ON THE THEORY OF THE ENTRY-PREVENTING PRICE AS AN OPTIMAL PRICING STRATEGY*

GENTARO MATSUMOTO

I. INTRODUCTION

The Theory of the Entry-preventing Price deals with the long-run optimal pricing behavior of the oligopolistic firm which is confronted with not only existing rivals in its particular industry but also potential competitors. We will call the latter "potential entrants".

It is a rational assumption that if existing firms enjoy excess profits, that is when the price exceeds the average production cost (including the normal profits), new entrants will come into existence and make the excess profits zero. However, the theory of the entry-preventing price focuses our attention on the interesting case where an entry is prevented by —and within the limits of— certain price-output policies of the existing producers. This theory was integrated by F. Modigliani [9], and now, is referred to as the SBM model. The price level at which the existing firms can gain excess profits without stimulating an entry is called as the Entry-Preventing Price. And the entry-preventing price is based on the barriers to new entry, which means the existing firms' advantages over the potential competitors.

Hitherto, the SBM model was the authority for a lot of econometric research on the barriers to entry. But it has only a static framework. As Modigliani criticized, the analyses in the area of oligopolistic market structures, particularly, the theory of the entry-preventing price, are still largely limited to a static framework, and there is a reason to believe that certain aspects of oligopolistic behavior can be adequately accounted for only by explicitly introducing dynamic elements into the analysis.

From the new entrant's point of view, the attractiveness of a particular industry is profitability both now and the future. Future profitability depends upon whether that industry has the ability to grow or not. In this paper, we investigate the dynamic optimal pricing policy of the oligopolistic firm and consider the effects of the barriers to new entries in a growing industry as compared with a stationary industry. In the next section, we extend the SBM model to cover the case of a growing industry and discuss the level of entry-preventing price. In section III, we explore the problem of

* The author is grateful for helpful comments from Professor Yoshihiro Kobayashi, Hokkaido University.

a dynamic optimal pricing and then investigate the effectiveness of the barriers to new entries.

II. AN EXTENTION OF THE SBM MODEL

According to J. S. Bain [2], there are three important factors composing barriers to the entry; (1) the products differentiation, particularly, the existing firm's goodwill, (2) the absolute advantages on the cost of production, and (3) the economy for a large scale plant. The entry-preventing price, denoted by p_0, reflects these factors and then the excess profits is p_0-p_c, where p_c is the competitive price level at which nobody can gain the profit margin. And we define $\bar{x}$ as the minimum size of the scale of most efficient production.

Introducing the Sylos' Postulate[1], the SBM model shows the maximum entry-preventing price by the following approximate formula,

$$p_0=p_c\left[1+\frac{\bar{x}}{eX_0}\right]. \tag{1}$$

Where e and X_0 are defined as the price elasticity of demand at p_c and the quantity of demand at p_c, respectively. From the above equation, we can understand that the entry-preventing price p_0 is largely dependent upon the relative scale of this industry (market), $X_0/\bar{x}$. In a growing industry, as a matter of course, this relative scale changes over time and it will produce a change in p_0.

Therefore, let us investigate the effect of growth in the industry on the entry-preventing price p_0. Assume that the rate of growth is g, which is expected by the potential competitor (the new entrant). His entry will be successful and profitable if and only if he can gain the quantity of demand

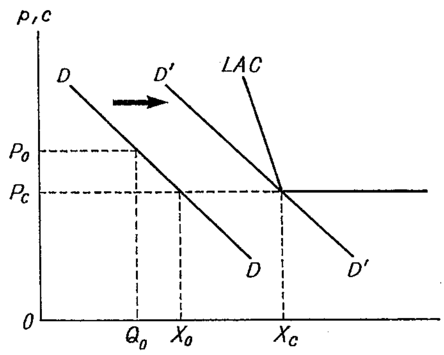

Fig. 1

1) The Sylos' Postulete means such an assumption that the existing firms maintain their output unchanged when entry occurs.

no less than $\bar{x}$ after entry. From Fig. 1, we can see $\bar{x}$ as $X_c - Q_0$. X_c and Q_0 are the scale of this market at p_c after entry and the current quantity of demand (the scale of the market before entry), respectively.

Further, $\bar{x}$ is given as the following,

$$\bar{x} = \Delta Q + (X_c - X_0). \tag{2}$$

The first term of the right hand side denotes an increment of demand caused by the price deduction from p_0 to p_c, and the second term by growth of the market scale from X_0 to X_c.

