q))}{f_k(Q)} + \varepsilon_k(Q)\left[c'(f_k(Q)) - \frac{c(f_k(Q))}{f_k(Q)}\right]. \quad (12)$$

Equation (11)' means that the social marginal benefit resulting from entry, that is, market price is equal to its additional cost which the entrant incurs. This additional cost is called as an *industry marginal cost.* We can also define an *industry average cost* $IAC_k(Q)$

as $IAC_k(Q) \equiv n_k(Q)c(f_k(Q))/Q = c(f_k(Q))/f_k(Q)$. We rewrite (12) as

$$IMC_k(Q) = IAC_k(Q) + Q \cdot IAC_k'(Q). \quad (12)'$$

We assume that the second order conditions of (11) hold at the entry stage.

Assumption 4: $IMC_k(Q)$ is a nondecreasing function of Q.

Using the industry average cost function, the zero-profit condition (3) is modified as

$$p(Q) = IAC_{SB}(Q), \quad (13)$$

which means the private marginal benefit resulting from entry equals the industry average cost.

Finally we can describe the equilibrium outcomes in three types of intervention regime (first-best, second-best, and free-entry). We denote the free-entry equilibrium by (q^{FE}, Q^{FE})

satisfying (2) and (13). In the first-best regulation, the equilibrium is described as the pair (q^{FB}, Q^{FB}) satisfying (5) and (11). In the second-best one, its equilibrium is written by the pair (q^{SB}, Q^{SB}) satisfying both (2) and (11). We establish the following Lemma 2 to compare the three outcomes.

Lemma 2: Suppose that Assumptions **1-4 hold.** If the marginal benefit at the second stage is (not) smaller than that at the first stage, then each firm (does not) produce less than the minimum efficient scale $\bar{q}$.

(*proof.*) From the first order conditions at the each stage under three interventions, the following relationship obtains: The difference between the marginal benefit at the first stage and that at the second stage becomes $(1 - \delta\varepsilon_k)\ (c' - c/q)$ where $\delta = 1$ in the first or second -best regulation case, and $\delta = 0$ in no intervention case. Because Assumption 3 ensures that $\varepsilon_k < 1$ from (8), therefore, if the marginal benefit at the first stage is (not) smaller than that at the second stage, then $q < (\geq) \bar{q}$. *Q. E. D.*

3. An explanation

We examine why three equilibrium outcomes differ. The planner has two policy instruments in the first-best entry regulation: (i) the output of each incumbent and (ii) the number of operating firms. Both the instruments affect the marginal benefit at each stage by changing the total output. At the equilibrium, these two marginal benefits should be equalized. In other words, at the equilibrium, the marginal value of total output at the first stage should be the same as that at the second stage. From (5)' and (11)', the marginal cost of each firm also equals the industry marginal cost, which implies that each firm produces at the minimum efficient scale $\bar{q}$ from Lemma 2.

Under the first-best regulation, therefore, the planner does not have any incentive to change the incumbents' outputs when she determines the number of entrants, because the industry average cost is minimized; the industry marginal cost is equal to the industry average cost. The planner is only concerned about the additional cost paid by entrant at the first-best equilibrium.

We investigate the second-best entry regulation. The planner can only control the number of entrants. From (2) and (5)', each entrant underestimates the marginal benefit of production, because its objective π_i differs from the planner's one TS. (See (1) and (4).) For example, under Cournot competition, a profit-maximizing firm cannot recognize the social marginal effects on consumers' surpluses and incumbents' revenues. This difference results in each firm's misestimation of the marginal benefit at the second stage. Then, each firm's marginal cost differs from the industry marginal cost, and produces less than the minimum efficient scale. The firm's resulting output deviates from the first-best equilibrium output from Lemma 2.

If strategic interaction between incumbents and entrant (business-stealing or business-augmenting effect) is invoked, an incumbent is obliged to adjust its output associated with entry. Because $q^{SB}<\bar{q}$, the strategic interaction occurs under second-best regulation. The planner has to consider evaluate not only the additional cost paid by entrant (the first term on the RHS of (12)') but also the marginal change in total industry cost experienced by the incumbents (the second term on the RHS of (12)'). Thus, the difference in the objective function at the second stage leads to inefficiency from the first-best viewpoint.

Next we compare the free-entry equilibrium outcome with the second-best one. From (11)' and (12)', we have

$$p(Q) = IAC_{SB}(Q) + Q \cdot IAC_{SB}'(Q). \tag{14}$$

(Each entrant does not take account of $Q \cdot IAC_{SB}(Q)$ in (14) at the free-entry equilibrium.) The entrant miscalculates the social marginal cost at the first stage. This miscalculation may occur at free-entry equilibrium. From (12) and (12)', if the business-stealing (-augmenting) effect prevails, then the industry average cost curve is upward (downward) sloping. Entry decreases (increases) the each incumbent's cost.

