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LIMIT PRICING THROUGH ENTRY REGULATION*

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Abstract

This paper is about limit pricing under complete information and intertemporal market demands. If pre-entry and post-entry market demands are correlated, then limit pricing can be an equilibrium strategy even under complete information without government intervention. Furthermore, with government intervention, limiting entry via government dominates self-limiting strategy for the incumbent monopolist. The entry regulation by the benevolent government to prevent excess entry is exploited by the incumbent as a way to protect monopoly position. As a result, the social welfare with entry regulation is lower than under pure market equilibrium. The idea of this paper is general enough to be applied to other dynamic models of sequential entry like a location model of product differentiation.

Key words: limit pricing, intertemporal market demands, excess entry, entry regulation
JEL Classification: L12, L13, L51

I. *Introduction*

The strategic behavior of the incumbent firm confronting new entrant is the key to the study of dynamics of market structure. Even though the incumbent sometimes has an incentive to invite entry, it is more natural that the incumbent firm wants to deter entry.[1] There can be various ways to deter entry, however, one common condition must be satisfied to effectively deter entry; the incumbent's action in the pre-entry period must be able to affect the profitability of new entrants in the post-entry period.

There are several channels through which the incumbent firm can affect the profitability of new entrants. Recall that the profit of a new entrant depends on its own cost, the cost of the incumbent, and the market demand in post-entry period. Then it is not difficult to see that

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[1] There are some situations that the incumbent benefits from new entrants. For example, Economides (1996) shows that under network externality with complementarities, the incumbent firm may have incentive to invite entry, and Farrell and Gallini (1988) proves incumbent's incentive to invite entry when consumers have to incur setup costs.

signaling low cost to the new entrant under incomplete information, raising costs of new entrants, and restricting future market demand to discourage entry are the main strategies of the incumbent.

Limit pricing theory originated by Bain (1949, 1956), Modigliani (1958), and Sylos-Labini (1962) focuses on incumbent's behavior to make future market demand unprofitable to the new entrant. However, due to the development of game theory, the original idea of the limit pricing is rejected as an optimal strategy of the incumbent. It is because limit-pricing strategy does not satisfy the subgame perfection criterion. Since then the main result of the limit pricing theory changes to that in a complete information entry game, limit pricing cannot be an equilibrium strategy.

It is Milgrom and Roberts (1982) that initiates the revival of limit pricing under incomplete information. They show that under incomplete information, pre-entry stage price can be a signal of the incumbent's cost, and so can affect the entry decision of the potential competitors. Following Milgrom and Roberts, there have been a lot of researches that expand signaling strategies to affect new entrant's perception of the future profitability.[2]

We should be careful to notice that there are two key assumptions in rejecting the original limit pricing theory; complete information and time-independent market demands. Milgrom and Roberts refer to Friedman (1979) this way: "Friedman notes that, under the usual sort of assumptions on demand, the profits which would accrue should entry occur are completely independent of the pre-entry price. … Friedman's argument will be generally valid in any complete-information, game-theoretic model in which the established firm's pre-entry actions do not influence post-entry costs and demand". Even though the assumption of time-independent market demands is only implicitly described, it is clear that there must be no strategic links between pre-entry and post-entry market demands for Friedman's argument to be valid.

While the role of the incomplete information in the limit pricing analysis is now well-known, the importance of the exogenous market demand assumption in Friedman's argument is not equally recognized. It is not difficult to verify that exogenous market demand in each period is still the standard assumption in entry model.[3] However, if market demands are intertemporally linked, then the incumbent can affect post-entry market structure through its own pre-entry action even under complete information. In this paper, it will be confirmed that under intertemporal market demands limit pricing revives as an equilibrium strategy without assuming incomplete information.

Based on such a basic limit pricing analysis, what is more interesting in this paper is the fact that limit pricing is reinforced by entry regulation. It is common for the benevolent government to regulate entry to prevent excess competition. The excess entry theorem successfully proves that the free market may generate too many firms without government intervention.[4] However, once we introduce entry regulation following the recommendation of

[2] The basic model of Milgrom and Roberts is also extended to the oligopoly limit pricing under incomplete information. See Bagwell and Ramey (1991) and Schultz (1999).

[3] Kim (1993) questions the tradition of assuming the same exogenously given market demand in each period in IO, particularly in the analysis of the multiperiod dynamics like entry games. The consumptions of the pre-entry and post-entry periods are normally assumed to be substitutes and so the current price should affect future demand. Even though Kim shows the importance of time-dependent demands in analyzing dynamics of the market structure, he does not explicitly model incumbent's strategic entry deterring behavior.

