Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(3):239-244

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Product differentiation and market exclusion

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ABSTRACT

The game model is founded on the product differentiation, and in the system consisting of two upstream enterprises and two downstream enterprises, the market exclusion effect of the vertical integral enterprises towards the non-integral enterprises is studied. The research results indicate that after vertical integration the intermediate product price ascends and causes the market exclusion to the non-integral enterprises. The greater the product differentiation is, the greater the degree of the market exclusion is; after vertical integration the production of integral enterprises increase while the downstream independent enterprises decrease with descending profits.

Key words: vertical integration; market exclusion; product differentiation; game

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INTRODUCTION

Salinger shows that a vertical merger in a successive oligopoly with quantity competition, causes the integrated firm to withdraw from the intermediate good market[1]. Ordover, Saloner and Salop examine a fixed-proportion model with endogenous integration decisions[2]. Hart and Tirole (1990)show that market foreclosure is strictly linked to vertical integration[3]. Chen examines a fixed-proportion model where two downstream firms produce differentiated final products and compete in prices[4]. Nocke and White investigate whether vertical mergers can facilitate upstream tacit collusion[5].Domestic scholars Weng, Chen and Ni have discussed in detail the motivations of merger and the development situation of the social welfare theory model [6]. This thesis focuses on the influence of the vertical integration on the intermediate product market, the final product market, and non-vertically integrated enterprises when the final products are heterogeneous.

2. Hypotheses and models

Suppose that a system consists of the upstream market and the downstream market. In the upstream market, two upstream enterprises (enterprise U_1 and enterprise U_2) produce the homogeneous intermediate products, with which two downstream enterprises (enterprise D_1 and enterprise D_2) make heterogeneous final products. Assume that each downstream enterprise producing one unit of final product requires one unit of intermediate product, and the production costs of intermediate products and final products are both zero. Therefore, once vertically integrated, the enterprises produce per unit of final product with zero marginal cost.

Someone assuming that vertically integrated enterprises do not interfere in the intermediate products markets, such as Greenhut and Ohta [7], Salinger and so on; the other assuming that vertically integrated enterprises still have transactions in the intermediate products market, and the literature of Schrader and Martin [8], Higgins [9], and Normann [10]is of this kind. Due to space constraint, in this thesis only the case that after vertical integration, vertically integrated enterprises do not interfere in the intermediate products market is discussed.

In the aspect of the downstream market demand, the substitution degree of the products is decided by consumers,

$$p_i = a - q_i - \lambda q_j \qquad (i, j = 1,2; i \neq j) \qquad (1)$$

in which, $\lambda \in [-1,1]$. When $\lambda = 0$, in consumers' sense, product 1 and product 2 are completely different products; while $\lambda = 1$, from the consumers' point of view they are completely substituting products; when $\lambda \in [-1,0)$, from the consumers' point of view, they are complementary products.

The results of vertical integration will change the market structure:
① The vertical integration does not appear, and the upstream enterprises offer the intermediate goods to downstream enterprises at a linear w_u price , which is the marginal cost of the downstream enterprises.

② The enterprises U_1 and enterprise D_1 vertically integrate, and the downstream market is made up of a vertically integrated enterprise (enterprise V) and an independent enterprise (enterprise D_2). Therefore, the upstream enterprise U_2 offers intermediate products to the enterprise D_2 at a linear price w_v .

3. Pre-integration

The profits functions of the two downstream enterprises are as follows:

$$\pi_1^D = (a - q_1 - \lambda q_2 - w_u) q_1 \qquad (2)$$

$$\pi_2^D = (a - q_2 - \lambda q_1 - w_u) q_2 \qquad (3)$$

Downstream enterprises carry out the Cournot game, from equation (2) and (3) the first-order conditions:

$$\frac{\partial \pi_1^D}{\partial q_1} = (a - \lambda q_2 - w_u) - 2q_1 = 0 \qquad (4)$$

$$\frac{\partial \pi_2^D}{\partial q_2} = (a - \lambda q_1 - w_u) - 2q_2 = 0 \qquad (5)$$

