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Market Conduct in the U.S. Ready-to-Eat Cereal Industry*

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I. Introduction

Three characteristics distinguish the U.S. ready-to-eat (RTE) cereal industry. First, the industry is *highly concentrated*. Although there are approximately 40 companies producing more than 400 brands, more than 90% of output since 1980 has been produced by just five companies[1]. Another characteristic is *extensive advertising*. Average selling expenses are 30% of sales value, with smaller firms tending to advertise more than large firms. Moreover, most of this expense is for mass-media advertising. The third distinguishing characteristic of the RTE cereal industry is *product proliferation*. New product launches have increased from one or two products per year in 1950, to more than 100 per year since 1989. If one accounts for all of the variations in sizes and flavors of the 400 brands, there are approximately 1000 RTE cereal products for sale in the U.S. Private label products, an important source of competition in other industries, have limited effect in the RTE cereal industry. Though they are priced about 40% above private label products, branded products continuously capture more than 90% of the market (Connor, 1999).

These attributes tend to facilitate the exercise of either unilateral or cooperative market power, and in the past have led U.S. antitrust authorities to closely scrutinize the RTE cereal industry. The Federal Trade Commission (FTC), in fact, devoted up to two-thirds of its resources to investigate the industry during the Ford and Carter administrations. The FTC sued the top three manufacturers – Kelloggs, General Mills, and Post – for effectively operating as a "shared monopoly". However, the prosecution was ended abruptly by Congressional action in 1981 (Warner, 1981).

The objective of this study is to examine both the degree and type of market power that may have

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[1] These numbers are valid for the RTE cereal industry as a whole. If the classification is made by individual product (corn flakes, for example) the concentration would be still higher.

been exercised by top cereal companies in the years before termination of the "Big Three" case (1975-1980), and then in the years after termination of the case (1982-1990). Our hypothesis is that once the industry no longer found itself under the spotlight of an on-going governmental investigation, conduct became substantially less competitive. Additionally, we hypothesize that the increase in overall market power was driven mainly by a rise in *coordinated* as opposed to *unilateral* market power.

To test these hypotheses, we quantify the conduct of U.S. cereal makers using the differentiated-products oligopoly framework of Cotterill, Franklin, and Ma (1996). Their approach provides us with a convenient way to parameterize the spectrum of oligopoly outcomes, ranging from perfect collusion to perfect rivalry. The Cotterill, Franklin, and Ma (CFM) approach nests as special cases residual demand models that do not enable separation of unilateral from coordinated market power (e.g. Baker and Bresnahan, 1985), as well as unilateral demand approaches allowing for only Nash-Bertrand behavior (e.g. Hausman, Leonard, Zona, 1994; Nevo, 2001). As in CFM's analysis, we employ the Rothschild, Chamberlin, and Cotterill indexes to quantify the exercise of different forms of market power.

Data are from Selling Area Markets Inc. (SAMI), which reported the four-week U.S. average price and quantity of approximately 70 cereals sold in supermarkets between 1975 and 1990. In this stage of the paper's development, we work with 12 brands of the "traditional kid" segment. This sample accounts for 80% of that segment and represents four cereal companies.

The paper is organized as follows. In section II we lay out our conceptual model for addressing the issue of market conduct. In section III the empirical procedures and data used to implement the conceptual model are described. The results are described in section IV, and section V gives our conclusions.

II. Conceptual framework

Models of differentiated products using brand level data have been developed by Baker and Bresnahan (1985 and 1988), Hausman, Leonard, and Zona (1994), and Cotterill and Haller (1997). The Baker and Bresnahan approach involves the estimation of residual demands, which can indicate whether the demand facing a group of firms is sufficiently inelastic (after accounting for rival behavior) to enable the exercise of market power. In contrast to the residual demand approach, Hausman, Leonard, and Zona, and Cotterill and Haller assume Nash-Bertrand conjectures (implying $\partial p_i / \partial p_j = 0 \;\; \forall\, i \neq j$) and estimate unilateral demand systems. For the purposes of this study, each of these frameworks have a key limitation. Specifically, the residual demand approach does not enable separation of unilateral from coordinated market power, and the unilateral demand approach allows for only one type of behavior (Nash-Bertrand).

In a 1996 paper, Cotterill, Franklin, and Ma (CFM) developed a framework that does not have these limitations. Their approach allows price reaction elasticities (also known as conjectural variations parameters) to be non-zero and vary across brands, and enables the identification of unilateral market power separately from that of coordinated market power. It allows for both perfect collusion and perfect competition, and nests the Hausman, Leonard, Zona and Baker and Bresnahan models as special cases. CFM use three indexes of market power to decompose the degree of market power arising from collusion versus that which arises from unilateral market power. A less-satisfying feature of the CFM approach is that the observed and estimated price reaction elasticities are not consistent in general[2], and a static

[2] Inconsistent conjectures are also a feature of the Baker and Bresnahan model. Hausman, Leonard, and Zona ignore rather than resolve the lack of consistency in Nash-Bertrand models (CFM).

framework is used to characterize strategic interaction among firms. Despite these theoretical shortcomings, CFM's framework has been shown to be empirically tractable, and provides us with a convenient way to parameterize the spectrum of oligopoly outcomes. As such it greatly facilitates empirical analysis of pricing and profitability at the brand level.