[4] See Mankiw and Whinston (1986), Perry (1984), Spulber (1981), Suzumura and Kiyono (1987) and von Weizäcker (1980a, 1980b) for the excess entry theorem and its policy recommendation of entry regulation.

excess entry theorem, the incumbent's incentive will change drastically since it now has an additional way to deter entry, inducing government to regulate entry.

Under intertemporal market demands and entry regulation, the incumbent monopolist has two kinds of limit pricing strategies: self-deterring and limiting entry via government's intervention. Self-deterring is the conventional limit pricing such that the incumbent lowers pre-entry stage price to make post-entry market demand small and so entry unprofitable. On the other hand, limit pricing via government is lowering current price to make future demand small so that further entry is socially undesirable, that is excessive, even though it may be desirable to the entrant. Since the latter is less costly than the former, the incumbent strategically generates a situation of excessive competition with further entry and triggers government's entry regulation. Entry regulation by the benevolent government protects monopoly position at the cost of social welfare.

The main results of the paper are as follows. First, if current and future market demands are correlated, then limit pricing can be an equilibrium strategy under complete information without government intervention (section III). Second, with government intervention, limiting entry via government dominates self-limiting strategy for the incumbent monopolist (section IV). Third, the entry regulation to prevent excess entry is exploited by the incumbent as a way to protect monopoly position, and as a result the social welfare with entry regulation, which is aimed at enhancing efficiency, is lower than under pure market equilibrium (section V).[5] Finally, the idea of this paper is general enough to be applied to other dynamic models of sequential entry. As an example, the inefficiency of entry regulation is also proved in a simple model of horizontal product differentiation (section VI).

II. *Intertemporal Market Demands*

Assume intertemporal market demands for t_1 and t_2 as follows where x_i is the total output and p_i is the market price at t_i respectively for $i=1, 2$.[6]

$$x_1 = a - p_1 + cp_2$$
$$x_2 = a + cp_1 - p_2$$

Intertemporally linked market demands are natural in economic analyses. Consumers' intertemporal consumption decisions, pricing of the durable goods, location theory with sequential entry are some examples.[7] Especially, intertemporal market demand is an appropriate specification in dynamics models such as entry game unless the product is perishable so that

[5] This is worth a special note since it means that the policy recommendation of the excess entry theorem is misleading. Kim (1997) proves that, under a different model specification, entry regulation to prevent excess entry lowers social welfare contrary to the expectation of the excess entry literature. This paper reconfirms Kim's result with intertemporal market demands along the evolutionary path of the limit pricing theory.

[6] Singh and Vives (1984) provide a utility function that generates such demand functions, which is $U(x_1, x_2) = \frac{1}{1-c}(x_1+x_2) - \frac{c}{1-c^2}x_1x_2 - \frac{1}{2(1-c^2)}(x_1^2+x_2^2)$. Introducing discount factor for the future consumption adds no further insight.

[7] In a location model with sequential entry, the incumbent's location choice in the pre-entry period affects the profitability and the social value of new entrant in the post-entry period.

there is no interconnection between the current and the future periods.[8]

Once demands are interrelated over time, the incumbent's strategic choice of a current price (or any other strategic variables) to affect market condition in the post-entry stage becomes an important aspect of the analysis. We assume $c \in (0, 1)$, implying that current and future consumptions are substitutes and the cross price effect is less than the direct price effect. At t_1, consumers make intertemporal consumption decisions with some expectations about future price p_2, or equivalently about future entry, which should be fulfilled in equilibrium.

III. *Self-limit Pricing*

Consider a two-person two-stage game assuming that there is no government intervention at all. At t_1 firm 1 is a monopolist choosing x_1 (or p_1). At t_2 firm 2 decides on entry, and if it enters with entry cost $F>0$, firm 1 and firm 2 compete with each other à la Cournot, producing x_2^D symmetrically.[9] If firm 2 does not enter, firm 1 maintains its monopoly position producing x_2^M. Let p_2^D and p_2^M be the market prices at t_2 under duopoly and under monopoly respectively, and define firm's profit π_2^D and π_2^M in the same way.