Further, from equation (4) and equation (5), it is easy to get the output of downstream enterprises D_1 and D_2 :

$$q_1^D = q_2^D = \frac{a - w_u}{2 + \lambda} \qquad (6)$$

The equation (6) is respectively substituted into equation (2) and equation (3), and the profits of downstream enterprises D_1 and D_2 are as follows:

$$\pi_1^D = \pi_2^D = (\frac{a - w_u}{2 + \lambda})^2 \qquad (7)$$

By equation (6) the downstream enterprises' total output of final products is:

$$q^D = q_1^D + q_2^D = \frac{2(a - w_u)}{2 + \lambda} \qquad (8)$$

As a unit of final products requires one unit of intermediate products to process, therefore, by equation (8) the expanding demand for intermediate products of independent downstream enterprises is:

$$w_u = a - \frac{1}{2} X^D (2 + \lambda) \qquad (9)$$

At this point the supply of intermediate products is the sum of the two upstream enterprises, $X^S = x_1 + x_2$. The

profit function of the independent upstream enterprises is as follows:

$$\pi_1^U = w_u x_1 \quad (10)$$

$$\pi_2^U = w_u x_2 \quad (11)$$

Upstream enterprises carry out the Cournot game, from equation (10) and (11) the first-order conditions:

$$\frac{\partial \pi_1^U}{\partial x_1} = a - \frac{(2x_1 + x_2)(2+\lambda)}{2} = 0 \quad (12)$$

$$\frac{\partial \pi_2^U}{\partial x_2} = a - \frac{(2x_2 + x_1)(2+\lambda)}{2} = 0 \quad (13)$$

Further, from equation (12) and (13), it is easy to get the output of upstream enterprises U_1 and U_2 as follows:

$$x_1^U = x_2^U = \frac{2a}{3(2+\lambda)} \quad (14)$$

Through market equilibrium conditions of the intermediate products, $X^D = X^S = x_1 + x_2$, and taking the equation (14) into equation (9), under maximized profits condition, the upstream enterprises requested price w_u of intermediate products is:

$$w_u = \frac{a}{3} \quad (15)$$

Take the equation (15) into equation (6), the output of downstream enterprises D_1 and D_2 is:

$$q_1^D = q_2^D = \frac{2a}{3(2+\lambda)} \quad (16)$$

Take the equation (15) into equation (7), the profits of downstream enterprises D_1 and D_2 before vertical integration are:

$$\pi_1^D = \pi_2^D = \pi^D = (\frac{2a}{3})^2 (\frac{1}{2+\lambda})^2 \quad (17)$$

4. Post-Vertical Integration

After the vertical integration, the downstream market consists of a vertically integrated enterprise (enterprise V) and an independent enterprise (enterprise D_2), and the two enterprises carry out the Cournot game. Two downstream enterprises' profits functions are as follows:

$$\pi^V = (a - q^V - \lambda q_2^{D*}) q^V \quad (18)$$

$$\pi_2^{D*} = (a - q_2^{D*} - \lambda q^V - w_v) q_2^{D*} \quad (19)$$

The first-order conditions of equation (18) and (19) result in:

$$\frac{\partial \pi^V}{\partial q^V} = \left(a - \lambda q_2^{D*}\right) - 2q^V = 0 \quad (20)$$

$$\frac{\partial \pi_2^{D*}}{\partial q_2^{D*}} = \left(a - \lambda q^V - w_v\right) - 2q_2^{D*} = 0 \quad (21)$$

Solving equation (20) and (21), the output of the integrated enterprise V and independent enterprise D_2 is respectively as follows:

$$q^V = \frac{a(2-\lambda)+\lambda w_v}{4-\lambda^2} \quad (22)$$

$$q_2^{D*} = \frac{a(2-\lambda)-2w_v}{4-\lambda^2} \quad (23)$$

Take the equation (22) and (23) into equation (18) and (19) respectively, the profits of the integrated enterprise V and independent enterprise D_2 are:

$$\pi^V = [\frac{a(2-\lambda)+\lambda w_v}{4-\lambda^2}]^2 \quad (24)$$

$$\pi_2^{D*} = [\frac{a(2-\lambda)-2w_v}{4-\lambda^2}]^2 \quad (25)$$

By equation (23) the expanding demand for intermediate products of independent downstream enterprises is:

$$w_v = \frac{1}{2}[a(2-\lambda)-X^V(4-\lambda^2)] \quad (26)$$

Give equation (26) a certain intermediate products demand, and the profit function of the independent upstream enterprise is as follows:

$$\pi_2^{U*} = w_v x_2^{U*}, \quad (27)$$

Intermediate products are provided by the upstream independent enterprises, and the upstream enterprises determine the intermediate products' price w_v according to their own profit maximization. Thus, through the market equilibrium condition $X^V = x_2^{U*}$ and first-order conditions of the maximized profits from the equation (27) the optimal output of the independent upstream enterprises is as follows:

$$x_2^{U*} = \frac{a}{2(2+\lambda)} \quad (28)$$

Take equation (28) into equation (26), and the balanced price of intermediate products is:

$$w_v = \frac{(2-\lambda)a}{4} \quad (29)$$

Take equation (29) into equation (22) and (23), the balanced output of the two final products is:

$$q^V = \frac{a(8-2\lambda-\lambda^2)}{4(4-\lambda^2)} \quad (30)$$

$$q_2^{D*} = \frac{a}{2(2+\lambda)} \quad (31)$$

Take equation (29) into equation (24) and (25), the profits of the integrated enterprise V and the independent enterprise D_2 are as follows:

$$\pi^V = [\frac{a(8-2\lambda-\lambda^2)}{4(4-\lambda^2)}]^2 \quad (32)$$

$$\pi_2^{D*} = [\frac{a}{2(2+\lambda)}]^2 \quad (33)$$

5. Comparative Analysis

To compare the vertical integration influences on the markets of the intermediate products and final products, we subtract equation (15), and equation (16) respectively from equation (29), equation (30), and equation (31) and the results are:

$$w_v - w_u = \frac{a(2-3\lambda)}{12} \quad (34)$$

$$q^V - q_1^D = \frac{8a + 2a\lambda - 3a\lambda^2}{12(4-\lambda^2)} \quad (35)$$

$$q_2^{D*} - q_2^D = \frac{-a}{6(2+\lambda)} \quad (36)$$

Conclusion 1: when $\lambda < 2/3$, vertical integration causes market exclusion, the smaller λ is, the severer the degree of market exclusion becomes.

From equation (34) it can be seen that, when $\lambda < 2/3$, $w_v > w_u$, the intermediate products prices mount with the generating of the market exclusion. The smaller λ is, that is, the greater the product differentiation is, the more the intermediate goods prices rise, and the severer the degree of market exclusion becomes.

Conclusion 2: After vertical integration the output of the integrated enterprises increases, while the output of the downstream independent enterprises decreases.

Certification: In equation (35) the denominator is positive, therefore the positive and negative of $q^V - q_1^D$ are the numerators. The numerators of the equation (35) do the second-order calculus to λ, its value being smaller than 0, and thus it is a convex function. When $\lambda = 0$ or $\mathbf{1}$, its numerators being both positive, $q^V - q_1^D$ must be greater than zero.

From the equation (36) it can be seen that, $q_2^{D*} - q_2^D < 0$, namely, under any condition, vertical integration leads to the decrease of non-integrated enterprises.

Conclusion 3: After vertical integration the profits of the downstream independent enterprises D_2 are lower than those before vertical integration.

Certification: it can be get through equation (33) and equation (17) $\pi_2^{D*} - \pi_2^D = \frac{a^2}{4(2+\lambda)^2} - \frac{4a^2}{9(2+\lambda)^2} < 0$, and this is due to the market exclusion which affects the downstream independent enterprises: the increase of the intermediate products prices increases their own cost while the output declines, therefore the profits descend.

CONCLUSION

Our research reveals that, after vertical integration intermediate products prices go up, making the costs of non-integrated downstream independent enterprises increase, and the market exclusion comes into being. The smaller λ is, the greater the product differentiation is, and the more the intermediate goods prices mount, the severer the degree of market exclusion becomes. Vertical integration lead to the decline in the profits of the downstream independent enterprises after the vertical integration.

Acknowledgement

We are grateful to professor Hu Shihua, supported by Fundamental Research Funds for the Central Universities(SWU1309005) and Southwest University Dr. Fund (SWU09022).

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