For these reasons, we follow CFM's general framework to examine the issue of market power in the RTE cereal industry, although we make two minor modifications. First of all, we derive the expression for optimal markup and the price elasticity of demand from a brand manager's profit-maximization problem, instead of a brand's demand function. Additionally, we follow a different route to derive fully collusive elasticities. These departures will be explained in more detail below.

Brand manager's problem

The cereal industry is characterized by a small number of firms selling multiple brands. As such, it may be more realistic to consider the profit-max problem of a multi-brand firm (as in Nevo 2001) than that of a brand manager who maximizes profits independently of other brand managers in the same firm. However, in terms of the optimal markup (i.e. price-cost margin), the only practical difference between these approaches is that the multi-brand approach automatically assumes that brands of the same firm have price reaction elasticities (ε_{ij}) identically equal to 1 (that is, pricing behavior is "fully collusive" across brands within a firm). With the brand-manager approach, price reaction elasticities are determined empirically, using observations of actual market behavior, and so may differ from 1. Viewing this greater generality as an advantage, we analyze the profit-max problem from the perspective of an independent brand manager.

We begin by assuming that the profit function for a individual brand of cereal – in this case brand 1 – can be represented as:

$$\Pi_1 = (p_1 - mc_1)q_1 - C_1 \tag{1}$$

where p_1 is the price of brand 1, mc_1 is the (constant) marginal cost of brand 1, and C_1 is the fixed cost of production. We assume that the quantity q_1 produced by firm 1 is dependent on the prices of competing brands such that $q_1 = q_1(p_1,..., p_n)$. A firm maximizes profit by choosing the price of its brand (i.e. Bertrand competition), leading to the first order condition:

$$q_1 + (p_1 - mc_1)\left[\frac{\partial q_1}{\partial p_1} + \frac{\partial q_1}{\partial p_2}\frac{\partial p_2}{\partial p_1} + \cdots + \frac{\partial q_1}{\partial p_n}\frac{\partial p_n}{\partial p_1}\right] = 0 .$$

Multiplying though by $p_1 / \sum p_i q_i$ as well as by (p_1 / p_1), (p_2 / p_2), (p_n / p_n), and (q_1 / q_1) in certain terms leads to the following modified first order condition:

$$w_1 + (pcm_1)w_1[\eta_{11} + \eta_{12}\varepsilon_{21} + \cdots + \eta_{1n}\varepsilon_{n1}] = 0 \tag{2}$$

where w_1 is the expenditure share on brand 1, $pcm_1 = (p_1 - mc_1)/ p_1$ is the price-cost margin, $\eta_{ij} = (\partial q_i / \partial p_j)(p_j / q_i)$ is the elasticity of demand for brand *i* with respect to the price of brand *j*, and $\varepsilon_{ij} = (\partial p_i / \partial p_j)(p_j / p_i)$ is a price reaction elasticity (i.e. the degree that brand *i* tends to respond to a change in brand *j*'s price). Solving for the optimal markup (i.e. price-cost margin) yields[3]:

$$pcm_1 = \frac{-1}{\eta_{11} + \eta_{12}\varepsilon_{21} + \cdots + \eta_{1n}\varepsilon_{n1}} . \tag{3}$$

The remainder of the analysis focuses on the denominator of the right-hand side of (3), which – following CFM – we call the *observable* own price elasticity of demand (η_1^O). Mathematically, $\eta_1^O = \eta_{11} + \sum_2^n \eta_{1i}\varepsilon_{i1}$. Three special cases of η_1^O can be distinguished. In the Nash-Bertrand case there

[3] The optimal markup derived from a multi-brand firm problem would differ only in that the price reaction elasticities would be 1 for brands of the same firm. It is not difficult to incorporate this restriction if felt to be important.

is only *unilateral market power*, since $\varepsilon_{ij} = 0$ for all *i* and *j* (*i*≠ *j*) and the price elasticity is equal to η_{11} alone[4]. When there is *full collusion* among brands (for which we denote the elasticity by η_1^C), all price reaction elasticities are one, such that the price elasticity for brand 1 is $\eta_1^C = \sum_1^n \eta_{1i}$. In the case that there is there is a *perfectly competitive rivalry* among brands (for which we denote the elasticity by η_1^R), we have that $\varepsilon_{ij} = -1$ for all *i* and *j* (*i*≠ *j*), yielding a price elasticity of $\eta_1^R = \eta_{11} - \sum_1^n \eta_{1i}$.

These cases are portrayed in Figure 1. Note that the fully collusive elasticity (η_1^C) corresponds to the steepest demand slope in price-quantity space, while that of the competitive rivalry (η_1^R) approaches the horizontal axis. Given the market characteristics outlined in the introduction, we would expect that the observed own price elasticities (η_1^O) will fall somewhere between the unilateral (η_{11}) and fully collusive (η_1^C) estimates.