Assume that the production costs are zero for both firms, then it is easy to find that, in the second period, given p_1, the symmetric duopoly outcome with entry is $x_2^D=(a+cp_1)/3$, $p_2^D=(a+cp_1)/3$, $\pi_2^D=(a+cp_1)^2/9$, and the monopoly outcome without entry is $x_2^M=(a+cp_1)/2$, $p_2^M=(a+cp_1)/2$, $\pi_2^M=(a+cp_1)^2/4$. Firm 2 enters the market if and only if $\pi_2^D>F$, or equivalently $p_1>p_1^o\equiv(3\sqrt{F}-a)/c$.[10] Therefore firm 1 can deter firm 2's entry with $p_1\leq p_1^o$, however, we have to check if such a limit pricing is consistent with firm 1's self-interest.

At t_1 firm 1 chooses p_1^* which maximizes two period total profit π^1.

$$\pi^1=\begin{cases}[a-p_1+cp_2^M(p_1)]p_1+\pi_2^M(p_1) & \text{if} \quad p_1\leq p_1^o\\ [a-p_1+cp_2^D(p_1)]p_1+\pi_2^D(p_1) & \text{if} \quad p_1>p_1^o\end{cases}$$

Note that consumers have perfect foresight when they make consumption decisions at t_1 such that $E(p_2|p_1)=p_2^M(p_1)$ if $p_1\leq p_1^o$ and $E(p_2|p_1)=p_2^D(p_1)$ if $p_1>p_1^o$. This is a condition for a fulfilled expectations equilibrium. Consumer expectation about future price, or equivalently about future market structure, as a function of current price, should be consistent with the actual market outcome in equilibrium.

Define p_1^M and p_1^D as the prices that maximize $(a-p_1+cp_2^M)p_1+\pi_2^M$ and $(a-p_1+cp_2^D)p_1+\pi_2^D$ respectively. And finally let p_1^L be the minimum p_1, which satisfies $(a-p_1+cp_2^M)p_1+\pi_2^M=Max[(a-p_1+cp_2^D)p_1+\pi_2^D]$. Then, the subgame perfect Nash equilibrium of the entry game without government intervention is as follows.

Lemma 1. If $p_1^o\geq p_1^M$, then $p_1^*=p_1^M$ and entry is blockaded. If $p_1^M>p_1^o\geq p_1^L$, then limit pricing $p_1^*=p_1^o$ is the optimal strategy of the incumbent and entry is deterred. If $p_1^L>p_1^o$, then $p_1^*=p_1^D$ and entry is accommodated by the incumbent firm.

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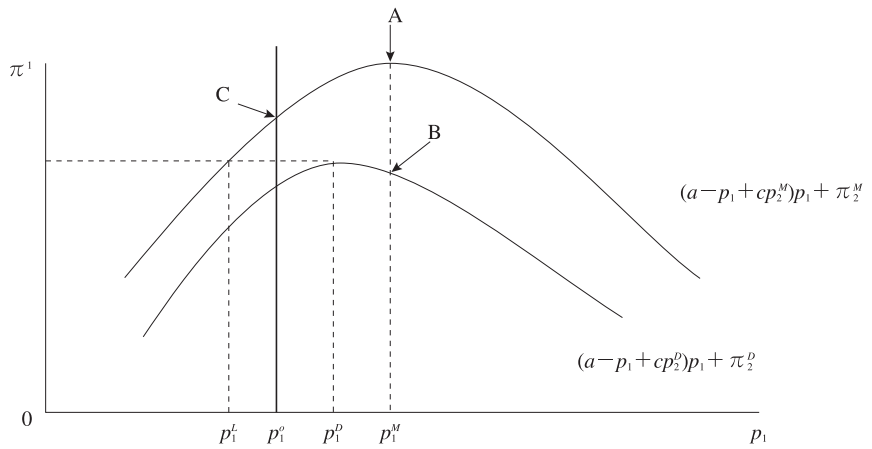
[8] If products are perishable within each period, then $c=0$.

[9] This is for the simplicity of notations and refers to the symmetric Cournot equilibrium in the post-entry stage.

[10] If entry cost F is so small and/or the market size a is large enough so that $(3\sqrt{F}-a)/c$ is negative, then $p_1^o=0$, which means that there will be an entry for all $p_1>0$.

FIG. 1. SELF-LIMIT PRICING



Proof. Omitted. (Refer to <Figure 1>.)

<Figure 1> describes the case of $p_1^M > p_1^o \geq p_1^L$ where the incumbent deters entry by lowering pre-entry period price, that is, limit pricing is the optimal strategy of the incumbent. The incumbent does not choose p_1^M because then firm 2 comes into the market to make incumbent's profits at B, not at A, but chooses a lower price p_1^o to earn profit at C, which dominates B.

Define $F^M = \left(\frac{a+cp_1^M}{3}\right)^2$ and $F^L = \left(\frac{a+cp_1^L}{3}\right)^2$. Then Lemma 1 can be rewritten in terms of entry cost F as follows.

