Iranian Economic Review, Vol.11, No.15, Winter 2006

The Theory of Concentration Oligopsony

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Abstract

This paper originates the theory of buyer concentration for a main raw material input for a single processing industry. The oilgopsony concentration is obtained and subsequently decomposed into several factors, affecting indirectly the industry's profitability. It is found that the leading firms' efficiencies hypothesis is reaffirmed due to variations associated with the marginal productivity differentials. This finding is based on concentration separation approach rather than analyzing the cost-efficiency effect against market power effect from increasing concentration on the industry's markup, provided by structural approach of minimum cost function.
Keywords: Cost Efficiency, Market Power, Oligopsong Concentration, Leading Firms.

I. Introduction

One of the major elements of the observable variables determining market structure is the concentration ratio which is widely employed in several applied and theoretic al models across industries over a given period of times. It is called Herfidahl-Hircshman index and defined as the sum of squired market shares of

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Financial support was provided by Tehran University due to special grant belonged to M. Ahmadian.

the firms within a single producing industry. Its positive correlation with the industry's economic performance has been discussed and tested through efficiency proxies by Demsetz (1973) and Rosenbaum (1994), and with costs by Dickson (1994). In the original paper pioneered by Cowing and Waterson (1976), this positive links has worked out in an equation of pric e-cost margin for an oligoploitic market. In their paper, the concentration index is decomposed into two different parts and that the first is being the inverse of the number of firms considered as a lower limit and the second part depends on the coefficient of variation in outputs. In its theoretical expansion, the second component is related to the industry price elasticity of demand as well as the differentials in marginal costs among firms as measured by the coefficient variation. It is originally constructed by the Clarke and Davies (1982) in the oligopolies for the Cournot behavior. By introducing equal collusion parameter between firms, they showed that the Herfindahl index became higher than the Cournot case. In a few recent studies, the concentration effects of economic performance has been separated out between market power versus cost efficiency using structural models developed by Azzam (1997), Azzam and Schroeter (1995) in oligopsoneis, however it is discussed by Schroeter and Azzam (1991), and Lopez, Azzam and Carmen (2002) in the oiligopolies. These models are the extension of the framework originally introduced by Appelbaum (1982). Therefore, it is worthwhile to decompose the oiligopsony concentration into different components for main input demand in a single processing industry. The purpose of this paper is to outline a theoretical model in order to determine and separate the oligopsony concentration. In the model, the material input is converted into a single output, using non- material inputs purchased in the competitive market. It yields a concentration index, which is summed up by two parts. Its first part is the inverse of the number of firms as a lower bound and the second part is responsive for the price elasticity of material input supply, the degree of collusion and the coefficient of variation in marginal productivity differentials.

This paper organizes as follows: the second section develops a theoretical model and the theory of buyer concentration is derived in the third section. In the forth section the industry margin is analyzed and final section deals with concluding remarks.

II –Theoretical Model

Assume that a processing industry consists of n firms and each firm converts a single raw material input into a final homogeneous output. Conversion needs to use the number of the nonmaterial inputs, m, which are the same across firms and purchased by each firm in the competitive market. Firm i processes output q_i, using separable production technology given by $q_i = F_i(X_i, f_i(y_{i1}, y_{i2}, \ldots, y_{im}))$ where x_i is the raw material (agricultural) input, r is its price, and $r = v(x)$ is its supply function to be required by processing industry. The profit function for firm i is given by $\pi_i = pq_i - x_i v(x) - \sum_{j=1}^{m} r_{ij} y_{ij}$, where y_{ij} is the j the non-material (non-agricultural) input, r_{ij} is its price, p is the competitive price of a processed output, and $x = \sum_{i=1}^{n} x_i$ is the industry's purchases of major material input. Firm i decide to maximize its own profit function in order to determine is demand for all factors of production. Its first – order conditions for profit maximization is summarized as follows:

$$O_i = \frac{\alpha_i}{e_x} \qquad (1)$$

$$PA_{ij} = r_{ij} \qquad (2)$$

Where, $O_i = \frac{Pa_i - v}{v}$ is the relative mark-up over material input price and $a_i = \frac{\partial F_i}{\partial X_i}$ is the marginal productivity for the i th firm. In addition, $e_x = \frac{dX}{dr}.\frac{r}{X}$ is the price elasticity of supply of material input, $\alpha_i = \frac{\partial X}{\partial X_i}.\frac{X_i}{X}$ is the conjectural elasticity of total industry's demand for material input with respect to the firm i's demand, and $A_{ij} = B_i a_{ij}$ is the marginal productivity of the j th non-material input[1].

