Fiscal Efficiency of Government Policies

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The purpose of this paper is to consider the policies to maintain a target number of firms at the free entry equilibrium in an oligopolistic industry. We examine two measures: the subsidy to firms in the concerned industry, and the government purchases of the output of these firms in the market. We evaluate these two measures from the viewpoint of fiscal efficiency, that is, implementation with least government expenditure. We prove that in the oligopolistic market, the government purchase of output becomes more fiscally efficient if the market size is sufficiently large. Otherwise, the lump-sum subsidy is more fiscally efficient.

Ⅰ. Introduction

Some governments regulate the entry of new firms into a specific industry and/or restrain the competition among incumbent firms in order to make them survive. For example, in Japan, the various regulations for financial institutions in the 60's may be considered as such a policy. However, if these governments intend to maintain a certain level of output or employment in the concerned industry, it is more effective than such a policy to promote the entry of new firms and increase the total number of firms operating in the particular industry. In the literatures on public finance or industrial organization, few researchers have studied the policy of the government for maintaining a specific number of firms in a particular industry. However, there are certain exceptions in the field of international economics in which a few researchers have analyzed the government intervention in the market for maintaining the volume of output or export above a certain level, not to maximize the utility of a representative household. In a perfectly competitive framework, Bhagwati (1967), Bhagwati and Srinivasan (1969) and Tan (1971) investigated optimal government intervention for achieving such a non-economic objective.

The purpose of this paper is to examine the policies of the government for maintaining a target number of firms at the free entry (long-run) equilibrium in an imperfectly competitive industry; this subject has been rarely studied in previous researches. In the following analysis, we assume that the firms play Cournot competition in the concerned industry. In such an environment, the typical policies that the government may implement are as follows: (1) The provision of a fixed amount of subsidy to the firms in the concerned industry, and (2) government purchases of the output of these firms in the market. We evaluate these two measures from the viewpoint of "*fiscal efficiency*", that is, attaining the objective with least expenditure.

This paper is organized as follows. In the next section, the model that is used in the following analysis is introduced. In section 3, the Cournot equilibrium of this model is derived. In section 4, the effects of the policies of lump-sum subsidy and government purchase of output in the long-run Cournot equilibrium is examined. In section 5, these policies are compared in terms of fiscal efficiency. Further, the effects of parameter values on the critical value N^*—below which the government purchase of output is more fiscally efficient as compared with the provision of lump-sum subsidy to firms—is examined. In the last section, the results are summarized and the perspective for future research is provided.

Ⅱ. The model

There are N firms with an identical technology in the concerned industry and they produce a homogeneous good. The market inverse demand function is given as

$$p = A - X, \tag{1}$$

where p denotes the price of the good and X is the total output of the industry. Then,

$$X = \Sigma_1^N x_i,$$

where x_i is the output of firm i. The parameter $A(>0)$ indicates the size of this market.

We assume that each firm incurs a fixed entry cost (f) and a marginal cost (c) for producing the output. Then the cost function of the firm i is

$$C(x_i) = cx_i + f. \tag{2}$$

Then, the profit of firm i is expressed as

$$\begin{aligned} \pi_i &= px_i - cx_i - f \\ &= (A - c - X)x_i = f. \end{aligned} \tag{3}$$

We assume that the market has a sufficiently large size as compared with the cost of each firm, that is, $A > c + \sqrt{f}$.

Next, we consider the objective of the government. We assume that the govermen tries to maintain a targeted level number of firms in the long run (free entry/exit) equilibrium for political concerns.

Ⅲ. The Cournot equilibrium

In this section, we examine the equilibrium when firms play Cournot competition in the output market. We use the "fitting-in" function, which is a simpler method for deriving the equilibrium than those used in previous studies. This approach is different from that of Mankiw and Whinston (1986) and Suzumura and Kiyono (1987). We begin with the short-run Cournot equilibrium where no firm enters or exits from the industry and the total number of operating firms is constant. Then, we proceed to a detailed examination of the long-run (free entry) Cournot equilibrium where certain firms enter or exit from the industry.