Market conduct indexes

While the elasticities described above can characterize the competitive structure of the RTE cereal industry, it is helpful to further use a set of standardized indexes to analyze market conduct. Following CFM, we employ the Rothschild Index, Cotterill Index, and Chamberlin Quotient to decompose total market power into its unilateral and collusive components.

The **Rothschild Index** (*RI*) indicates how close the brand comes to reaching its maximum market power (as given by the fully collusive demand elasticity, η_1^C) when it acts unilaterally. The *RI* is defined as the slope of the unilateral demand divided by the slope of the fully collusive demand. In the neighborhood of the price p_1 (see Figure 1), this is equivalent to dividing the fully collusive price

[4] This is the underlying assumption of Hausman, Leonard, and Zona; Cotterill and Haller; and Nevo (2001).

elasticity by the unilateral price elasticity: $RI \equiv \eta_1^C/\eta_{11}$, where $RI \in [0,1]$. When *RI* equals zero there is perfect competition; when it equals one there is full collusion.

Assuming again that η_1^C is the maximum market power that could be exerted by a brand, the **Cotterill Index** (*CI*) indicates the extent to which that theoretical maximum is achieved by the brand. The *CI* is obtained by dividing the fully collusive price elasticity by the observed price elasticity at a given price and quantity observation: $CI \equiv \eta_1^C/\eta_1^O$, where $CI \in [0,1]$. When the *CI* equals zero there is perfect competition or unilateral market power offset by rivalry; when the *CI* equals one there is monopolistic behavior.

A third index used by CFM is the **Chamberlin Quotient** (*CQ*), which is the proportion of the observed market power that is not assigned to unilateral power: $CQ \equiv 1-(\eta_1^O/\eta_{11})$ such that $CQ \in (-\infty,1]$. If there is no coordination or rivalry across brands, the *CQ* is zero (Nash-Bertrand conjectures) and the observed price elasticity is identical to the unilateral price elasticity. With increasing degrees of collusion the *CQ* approaches one. In the case of competitive rivalry, the *CQ* becomes negative, with a lower bound of ($-\infty$).

III. Empirical framework and data

The empirical procedure consists of estimating unilateral (η_{11}), observed (η_1^O) and fully collusive (η_1^C) elasticities, then using them to calculate the Rothschild Index, Cotterill Index, and Chamberlin Quotient for each brand. This requires a set of own and cross-price elasticities of consumer demand (η_{ij}), as well as price reaction elasticities (ε_{ij}). In turn, the former requires estimation of a set of demand equations, while the latter involves the estimation of price response equations. We describe these steps below.

Demand elasticity estimation framework

Estimating brand-level elasticities is particularly challenging for an industry in which there are hundreds of brands[5]. One method for limiting the number of parameters to be estimated while analyzing multiple brands is to employ a multinomial logit model. Although this approach is appealing for its tractability, substitution between products is driven completely by market shares instead of how similar the products are. This poses a particular problem for brand-level analysis in a market with multiple segments. For example, suppose there are two kid cereals, *Kid1* and *Kid2*, and a third, mature adult-oriented cereal, *Health*. If *Kid2* and *Health* have the same share of the overall market, then a logit model will restrict the cross-price elasticity of demand with respect to *Kid1* to be the same for *Kid2* and *Health*. In other words, if the price of kid cereal *Kid1* goes up, consumers are assumed to switch towards *Health* by the *same* amount that they do for *Kid2*. Since we would not expect *Health* to be as good a substitute for *Kid1* as would *Kid2*, this feature of the logit model has traditionally made it less appealing for analyzing market power in differentiated-product industry[6].

Recent improvements to the logit model appear to have minimized this shortcoming, however. For example, Nevo (2001) developed a generalized version of the logit framework, and used it to estimate brand level elasticities for the RTE cereal market[7]. The use of a random-coefficients model allows him to avoid the cross-price elasticity problem described above, without having to make assumptions about the

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[5] The precise number of brands depends on how a brand is defined, as well as the year in question.
[6] CFM, in fact, characterize this feature as a “major flaw” (p. 9).
[7] See the exchange between Timothy Bresnahan and Jerry Hausman regarding Aviv Nevo’s econometric work on the cereal industry at the bottom of this web page: http://www.stanford.edu/~tbres/research.htm

way in which the cereal industry is segmented. Nevo's model is still highly restricted (since each brand of cereal has the same coefficient on price in the indirect utility function) but he provides very plausible elasticity estimates for 25 different cereals. In particular, all cross-price elasticities are positive (as one would intuitively expect), and those corresponding to cereals of the same segment tend to be larger than those corresponding to separate segments. While these results suggest that recent developments in logit models are promising, they have yet to be used in price reaction analysis without the Nash-Bertrand assumption.

