A note on monopolistic competition with OEM

Toshihiro Atsumi
Faculty of Economics, Meiji Gakuin University

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Abstract

This paper studies a kind of original equipment manufacturing (OEM) defining it as a mode of business in which new firms can enter by asking an incumbent firm to supply an OEM product which will be sold to the consumers under its brand name. It is found that the existence of OEM can be explained as an equilibrium outcome, in a form of multiple equilibria. There are no welfare effects in comparison to the standard monopolistically competitive equilibrium. The production structure, however, becomes lumpy under the OEM equilibria: there will be larger producers acting as manufacturers of their own brands as well as OEM suppliers. Firm heterogeneity arises not from ex-ante productivity difference but from OEM.

1. Introduction

Original equipment manufacturing (OEM) is a popular business practice. I define OEM as a mode of business in which new firms can enter by asking an incumbent firm to supply an OEM product which will be sold to the consumers under its brand name. Although there are other types of OEM, I focus on this type of OEM.

The idea of this note is to consider OEM as an alternative form of firm entry in the framework of monopolistic competition in general equilibrium. I study whether OEM can be explained as an equilibrium outcome.

It is found that the existence of OEM can be explained as an equilibrium outcome, in a form of multiple equilibria. There are no welfare effects in comparison to the standard monopolistically competitive equilibrium, as long as the varieties including OEM varieties are valued equally by consumers. The production structure, however, becomes lumpy under the OEM equilibria: there will be larger producers acting as manufacturers of their own brands as well as OEM suppliers. Therefore, firm heterogeneity arises not from ex-ante productivity difference but from OEM.

In the next section I review the standard general equilibrium results of monopolistic competition. In section 3, I derive conditions under which a potential entrant uses OEM to set up its own brand. Section 4 studies equilibrium with OEM, followed by concluding comments.

2. Standard monopolistically competitive equilibrium

Assumptions

Consumer preference is given by

$$U = \left[\int_0^n m(i)^\rho di\right]^{\frac{1}{\rho}} \quad (0 < \rho < 1), \tag{1}$$

which is a constant elasticity of substitution (CES) function, and $m(i)$ is the consumption of each variety i, and n is the total mass of variety. The elasticity of substitution between any variety is $1/(1-\rho) \equiv \sigma$ $(\sigma > 1)$.

On the production side, a firm producing a particular variety requires a fixed number (F) of workers and c units of workers per unit output. The firm thus face s increasing returns to scale. Its total cost for producing a given amount, q is then

$$C(q) = Fw + cwq, \tag{2}$$

where w is the wage of the workers. It is assumed that this industry is monopolistically competitive. Factor endowment, that is, total workers, is L, and the workers are also consumers.

Consumer behavior

For a given income Y, and a given price $p(i)$ for each variety, the consumers problem is to maximize her utility, subject to the budget constraint

$$\int_0^n p(i)m(i)di = Y. \tag{3}$$

Then consumers should choose $m(i)$ to minimize the cost of consuming U. This implies minimizing expenditure

$$\int_0^n p(i)m(i)di$$

subject to

$$\left[\int_0^n m(i)^\rho di\right]^{\frac{1}{\rho}} = U. \tag{4}$$

The first-order condition of the problem is that the marginal rate of substitution between any two varieties i and j is equal to their price ratio:

$$\frac{m(i)^{\rho-1}}{m(j)^{\rho-1}} = \frac{p(i)}{p(j)}. \tag{5}$$

Substituting (5) into (4) produces the following expression, which is the compensated demand function for variety j:

$$m(j) = \frac{p(j)^{\frac{1}{\rho-1}}}{\left[\int_0^n p(i)^{\frac{\rho}{\rho-1}} di\right]^{\frac{1}{\rho}}} U. \tag{6}$$

The minimum expenditure to consume U is, therefore,

$$\int_0^n p(j)m(j)dj = \left[\int_0^n p(i)^{\frac{\rho}{\rho-1}} di\right]^{\frac{\rho-1}{\rho}} U. \tag{7}$$

The term

$$\left[\int_0^n p(i)^{\frac{\rho}{\rho-1}} di\right]^{\frac{\rho-1}{\rho}}$$

in (7) is called the price index, G:

$$G \equiv \left[\int_0^n p(i)^{\frac{\rho}{\rho-1}} di\right]^{\frac{\rho-1}{\rho}} = \left[\int_0^n p(i)^{1-\sigma} di\right]^{\frac{1}{1-\sigma}}. \tag{8}$$

Using G, (6) can be written simply as

$$m(j) = \left[\frac{p(j)}{G}\right]^{-\sigma} U. \tag{9}$$

Then the demand function for variety j is

$$m(j) = p(j)^{-\sigma} G^{\sigma-1} Y. \tag{10}$$

Using (10), price elasticity of demand

$$[dm(j)/dp(j)]/[m(j)/p(j)]$$

becomes

$$\sigma + [p(j)^{1-\sigma}(1-\sigma)]/\int_0^n p(j)^{1-\sigma} dj. \tag{11}$$

Since $n \to \infty$ under a continuum of varieties, the second term approaches zero. The price elasticity of demand is therefore simply σ.

