A Nonparametric Test for Monopoly Market Power Exertion by Breakfast Cereal Manufacturers

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Abstract

Using a nonparametric method, monopoly market power exertion is estimated for the breakfast cereal industry for the period 1963-1992. This model does not require the assumption of a functional form, constant returns to scale, nor Hicks neutral technology. Our results indicate that a limited amount of market power is exerted in some years.

Keywords: Nonparametric, market power, breakfast cereal

A NONPARAMETRIC TEST FOR MONOPOLY MARKET POWER EXERTION BY BREAKFAST CEREAL MANUFACTURERS

I. INTRODUCTION

Consumers have long complained about high cereal prices. Every year prices of ready-to-eat breakfast cereals seem to increase considerably to the point that today some cereals cost nearly $5. Last year some members of Congress claimed that top

cereal industry giants were keeping prices artificially high, and called on the Justice Department for an antitrust investigation. Since then all the major companies refrained from their continuous price hikes, but cereal sales have been not increased.

Investigators have tried for decades to uncover the reasons for high cereal prices. In 1915 the Federal antitrust commission sued Quaker Oats for monopoly power exertion, but the court ruled in favor of Quaker Oats. In 1972 the Federal Trade Commission (FTC) mounted another legal campaign against cereal makers, accusing them of collusion and large consumer overcharge. After 10 years (and 35,000 pages of testimony), the FTC once again lost its case. The courts have generally concluded that there is no conspiracy among cereal manufacturers and that the selling of cereal is a tough and competitive business.

However, Schmalensee (1978) analyzed the situation in the 1970's and argued that, within the framework of spatial competition, the industry's conduct avoids price competition, but rivalry focuses on new brand introductions, which tends to deter entry and protect profits.

The purpose of this paper is to try to answer the time long question: Do breakfast cereal manufacturers exert monopoly power? We use nonparametric techniques to measure the degree of potential market. Many types of tests exist to test for market power. The New Empirical Industrial Organization (NEIO) techniques pioneered by Applebaum (1979, 1982) have the advantage that aggregate data can be used and nontrivial restrictions such as constant returns to scale (CRS) and Hicks neutral technology need not be imposed. However, this method has drawbacks. Tests for market power are joint tests of a functional form and market power exertion and estimation of market power depends critically on second order curvature for identification. Reduced-

form tests for market power, pioneered by Hall (1988), also have weaknesses such as imposing CRS and Hicks neutral technological change. However, reduced-form tests do have the advantage of not requiring a functional form assumption and flexibility regarding the use of aggregate data. The last model considered, and chosen, is the nonparametric test for market power developed by Love and Shumway (1994). The structure of the paper is as follows. The next section describes the model, followed by a discussion of the data, then by a presentation of the results, and lastly some concluding remarks.

II. NONPARAMETRIC MODEL

Previous nonparametric market power tests, Ashenfelter and Sullivan (1987), did not incorporate measures, which if not accounted for, could distort market power measurements. Some of the restrictive hypotheses maintained by these models were: a residual firm-level input supply curve that does not shift, that the firm's technology does not change, and that there was no general price inflation. Love and Shumway (1994) relax these assumptions in their deterministic monopsony power test. To overcome the first hypothesis restriction they exclude from analysis those instances when shifts in supply are not offset by shifts in demand. To solve the second problem they include technical change measures, based on work by Chavas and Cox (1988) and Cox and Chavas (1990, 1992). And to avoid the inflation problem, real prices rather than nominal prices are used. These innovations imply a set of linear inequalities that must be satisfied and are easily evaluated with linear programming techniques. The optimal solution yields both an index of monopsony market power exertion in an input market and an index of technical change.

Raper, Love, and Shumway have modified Love and Shumway's test for measuring monopoly market power and that test is presented.

Following Raper, Love and Shumway assume that the input sector is perfectly competitive. The processing firm's profit maximizing problem is

$$(1) \qquad \max_{yi} \Pi = py_i - \sum_{k=1}^{n} r_k x_k \quad \text{s.t. } F_i(x_i) \geq y_i$$

where r_k is price of input k, x_k is quantity of variable input k demanded by firm i to produce output, y_i, whose price is p, given firm i's production function, F_i . For a discrete change in input and output levels, profit-maximizing behavior requires

$$(2) \qquad \Delta\Pi_i = p\,\Delta y_i - \sum_{k=1}^{n} r_k \Delta x_k \leq 0.$$

For any input and output bundle optimally chosen at time t, no other solution, say at time s, will be optimal. So, comparing combinations of quantities observed at s relative to t, given price at t, must not result in an increase in profit:

$$(3) \qquad p^t(y_i^s - y_i^t) - \sum_{k=1}^{n} r_k^t \ (x_k^s - x_k^t) \leq 0$$

where superscripts t and s correspond to the data in that time period.