Another approach for reducing the number of parameters that must be estimated is to use a multilevel demand model. Originally this method was developed to deal with demand for broad categories like food, clothing, and housing. More recently it has been adapted for the analysis of demand for differentiated products (Hausman, Leonard and Zona; CFM). The multilevel demand assumption would seem to be consistent with the RTE cereal industry, since research indicates that cereals are "spatially" differentiated products that can be grouped into different segments (Schmalensee 1978). For instance, although he does not estimate a multilevel demand model, Nevo (2001) categorizes the cereals he analyzes into 4 segments[8]. Segmentation of this type has also been confirmed by professional industry analysts. For example, Cotterill and Haller provide the following quote from Nielsen Marketing Research executives on page 2: "The [Taste Enhanced Wholesome] segment consists of brands that possess strong interactions with each other. Including other category segments into the evaluation may 'dilute' the switching patterns observed in the data."

Given the segmentation of the RTE cereal industry, we use the multilevel demand model and

[8] The four segments are all family/basic, simple health/nutrition, taste enhanced wholesome, and kids' cereal.

focus on one segment at a time, which greatly facilitates estimation work. For the present paper we focus exclusively on the "Traditional Kid" segment identified in Cotterill and Haller, because it appears to be one of the better defined segments, in terms of the substitutability of brands within it. (For more on the 12 brands we included within the Traditional Kid segment, see the "Data" section below.) We assume that brand managers recognize both the segmentation of the cereal market and the multi-stage decision process of consumers.

We estimate demand elasticities using the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980). AIDS is widely used for demand system analysis because it is flexible, is compatible with aggregation over consumers, and is easy to estimate and interpret. The AIDS model in budget share form is:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log p_j + \beta_i \log(x/P), \quad \forall \text{ brands } i, j$$

where w_i is the expenditure share on the *i*th brand, p_j is the price of the *j*th brand, *x* is total expenditure on kids' cereals, and log *P* is a general price index. In the case of the Linear Approximate AIDS model, which is estimated in this paper, log *P* is approximated by what Deaton and Muellbaeur refer to as 'Stone's price index'. Mathematically this index is: $\log P = \sum w_k \log p_k$. The theoretical properties of adding-up, zero-degree homogeneity of demand functions, and symmetry of cross price effects imply the following parametric restrictions: $\sum \alpha_i = 1$, $\sum_i \gamma_{ij} = 0$, $\sum \beta_i = 0$, $\sum_j \gamma_{ij} = 0$, $\gamma_{ij} = \gamma_{ji}$.

Because the data employed in this study is purely time series (which may cause problems with serial correlation), we follow Deaton and Muellbauer's suggestion to use the first differences of the variables. Differentiating the budget share form of the AIDS model and making use of the fact that $d \log(x/P) = d \log Q$ (see Barten, 1993, p. 134-135) yields:

$$dw_i = \sum_j \gamma_{ij} d \log p_j + \beta_i (d \log Q) .$$

For estimation purposes the above equation needs to be transformed into finite differences, and needs an error term u_{it}. The final empirical form of the demand model is then:

$$\Delta w_{it} = \alpha_i + \sum_j \gamma_{ij} \Delta \log(p_{jt}) + \beta_i (\Delta \log Q_t) + u_{it}, \quad \forall \text{ brands } i,j \text{ and periods } t . \qquad (4)$$

In this equation we define $\Delta w_{it} = w_{it} - w_{i,t-1}$, $\Delta \log p_{it} = \log(p_{it} - p_{i,t-1})$, and $\Delta \log Q_t = \sum_i w_{it} \log(q_{it} - q_{i,t-1})$. Note that a constant parameter α_i is included based on general econometric practice. Because the equation is in log differences, α_i is interpreted as the percentage change in expenditure share between time periods. Own and cross price elasticities are calculated in the LA/AIDS model as $\eta_{ii} = -1 + (\gamma_{ii} / w_i) - \beta_i$ and $\eta_{ij} = (\gamma_{ji} / w_i) - \beta_i (w_j / w_i)$ respectively.

Price reaction estimation framework

Price reaction equations are deduced by substituting the AIDS demand functions into the brand manager's profit function (1) and (as before) assuming Bertrand price competition. Because the details of CFM's derivation are lengthy and involved, we refer the reader to their paper instead of repeating the derivations here. The end result is a system of price reaction functions that are logarithmic in prices:

$$\log p_i = \theta_i + \sum_{j \neq i} \varepsilon_{ij} \log p_j , \quad \forall \text{ brands } i, j$$

Although these *i* simultaneous equations appear simple, note that the parameters θ_i and ε_{ij} represent complex functions of the model's structural parameters, due to the incorporation of AIDS functions into the profit-maximization framework.