Proposition 1. If $F \geq F^M$, then $p_1^* = p_1^M$ and entry is blockaded. If $F^M > F \geq F^L$, then $p_1^* = p_1^o$ (limit pricing) and entry is deterred. If $F^L > F$, then $p_1^* = p_1^D$ and entry is accommodated.

When entry cost is large enough, there will be no entry even though the incumbent does not try to deter entry. On the other hand, if entry cost is sufficiently small, entry cannot be deterred, or more correctly, deterring entry is too costly to be adopted by the incumbent. For intermediate values of entry cost, the incumbent will adopt limit pricing strategy and maintain its monopoly position.

Proposition 1 shows that limit pricing can be an optimal strategy of the incumbent firm even under complete information if market demands are intertemporally linked. The intuition behind Proposition 1 is extremely simple and based on the introductory economics. When the current and the future consumptions are substitutes, the incumbent firm has an incentive to lower current monopoly price to make future market demand small enough to make entry unprofitable. If the profit gain from maintaining the monopoly position in the future is more than offsetting the profit loss in the pre-entry monopoly period due to a lowered price, then limit pricing becomes an equilibrium strategy of the incumbent firm.

IV. *Limit Pricing via Government*

It is not only the incumbent firm that might want to discourage entry. The benevolent government wants to deter entry if free market generates too many firms in terms of social welfare. This is what excess entry theorem cares about. Excess entry theorem successfully shows that if (1) firms produce homogeneous products, (2) there exists business-stealing effect, and (3) market competition is imperfect due to entry cost and/or scale economy, then free market equilibrium number of firms is greater than the social optimum.[11] The natural policy implication of the excess entry theorem is therefore government's entry regulation to prevent excess market entry. However, the theorem, even though it deals with oligopoly, or imperfect competition markets, ignores firms' strategic behavior against government intervention, and so the policy recommendation of the excess entry theorem is misleading as we show in this paper.

Excess entry depends on market size and entry cost, and it is more probable with small market demand and/or with large entry cost. Therefore, when current and future consumptions are substitutes as in our model, if the incumbent monopolist charges a low price in t_1, market demand in t_2 becomes small and so further entry might be socially excessive.

Government intervention provides the incumbent with additional way to deter entry: inducing entry regulation. Now the incumbent has two alternatives to deter entry; deter entry by its own limit pricing strategy as in the previous section, and deter entry by generating the situation of excess entry and so inducing the government to regulate entry. Both strategies can be implemented by lowering current price and making future market demand small relative to entry cost. The question is which is more attractive to the incumbent; discouraging entry via self-limit pricing or inducing government to regulate entry?

To show that, for the incumbent monopolist, inducing government's entry regulation dominates deterring entry by itself, let's introduce a benevolent government into the model. Then the game structure changes slightly such that when firm 2 decides to enter, the government either allows or denies entry. As the excess entry theorem literature proposes, optimal entry regulation is to allow entry if social welfare at t_2 is higher under duopoly than under monopoly, and to reject entry otherwise.

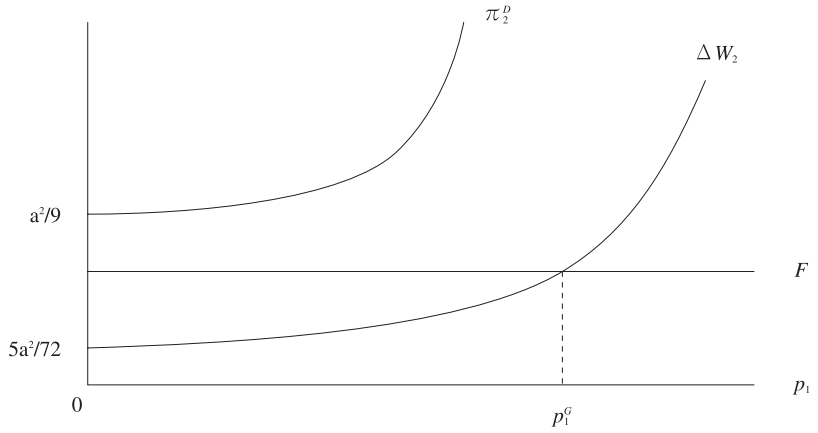
Define social welfare as the sum of consumer surplus and firm's profit ignoring entry cost. It is easy to see that the social welfare at t_2 is $W_2^D=4(a+cp_1)^2/9$ under duopoly and $W_2^M=3(a+cp_1)^2/8$ under monopoly given p_1. Let $\Delta W_2=W_2^D-W_2^M=5(a+cp_1)^2/72$ be the welfare increment at t_2 with entry given p_1. The benevolent government should allow entry if $\Delta W_2>F$ and reject entry otherwise.