In the short-run, firm i selects its output level in order to maximize its profit, given outputs of other firms. In other words, the problem that firm i faces is given as follows.

$$\text{Max } \pi_i = (A-c-X)x_i - f,$$
$$\text{given } X_{-1} = \Sigma_{j \neq i} x_j$$

The first-order condition for profit maximization of firm i is

$$\frac{\partial \pi_i}{\partial x_i} = A-c-X-x_i = 0. \tag{4}$$

The short-run Cournot equilibrium is expressed as (X, x_i), which satisfies equation (4). Following Selten (1973), we solve the output of firm i as a function of market output X and obtain

$$x_i(X) = A-c-X. \tag{5}$$

The function $x_i(X)$ is known as the "fitting-in" function of the firm i. Differentiating equation (5) with respect to x_i and x_j, we have

$$\frac{\partial x_i}{\partial x_j} = -\frac{1}{2} < 0.$$

This indicates that the output of firm i is a strategic substitute for that of firm j.

Next, we examine the long-run Cournot equilibrium. If an incumbent firm makes a positive (negative) profit in the short-run equilibrium, some firms outside eventually enter (exit from) the industry. Potential entrants continue to enter (exit from) this industry as long as they earn a positive (negative) profit there. As a consequence of entry or exit of firms, each firm earns zero profit in the long-run equilibrium. In the long-run Cournot equilibrium, we have

$$\pi_i = (A-c-X)^2 - f = 0. \tag{6}$$

Equation (6) determines the total output of the market in the long-run Cournot equilibrium X_{FE} as

$$X_{FE} = A-c-\sqrt{f} > 0. \tag{7}$$

Using equation (5) and X_{FE}, the output level of each firm x_{FE} is expressed as

$$x_{FE} = \sqrt{f}. \tag{8}$$

In the long-run Cournot equilibrium, the number of firms in this industry (N_{FE}) is calculated as the ratio of X_{FE} to x_{FE}, that is,

$$N_{FE} = \frac{A-c}{\sqrt{f}} - 1 \tag{9}$$

Thus the long-run Cournot equilibrium of our model has been obtained.

Ⅳ. The effect of lump-sum subsidy and government purchase of output

In this section, we introduce two industrial policies of the government and investigate their effects on the long-run equilibrium. Suppose that the government aims to assure the survival of a fixed number of firms in the long-run equilibrium of the industry. In order to attain this objective, the government may utilize two industrial policies—the lump-sum subsidy provided to the firms in the concerned industry and government purchase of their output in the market. Lump-sum subsidy reduces the fixed cost of a firm and increases its profit, which makes it easy for new firms to enter the industry. On the other hand, if the government purchases the output produced by the firms in this industry in order to expand the market demand, potential entrants expect to make a profit and therefore enter the industry.

We begin with examining the effect of the lump-sum subsidy. If the government provides a lump-sum subsidy's to the firms in the concerned industry, their profits increase by the same amount. Then, the profit of firm i is expressed as follows.

$$\pi_i = (A-c-X)x_i - f + s\,.$$

The first-order condition for profit maximization is the same as equation (4). As a result, the fitting-in function of firm i is also the same as equation (5). After new firms enter or a few incumbent firms exit, each firm in this industry will earn zero profit, at most, in the long-run equilibrium; that is,

$$\pi_i = (A-c-X)^2 - f + s = 0\,.$$

When the government provides a lump-sum subsidy s ($s < f$) to firms, the industrial output $X(s)$, output of each firm $x_i(s)$, market price $p(s)$, and number of firms $N(s)$ in the long-run equilibrium are written as a function of the subsidy, s, as follows.

$$X(s) = A-c-\sqrt{f-s} \tag{10}$$

$$x_i(s) = \sqrt{f-s} \tag{11}$$

$$N(s) = \frac{A-c}{\sqrt{f-s}} - 1 \tag{12}$$

$$p(s) = c+\sqrt{f-s} \tag{13}$$

In order to investigate the effect of the lump-sum subsidy on these variables, we differentiate equation (10)-(13) with respect to s.