Estimating the price reaction model involves a number of challenges. First of all, this is a system of simultaneous equations, each of which are unidentified. Additionally, the data that we use (discussed below) are purely time series in nature, which makes it difficult to distinguish brand-level pricing interactions from supply/demand fluctuations. With these issues in mind, we use a three-stage least squares estimation procedure, and include a one-period lag of the dependent variable as an explanatory variable in each equation. This makes each equation just-identified, since there are *n* endogenous variables in each equation, and *n - 1* predetermined variables that are excluded from each equation. To address (in part) the issue of how general supply/demand conditions may affect prices over time, we include total expenditure *x* as an explanatory variable in each equation. As such, the final empirical form of the equations are:

$$\log p_{it} = \theta_i + \sum_{j \neq i} \varepsilon_{ij} \log p_{jt} + \lambda_{lag} \log p_{i,t-1} + \lambda_{\exp} x_t + u_{it} \quad \forall \text{ brands } i,j \text{ and periods } t \qquad (5)$$

Ideally, both the AIDS demand equations and the price reaction functions would be estimated together in a large seemingly unrelated regression (SUR) framework, as in CFM, since SUR is asymptotically the most efficient procedure. However, as the number of brands in the analysis increases, the size of the equation system increases exponentially, making it much more costly – in terms of degrees of freedom as well as computing resources – to undertake three-stage least squares estimation. Since we work with 12 brands, the SUR system would involve 256 coefficients in 23 equations, even with all restrictions from demand theory in place. Attempting this is a topic for a future version of the paper[9].

Another way to improve estimation would be to include additional exogenous, identifying variables in the demand and price reaction models. Currently both (4) and (5) assume, for example, that costs, marketing strategies, demographic patterns, preferences, and the number of competing products are constant over the period of estimation. Variables that could be added include: (a) advertising

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[9] Note that CFM worked with far fewer brands, such that they never had more than 8 equations in the SUR system.

expenditures / marketing campaigns, (b) the price of raw cereal ingredients (although these are only a fraction of selling price), (c) the price of paper used in cereal boxes (another small fraction of selling price), and (d) the total number of cereals available in the segment.

Once we have the estimated set of demand and price reaction elasticities, we: (a) have the **unilateral elasticity** (η_{11}) that a brand manager theoretically perceives if acting alone, (b) can calculate the **observed elasticity** actually perceived by brand managers using the formula $\eta_1^O = \eta_{11} + \sum_2^n \eta_{1i}\varepsilon_{i1}$, and (c) can calculate the **fully collusive elasticity** that would be perceived if price reaction elasticities were all 1, using the formula $\eta_1^C = \sum_1^n \eta_{1i}$.

Data

To estimate equations (4) and (5), we use data from Selling-Area Markets, Inc. (SAMI) covering the period January 1975 to November 1990[10]. SAMI observations are at the brand-level, are in dollars and pounds for the U.S. market as a whole, and correspond to four-week intervals, such that there are 13 observations per year. The average price for a brand is obtained by dividing sales in dollars by sales in pounds. To account for general inflation over time, we deflated the value data using the Bureau of Labor Statistics U.S. City Average Food and Beverage Price Index, which is available on their web site. The time series was split into two periods (January 1975 to December 1980, and January 1982 to November 1990) in order to capture the effects of changes in the regulatory environment (i.e., the termination of the FTC "Big Three" case in early 1981).

For this paper – which is exploratory at this point – we focus on the 'Traditional Kids' cereal

[10] November 1990 is the last month for which SAMI published data.

market. This segment was chosen because it is well-defined in the sense that it is easier to discern whether a cereal belongs to this group than it is within the other segments identified in Cotterill and Haller (all family/basic, simple health/nutrition, and taste enhanced wholesome). Traditional kids cereals are distinguished by a combination of high sugar content and marketing targeted at kids, in which the image of a colorful cartoon character is typically emphasized as opposed to family imagery, or health/nutritive properties[11]. For example, Quaker Cap N Crunch is unquestionably a kid cereal, while Frosted Flakes is not necessarily so, since it is popular with adults. The 12 kid cereals included in the study account for an average 79% share[12] of the kid segment in the SAMI data from 1975 to 1990. The SAMI data itself accounts for approximately 95% of cereal sales in the U.S.

IV. Some preliminary results

During estimation of models (4) and (5), a problem with multicollinearity in the price series was encountered. In particular, the median pair-wise correlation coefficient out of 66 calculated was found to be 0.96! This level of multicollinearity hinders our ability to distinguish brand price interactions from general price trends over time. A problem with positive serial correlation in a number of equations was also encountered during early regression runs. However, making a correction for autocorrelation in the econometric software resulted in Durbin-Watson statistics that were approximately 2.0 (the ideal) for nearly all of the equations[13].

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[11] The 12 cereals analyzed are Post Fruity Pebbles, Post Honey Comb, Post Super Golden Crisp, General Mills Cocoa Puffs, General Mills Lucky Charms, General Mills Trix, Quaker Cap N Crunch, Quaker Cap N Crunch Berry, Kelloggs Froot Loops, Kelloggs Corn Pops, Kelloggs Honey Smacks, and Kelloggs Apple Jacks.

[12] These particular shares are calculated on the basis of pounds of cereal. Shares in the empirical analysis are on an expenditure basis.

[13] We carried out estimation in SHAZAM version 8. To correct for autocorrelation we used non-linear estimation, which enables selection of the 'auto' option (see SHAZAM version 8 manual, p. 148).