Note $\pi_2^D>\Delta W_2$ in <Figure 2>, which implies that welfare increment due to additional entry is less than the profit of the new entrant. This observation that entry is more attractive to the entrant than to the whole society is the intuitive basis of the main results of this paper: limit-pricing entry via government is less costly to the incumbent than self-limiting.

It is obvious that both entry decision of firm 2 and the government's entry regulation depend on the entry cost F. More specifically, in <Figure 2>, if $F\leq 5a^2/72$ then firm 2's entry cannot be deterred by firm 1 and it is also allowed by the government for any $p_1>0$. On the other hand, if $F>a^2/9$ then entry is deterred by firm 1 (and would be also rejected by the

[11] See Mankiw and Whinston (1986) for the business-stealing effect.

FIG. 2. ENTRY AND REGULATION DEPENDING ON F



government) with low p_1, rejected by the government (while it is not deterred by firm 1) with intermediate value of p_1, and allowed both by firm 1 and by the government for high p_1. Finally, if $F \in (5a^2/72, a^2/9]$, then entry cannot be deterred by the incumbent monopolist itself with any $p_1 > 0$, however, entry can be rejected by the government for a low p_1. Since our main interest is in the case that limiting entry through government regulation is easier or less costly to the incumbent than deterring entry by itself through self-limit pricing, assume intermediate entry cost so that entry can be rejected by the government while it cannot be deterred by the incumbent itself.

Assumption 1. $5a^2/72 < F \leq a^2/9$

Note that Assumption 1 is not restrictive. Even in the case of $F > a^2/9$, we can see that entry is deterred more easily through government entry regulation than by the incumbent's limit pricing strategy. The incumbent should choose a substantially low price to deter entry by itself, however, it can induce the government to regulate entry by choosing only a relatively low price.

Let p_1^G satisfy $\Delta W_2 = 5(a + cp_1)^2/72 = F$ such that $\Delta W_2 > F$ if $p_1 > p_1^G$ and $\Delta W_2 \leq F$ if $p_1 \leq p_1^G$.

Lemma 2. Assume that $F \in (5a^2/72, a^2/9]$. Entry cannot be deterred by the incumbent monopolist's self-limit pricing strategy for any $p_1 > 0$. However, entry is regulated by the benevolent government if $p_1 \leq p_1^G$, and entry is allowed otherwise.

Lemma 2 says that the incumbent firm, even when it cannot deter entry by itself for any price $p_1 > 0$, can deter entry by inducing government entry regulation. If firm 1 chooses $p_1 \leq p_1^G$, then the post-entry period market demand becomes small enough compared to entry cost F to make firm 2's entry excessive in terms of social welfare, that is, given p_1, social welfare at t_2 is lower in duopoly than in monopoly.

Will firm 1 actually choose $p_1 \leq p_1^G$ to maintain its future monopoly position at the cost of current monopoly profit? The incumbent's decision making at t_1 is as follows.

$$\pi^1 = \begin{cases} [a-p_1+cp_2^M(p_1)]p_1+\pi_2^M(p_1) & \text{if} \quad p_1 \leq p_1^G \\ [a-p_1+cp_2^D(p_1)]p_1+\pi_2^D(p_1) & \text{if} \quad p_1 > p_1^G \end{cases}$$

As in the case without government, consumers should have correct expectations about future price in equilibrium such that $E(p_2|p_1)=p_2^M(p_1)$ if $p_1 \leq p_1^G$ and $E(p_2|p_1)=p_2^D(p_1)$ if $p_1 > p_1^G$. Recall that p_1^L is the minimum p_1 that satisfies $(a-p_1+cp_2^M)p_1+\pi_2^M = Max[(a-p_1+cp_2^D)p_1+\pi_2^D]$. Then, the subgame perfect Nash equilibrium of the entry game with government's entry regulation is as follows.

Lemma 3. If $p_1^G \geq p_1^M$, then firm 1 chooses p_1^M and entry is regulated by the government (blockaded entry). If $p_1^M > p_1^G \geq p_1^L$, then firm 1 lowers price down to p_1^G and entry is regulated (deterred entry). If $p_1^L > p_1^G$, then firm 1 chooses p_1^D and entry is allowed by the government (entry accommodated).