For a firm that is competitive in all markets, equation (3) represents the Weak Axiom of Profit Maximization (WAPM) and creates the basis for nonparametric tests of price-taking profit-maximizing behavior (Varian). Assuming that the residual excess demand curve perceived by the firm is downward sloping , (3) becomes a stronger condition than WAPM if $y_i^t > y_i^s$ because it implies that a corresponding causal increase in its price from observation s to t would be positive. Shifts in the demand curve not offset by shifts in the supply curve may lead to movements in prices between observations in the

opposite direction than quantities. Since these movements are not caused by market power, all comparisons are deleted where $p^s - p^t \overset{s}{\neq} y_i^s - y_i^t$ where $\overset{s}{\neq}$ means "not the same sign as".

Cox and Chavas propose an additive specification that allows for regressive and nonregressive technical change

(4) $$y_i^t = Y_i^t - a_i^{t+} + a_i^{t-}$$

where y_i is redefined as "effective" output, Y_i is "observed" output, a_i^+ is positive neutral technical change, and a_i^- negative neutral technical change.

Equations (2) and (3) give necessary and sufficient conditions for the existence of a well-defined production function that could generate the data under profit maximization (Varian). Love and Shumway look at an approach, suitable when market power and technical change are possible, by finding whether there exists a set of market power parameters, m_i^{ts}, and technical change parameters, a_i^{t+} and a_i^{t-}, that solve the linear programming model

(5) $$\min_{a_i^{t+}, a_i^{t-}, m_i^{ts}} \sum_{t=1}^{T} \left(b^{t+} a_i^{t+} + b^{t-} a_i^{t-} + \sum_{s \neq t=1}^{T} c^{ts} m_i^{ts} \right)$$

subject to

(i) $$p^t[(Y_i^t - a_i^{t+} + a_i^{t-}) - (Y_i^s - a_i^{s+} + a_i^{s-})] - m_i^{ts}(Y_i^t - Y_i^s) - \sum_k^n r_k^t (x_{ki}^t - x_{ki}^s) \geq 0$$

$\forall\ s \neq t$ except when $p^t - p^s \overset{s}{\neq} Y_n^t - Y_n^s$

(ii) $$m_i^{ts} \geq 0, \quad \forall\ s \neq t$$

(iii) $a_i^{t+} \geq 0, \quad \forall\, t$

(iv) $a_i^{t-} \geq 0, \quad \forall\, t$

where c^{ts}, b_i^{t+}, and b_i^{t-} are arbitrary weight, $m_i^{ts} = -\eta_i^{ts}\, p^t$ and

$\eta_i^{ts} = [(p^t - p^s)/(Y_i^t - Y_i^s)](Y_i^s / p^t)$ is the price flexibility of the ith firm's perceived residual demand curve. The term η_i^{ts} is also interpreted as the monopoly Lerner index since $\eta_i^{ts} = -[(p^t - mc_i^t)/p^t)]$, where mc_i^t is marginal cost for the firm. Solutions for the monopoly Lerner index are recovered by $L_i = m_i^{ts} / p^t$. If $L_i = 0$, then firm i perceives it cannot impact output price by altering quantity supplied. If $L_i \geq 0$, then firm i perceives the residual demand curve as downward sloping and exerts monopoly market power by restricting supply below the competitive level.

Equation (5) can be solved by linear programming methods using GAMS 2.25.

III. DATA

Most of the data comes from the *Annual Survey of Manufactures* (ASM) and the *Census of Manufactures* for grain mill products, cereal breakfast foods, in particular (SIC 2043). They consist of quantities and costs of input products and quantities and values of output products for the years 1963, 1967, 1972, 1977, 1982, 1987, and 1992, which correspond to the years when the ASM is published. From the available information, five input categories are formed: grains (wheat, rice, oat, flour), sugar (cane and beet), materials (packaging paper, bags, paperboard containers, boxes,etc.), capital (gross book value of depreciable assets, specifically new capital expenditures at the beginning of the year), and labor (number of employees). Due to inconsistencies in ASM's reporting of

data, the price for grains is set as the price of wheat, the most important grain used in breakfast cereal production. Price of sugar is calculated by dividing cost by quantity. Price for labor was calculated from payroll divided by number of employees. Price for materials is the producer price index (PPI)of material components for manufacturing from *the Statistical Abstract of the United States*. Price for capital is the PPI for capital from the *Economic Report of the President*. To obtain quantity of grains used, all the available cost figures for grains are summed and divided by the total by price of wheat. Similarly, for materials, quantity is obtained by adding all available costs and dividing by the PPI for materials.

A single output price is computed using the Divisia index to aggregate individual output quantities and prices of corn flakes, wheat flakes, and rice breakfast foods, dividing the total value of output, reported in the ASM, by this price index. Aggregate output quantity is then obtained by the output. All prices are converted to real terms by dividing by a GDP deflator1987, obtained from the *Economic Report of the President*, with base year.

IV. RESULTS

The results presented in Table 1 show that breakfast cereal manufacturers exert monopoly power and have been doing so since at least 1963. However, the degree of market power has oscillated often throughout the years, as seen in Figure 1. Nevertheless, the results indicate that in recent years breakfast cereal manufacturers have been losing market power and that in 1992 they had reached the lowest level in the 1963-1992 period.