Price elasticities of demand

Because of space constraints, it is not possible to report the cross-price elasticities of demand for either of the two time periods. (These are used to calculate the observed and fully collusive price elasticities, which are described below.) In general there is little to report except that, while we might expect all cross-price elasticities to be positive (since brands should be substitutes for each other), there were a substantial number of *negative* cross-price elasticities. This may have been because we burdened the estimation framework with too many brands (12 in total). Nevo (2000a) states that the multi-stage AIDS framework works well for a small number of brands, but "as the number of brands in each segment increase beyond a handful, this method becomes less feasible" (p. 545). Own-price elasticities, which represent *unilateral* market power, are discussed below.

Price reaction elasticities

As with the cross-price elasticities, for lack of space it is not possible to display the price-reaction elasticities, which indicate the degree to which one brand's price is changed as the price of another changes. These are generated for the purpose of calculating the *observed* own-price elastictiés, and we describe those below.

Elasticities perceived by brands

Table 1 presents the own price elasticities which are later used to calculate indexes concerning the *type* and *degree* of market power exhibited by brands. The second and third columns of Table 1 report the *fully collusive* price elasticities, which are calculated using the formula $\eta_1^C = \sum_1^n \eta_{1i}$. In brief, the fundamental finding was that the fully collusive elasticities on average changed little across the two time periods.

Own-price elasticities reflect market power under purely *unilateral* behavior, and are reported in columns four and five of Table 1. Those for 1975-1980 are reported in column four, and range from –0.89 for Honey Comb to –7.62 for Super Golden Crisp (with the exception of Trix, which is slightly positive). Own-price elasticities for the second period are reported in the fifth column, and range from –3.23 in the case of Apple Jacks to –8.17 in the case of Super Golden Crisp. The key result is that there is notably higher price sensitivity in the second period, which suggests that consumers lost loyalty to particular brands. This may be related to the rapid entry of new cereals between the periods of the study.

Columns six and seven of Table 1 present the own-price elasticities that brand managers *actually observed* in each time period, calculated with the formula $\eta_1^O = \eta_{11} + \sum_2^n \eta_{1i}\varepsilon_{i1}$. Entries in these two columns with an asterisk (*) indicate that collusion was occurring because the demand curve perceived by a brand manager is *more inelastic* than the demand curve that would have been perceived unilaterally. Entries with no asterisk indicate that a brand is involved in competitive rivalry. Looking at the period during the FTC case, only 4 brands appear to have behaved collusively. However, after the case was dropped, 6 of the brands exhibited collusive behavior (only two exhibited collusive behavior in both of the periods). Two of the observed own price elasticities were extremely elastic in the first period (including –75.35 for Trix), suggesting that behavior was essentially competitive (Table 2). The few entries that are positive (Honey Comb, Cap N Crunch, Cap N Crunch Berry, and Honey Smacks), are due to exceptionally large price reaction elasticities estimated for some brands.

Indexes of market behavior

Tables 2 through 4 are the results of central interest, and correspond to the indexes of market power described in Section II above. These indexes allow us to determine (i) the *degree* to which brands exercised market power before and after the termination of the FTC case, (ii) the *type* of market power that may have been exercised (unilateral versus collusive), and (iii) whether there was *change* in the above two characteristics once the FTC dropped its case in the early 1981.

Table 2 presents the Rothschild index for each of 12 brands for both periods. The index, defined as $RI \equiv \eta_1^C / \eta_{11}$, measures the degree of unilateral market power held by a firm. Post Fruity Pebbles, for example, had sufficient product differentiation to exercise unilateral pricing power equivalent to 29 percent of the pricing power it would have if it jointly managed all 12 cereal brands, during the 1975-1980 period. This pricing power fell to 16 percent during the 1982-1990 period. All but two estimates are between 0 (perfect competition) and 1 (monopoly), as the theory predicts[14]. Three of them, namely Honey Comb, Cocoa Puffs, and Cap N Crunch Berry, effectively have unilateral market power equivalent to what is possible with the joint managing of all brands.

For 10 of the 12 brands, unilateral pricing power fell over the period in which the FTC dropped its case. For example, the unilateral pricing power of Cap N Crunch Berry fell from 88 percent to 19 percent. These results are generally not explained by any change in collusive market power among the brands (Table 1, columns two and three). Instead, these results are due to the fact that unilateral own price elasticities became much more elastic in the second period of the study (Table 1, columns four and

[14] Two cases are outside the unit interval. In the case that the index is greater than 1 (Honey Comb), unilateral market power was effectively stronger than collusive. In the case that the index is negative (Trix), the own price elasticity was positive.

five). One explanation is that new product introduction in the industry during this period led consumers to be more price sensitive. This "flattening" of the demand curve reduced the ability of brands to exercise market power unilaterally.