Firm behavior

Because of the infinite number of potential varieties and increasing returns to scale at the firm level, each firm becomes a sole producer of differentiated variety. The first-order condition of profit maximization is then the equalization of marginal revenue and marginal costs. Since the demand elasticity that each firm faces is σ, firms will exhibit the following mark-up pricing behavior

$$p\left(1 - \frac{1}{\sigma}\right) = cw, \tag{12}$$

and the price index of goods is

$$G = [np^{1-\sigma}]^{\frac{1}{1-\sigma}} = n^{\frac{1}{1-\sigma}}p. \quad (13)$$

Equilibrium

Equilibrium requires market clearing in the goods and factor market, and zero profit of firms as a result of free entry. Then in equilibrium, operating profits equals fixed cost. That is

$$pq - cwq = Fw. \quad (14)$$

Another equilibrium condition is clearing of the labor market. Since each firm employs $F + cq$ workers, full employment requires

$$n(F + cq) = L. \quad (15)$$

Finally, goods markets need to clear in equilibrium, that is,

$$p^{-\sigma}G^{\sigma-1}Y = q. \quad (16)$$

Substituting for p in (14) using (12) and rearranging terms produces a constant equilibrium firm size:

$$q = \frac{F(\sigma-1)}{c}. \quad (17)$$

Substituting (17) into (15) and rearranging terms results in a equilibrium firm mass of

$$n = \frac{L}{F\sigma}, \quad (18)$$

And it can be confirmed that (17) and (18) satisfy (16).

3. Entry by use of OEM

In the standard monopolistically competitive equilibrium, each firm produces its own product to be sold under its brand name. The idea of the analysis is to allow for entry by use of OEM. A potential entrant considers profitability of setting up a new brand using OEM. That is, the potential entrant, instead of manufacturing a new variety on its own, asks an incumbent firm to supply products to be sold under this potential entrant's brand name.

Suppose the OEM product is available at a unit price of c^*, by setting $w = 1$. Then the potential entrant can calculate its hypothetical profit $\pi^* = p^*q^* - (F^* + c^*q^*)$, where

$$p^* = \frac{\sigma c^*}{\sigma-1} \quad (19)$$

and

$$q^* = p^{*-\sigma}n^{-1}p^{\sigma-1}Y. \quad (20)$$

Hereafter, variables given asterisks (*) are those for the OEM firms. Using (19) and (20),

$$\pi^* = \left(\frac{c^*}{\sigma-1}\right)\left(\frac{\sigma c^*}{\sigma-1}\right)^{-\sigma}\left(\frac{F\sigma}{L}\right)\left(\frac{\sigma}{\sigma-1}\right)^{\sigma-1}L$$

Therefore the potential entrant will decide to enter as an OEM firm if $\pi^* > 0$, or

$$\left(\frac{c}{c^*}\right)^{\sigma-1} > \frac{F^*}{F}, \quad (21)$$

where c^* is the unit price offered by an incumbent firm that manufactures on its own, or in-house manufacturing (hereafter IHM) firm, to the OEM entrant, and F^* is the fixed cost of the OEM entrant. Condition (21) implies the lower c^* and/or the lower F^*, the higher the profitability of OEM entry.

4. The OEM equilibrium

Equilibrium with OEM

Would incumbent IHM firms supply OEM products to entrants? In the standard monopolistic competition framework, there are still many firms, and because of that, incumbent firms take no strategic actions, although allowing entry toughens competition. For incumbent IHM firms to gain from supplying to OEM firms, the unit price must be $c^* > c$. However, if $c^* > c$ then other IHM firms would offer a lower c^* undercutting c^*. Therefore, in equilibrium,

$$c^* = c. \tag{22}$$

Free entry leads to zero profits both for IHM and OEM firms. Therefore, for the IHM firms,

$$p_i q_i - (F + cq_i) + m_i\left(c^* q_j^* - cq_j^*\right) = 0, \tag{23}$$

where

$$\int_0^n m_i d_i = n^*. \tag{24}$$

In (23) and (24), m_i is the mass of OEM firms that IMS firm i supplies to. (m would be zero for IHM firms that do not supply OEM products.) Therefore, the third term of the left-hand-side of (x) is profits raised from supplying OEM products.

For the OEM firms, free entry leads to their profits being driven down to zero, that is,

$$p_j {q_j}^* - \left(F^* + c^* {q_j}^*\right) = 0. \tag{25}$$

Next, labor market equilibrium implies

$$nF + n^* F^* + ncq + n^* cq^* = L, \tag{26}$$

where $n^* cq^*$ is total labor used for OEM production. Finally, equilibrium in the goods market requires

$$q = p^{-\sigma} G^{\sigma-1} Y \tag{27}$$

and

$$q^* = p^{-\sigma} G^{\sigma-1} Y, \tag{28}$$

for the varieties supplied by IHM and OEM firms, respectively.