$$X'(s) = \frac{1}{2\sqrt{f-s}} > 0$$

$$x'(s) = \frac{1}{2\sqrt{f-s}} < 0$$

$$N'(s) = \frac{(A-c)}{2(f-s)^{\frac{3}{2}}} > 1$$

$$p'(s) = \frac{-1}{2\sqrt{f-s}} < 0$$

We summarize the above results and obtain the following Lemma.

Lemma 1

If the government increases a lump-sum subsidy, the total output and number of firms in the industry increase; however, the market price and output of each firm decrease in the long-run equilibrium.

Lemma 1 reveals that lump-sum subsidy is effective for increasing the long-run equilibrium number of firms in the industry. Moreover, it is straightforward that no subsidy results in the long-run Cournot equilibrium, that is, $N(0) = N_{FE}$.

Using equation (12), we calculate the amount of subsidy per firm that can enable N firms to survive in the long-run equilibrium, $s(N)$.

$$s(N) = f - \left(\frac{A-c}{N+1}\right)^2 \tag{14}$$

Further, we obtain

$$s'(N) = \frac{2(A-c)^2}{(N+1)^3} > 0$$

This result indicates that the government should raise the subsidy per firm in order to sustain more firms in the long-run equilibrium. Multiplying equation (14) by the number of firms N yields the total amount of subsidy required for sustaining N firms, $S(N)$.

$$S(N) = N\left(f - \frac{(A-c)^2}{(N+1)^2}\right) \tag{15}$$

We examine the relation between the total amount of subsidy and the number of firms that the government wishes to maintain in the industry. Note that $s(N_{FE}) = 0$. Differentiating equation (15) with respect to N yields

$$S'(N) = f + \frac{(A-c)^2(N-1)}{(N+1)^3} > 0 \tag{16}$$

and

$$S''(N) = \frac{2(A-c)^2(2-N)}{(N+1)^4}. \tag{17}$$

We confirm that $S''(N) < 0$ if $N > 2$. Since we suppose that $N_{FE} > 2$, $S(N)$ passes through N_{FE} and is an upward sloping concave curve.

Next, we examine the effect of government purchase of the output produced by the firms in the concerned industry. If the government purchases G units of output in the market, the market demand is increased by G and the inverse market demand function becomes

$$p = A + G - X. \tag{18}$$

Then, the profit of firm i is

$$\pi_i = (A - c + G - X)x_i - f.$$

Using the first-order condition of profit maximization, the "fitting-in" function of firm i is given by

$$x_i = A - c + G - X. \tag{19}$$

In the long-run Cournot equilibrium, the total output $X(G)$, output of firm i $x_i(G)$, market price $p(G)$, and number of firms $N(G)$ are given as follows.

$$X(G) = A - c + G - \sqrt{f} \tag{20}$$

$$x_i(G) = \sqrt{f} \tag{21}$$

$$p(G) = c + \sqrt{f} \tag{22}$$

$$N(G) = \frac{A-c+G}{\sqrt{f}} - 1 \tag{23}$$

Furthermore, the effects of government purchase of output on these variables are obtained as follows;

$$X'(G) = 1 > 0,$$

$$x_i'(G) = 0,$$

$$p'(G) = 0,$$

$$N'(G) = \frac{1}{\sqrt{f}} > 0.$$

We summarize the above results and provide the following Lemma.

Lemma 2

If the government purchases a greater amount of output of the industry, the total output and number of firms increase; however, the market price and output of each firm are invariant.