Table 3 presents the Cotterill index of total market power, defined as $CI \equiv \eta_1^C / \eta_1^O$. This indicates the degree of combined unilateral and collusive pricing power possessed by a brand. In each of the two periods, 9 of 12 brands had the ability to exercise coordinated market power (i.e. had non-negative values). While in the majority of cases this pricing power appears quite moderate, the third column of Table 3 indicates that 8 of 12 brands saw an *increase* in total market power after the FTC dropped its case. This is the result of central interest in our study. Since Table 1 shows that in most cases brands had less unilateral market power in 1982-1990 than in 1975-1980 (columns four and five), the increase in total power must have been due to a rise in the ability to exercise *coordinated* market power.

Examination of Table 4 indicates that this is indeed the case for most of the brands. This table presents the Chamberlin quotient of collusive market power, which is calculated as $CQ \equiv 1-(\eta_1^O / \eta_{11})$, and quantifies the proportion of market power that is collusive as opposed to unilateral. Interestingly, for 7 of 12 brands during 1975-1980, the CQ was negative, indicating that there was competitive rivalry among the brands. This continued to be a feature during the 1982-1990 period, as 6 of the 12 brands were in a state of competitive rivalry, though to less of a degree than before. The third column indicates that for 8 of 12 brands, the degree of coordinated market power rose after the FTC dropped its case. Two of the four brands that did not experience an increase in collusive market power (Trix and Corn Pops), *did* experience an increase in unilateral power, however. This explains why the total market power for 8 of the 12 brands was higher in the 1982-1990 period than it was in the 1975-1980 period (Table 3).

V. Summary and preliminary conclusions

The U.S. ready-to-eat (RTE) cereal industry is highly concentrated, engages in extensive advertising, and continually introduces new varieties of cereal. These attributes are consistent with the exercising of either unilateral or cooperative market power, and in the 1970s led the FTC to prosecute the three largest U.S. cereal makers as a "shared monopoly". The "Big Three" case, however, was ended abruptly by Congressional action in 1981. This study examines the *degree* and *type* of market power that may have been exercised prior to and following the termination of the case. Our hypothesis is that once the industry no longer found itself under the spotlight of an on-going governmental investigation, conduct became substantially less competitive. Additionally, we hypothesize that the increase in overall market power was driven mainly by a rise in coordinated as opposed to unilateral market power. We investigate these issues with the differentiated-products oligopoly framework of Cotterill, Franklin, and Ma (1996), and time-series SAMI data on sales of traditional kids cereals for the periods 1975-1980 and 1982-1990.

In preliminary results we find that while unilateral market power was exercised before and after termination of the "Big Three" case, it was lower during the latter period, since consumer own-price elasticities became much more elastic. The decline in the power of brands may have been due to the rapid introduction of competing products. With regard to pricing interaction among the 12 kids cereals, the number of brands engaged in competitive rivalry equaled the number of brands engaged in collusion during the FTC case. After termination of the case, however, the competitive rivalries generally weakened, and collusive behavior became more prevalent. Since the overall rise in collusive power outweighed the fall in unilateral power, these initial results ultimately suggest that total market power increased following termination of the FTC case.

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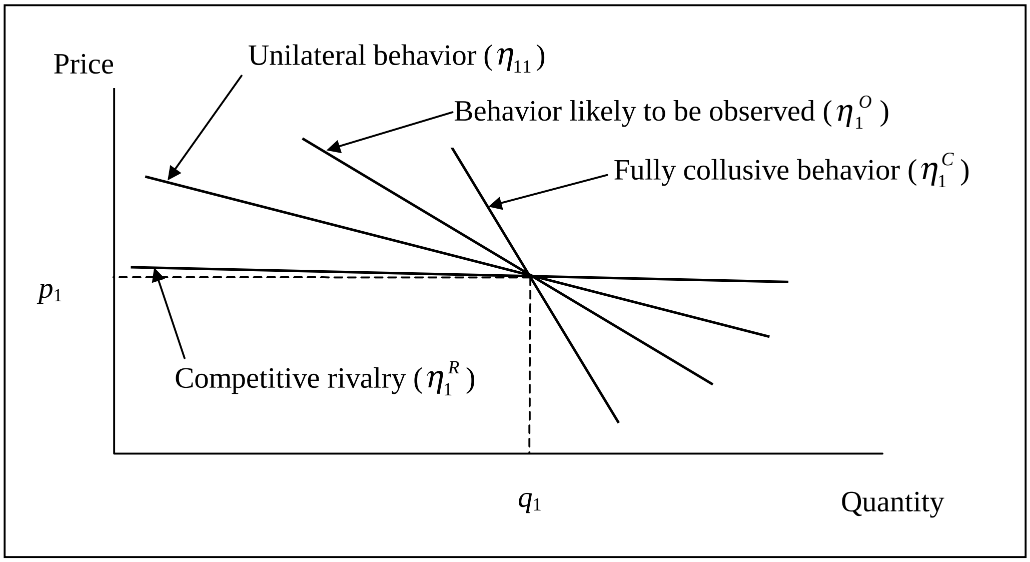
Figure 1. Demand that would be perceived under different types of market conduct



Note: The linear demand curves for brand 1 are for illustrative purposes only; in the analysis no restrictions are placed on the shape of the demand curves. Only the value of the elasticity at a single point (p_1, q_1) is used, which corresponds to a brand's mean logged price and mean expenditure share.