Zero profits imply

$$Y = L. \tag{29}$$

From (27) and (28),

$$q = q^*. \tag{30}$$

Substituting (19), (22) and (30) into (23) and (25),

$$F = F^* \tag{31}$$

and

$$\frac{c}{\sigma-1} q = F. \tag{32}$$

Substituting (29) and (30) into (26), and using (31) we have

$$n + n^* = \frac{L}{F\sigma}, \tag{33}$$

which is the total mass or firms or varieties, and it is the same as in the benchmark case in which OEM is ruled out.

Maximum firm size

Size of IHM firms is maximized when a single IHM firm supplies to all the rest of OEM firms. The output of this IHM firm is

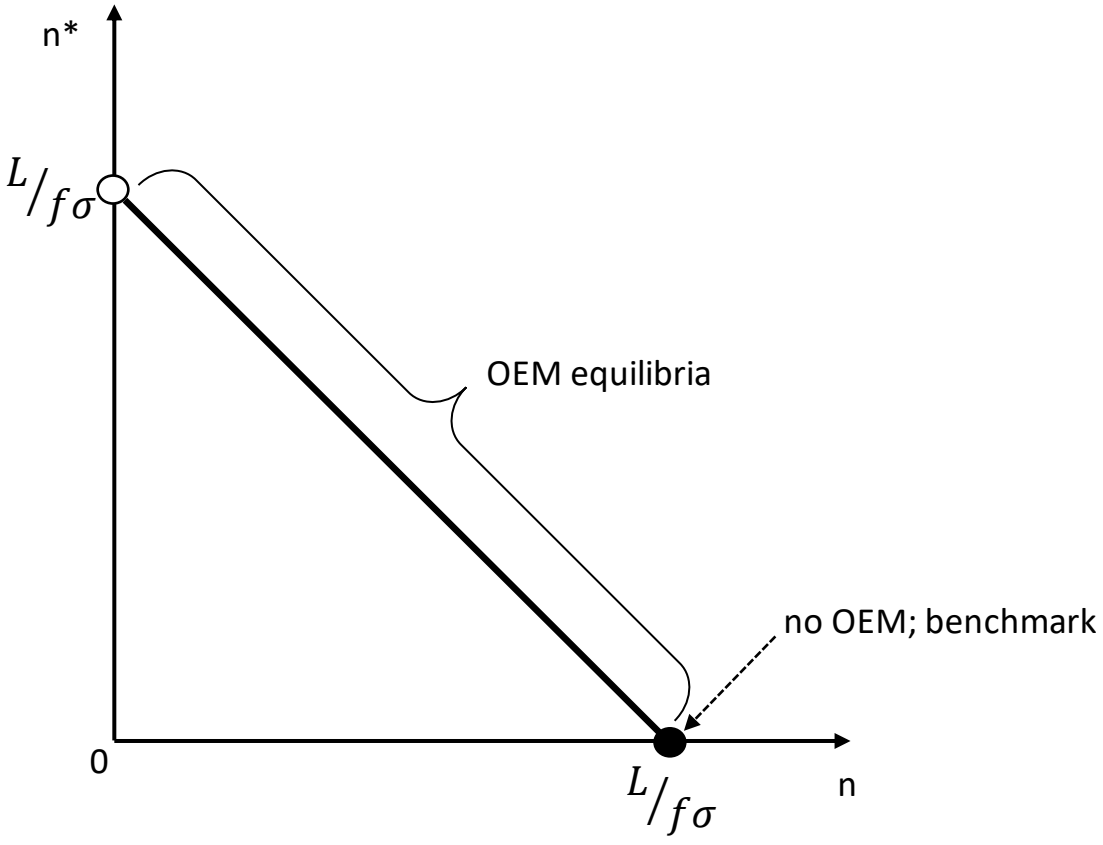
$$q = \frac{F(\sigma-1)}{c} + n^* q^* = \frac{F(\sigma-1)}{c}(n^* + 1) = \frac{(\sigma-1)(L+F\sigma)}{\sigma c}. \quad (34)$$

Stability of the OEM equilibria

Once a firm operates as an OEM firm, there are no gains to be made by manufacturing on its own. That is, no profit-seeking OEM firm attempts to switch to become an IHM firm. Therefore, the OEM equilibria is stable.

Interpretation

If F^* is sufficiently lower than F to satisfy the OEM entry condition given by (21), firms would enter in the form of OEM. However, results show that in order to explain the coexistence of IHM and OEM firms in the same industry, F^* must rise to F in equilibrium. This suggests that OEM firms eventually pay more fixed costs, for example, for branding, compared to what they expected at the time of entry.



Concluding comments

In this model, firms in the same industry become heterogeneous because of OEM and not because of ex-ante productivity differences; OEM makes firms lumpy, that is, makes the firms heterogeneous in size.

This analysis, however, only explains a particular type of OEM. The OEM product studied here is a product produced by in-house manufacturing (IHM) firms on behalf of OEM firms to be sold under the brand name of the OEM firm. Many of the sport bicycles sold under numerous different brand names are in fact produced by a few Taiwanese manufacturers (in the form of OEM) . The analysis probably applies to products in which branding is important.

It does not explain contract manufacturers that specialize solely on producing OEM products, and the strategic interactions between contract manufacturers and OEM firms, as studied by Arruñada and Vázquez (2006) in the business literature.

References

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