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

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## Abstract

Product differentiation is well established as being the key source of the cereal industry's high price-cost margins. However, there is little consensus as to whether pricing collusion is also a source of profitability, and indeed, whether price even serves as a strategic variable in this industry. This paper seeks to resolve this debate by determining whether cereal firms strategically interact on price, and if so, estimating the extent that this increases margins relative to what perfect collusion among firms could achieve. Firms are estimated to cooperate on price to the extent that margins are 2.5 percentage points higher than what is possible under a Nash-Bertrand game. This raises margins by about 43% of what could be achieved under a perfectly executed agreement to fix prices. The results are consistent with studies in the literature that characterize the industry's pricing as "approximately cooperative."


**KEYWORDS:** collusion, cartel, oligopoly, cereal, shared monopoly, parallel pricing

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## 1. Introduction

The U.S. ready-to-eat breakfast cereal industry is remarkable for its high levels of profitability, not only relative to other food manufacturing firms, but compared to most sectors in the economy as a whole. After-tax returns on cereal manufacturer assets have at times exceeded twice the average among manufacturing corporations in the broader economy (Scherer, 1982). Manufacturer gross margins average 43.7% of retail price, with production costs and retailer share comprising just 36.3% and 20.0% of retail price, respectively (Cotterill, 1999). National brand cereal prices increased 90% between 1983 and 1994, *twice* the rate of all other food products in the same period (Gejdenson and Schumer, 1999).

On the one hand cereal firms can be lauded for effective use of modern management and marketing techniques in attaining their profitability. Manufacturers channel their rivalries in ways so that margins are not eroded. On the other hand, high price-cost margins redistribute income from millions of cereal-buying households to a relatively small number of investors, and reflect an inefficient allocation of resources. Whatever one's perspective on such matters, there is considerable interest in distinguishing the sources of profitability in this industry (e.g., Schmalensee, 1978; Scherer 1979, 1982; Liang, 1989; Cotterill, 1999; Connor, 1999; Nevo, 2001).

In investigating this issue, most previous studies identify high industry concentration, product differentiation, and aggressive brand promotion as key aspects of firm profitability. Instead of responding to the threat of entry by lowering price, existing firms introduce new brands to fill up those parts of the product space where entry might occur (Schmalensee, 1978). In turn, consumer loyalty to a given brand is developed and maintained through intensive mass-media advertising. This strategy has resulted in an industry with some rather extreme characteristics. Although there are approximately 40 companies producing more than 400 brands, more than 90% of output since 1980 has been produced by just four firms.[1] If one accounts for all the variations in sizes and flavors, there are approximately 1000 cereal products for sale in the U.S. (Connor, 1999). Marketing and promotion expenses alone constitute 38% of manufacturer price (Cotterill, 1999).

There is much less consensus as to whether oligopoly pricing, or (for lack of a better term) "strategic pricing interactions" also play a role in the high price-cost margins, however. When determining the profit-maximizing prices of their

[1] The high concentration (CR4 > 90%) appears unrelated to economic efficiency. Engineering estimates indicate that no additional economies of scale are gained from having a plant (or firm) larger than 4-6% of total industry output (Scherer 1982, p. 196).

brands, oligopolistic firms take the anticipated actions of their rivals into consideration. This may facilitate the setting of prices at supra-competitive levels.

Previous studies reach notably different conclusions as to whether cereal firms interact on price, let alone whether they engage in tacit collusion. On the one hand, Schmalensee (1978, p. 315) characterizes the industry's pricing as "approximately cooperative," and Scherer (1982) presents detailed evidence that firm pricing is collusively parallel. In turn, Scherer and Ross (1990, p. 249) point out that the industry has many of the characteristics associated with perfectly collusive pricing, namely: (a) it is tightly oligopolistic, (b) sellers' products are close substitutes, (c) cost curves are similar, (d) there are barriers of entry to new rivals, and (e) demand for cereals is relatively inelastic.