Using equation (23), we can derive the

amount of output that the government must purchase in order to sustain N firms in the long-run equilibrium, $G(N)$. That is,

$$G(N)=\sqrt{f}(N+1)-A+c. \qquad (24)$$

Consequently, the amount of government expenditure that is necessary to purchase G units of output $GE(N)$ is

$$\begin{aligned} GE(N) &= p(X(G))G(N) \\ &= (f+c\sqrt{f})N+(\sqrt{f}+c-A)(\sqrt{f}+c). \end{aligned} \qquad (25)$$

Moreover, $GE(N_{FE})=0$, that is, the government does not need to purchase any output for maintaining N_{FE} firms. It can be confirmed from equation (25) that $GE(N)$ is a linear function of N.

V. Which is more fiscally efficient, the government purchase or the subsidy?

It is assumed that the government tries to maintain a fixed number of firms in the long-run equilibrium in the concerned industry. In order to achieve this goal, the government can employ the policies of either lump-sum subsidy or purchase of output produced by the firms. In this section, we compare the levels of government expenditure entailed in these two policies that is necessary for achieving the goal of the government; further, we examine which policy is more fiscally efficient, that is, expenditure on which policy is lower. A fiscally efficient policy is defined as one that requires minimum expenditure from the government viewpoint

Definition: Fiscal efficiency

If $S(N)<(>)GE(N)$ holds for N number of firms, lump-sum subsidy (the government purchase of output) is more fiscally efficient than government purchase of output (the lump-sum subsidy) with respect to N.

We compare the lump-sum subsidy provided to firms with government purchase of output, and examine which of these policy measures entails lower expenditure. In order to evaluate these measures, we denote the total amount of lump-sum subsidy as $S(N)$ and that of government purchase of output as $GE(N)$. $S(N)$ is a concave curve, while $GE(N)$ is a straight line. Further, both $S(N)$ and $GE(N)$ pass through N_{FE}. If the slope of the tangent line of $S(N)$ is smaller than or equal to that of $GE(N)$ at N_{FE}, $GE(N)$ and $S(N)$ do not intersect except at N_{FE}. On the contrary, if the tangent line of $S(N)$ is steeper than $GE(N)$ at N_{FE}, $GE(N)$ and $S(N)$ necessarily intersect only once except at N_{FE}, because $S(N)$ is a concave curve. Thus, the slopes of $GE(N)$ and $S(N)$ at N_{FE} decide whether or not government purchase of output is more fiscally efficient as compared with the lump-sum subsidy provided to firms.

Differentiating $GE(N)$ and $S(N)$ with respect to N and evaluating at N_{FE} yields the following results.

$$GE'(N_{FE}) = f+c\sqrt{f}$$

$$S'(N_{FE}) = 2f\left(1-\frac{\sqrt{f}}{A-c}\right)$$

If $S'(N_{FE}) \leq GE'(N_{FE})$, $S(N)$ and $GE(N)$ intersect only at N_{FE} as shown in Figure 3, because the former curve always runs below the latter one, above N_{FE}. Then, the lump-sum subsidy to firms is more fiscally efficient than government purchase of output. On the contrary, if $S'(N_{FE}) > GE'(N_{FE})$, $GE(N)$ and $S(N)$ necessarily intersect only once at N^* except at N_{FE}, as shown in Figure 4. In that case, $S(N)$ runs above $GE(N)$, between N_{FE} and N^*. If the target number of firms lies in this area, government purchase of output is more fiscally efficient as compared to lump-sum subsidy.

In order to examine the condition that makes government purchase of output fiscally efficient as compared with lump-sum subsidy, we calculate the difference between $S'(N_{FE})$ and $GE'(N_{FE})$. Considering A as a parameter with c and f fixed, we obtain $S'(N_{FE}) < 2f$. Then, if $c \geq \sqrt{f}$,

$$GE'(N_{FE}) = f+c\sqrt{f} \geq f+\left(\sqrt{f}\right)^2 = 2f,$$

and $GE'(N_{FE}) > S'(N_{FE})$. That is, lump-sum subsidy is more fiscally efficient as compared to the government purchase of output for any number of firms that the government wishes to maintain.