Proof. Omitted. (Refer to <Figure 1> replacing p_1^o with p_1^G.)

Define $F^{MG} = \frac{5}{72}(a+cp_1^M)^2$ and $F^{LG} = \frac{5}{72}(a+cp_1^L)^2$. Then Lemma 3 can be rewritten in terms of entry cost F as in the case without government.

Proposition 2. If $F \geq F^{MG}$, then firm 1 chooses $p_1^* = p_1^M$ and entry is regulated by the government (blockaded entry through regulation). If $F^{MG} > F \geq F^{LG}$, then firm 1 chooses $p_1^* = p_1^o$ and entry is regulated by the government (deterred entry through regulation). If $F^{LG} > F$, then $p_1^* = p_1^D$ and entry is allowed by the government (entry accommodated).

Proposition 2 is an extension of Proposition 1. It shows that limit pricing via government dominates self-limit pricing in the sense that entry can be deterred by the former strategy even when it cannot be deterred by the traditional self-limit pricing.

V. *Inefficiency of Entry Regulation*

At this point, it should be emphasized that excess entry theorem itself and the policy recommendation of the theorem are not consistent with each other. More specifically, excess entry theorem cannot be a justification of government entry regulation. This is because the entry regulation ignores the strategic reaction by the incumbent firm.

The incumbent who has an incentive to lower p_1 down to p_1^G to induce entry regulation would not have adopted such a limit pricing strategy if there were no government intervention from the beginning. A new entrant might not have generated excess entry without entry regulation, even though it is regulated because it generates excess entry under government intervention.

This implies that the welfare standard for entry regulation — comparing duopoly welfare with monopoly welfare under the same first period price — is incorrect. Comparing welfare based on the same p_1 seems inevitable to the government who moves only in the second stage after firm 1 chooses p_1. However, welfare with entry should be evaluated by a different p_1 from that is used to evaluate welfare without entry because the incumbent will choose different prices at t_1 with and without government intervention. The mistake of the excess entry theorem

is comparing two outcomes in different subgames unduly assuming that they occurred in the same subgame.

The point is that the government policy changes the incentive of the incumbent. The policy recommendation of the excess entry theorem ignores the simple lesson from the game theory that any government policy that ignores the reaction of the market is empty. This section will show that entry regulation, which has a correct goal but a wrong standard, is exploited by the incumbent as a strategy to protect its monopoly position, and so lowers social welfare.

Limit pricing can be interpreted as lowering pre-entry market price to deter entry below the price level that the incumbent would have chosen without entry deterring considerations. Following such an interpretation, limit pricing via government occurs for $p_1^D > p_1^G \geq p_1^L$ since firm 1 chooses p_1^G to induce entry regulation, while it would have chosen p_1^D if there were no government intervention so that no considerations of entry deterring were taken. Therefore, without loss of generality, restrict our attention on $p_1^D > p_1^G \geq p_1^L$, or equivalently on $F \in \left[\frac{5}{72}(a+cp_1^L)^2, \frac{5}{72}(a+cp_1^D)^2\right)$.[12]

Define $W_2^{M^*}$ and $W_2^{D^*}$ as the social welfare at t_2 under monopoly (with entry regulation) and under duopoly (without government intervention) respectively. Note that $W_2^{M^*}$ and $W_2^{D^*}$, which are evaluated at two different equilibria with and without government, are different from W_2^M and W_2^D, which are evaluated at the same p_1. Since p_1 is equal to p_1^D without entry regulation, and equal to p_1^G with regulation, $W_2^{D^*} = \frac{4}{9}(a+cp_1^D)^2$ and $W_2^{M^*} = \frac{3}{8}(a+cp_1^G)^2$.

Proposition 3. For $F \in \left[\frac{5}{72}(a+cp_1^L)^2, \frac{5}{72}(a+cp_1^D)^2\right)$ such that limit pricing via government is an equilibrium strategy with government intervention, while the incumbent monopolist cannot deter entry by itself, social welfare at t_2 is higher without entry regulation than with entry regulation, that is, $W_2^{D^*} - F > W_2^{M^*}$.