On the other hand, there is well-known evidence against the idea that strategic pricing interactions underlie the high price-cost margins. For one, this was an issue of contention in the 1970s Federal Trade Commission (FTC) "shared monopoly" case against the top three cereal companies. On this and other aspects of shared monopoly theory, the judge ruled in favor of the cereal companies (Scherer, 1982). Although this conclusion was partly influenced by factors unrelated to the case's factual merits,[2] more recent research also casts doubt on the nature and extent of pricing interactions. In particular, Nevo (2001) presents evidence that market conduct is consistent with a multi-product Nash-Bertrand model. In other words, firms do *not* interact on price, and the high markups arise solely from non-price strategies.

The purpose of this paper is to resolve this debate by determining whether cereal firms strategically interact on price, and if so, to determine whether this boosts margins to the extent achievable under perfect collusion or "shared monopoly." To answer these questions, firms' pricing interactions are estimated directly, controlling for price movements associated with common reactions to changing overall market conditions. In this way, price changes occurring for strategic reasons are distinguished from those arising from cost and demand changes. The estimated conduct parameters – referred to here as price reaction elasticities – represent the observed tendency for a brand's price to be changed when the price of a competitor's brand is changed.[3]

While these elasticities indicate whether firms interact on price (as opposed to play a Nash-Bertrand game, for example), they do not indicate the extent that

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[2] For discussion of the outside elements that came into play, see Scherer and Ross (1990, p. 466). Among other things, presidential challenger Ronald Reagan and incumbent Jimmy Carter both made public comments unfavorable to the prosecution's side.

[3] An alternative approach would be to carefully estimate the demand function faced by firms to infer the extent of firms' price-setting power, as in Nevo (2001). This and other options are discussed below. For now, we note that some features of the conduct parameter approach make it particularly well-suited to the objectives of this study.

firms are competing or colluding on prices. To help with this interpretation, the price reaction elasticity estimates are plugged back into the Bertrand differentiated-products oligopoly framework from which they are derived. A "true" price-cost margin for each brand is then calculated based on the estimated price reaction elasticities and cereal demand elasticities from Nevo (2001). This "true" price-cost margin is compared to those arising from the benchmark cases considered in Nevo, including joint profit maximization and a multi-product Nash-Bertrand scenario. The use of previously estimated demand elasticities requires a strong assumption regarding their applicability and entails a loss of econometric efficiency relative to joint estimation of supply and demand. Nevertheless, this is a useful means of shedding light on the extent to which strategic pricing interactions reflect perfect collusion versus rivalry, and makes the results readily comparable to previous evidence.

The paper's results contradict earlier findings that price is not a strategic variable in this industry. Pricing is determined to be "consciously parallel" and related more to strategic considerations than movements in overall costs and demand. Firms mimic each others' brand pricing movements to an extent that price-cost margins are an average 2.5 percentage points higher than what is possible through product differentiation and the portfolio effect alone. This effect is about 43% of the maximum contribution that fully collusive pricing could theoretically add to the margins (i.e., the level associated with firms getting together and making an illegal agreement to fix prices).

The results therefore support those studies in the literature that find pricing to be "approximately cooperative." In other words, pricing cooperation is roughly half-way between the Nash-Bertrand and shared monopoly outcomes.

The remainder of the paper is organized as follows. The next section develops a conceptual framework involving a price-setting, differentiated-products oligopoly model, and approximated price reaction functions. Following sections describe the empirical implementation, including data and estimation scheme. The following section presents results and discussion. The final section summarizes and concludes.

## 2. Conceptual Framework

One of the defining characteristics of oligopoly is that firms recognize their mutual interdependence. In modeling oligopoly it is thus unrealistic to restrict agents to set prices independently, making decisions as if rivals' behavior is fixed. A number of approaches to modeling and estimating these interactions are offered in the empirical industrial organization literature. One is the "menu approach," in which a number of stylized games are specified, estimated, and evaluated via nonnested hypothesis tests to determine which game is most consistent with data (e.g., Gasmi, Laffont, and Vuong, 1992).

A drawback of this approach is that we are generally left at a somewhat extreme scenario, such as Nash-Bertrand or joint profit maximization. It seems likely that the truth lies somewhere within the continuum bounded by these outcomes. On the other hand, it is possible that the interactions drive prices in the opposite direction, that is, there is competitive rivalry.