The conjectural elasticity for firm i consists of its input market share times a change in industry's demand for major material input due to a change in its own demand. It is important to make clear the relationship between the collusion parameter among processing firms with each firm's conjectural elasticity in the oilgopsonistic market. For oligopoly firms, the degree of collusion is originally developed and modified by Clarke and Davies (1982) in processing homogeneous output. However, it is going to be elaborated for demand of the main input here.

Following Clarke and Davies' (1982) work, the definition of collusion parameter is specified by $\frac{\partial X_k}{X_k} = b\frac{\partial X_i}{Xi}$ in the oligopsonistic material market. Modifying the i th firm's conjectural elasticity with the degree of collusion, it is written as $\alpha_i^* = b + (1-b)t_i$, and substituting it into equation (1), the outcome will be:

$$O_i^* = \frac{b+(1-b)t_i}{e_x} \tag{3}$$

Where O_i^* is the i th firm of modified economic performance and t_i is its share of market demand for material input. Multiplying both side of equation (3)

1- In equation (2), $A_{ij} = \frac{\partial q_i}{\partial y_{ij}}$ is the marginal productivity of the j th nonmaterial input, $a_{ij} = \frac{\partial f_i}{\partial y_{ij}}$ is its productivity in the sub-production function of $f_i(y_{il} . y_{im})$, and $B_i = \frac{\partial q_i}{\partial f_i}$ is the productivity of function f_i with respect to firm i's output. Equation (2) is an optimal condition for a processing firm and equates the value of marginal productivity of the j th non-material input to its price in the competitive market.

for t_i and then summing across n firms, the following expression will be obtained for the industry's profit-cost margin

$$O^* = \frac{b}{e_x} + \frac{1-b}{e_x} h \tag{4}$$

Where $O^* = \frac{R-C}{C}$ is the industry's profit over the cost allocated to purchasing material input, $R = P \sum_{i=1}^{n} a_i X_i$ is the gross revenue, and $C = vX$ is the total cost resulted from employing the material input in the processing industry[1]. Furthermore, $h = \sum_{i=1}^{n} t_i^2$ is the concentration index and it is called the Herfindahl index of concentration in the oligopsonistic market. If h=1, indicating its upper bound , then the industry as a unified group will act as a monopsonist in the material input market. In equation (4), the parameter, $\alpha^* = b + (1-b)h$ is the weighted average of conjectural elasticities of each firm, which is determined by $\alpha^* = \sum_{i=1}^{n} t_i \alpha_i^*$, representing the industry's conjectural elasticity.

III- The Theory of Buyers Concentration

There are few factors affecting the buyer's concentration ratio, which are resulted from the equilibrium conditions of industry and its processing firms. It is required to analyze the effects of these factors on concentration index in the

(3) Parameter b varies between zero and one in equations (3) and (4), if b=0 then $O_i^* = \frac{t_i}{e_x}$ and subsequently $O^* = \frac{h}{e_x}$ and therefore the model will be reduced to the Cournot case. If b=1 then $O_i^* = O^* = \frac{1}{e_x}$ and thus the industry as a unified unit is intending to behave as a monopsonist in the material input market.

material input market In so doing, summing equation (3) across the n firms, obtaining the price of a final output, P, and then substituting p again into equation (3), it will give the following expression for the i th firm's share of demand for material input.

$$t_i = \frac{1}{(1-b)}\left(\frac{a_i}{a}\right)\left[ne_x + 1 + b(n-1)\right] \tag{5}$$