Next, we investigate what happens if $c < \sqrt{f}$. The difference between $S'(N_{FE})$ and $GE'(N_{FE})$ is expressed as follows.

$$GE'(N_{FE}) - S'(N_{FE})$$
$$= \sqrt{f}\left(\frac{2f}{A-c} - \sqrt{f} + c\right) \quad (26)$$

With regard to the right-hand side of equation (26) as a function of A, we define $h(A)$ as

$$h(A) = \sqrt{f}\left(\frac{2f}{A-c} - \sqrt{f} + c\right)$$

Further, we define $\tilde{A}$ as

$$\tilde{A} = c + \frac{2f}{\sqrt{f} - c}.$$

Then, $\tilde{A}$ satisfies $h(\tilde{A}) = 0$. Since $h(A)$ is a decreasing function with respect to A,

$$h(A) > 0 \text{ if } c < \sqrt{f} \text{ and } A \leq \tilde{A}.$$

In this case, the lump-sum subsidy is always fiscally efficient as compared to government purchase of output. On the other hand,

$$h(A) < 0 \text{ if } c < \sqrt{f} \text{ and } A > \tilde{A}.$$

In this case, there is some N^* and government purchase of output is fiscally efficient for $N_{FE} < N < N^*$. Moreover, the lump-sum subsidy is fiscally efficient for $N^* < N$.

The above results are summarized as follows.

Theorem (***Fiscal Efficiency***)

(***1***) ***The lump−sum subsidy policy is fiscally efficient if the government wants to maintain over N^* firms.***

(***2***) ***In the case that the government wants to maintain less than N^* firms, the government purchase policy is fiscally efficient if the marginal cost of a firm is relatively small as***

compared with the fixed cost and the market size is large. Otherwise, the lump−sum subsidy policy is fiscally efficient.

Ⅵ. Comparative statics of the critical value N^*

In this section, we examine the effects of the parameter values on N^*, below which the government purchase of output is fiscally efficient as compared to lump-sum subsidy. The line of $GE(N)$ and the curve of $S(N)$ necessarily intersect once at N^*, except at N_{FE}, if $c<\sqrt{f}$ and $A>\tilde{A}$. We can rearrange $GE(N)$ and $S(N)$ as follows.

$$GE(N)=(f+c\sqrt{f})(N-N_{FE})$$

$$S(N)=\frac{fN(N-N_{FE})(N+N_{FE}+2)}{(N+1)^2}$$

Consequently, N^* is the solution of the following equation.

$$f+c\sqrt{f}=\frac{fN(N-N_{FE}+2)}{(N+1)^2} \qquad (27)$$

We define $g(N)$ as the right-hand side of this equation.
Then,

$$g'(N)=\frac{fN_{FE}}{(N+1)^3}\left[\frac{N_{FE}+2}{N_{FE}}-N\right]$$

It is easily confirmed that $g(0)=0$, $g'(0)>0$. Further, $g(N)$ has a single peak at N_p, where

$$N_p=\frac{N_{FE}+2}{N_{FE}}.$$

Figure 1 depicts $g(N)$. This figure indicates that equation (27) has two solutions. The right solution (N^*) that we look for is the larger one of these because $1<N_p<2$ and $N_{FE}>1$.

Insert Figure 1

Totally differentiating equation (27) yields the following equation.

$$\sqrt{f}\,dc+\left(1+\frac{c}{2\sqrt{f}}\right)df$$
$$=g_N dN+g_A dA+g_c dc+g_f df, \qquad (28)$$

where gi is the partial derivative with respect to argument i. In order to examine the effect of the market scale (A) on N^*, we set $dc=df=0$ in equation (28) and obtain the following equation.

$$0=g_N dN+g_A dA$$

Then,

$$\frac{dN}{dA}=-\frac{g_A}{g_N}.$$

Since $g_A=\dfrac{fN}{(N+1)^2}\dfrac{dN_{FE}}{dA}>0$ and $g_N<0$ at N^*, we obtain $\dfrac{dN^*}{dA}>0$. That is, N^* increases with the market scale.