One way to measure departures from benchmark outcomes is through a conduct parameter approach. Instead of specifying strategic interactions *a priori*, behavior is identified through estimation of the conjectural variation parameters of a reaction-curve oligopoly model (e.g., Roberts, 1984; Liang, 1989). Of course, the conduct parameter approach is not without drawbacks. Corts (1999) shows that conduct parameter estimates can understate the extent of strategic interactions, and in some rare cases they may fail to detect oligopoly market power altogether. However, one notes that being on the conservative side in our measurements is not necessarily a bad problem to have. More importantly, direct tests of conduct parameter methods show that Corts' bias is quite small (Genesove and Mullin, 1998; Wolfram 1999). It would appear that Corts' critique is true in principal, but unimportant in an empirical sense.

Another concern with conduct parameters is how to interpret them. For example, suppose a firm raises the prices of its brands, and other firms follow. While a reaction function approach can reliably capture the magnitude and timing of this response, it may be unsuccessful in distinguishing whether firms are colluding on price, competing fiercely, or interacting in a leader-follower manner. In this study this is less of a problem since in essence we are challenging recent findings that pricing is Nash-Bertrand in nature. We are primarily interested in determining the extent that pricing departs from this benchmark. In turn, incorporating the price reaction elasticities into a structural model and comparing them to well-known benchmark outcomes can shed a great deal of light on their interpretation.

The approach developed here begins with a Bertrand differentiated-products oligopoly model in which brand-level conjectured price reaction elasticities arise naturally. These represent "strategic pricing interactions" and indicate the manner by which rival firms respond when a firm changes the prices of its own brands.

Although the price reaction elasticities are of central interest here, the structural model also needs to be fleshed out with a realistic characterization of consumer demands. Consistent estimation of own- and cross-price elasticities of demand is particularly difficult for this industry since it has many closely related products. Nevo (2001) develops a state-of-the-art approach to this problem in the context of ready-to-eat cereals. An aggregate model of demand is estimated using the discrete choice approach of Berry, Levinsohn, and Pakes (1995). Substitutability among brands is modeled in terms of cereals' underlying characteristics, including calories, sweetness, and texture. The use of a random coefficients technique allows 25 brands to be examined simultaneously, while taking how they are grouped in segments into account. The model is identified by exploiting the panel structure of the data, using city-specific demographic variables.

One aspect of using Nevo's characterization of demand is that the first order conditions of the oligopoly model become extremely complex. Derivation of price reaction functions and expressions for conjectures (consistent and otherwise) becomes virtually impossible. This is a drawback with alternative demand systems as well, such as AIDS and Rotterdam, that perform less well in a differentiated-products setting (Nevo, 2000; Peterson and Cotterill, 1998; and Cotterill, Franklin, and Ma, 1996). Studies of ready-to-eat cereal such as Liang (1989) are able to proceed with a standard conjectural variations approach by using a very simple linear demand system. Unfortunately, only two brands can be considered at a time, and the model is quite restrictive in other ways as well. This approach is ultimately unsatisfactory given the most recent results on cereal demand.

A standard means of addressing this issue is to estimate a linear approximation to the price reaction functions (Cotterill and Samson, 2002; Cotterill, Putsis, and Dhar, 2000; Vilcassim, Kadiyali, and Chintagunta, 1999; Peterson and Cotterill, 1998; Kadiyali, Vilcassim, Chintagunta, 1996; Cotterill, Franklin, and Ma, 1996). This involves estimating a set of simultaneous equations with one equation per brand of cereal. In each equation, brand price is regressed on the prices of other firms' brands (to capture strategic interactions) and on cost- and demand-shifters that control for overall market conditions and identify the model. With an assumption that firms' conjectures are consistent, the estimated price reaction elasticities can be plugged into price-cost margins derived from the oligopoly model's first order conditions.[4] This enables both a rich characterization of demand *and* estimation of firms' strategic interactions.