Where $a = \sum_{i=1}^{n} a_i$ is the sum of marginal productiv ities of processing firms. Squaring equation (5), summing it over the n firms and rearranging yields

$$h = \frac{1}{n} + \frac{v_a^2}{n}\left[\frac{ne_x + 1 + bn - b}{(1-b)}\right]^2 \tag{6}$$

Where v_a^2 is the coefficient of variation in marginal productivities? As shown by equation (6), the inverse of the number of firms is the level of concentration at the value of the lower limit and its additional component is depended on the degree of the buyers' collusion and the industry price elasticity of material input supply. Differentiation of equation (6) with respect to its parameters indicates that the buyer concentration index will be higher if (1) the degree of collusion is larger, (2) the industry price elasticity of material input supply is greater and (3) the coefficient of variation in marginal productivities differentials is higher. Change in n implies that there exists entry into or exit from the market, which has indeterminate effect on the concentration level, holding v_a as a constant (see Appendix)[1].

1- Clarke and Davies (1982) derived the concentration index in the commodity market. In their finding, η is the industry demand elasticity with respect to price, α is the degree of collusion and v_a^2 is the coefficient of variation in marginal costs. They concluded that H increases with the increased in η , α and v_c. But, the effect of N on H is indeterminate.

IV- The Industry Margin Analyses

In equation (4), the industry margin is related directly to the Herfindahl index if b is treated as a constant. Differentiation of (4) with respect to the h yields the effect of concentration on the margin

$$\frac{\partial O^*}{\partial h}=\frac{1-b}{e_x} \tag{7}$$

Where this expression represents the market power effect[1] of increasing concentration on price-cost margin. Since b is less than unity and e_X is positive, the greater in h will cause the higher in the industry's economic performance.

The factor affecting concentration index will influence the industry profit-cost ratio indirectly. Substituting equation (6) into equation (4), the following expression will yield:

$$O^*=\frac{b}{e_x}+\frac{1-b}{e_x}+\frac{1-b}{e_x}\left[\frac{ne_x+1+b(n-1)}{1-b}\right]^2\left(\frac{v_a^2}{n}\right) \tag{8}$$

Differentiation of equation (8) with respect to b and e_X separately, holding the other parameters as constant, it will give their direct and indirect effects on the industry's profit-cost ratio in the material input market[2]. The collusion

1 - If the degree of collusion becomes as a positive function of the Herfindahl index, differentiation of (4) will give the following expression for concentration effect:

$$\frac{\partial O^*}{\partial h}=\frac{1-b(h)}{e_X}+\frac{db}{dh}\left(\frac{1-h}{e_X}\right)$$

Since $\frac{\partial b}{\partial h}$ is positive and so that the market power effect becomes higher.

2- Changing price-cost margin was analyzed by Komings (2005) due to privatization and competitive pressure, was measured by Morrison (2000) as a result of market power as well as cost economics, and was studied by Nevo (2000) through increasing only in the strength of market mechanism.

parameter, b, has direct effect denoted by $\frac{1-h}{e_x}$, using equation (4), and its indirect effect due to concentration variations is represented by $\frac{2v_a v_x(1+e_x)}{e_x(1-b)}$, where v_X is the coefficient of variation in the demand for material inputs. Since $h<1$ and $e_X>0$, both effects have positive signs and thus the higher degree of collusion will induce the greater industry's economic performance. The impact of the material input supply elasticity with respect to price on the industry π/C ratio is indeterminate since its direct effect denoted by $-\frac{\alpha^*}{e_x^2}$ is negative, using equation (4), and its indirect effect through concentration variations is positive as termed by $\frac{2v_a v_x}{e_x}$. This result is true also for change in the number of firms which is determined by variations in the concentration ratio (see Appendix).