The formula for the entry-preventing price, under this conditions, should now read[2),

$$p_0 = p_c\left[1 + \frac{\bar{x} - gQ_0}{eX_c}\right]. \tag{3}$$

which is calculated on the base of the existing firm's current quantity of demand Q_0, or equally

$$p_0 = p_c\left[1 + \frac{\bar{x} - gX_0}{eX_0}\right]. \tag{3'}$$

which is on the basis of the scale of the market at p_c before entry, X_0.

From the above formula, we can say that growing demand reduces the entry-preventing price, this result is due to the action of the growth upon the effect of the barriers to entry.

Hitherto, we assumed the constancy of the existing firm's output level even in growing demand. But this assumption is not convincing, so instead we assume that the existing firm expands his capacity of production in accordance with his expected rate of growth, g_0. Then the entry-preventing price is modified to the following formula,

$$p_0 = p_c\left[1 + \frac{x - (g - g_0)\,Q_0}{eX_c}\right]. \tag{4}$$

If $g > g_0$, the existing firm's advantages to new entrant (the barriers to entry) lose their effectiveness. Then it is difficult for the existing firm to prevent the potential competitor from making an entry into the industry. Inversely, if $g < g_0$, the existing firm can maintain his dominancy without stimulating new entry, but as a result, he has an over capacity of production and then the price of his product will fall because of the restriction of market demand.

Furthermore the SBM model lacks a crucial point of view in the theory

2) Using the relation $X_c - X_0 = \frac{g}{1+g} X_c$, we can calculate p_0 as the following,

$$p_0 = p_c\left[1 + \frac{\Delta Q}{eX_0}\right] = p_0\left[1 + \frac{\bar{x} - g(X_0 - \bar{x})}{eX_c}\right] = p_c\left[1 + \frac{\bar{x} - gQ_0}{eX_c}\right]$$

of a firm. As R. Marris pointed out, in most cases, an entrant is already an established corporation in another industry. Therefore, he has a good deal of capital available and experience with customers (goodwill), and other things that give him a lot of potentiality to succeed in the new market. In this case, it is not profitable for the existing firm to grapple with the new entrant in order to prevent entry. To make an illustration, defining α the rate, with respect to the entrant's goodwill, of the current buyer's transfer of custom to the entrant, the existing firm's profits margin is reduced to as the following formula,

$$(5) \qquad p_0 = p_c\left[1 + \frac{\bar{x} - \alpha X_c}{eX_c}\right] = p_c\left[\left(1 - \frac{\alpha}{e}\right) + \frac{\bar{x}}{eX_c}\right].$$

The same as in the case of growing demand, the existing firm's profits margin are reduced by α/e when *the big business* enters into the market.

From above discussion we can say that it is questionable to believe the relevancy of the SBM model as an optimal pricing strategy of an oligopolistic firm, and that many econometric results computed on the base of the SBM model may be over-estimations. In the next section, we explore a dynamic optimal pricing model under the threat of entry.

III. THE OPTIMAL PRICING STRATEGY AND THE BARRIERS TO ENTRY

In this section, we investigate the optimal pricing strategy of an oligopolistic firm which is occupying a dominant position in a particular industry. This dominant firm's objective is maximization of the present value of the profit flow, and it is subjected to the threat of entry. When he enjoys a profit margin in that industry more than in other industries, that is enough to stimulate potential competitors into trying to enter the market. Let us define the dominant firm's average production cost, quantity of demand, and discount rate, respectively, as c (assumed constant over time), $q(p(t))$, and r (assumed constant). Then we can formulate the dominant firm's objective function as the following,

$$(6) \qquad V = \int_0^\infty \left(p(t) - c\right) q\left(p(t)\right) \exp(-rt)\, dt.$$

Where the dominant firm's price strategy is represented by $p(t)$, and we assume that there is no products differentiation between producers. Further, we define the market share of rival firms as $s(t)$, and the demand function of the industry as a whole $f(p(t))$, so the dominant firm's quantity of demand is represented as $q(p(t)) = f(p(t))\ (1 - s(t))$. Lastly, from the above discussion, we assume that the potential competitor will decide to enter into the industry according to the dominant firm's pricing strategy, so the new entrant's behavioral equation is given as the following formula,

$$\dot{s}(t)=\beta\big(p(t)-v\big), \qquad 0<\beta<\infty, \tag{7}$$

where β is a coefficient of response and v the normal profit in the other industry to which this entrant belongs, and the dot denotes the time derivative.