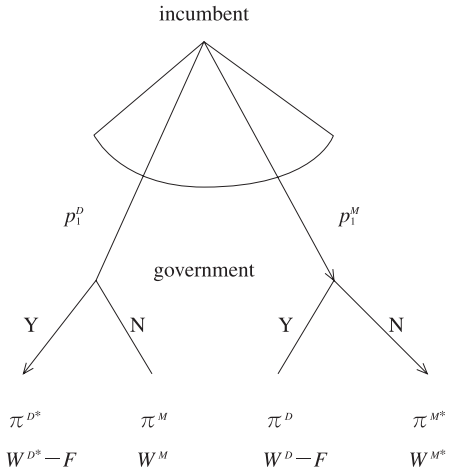
Proof. $W_2^{D^*} - F = \frac{4}{9}(a+cp_1^D)^2 - F > \frac{4}{9}(a+cp_1^D)^2 - \frac{5}{72}(a+cp_1^D)^2 = \frac{3}{8}(a+cp_1^D)^2 > \frac{3}{8}(a+cp_1^G)^2 = W_2^{M^*}$. *Q. E. D*

<Figure 3> explains why entry regulation is subgame optimal, however, it is suboptimal in the whole entry game. Figure 3 is a reduced form of the entry game between the incumbent and the regulator. When the government decides on entry regulation, it compares monopoly profit with duopoly profit. In the subgame starting after the incumbent chooses an accommodating price p_1^D the regulator allows entry since $W^{D^*} - F > W^M$. On the other hand, in the subgame after firm 1 chooses an entry-deterring price p_1^M, the government disallows entry because $W^D - F < W^{M^*}$. It is no doubt that the government acts optimally in each subgame.

The incumbent, knowing correctly about the choices of the government in each subgame,

[12] This is to focus on the main theme of the paper without incurring complicated calculation. It is possible that p_1^G belongs to the range of $[p_1^D, p_1^M)$. In this case, entry is deterred by the regulation, however, the second period market becomes larger than without entry regulation. Since such a range is small and the proof is still valid in the neighborhood of p_1^D by continuity, and furthermore, since focusing on limit pricing is enough for our purpose, we can restrict attention on $p_1^D > p_1^G \geq p_1^L$.

FIG. 3. INEFFICIENCY OF ENTRY REGULATION



Government : $W^{D*}-F>W^M$, $W^D-F<W^{M*}$

Incumbent : $\pi^{M*}>\pi^{D*}$

Social welfare : $W^{D*}-F>W^{M*}$

will choose an entry-deterring price p_1^M, since the profit in the subgame with no entry (due to regulation) is higher than that in the subgame with entry, that is, $\pi^{M*}>\pi^{D*}$. However, in this case, $W^{D*}>W^{M*}$. This means that, even though the government does its best to enhance efficiency, it fails to bring the best outcome to the society. The incumbent chooses a path of the entry game that is most favorable to itself while undesirable to the whole society.

VI. *Robustness: An Application*

The policy recommendation of anti-competitive intervention by the benevolent government is a common feature in various market competition models. The excess entry theorem itself is about the quasi-Cournot type market competition with sequential entry. However, excess entry can be observed in other market models, too. For example, in the analysis of product differentiation, whether market generates too many brands is one of the standard questions. Even though there seems no unanimous answer to this, if someone obtains a result that free market with sequential entry generates excessive brands, he concludes his paper, without an exception, with an anti-competitive policy recommendation. The similar conclusion can be found in R&D competition, capacity investment, and etc. The main theme of this paper that government intervention affects the incumbent's incentive, and the resulting critic on the policy recommendation of excess entry theorem, can be applied to these similar situations. To confirm the generality of the problem, let's examine a simple model of product differentiation with sequential entry.

Consider a linear location model à la Hotelling. The length of the product space is 1 and

the consumers are uniformly distributed according to their most preferred brands along the product space with total measure 1. Assume that firm 1 is already located at 1/4 at t_1, and firm 2 enters market at t_2 and firm 3 chooses its location sequentially at t_3 with entry cost $F>0$. To make our analysis simple and to focus on the validity of the entry regulation, assume fixed prices for all brands.[13] Note that, in a location model with sequential entry, market demands of pre-entry and post-entry stages are interrelated since the incumbent's location choice affects the demand of the post-entry period.

First, without government intervention, the equilibrium of the sequential location game is $(l_2, l_3) = (3/4, 1/2)$. Firm 2 chooses its location at 3/4 correctly expecting that firm 3 will enter at 1/2. Entry cost F is assumed to be less than 1/4, which is firm 3's post-entry profit. Note that in this situation the firm 2 cannot deter firm 3 no matter what location firm 2 chooses.[14]