### 2.1 Differentiated products oligopoly model

The cereal industry is characterized by a small number of firms each selling differentiated brands. In this context it is appropriate to consider the profit-max problem of a multi-brand firm. The set-up builds on Nevo (2001) but incorporates new features, most notably conjectural elasticities. Let $\Theta$ represent the set of brands associated with a certain segment of the cereal industry (e.g.,

[4] For reasons above we cannot verify that the price reaction elasticities equal the conjectural elasticities. Nevertheless, the above approach provides a reasonable way of getting at our key questions of interest.

kids' cereals). There are $F$ firms, each producing some subset, $\Theta_f$, of this segment's brands. Let $\Theta_{-f}$ be the subset of brands not associated with firm $f$. Therefore, $\Theta = \Theta_f \cup \Theta_{-f}$. There are $J$ brands in $\Theta$, indexed by $j$, $r$, or $k$. Marginal costs are constant. The profits of firm $f$ are:

$$\Pi_f = \sum_{j\in\Theta_f} (p_j - mc_j) q_j - C_f, \tag{1}$$

where $p_j$ is the price of brand $j$, $mc_j$ is the marginal cost of brand $j$, and $C_f$ are fixed costs of production (including advertising). The demand for brand $j$ depends on own price and the price of other cereals in the segment: $q_j =$ $q_j(p_1,...,p_J)$. In maximizing (1), firms simultaneously choose the prices of brands within their portfolios, taking into account the average price reactions of brands not part of their portfolio: $p_{j\in\Theta_f} = h(p_{k\in\Theta_{-f}})$, where $h$ is an unknown function.[5]

The first order condition of brand $j$ associated with firm $f$ is:

$$q_j + \sum_{r\in\Theta_f} (p_r - mc_r)\left[\frac{\partial q_r}{\partial p_j} + \sum_{k\in\Theta_{-f}} \frac{\partial q_r}{\partial p_k}\frac{\partial p_k}{\partial p_j}\right] = 0. \tag{2}$$

Multiplying through by $p_j / \sum p_r q_r$ as well as by ($p_r / p_r$), ($p_k / p_k$), and ($q_r / q_r$) in certain terms, yields the following modified first order condition:

$$s_j + \sum_{r\in\Theta_f} s_r \mathrm{PCM}_r \left[\varepsilon_{rj} + \sum_{k\in\Theta_{-f}} \varepsilon_{rk}\eta_{kj}\right] = 0. \tag{3}$$

The term $s_j$ is brand $j$'s expenditure share, and $\mathrm{PCM}_r = (p_r - mc_r)/p_r$ is the price-cost margin. The term $\varepsilon_{rj} = (\partial q_r / \partial p_j)(p_j / q_r)$ is the *price elasticity of demand* for brand $r$ with respect to brand $j$. The term $\eta_{kj} =$ $(\partial p_k / \partial p_j)(p_j / p_k)$ is a *conjectural variation elasticity*, and measures the degree to which $k$'s price is anticipated to change in response to a change in brand $j$'s price. The term $\mathrm{PCM}_r$ is brand $r$'s price-cost margin, and a useful gauge of the economic performance of a brand.

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[5] According to Scherer (2003), there is a lag between the announcement of price by an cereal manufacturer and implementation at retail. During this delay, other firms witness the firm's choice and can react such that retail prices ultimately get implemented about the same time. In effect, there is preplay communication that makes price changes appear to be simultaneous. MacLeod (1985) offers a formalization of this type of set-up.

We seek to estimate the observed counterpart to the conjectural variation elasticity, which for simplicity is called a *price reaction elasticity*. Thus, recovering estimates of $\eta_{kj}$ from the data is the essence of our empirical work. To help interpret these estimates, we need to incorporate them back into an expression for brand *r*'s price-cost margin ($\text{PCM}_r$). In preparation for doing this in the final empirical section, we now derive an explicit expression for the margins.

It is useful to rewrite (3) in matrix form, and introduce a term $\Psi_{jr}$, defined as:

$$\Psi_{jr} \equiv s_r\left[\varepsilon_{rj} + \sum\nolimits_{k\in\Theta_{-f}} \varepsilon_{rk}\eta_{kj}\right] = 0. \quad (4)$$

As in Nevo (1998), let $\mathbf{\Omega}'$ be a $(J \times J)$ matrix, with element $\Omega'_{jr}$ in row *j* and column *r* be:

$$\Omega'_{jr} = \begin{cases} 1, & \text{if there exists } f:\{r,j\}\subset\Theta_f \\ 0, & \text{otherwise} \end{cases}.$$