Table 1. Own price elasticities under full collusion, pure unilateral power, and what is observed

	Full collusion		Unilateral		Observed	
	1975-1980	1982-1990	1975-1980	1982-1990	1975-1980	1982-1990
Post Fruity Pebbles	-0.80	-0.87	-2.74	-5.39	-9.89	-6.42
Post Honey Comb	-1.10	-0.84	-0.89	-7.20	-0.98	1.33*
Post Super Golden Crisp	-1.65	-0.99	-7.62	-8.17	-9.01	-4.85*
General Mills Cocoa Puffs	-1.25	-0.64	-1.45	-4.83	-12.11	27.64*
General Mills Lucky Charms	-0.98	-0.78	-1.85	-7.75	-43.52	-10.19
General Mills Trix	-1.25	-0.75	0.25	-6.92	-75.35	-6.63*
Quaker Cap N Crunch	-1.14	-1.38	-2.42	-4.98	1.33*	-4.05*
Quaker Cap N Crunch Berry	-1.04	-1.23	-1.17	-6.47	0.36*	-19.86
Kelloggs Froot Loops	-0.68	-1.04	-2.34	-8.02	-5.58	-8.77
Kelloggs Corn Pops	-0.74	-1.25	-3.46	-4.13	3.57*	-21.30
Kelloggs Honey Smacks	-0.83	-1.11	-3.33	-5.78	-1.22*	19.46*
Kelloggs Apple Jacks	-0.60	-1.08	-1.17	-3.23	-6.10	-3.65

* In the two rightmost columns, the asterisk indicates that collusion is occuring because demand curve observed by brand manager is more inelastic than the demand curve that would be perceived unilaterally. Entries with no asterisk indicate the opposite is happening; that is, a brand is engaged in competitive rivalry.

Table 2. Rothschild index of unilateral market power

	1975-1980	1982-1990	Change in potential unilateral power
Post Fruity Pebbles	0.29	0.16	–
Post Honey Comb	1.24	0.12	–
Post Super Golden Crisp	0.22	0.12	–
General Mills Cocoa Puffs	0.86	0.13	–
General Mills Lucky Charms	0.53	0.10	–
General Mills Trix	-4.97	0.11	+
Quaker Cap N Crunch	0.47	0.28	–
Quaker Cap N Crunch Berry	0.88	0.19	–
Kelloggs Froot Loops	0.29	0.13	–
Kelloggs Corn Pops	0.21	0.30	+
Kelloggs Honey Smacks	0.25	0.19	–
Kelloggs Apple Jacks	0.51	0.33	–

Note: In theory this index runs from zero (perfect competition) to one (monopoly). In the one case where the index is greater than 1, unilateral market power was stronger than collusive. In the one case where the index is negative, it is because the own-price elasticity is positive (an unexpected result).

Table 3. Cotterill index of observed total market power (both unilateral and collusive)

	1975-1980	1982-1990	Change in exercise of total market power
Post Fruity Pebbles	0.08	0.14	+
Post Honey Comb	1.12	-0.63	–
Post Super Golden Crisp	0.18	0.20	+
General Mills Cocoa Puffs	0.10	-0.02	–
General Mills Lucky Charms	0.02	0.08	+
General Mills Trix	0.02	0.11	+
Quaker Cap N Crunch	-0.86	0.34	+
Quaker Cap N Crunch Berry	-2.88	0.06	+
Kelloggs Froot Loops	0.12	0.12	–
Kelloggs Corn Pops	-0.21	0.06	+
Kelloggs Honey Smacks	0.68	-0.06	–
Kelloggs Apple Jacks	0.10	0.30	+

Note: In theory this index runs from 0 (perfect competition) to 1 (monopolistic behavior). If the index is less than 0, then own price elasticity is positive. If the index is greater than 1, then observed market power is stronger than it is under full collusion (which is theoretically implausible).

Table 4. Chamberlin quotient of collusive market power

	1975-1980	1982-1990	Change in exercise of collusive market power
Post Fruity Pebbles	-2.61	-0.19	+
Post Honey Comb	-0.10	1.18	+
Post Super Golden Crisp	-0.18	0.41	+
General Mills Cocoa Puffs	-7.35	6.72	+
General Mills Lucky Charms	-22.46	-0.31	+
General Mills Trix	301.39	0.04	–
Quaker Cap N Crunch	1.55	0.19	–
Quaker Cap N Crunch Berry	1.31	-2.07	–
Kelloggs Froot Loops	-1.38	-0.09	+
Kelloggs Corn Pops	2.03	-4.16	–
Kelloggs Honey Smacks	0.63	4.36	+
Kelloggs Apple Jacks	-4.20	-0.13	+

Note: If between 0 and 1, there is collusion. If the quotient is negative, there is competitive rivalry.