Since we assume fixed prices, social welfare in the subgame starting after firm 3 enters can be evaluated by the total social cost, which is the sum of total disutility of the consumers, that is, total transportation costs, and firm 3's entry cost F. Total social cost under pure market equilibrium at t_3 is

$$TC^* = 2\int_0^{1/4} tdt + 4\int_0^{1/8} tdt + F = 3/32 + F$$

Now assume that the government is in the market with entry regulation. Then firm 2 will strategically change its location to induce the government to regulate firm 3's entry as long as such a behavior raises its own profit. What happens if firm 2 chooses at 1/2 instead of at 3/4?[15] It is clear that firm 3 will choose its location at 1/2 (slightly right to firm 2). However, if this happens at t_3, social welfare will be lowered with entry because consumers' total disutility does not change but new entry incurs social cost F. The benevolent government will reject firm 3' s entry, and it is obvious that firm 2 prefers this (duopoly) to allowing firm 3's entry (oligopoly of three firms). With entry regulation, the total social cost TC at the equilibrium is

$$TC^G = \int_0^{1/4} tdt + \int_0^{1/2} tdt + 2\int_0^{1/8} tdt = 11/64.$$

Note that entry cost is not included in the total social cost under government entry regulation.

Finally, does entry regulation really protect social welfare by preventing excess entry? The answer is negative when $F<5/64$ since $TC^*<TC^G$. To sum, when $F<5/64$, entry cannot be deterred by the incumbent firm itself; however, it will be regulated by the benevolent government. Furthermore, social welfare is lower under entry regulation than under pure market equilibrium even though entry regulation is evoked to prevent excess entry. The entry regulation which aims at preventing socially undesirable excess entry turns out to prevent socially desirable competition and protects incumbents' interests at the cost of social welfare.

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[13] This simple model is based on Shy (1995), pp.156-159.

[14] There is a late-mover advantage in this fixed price sequential entry model so that any other location choice by firm 2 than 3/4 will lower firm 2's profit and raises firm 3's profit. That is to say that firm 2's location at 3/4 gives minimum profit to firm 3.

[15] This is not an equilibrium location. The optimal choice of firm 2 will be at 1/4 correctly expecting that firm 3 will choose also at 1/4, which will be rejected by the government. I choose a less drastic situation which is enough for demonstrating the main point.

VII. *Concluding Remarks*

The main results of the paper are as follows. First, limit pricing revives as an optimal strategy of the incumbent firm with intertemporal market demands even under complete information. Second, limit pricing via government dominates self-limit pricing. Third, entry regulation to prevent excess entry is exploited by the incumbent to protect its monopoly position so that social welfare is lower under entry regulation than under free market. Finally, the idea of this paper is general enough to be applied to other dynamic models of sequential entry with and without government intervention.

It is not much surprising that limit pricing emerges as an equilibrium strategy when current and future consumptions are substitutes. Intertemporal demands provide a channel through which the incumbent's action in the pre-entry stage can affect new entrant's profitability in the post-entry period. What is more striking in our analysis is that limiting entry through entry regulation is very much attractive to the incumbent, that is, it dominates self-limit pricing strategy, and so harmful to the whole society.

The entry regulation, which aims at preventing excess entry and saving social welfare, is exploited by the incumbent to maintain its monopoly position at the cost of social welfare. Entry regulation, which is optimal only in the subgame starting after the incumbent' move, turns out to be suboptimal in the whole entry regulation game.

Two related issues can be raised as concluding remarks. The first is designing a general model which assumes both intertemporal market demands and asymmetric information. If we combine intertemporal demands and asymmetric information about incumbent's cost, then limiting entry might become easier than with just one model specification. It is because choosing a low price as a signal of low cost to prevent entry reinforces entry deterring by making future market demand small.

Another question is how the benevolent government can overcome its strategic disadvantage against the incumbent firm. The government might disallow a low price by the incumbent monopolist which strategically generates excess entry in case of new entry. However, can it be acceptable by the public? Disallowing a low price to prevent firms' strategic behavior of entry deterring is similar to regulating predatory pricing or traditional limit pricing. We need to check the validity of such a regulation as we did regarding entry regulation suggested by excess entry theorem.

Note that the inefficiency of the entry regulation is not due to the government's late-mover disadvantage in entry regulation game. There will be no change in the result if we assume that entry regulation, the condition of entry permission, is predetermined even before there exists a new entrant, even though the optimal entry regulation when the government moves first and takes incumbent's strategic reaction into considerations will be different from that presented in this paper.[16] What is crucial is that the regulator only cares about the aggregate market performance, not about who produces how much. As long as the incumbent's choice of low price is not regulated, entry regulation is subject to incumbent's strategic exploitation.

[16] As the anonymous referee points out, such a conjecture needs to be confirmed with a full derivation of the new equilibrium. We save this issue for future research.

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