Our dynamic optimizing model is formulated as the following,

$$\begin{aligned} &\max V=\int_0^\infty \big(p(t)-c\big)f\big(p(t)\big)\big(1-s(t)\big)\exp(-rt)\,dt \\ &\text{s. t.}\quad \dot{s}=\beta\big(p(t)-v\big) \\ &\qquad\quad s(0)=s_0. \end{aligned} \tag{8}$$

Where s_0 is the initial value of the share of rival firms (including the entrant's initial scale). Solving our model, set the Hamiltonian as the following, ($\lambda(t)$ is an auxiliary variable),

$$H=\exp(-rt)\Big[\big(p(t)-c\big)f\big(p(t)\big)\big(1-s(t)\big)+\lambda(t)\,\beta\big(p(t)-v\big]. \tag{9}$$

The necessary conditions for maximum value of V are[3].

$$\frac{d\big(\hat{\lambda}(t)\exp(-rt)\big)}{dt}=-\frac{\partial H\big[\hat{p}(t),\hat{\lambda}(t),\hat{s}(t),t\big]}{\partial s(t)} \tag{10-1}$$

$$\text{i. e.,}\quad \dot{\lambda}(t)-r\lambda(t)=\big(p(t)-c\big)f\big(p(t)\big)$$

$$\text{and}\quad \lim_{t\to\infty}\hat{\lambda}(t)\exp(-rt)=0$$

$$\dot{\hat{s}}(t)=\beta\big(p(t)-v\big) \tag{10-2}$$

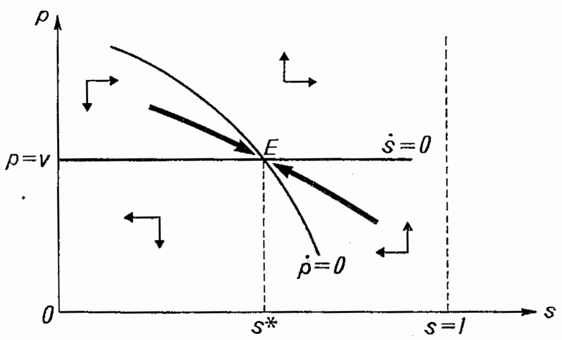

Fig. 2

3) The variables withmean the optimal value, and in the following discussion, we abbreviate the subscript t except in case of need.

$$H\left[\hat{p}(t), \hat{\lambda}(t), \hat{s}(t), t\right] = \max_{p(t)} H\left[p(t), \lambda(t), s(t), t\right]. \tag{10-3}$$

Eliminating $\lambda(t)$, the dynamic system of our model is given as the following formula,

$$\dot{p}(t) = \frac{\beta(p-c)f - \left[(p-c)f' + f\right]\left[(p-v) + r(1-s)\right]}{(1-s)\left[(p-c)f'' + 2f'\right]} \tag{11}$$

$$\dot{s}(t) = \beta(p-v). \tag{12}$$

This dynamic system has an equilibrium point and an unique time path of the dominant firm's optimal pricing[4]. Some characteristics of our model are represented by Fig. 2. The equilibrium market share of the dominant firm, $1-s^*$, or to the contrary, the share of the new entrant, s^*, is explicitly given as the following,

$$s^* = 1 - \frac{\beta(p-c)+f}{r\left[(p-c)f' + f\right]}. \tag{13}$$

Assuming that the elasticity of the dominant firm's profits with respect to the demand as a whole is less than unity, $s^* < 1$ is guranteed. And this is prosible.

Thus far, we explored the pricing strategy of the dominant firm in a stationary industry, which means the unchanged demand curve over time. Now, let us investigate the strategy in the case of a growing demand. Assume that the quantity of demand as a whole grows at a rate g. It would be rational to assume that the response of the potential competitor is affected by g. So we define the coefficient of response $\beta_0 \exp(gt)$, instead of β. In a growing industry, our dynamic problem is modified as the following,

$$\max V = \int_0^\infty \left(p(t) - c\right)\left(1 - s(t)\right) f\left(p(t)\right) \exp\left(-(r-g)\,t\right) dt \tag{14}$$

$$\text{s. t.} \quad \dot{s}(t) = \beta_0 \exp(gt)\left(p(t) - v\right)$$

$$\text{and } s(0) = s_0.$$

In solving this optimizing problem, we define the Hamiltonian as the following, ($\mu(t)$ is an auxiliary variable),

$$H = \exp\left(-(r-g)\,t\right)\left[(p-c)(1-s)f(p) + \mu(t)\,\beta_0(p-v)\right]. \tag{15}$$

4) Our model of optimal pricing policy of the dominant firm is largely dependent upon D. W. Gaskins' model in [5], and so are the properties of our model. Therefore, it is needless to investigate the properties of our model in detail. However our model is superior to Gaskins' at least in one point for example in our model the derivation of s^* is easy and seen clearly.