The social planner does not intervene in the free-entry case. However, we can interpret the free-entry equilibrium as if the planner holds a *fictitious* objective function that differs from her actual objective and intervenes the market to maximize this fictitious function. The fictitious objective function $\tilde{W}(Q)$ is defined by

$$\tilde{W}(Q) = \int_0^Q p(s)ds - \int_0^Q IAC_{SB}(s)ds. \tag{15}$$

At the optimum, we have

$$\tilde{W}'(Q) = p(Q) - IAC_{SB}(Q) = 0,$$

that is, the zero-profit condition (13). The social surpluses function (10) under second-best regulation is rewritten as

$$TS_{SB}(Q) = \int_0^Q p(s)ds - ITC_{SB}(Q) = \int_0^Q p(s)ds - \int_0^Q IMC_{SB}(s)ds. \tag{16}$$

We modify (15) by using (12)' and (16) as

$$\tilde{W}(Q) = TC_{SB}(Q) + \int_0^Q s \cdot IAC_{SB}'(s)ds$$

Differentiating $\tilde{W}(Q)$ yields

$$\tilde{W}'(Q) = TS_{SB}'(Q) + Q \cdot IAC_{SB}'(Q).$$

When the business-stealing (-augmenting) effect prevails at the second-best equilibrium, $\tilde{W}(Q)$ is positively (negatively) sloping from Lemma 1. This implies that the planner who holds fictitious objective function has an incentive to increase (decrease) the total output.

That is why entry is excessive (insufficient) from the viewpoint of second-best.

We can interpret the fictitious objective function. Because $\tilde{W}(Q)$ is rewritten as

$$\tilde{W}(Q) = \int_0^Q [p(s) - IAC_{SB}(s)]ds,$$

$\tilde{W}(Q)$ is measured by the sum of marginal net benefit, i.e., price minus unit cost if the actual industry cost increases by $IAC_{SB}(Q)$ resulting from additional output. But the actual cost increases by $IAC_{SB}(Q) + Q \cdot IAC_{SB}'(Q)$, because the new entrant arrives the market and each incumbent is forced to incur the additional cost increases (decreases) by $Q \cdot IAC_{SB}'(Q)$ if business-stealing (-augmenting) effect prevails. The planner with $\tilde{W}(Q)$ underestimates (overestimates) the total industry cost and this misrecognization generates overestimation (underestimation) of the social surpluses, which leads to excessive (insufficient) entry from the second-best viewpoint.

The free-entry equilibrium is identical to a second-best equilibrium in which a social planner pursues her fictitious objective. Therefore, the difference between social planner's objective and each firm's one emerges from the first-best viewpoint.

We refer to the differences between the social planner's objective and the firm's one at the second stage as *real objective discrepancy*, and differences between the planner's true objective and her fictitious one at the entry stage as *fictitious objective discrepancy*. We summarize as

Proposition: (i) Under the second-best entry regulation, the real objective discrepancy generates inefficiency from the first-best viewpoint. (ii) Under no intervention, the fictitious objective discrepancy invokes inefficiency from the second-best viewpoint. (iii) Under no intervention, inefficiency is caused by both discrepancies from the first-best viewpoint.

4. Concluding remarks

We have examined three degrees of government intervention: the first-best entry regulation that the social planner can control both a firm's output and the number of entrants, the second-best entry regulation that she can only control the number of entrant, and no intervention (free-entry). Each type of intervention regime is described as a two-stage model. We have investigated why social inefficiency of entry emerges under standard oligopoly model where each firm (social planner) seeks to maximize profit (social surpluses). By introducing the fitting-in function, we have regarded entry as a marginal increase in total output, and also to make the comparison among three equilibrium outcomes. We have consistently explained the efficiency of entry, so-called excess entry theorem, from the standpoint of the difference social planner's objective and each firm's one.

Table 1

	Real objective discrepancy	Fictitious objective discrepancy
Second-best regulation in the sense of first-best	○	×
Free-entry in the sense of first-best	○	○
Free-entry in the sense of second-best	×	○

We have establish the following results: (1) Under second-best regulation, the real objective discrepancy, that is, the differences between the planer's objective and each firm's one at production stage, causes the social inefficiency of entry from the first-best viewpoint. (2) Under no intervention, the fictitious objective discrepancy, that is, the planner's true objective and her fictitious one, results in entry bias from the second-best viewpoint, and both discrepancies lead to entry bias from the first-best one.

These results are derived from the general oligopoly model with standard assumptions. Quasi-competitiveness plays a crucial factor for the validity of the results. If quasi-competitiveness is not satisfied, validity of excess entry theorem will be a future research topic.

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