Next, we set $dA=df=0$ in equation (28) and examine the effect of marginal cost (c) on N^*. Equation (28) becomes

$$\sqrt{f}\,dc=g_N dN+g_c dc.$$

Consequently,

$$\frac{dN}{dc}=-\frac{g_c-\sqrt{f}}{g_N}.$$

Since $g_c=\dfrac{fN}{(N+1)^2}\dfrac{dN_{FE}}{dA}<0$, we have $\dfrac{dN^*}{dc}<0$. When the marginal cost increases, N^* decreases.

Finally, we examine the effect of fixed cost (f) on N^*. We rearrange equation (27) and obtain the following quadratic equation.

$$cN^2+(\sqrt{f}+3c-A)N+(\sqrt{f}+c)=0 \tag{29}$$

We define $h(N)$ as the left-hand side of equation (29). Then, the solution N^* of $h(N)=0$ is the same as that of $g(N)=f+c\sqrt{f}$. Differentiating equation (29) yields the following equation.

$$h_N dN+h_f df=0 \tag{30}$$

We obtain

$$\frac{dN}{df}=-\frac{h_f}{h_N}.$$

Since $h_N>0$ and $h_f=\frac{1+N}{2\sqrt{f}}>0$, we obtain

$$\frac{dN^*}{df}<0 \quad .$$

This result indicates that N^* decreases as fixed cost increases. We summarize these results.

Proposition

The critical number N^* increases (decreases) as A (c, f) increases.

This proposition implies that the government purchase policy becomes more fiscally efficient when the market size expands and/or the firm's technology becomes efficient.

Ⅶ. Concluding remarks

The government often prevents new firms from entering a special industry and/or regulates competition among the incumbents. However, if such governments wish to maintain the volume of output or employment in the concerned industry, it appears more effective to promote the entry of new firms and increase the number of firms rather than to restrict competition in the industry. Merely a few researchers have studied such a subject in the theory of industrial organization. The only exceptions are in international economics. The purpose of this paper is to examine the policies adopted by the government in order to maintain a target number of firms at the free entry equilibrium in an imperfectly competitive industry.

The government can use the following two typical policies in order to maintain a certain number of firms in the concerned industry. One is to provide the lump-sum subsidy to firms and the other is to purchase their output in the market. If the same number of firms is maintained, the policy that costs less appears to be more favorable. We examine these policies in the imperfectly competitive market where firms play Cournot competition. We compare the expenditure incurred by the government in providing lump-sum subsidy to firms with that incurred in the purchase of their output, and examine which policy entails lower expenditure for maintaining the target number of firms in the concerned industry. We prove that in the oligopolistic market, where firms play Cournot competition, government purchase of their output is fiscally efficient if the market size is sufficiently large.

We evaluate both policies from the viewpoint of the expenditure incurred by the government for maintaining a certain number of firms in the long-run equilibrium. In order to assure that the conclusions obtained in this paper are meaningful, social welfare must be the same regardless of the policy that the government implements. If the profit of firms and/or the welfare of consumers are different depending on the policy that the government implements, we need an alternative standard for evaluating these policies, even if the same number of firms is maintained.

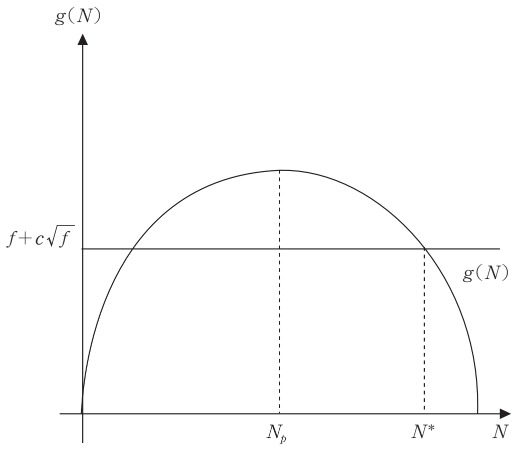

Figure 1

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