To discuss the effect of the marginal productivity differentials on the industry π/C ratio, differentiation of (8) with respect to v_a, holding the other parameters as constant, it will give the term $\frac{2v_x(1-b)}{ne_x v_a}$, which is positive. This effect is done through variations in concentration ratio. Considering equation (5), if $t_i \geq t_j$ then it implies that $S_i \geq S_j$, where $S_j = \frac{a_j}{a}$ is the j th firm's share of total marginal productivity. It means that a firm with higher marginal productivity will demand larger material input for processing and so that its share in concentration index will be greater[1]. This implies that the leading firms with greater marginal productivity than the smaller firms will induce the larger

1 - Equation (5) can be written as ti = Dsi where $D = [ne_x + 1 + b(n-1)] / (1-b)$. From this expression, if $t_i \geq t_j$ then Si will be greater than Sj.

profit over cost for industry. If the higher marginal productivity implies that the leading firms have efficiency advantages over the smaller firms then it may be argued that the Demsetz's (1973) efficiency hypothesis is valid in explaining the positive link between structures-conduct- performance paradigm.

V – Concluding Remarks

This paper develops the theory of buyer's concentration for a material input in the oligopsonistic market. It shows that the degree of collusion can increase the industry margin directly by its own effect and indirectly by the variations in concentration. Moreover, marginal productivity differentials lead to the differences in efficiencies within firms and so that the leading efficiency firm hypothesis is confirmed, as pointed out by demsetz (1973), in studying the positive link of the structure-conduct-performance paradigm. However, cost-efficiency effect of the increased concentration on the ratio of profit to cost versus the market power effect depends upon the pattern of cost function concerned with the purchases of non main material inputs in the processing industries. The trade off between the gains from cost efficiency effect against the social losses resulted from market power effect was the focus of attention by Rosenbaum (1994), Azzam and Schroeter (1995), Azzam (1997), and Morrison (2000). This finding has affirmed the long held view proposed by Williamson (1968). The cost-efficiency hypothesis caused by increasing concentration has not been the result obtained due to the decomposition of concentration in the main oligopsones, however it is a conclusion assigned for the minimum cost function required for providing the non-major input producing output.

Appendix

The coefficient of variation in demand for material inputs is written as $v_x^2 = \frac{\sum_{i=1}^{n}(X_i - \overline{X})^2 / n}{\overline{X}^2}$ and it gives a concentration ratio of $h = \frac{1}{n} + \frac{v_x^2}{n}$. By substituting h into equation (6), the result will become as

$$\frac{v_x}{v_a} = \frac{ne_x + 1 + b(n-1)}{1-b} \tag{1-i}$$

In expression (1-i), the ratio of v_x to v_a is positive since each of its components is positive. Given equation (1-i), the signs of the derivatives of O^* with respect to b, e_X, v_a and n are obtained as follows:

$$\frac{\partial O^*}{\partial b}=\frac{1-h}{e_x}+\frac{1-b}{e_x}\cdot\frac{\partial h}{\partial b} \qquad (2\text{-i})$$

$$\frac{\partial O^*}{e_X}=-\frac{\alpha^*}{e_X^2}+\frac{1-b}{e_X}\cdot\frac{\partial h}{\partial e_X} \qquad (3\text{-i})$$

$$\frac{\partial O^*}{\partial v_a}=\frac{1-b}{e_x}\cdot\frac{\partial h}{\partial v_a} \qquad (4\text{-i})$$

$$\frac{\partial O^*}{\partial n}=\frac{1-b}{e_x}\cdot\frac{\partial h}{\partial n} \qquad (5\text{-i})$$

Where:

$$\frac{\partial h}{\partial b}=\frac{2v_a v_X(e_X+1)}{(1-b)^2}>0 \qquad (6\text{-i})$$

$$\frac{\partial h}{\partial e_X}=\frac{2v_a v_X}{(1-b)}>0 \qquad (7\text{-i})$$

$$\frac{\partial h}{\partial v_a}=\frac{2v_X^2}{n v_a}>0 \qquad (8\text{-i})$$

$$\frac{\partial h}{\partial n}=-\frac{1+v_X^2}{n^2}+2v_a v_X\left(\frac{e_X+b}{n(1-b)}\right) \qquad (9\text{-i})$$

Since the first component in the expressions of (3-i) and (9-i) is negative and thus their signs are indeterminate.

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