The necessary conditions for the maximum value of V are similar to (10-1), (10-2), and (10-3), then we abbreviate them. The dynamic system of our model with a growing demand is illustrated as the following differential equation,

$$\dot{p}=\frac{\left[(p-c)f'+f\right]\left[\beta_0\exp(gt)(p-v)+(1-s)(r-g)\right]-\beta_0(p-c)f}{(1-s)\left[(p-c)f''+2f'\right]} \tag{16}$$

$$\dot{s}=\beta_0\exp(gt)(p-v)\,. \tag{17}$$

In order to illustrate the characteristics of this system, in imitation of D. W. Gaskins [5], we make the substitution as $y(t)=s(t)\exp(-gt)$, and then rewrite the equation (17) as the following,

$$\dot{y}(t)=\beta_0\big(p(t)-v\big)-gy(t), \qquad y(0)=s(0)=s_0\,. \tag{17'}$$

The phase diagram is illustrated by Fig. 3. At the equilibrium point E, the stationary market share of the rival firms is given as

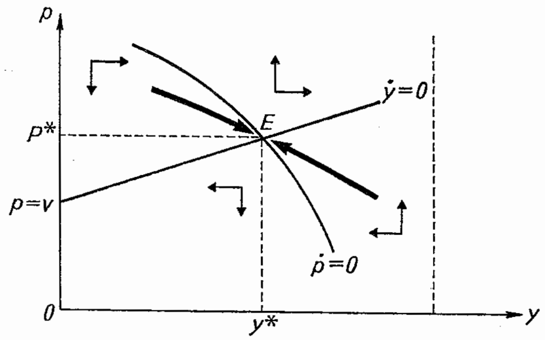

Fig. 3

$$s^{**}=1-\frac{\beta_0(p-c)f}{(r-g)\left[(p-c)f'+f\right]}\,. \tag{18}$$

From the same reason as in the previous case, $s^{**}<1$ is guranteed.

The above discussion shows us the unique time path of the dominant firm's optimal pricing strategy and the target share of market. However, there is no barriers to new entry. Now, let us investigate the effect of the barriers to entry on the dominant firm's pricing strategy and on the stationary market share, s^*, or $1-s^*$ (equally s^{**}, or $1-s^{**}$).

Assume that the dominant firm has an advantage to the potential competitor (the barriers to entry), $B\%$ of the average production cost, or $B'\%$ of the output price. In this case, the potential competitor's evaluated profit margin is modified as

(19)
$$p(t)-(Bc+v)$$
$$\text{or } p(t)(1-B')-v.$$

Therefore, the response of the potential competitor is represented by the following equations, in a static industry,

(20)
$$\dot{s}(t)=\beta\left[p(t)-(Bc+v)\right]$$

or equally

$$\dot{s}(t)=\beta\left[p(t)(1-B')-v\right],$$

and in a growing industry,

(21)
$$\dot{s}(t)=\beta_0\exp(gt)\left[p(t)-(v)\right]$$

and then

(21')
$$\dot{y}(t)=\beta_0\left[p(t)-(Bc+v)\right]-gy(t).$$

The barriers to entry shift the $\dot{s}=0$ curve (in Fig. 2) and the $\dot{p}=0$ curve (in Fig. 3) by Bc, and affect on the $\dot{p}=0$ curve[5]. After all, the barriers to entry effectively results a change in the equilibrium value of $s(t)$ and $p(t)$, that is to say, it makes s^* and s^{**} decrease, and p^* and p^{**} increase. This results is explicitly illustrated by Fig. 4 and Fig. 5. From these figures, it is quite obvious that the effectiveness of the dominant firm's barriers to entry are reduced in a growing industry compared with a static industry. The barriers to entry can pull up the stationary price level by the same proportion as its advantage in the case of unchanged demand, on the other hand in a growing industry, the barriers to entry can not fully affect the stationary price level.