The arbitrary weights of the model were altered to verify the robustness of these results. The two sets of market power parameters are presented in Table 1 and correspond

to the following weight values: $b_n=b_p=c^{ts}=1$ for column one and $b_n=100$ and $b_p=c^{ts}=1$ for column two. Other combinations were also estimated, but yielded the same results as those presented below. For example, when setting $b_p=100$ or 1000 and $b_n=c^{ts}=1$, we obtain the same result as in column one. Similarly, letting $b_n=1000$ and $b_p=c^{ts}=1$ yields the same result as shown in column two. The differences in market power parameter estimates are minimal and the two series follow a close and similar trend, see Figure 1, suggesting that our results are not sensitive to changes in weights. Estimated Hicks neutral technical change parameters differ for each of the cases presented. Given the weights in column one (and for all other equivalent cases), all positive and negative values are zero, except for one negative technical change value of 75.31 for 1977. For column two (and all equivalent cases), only the 1972 technical nonnegative change parameter is positive of 75.31. Both technical change parameters are identical in absolute value.

V. CONCLUSION

The breakfast cereal industry has long been suspected of monopoly power exertion. This paper estimates market power exertion in the breakfast cereal industry using a nonparametric method. Results confirm cereal manufacturers do exert limited monopoly power, however, it seems to be diminishing and in 1992 was at its lowest level since 1963 (which was its peak period). By varying criterion function parameters we confirmed that results are not very sensitive to chosen weights. Between 1963 and 1992, the market power exertion seems to have gone through two cycles. Between 1967 and 1972 the real price of raw inputs fell by 4.1%, while the real price of ready-to-eat cereals fell by 8.6%, more than double that amount. During this period, the breakfast cereal industry exercised significant market power. During the 1963-1977 period, market power exertion reached a

low of 0.0438 in 1972. A possible explanation for this dip is that the real wholesale price of breakfast cereal remained relatively constant while raw input prices experienced rapid increases.

The downward sloping trend in market power exertion observed between 1982 and 1992 suggests that the recent concern over market power seems not to be justified. The decrease in market power exertion may be due to the increased volume of private-label ready-to-eat. In recent years, the introduction of these products have eaten away at the market shares of some of the industry's national giants, see Table 2. Kellogg, the industry's leader, has been particularly affected. From 1987 to 1991 Kellogg's market share dropped from 42% to 37.2% while that of private-label increased from 2.6% to 4.5%. The market shares of Post and Quaker brands have also dropped.

Future work in this area should certainly look at the effect that private-label breakfast cereals are having on branded labels. This may help explain the recent diminishing levels of market power and what other effects they could have in the industry. Adding information about advertising expenditures, expected to be quite large, should also be incorporated in the model.

Table 1. LP Results: Estimated Lerner Index of Monopoly Market Power (L_i)

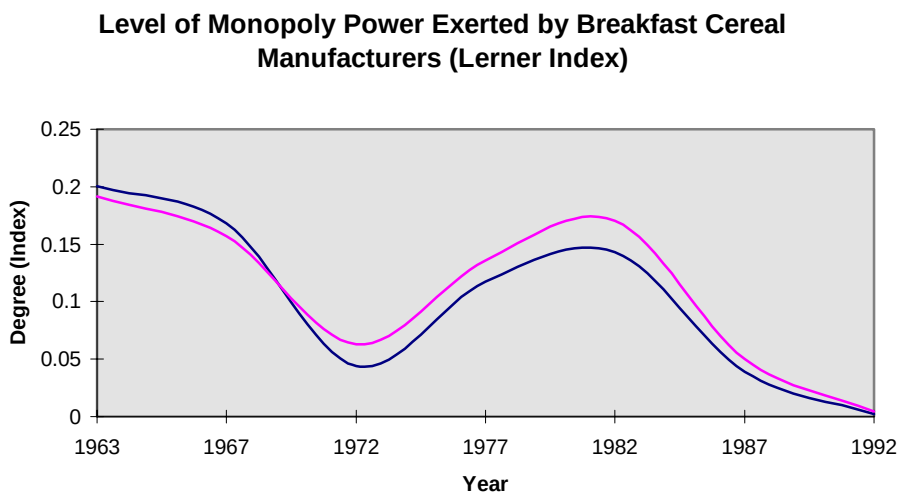
Time	Market Power Measures	
	$b_n = b_p = c^{ts} = 1$	$b_n = 100,\ b_p = c^{ts} = 1$
1963	0.2002	0.1915
1967	0.1679	0.1570
1972	0.0438	0.0631
1977	0.1175	0.1358
1982	0.1433	0.1706
1987	0.0391	0.0501
1992	0.0023	0.0043
Avg.	*0.1020*	*0.1103*

Table 2. National vs. Private-Label Cereal Brands 1987-1992

Company	1987	1988	1989	1990	1991
Kellogg	42.0%	42.2%	39.6%	37.2%	37.2%
General Mills	23.6	24.4	26.5	28.0	29.0
Post	12.1	11.4	10.0	10.7	11.1
Quaker	7.9	8.0	7.8	7.3	7.1
Ralston Purina	3.4	3.3	5.0	6.7	5.6
Private Label	2.6	2.9	3.3	4.0	4.5

Source: Wheat First Securities; Prudential-Bache Securities

Figure 1.



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