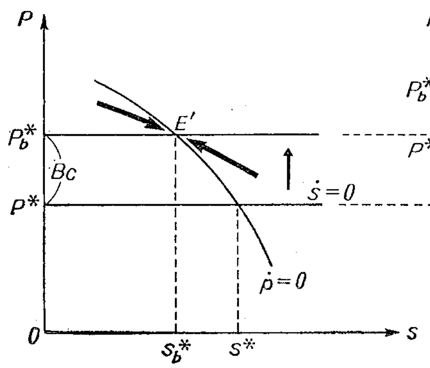

Fig. 4

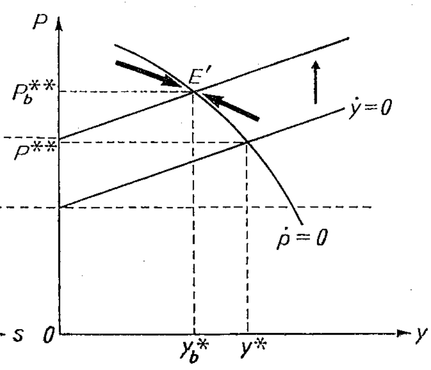

Fig. 5

5) The existing firm's cost advantage over the potential competitor, Bc, shifts the $\dot{s}=0$ or $\dot{y}=0$ curve upward by B_c. But its effect on the $\dot{p}=0$ curve is not determinable. This does not, however, alter our conclusions.

That is,

$$p_b^{**} - p^{**} < Bc = p_b^{*} - p^{*} . \tag{22}$$

This interesting result corresponds with our previous discussion of the SBM model.

IV. SUMMARY AND CONCLUSION

As J. N. Bahgwati pointed out, "The recent thinking on the oligopoly theory, therefore, departs from the tradition in two important and related ways: (1) it focuses on the problem of 'potential' competition; and (2) it correspondingly distinguishes between short-period and long-period profit maximization and takes the latter to be the objective of firms that maximize profits ([4], p. 299)". The SBM model is the most important contribution in this area.

However, this model is still largely limited to a static framework. From a potential competitor's point of view, the future profitability of an industry plays just as a crucial role in decision making to enter. Then, the entry-preventing price, which is considered as an optimal pricing strategy of the established firm's long-run profits maximizing behavior, must be investigated in the dynamic framework.

From our discussions, we can say that growing demand diminishes the effectiveness of the barriers to entry which is the existing firm's advantage over the potential competitor. This realistic and interesting result is deduced both from the SBM model and from the general dynamic pricing model.

REFERENCES

[1] Bain, Joe S. *Barriers to New Competition.* Harvard Univ. Press, 1956.

[2] ———. *Industrial Organization.* Joh Wiley & Sons, Inc, 1968.

[3] Baron, David P. "Limit Pricing, Potential Entry, and Barriers to Entry." *American Economic Review* 63, Sep. 1973, 666–674.

[4] Bhagwati, Jagdish N. "Oligopoly Theory, Entry-Prevention, and Growth." *Oxford Economic Papers* 22, Nov. 1970, 297–310.

[5] Gaskins, Darius W. Jr. "Dynamic Limit Pricing: Optimal Pricing under Threat of Entry." *Journal of Economic Theory* 3, Sep. 1971, 306–322.

[6] Ireland, N. J. "Concentration and Growth of Market Demand: A Comment on Gaskins Limit Pricing Model." *Journal of Economic Theory* 5, Sep. 1972, 303–305.

[7] Kamien, Morton I. and Nancy L. Schwartz "Limit Pricing and Uncertain Entry." *Econometrica* 39, May, 1971, 441–454.

[8] Marris, Robin. *The Economic Theory of "Managerial" Captitalism.* Macmillan, 1964.

[9] Modigliani, Franco "New Development on the Oligopoly Front." *Journal of*

Political Economy 66, June, 1958, 215–232.

[10] Osborne, Dale K. "The Role of Entry in Oligopoly Theory." *Journal of Political Economy* 72, Aug. 1964, 396–402.

[11] Pashigian, Peter "Limit Price and the Market Share of the Leading Firm." *Journal of Industrial Economy* 16–17, July, 1968, 165–177.

[12] Sylos-Labini, Paolo *Oligopoly and Technical Progress.* Harvard Univ. Pree, 1962.

[13] Wenders, John T. "Collusion and Entry," *Journal of Political Economy* 79, Nov./Dec. 1971, 1258–1277.