In turn, $\mathbf{\Omega}$ is a $(J \times J)$ matrix with typical element $\Omega_{jr} = \Omega'_{jr}\Psi_{jr}$. **PCM** is a $(J \times 1)$ vector, and **s** is a $(J \times 1)$ vector of expenditure shares. Now, rewrite (3) in matrix form:

$$\mathbf{s} + \mathbf{\Omega}(\mathbf{PCM}) = \mathbf{0}. \quad (5)$$

Solving for price-cost margins yields:

$$\mathbf{PCM} = -\mathbf{\Omega}^{-1}\mathbf{s}. \quad (6)$$

To aid in understanding (6), consider the following scenario. A segment is comprised of three firms and seven cereals. Firm A produces brands 1 and 2; firm B produces brands 3 and 4; and firm C produces brands 5, 6, and 7. In this case (6) takes the form:

$$\begin{pmatrix} \text{PCM}_1 \\ \text{PCM}_2 \\ \text{PCM}_3 \\ \text{PCM}_4 \\ \text{PCM}_5 \\ \text{PCM}_6 \\ \text{PCM}_7 \end{pmatrix} = -\begin{bmatrix} \psi_{11} & \psi_{12} & 0 & 0 & 0 & 0 & 0 \\ \psi_{21} & \psi_{22} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & \psi_{33} & \psi_{34} & 0 & 0 & 0 \\ 0 & 0 & \psi_{43} & \psi_{44} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & \psi_{55} & \psi_{56} & \psi_{57} \\ 0 & 0 & 0 & 0 & \psi_{65} & \psi_{66} & \psi_{67} \\ 0 & 0 & 0 & 0 & \psi_{75} & \psi_{76} & \psi_{77} \end{bmatrix}^{-1} \begin{pmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \\ s_5 \\ s_6 \\ s_7 \end{pmatrix}. \quad (7)$$

Equation (7) implies that brand-level "true" price-cost margins can be calculated using price reaction elasticities, demand elasticities, expenditure shares, and information on which firms hold what brands.

Recall that we wish to calculate hypothetical benchmarks that correspond to those in Nevo (2001). These are variations of (7), and take on the following forms. In all three scenarios there are no inter-firm reactions ($\eta_{kj} = 0 \ \forall\, k,j \in \Theta$), so (4) reduces to: $\Psi_{jr} = s_r \varepsilon_{rj}$. **Scenario (i)** isolates the potential for the market power of an individual brand to be exercised. To do this, the cereal industry is modeled as being comprised of single-brand firms deriving market power solely from product differentiation. In this case, $\mathbf{\Omega}'$ is an identity matrix and PCM$_r$ $= -1/\varepsilon_{rr}$. **Scenario (ii)** gauges the additional market power available through the portfolio effect. Firms are modeled as managing their actual portfolio of brands, internalizing the associated cross-price effects of demand. As a result, a firm producing two imperfectly substitutable brands will charge a higher price for them than if they are produced by two rival, single-brand firms. As with scenario (i), firms are assumed to operate in isolation, and $\mathbf{\Omega}'$ contains blocks of ones centered on the diagonal in a pattern reminiscent of the non-zero elements of $\mathbf{\Omega}^{-1}$ in (7).[6] In **scenario (iii)**, a single agent manages all brands, and $\mathbf{\Omega}'$ is comprised entirely of ones. The difference between scenarios (ii) and (iii) represents the maximum added market power from overt collusion.

Ultimately we are interested in the extent by which the estimated "true" margins depart from the multi-product Nash-Bertrand model (scenario ii). Note that we are not interested in demonstrating the importance of product differentiation versus other forms of market power (as in Nevo, 2001). The benchmarks are only intended to shed light on the extent to which strategic pricing interactions reflect perfect collusion versus rivalry and so forth.

## 3. Empirical Implementation

The SAMI data obtained for this study are at the brand level, and indicate sales for the U.S. market as a whole in both dollars and pounds (95% of U.S. cereal sales are covered).[7] There are 13 observations per year corresponding to four-week intervals. Brand-level retail unit values or "prices" are found by dividing sales in dollars by sales in pounds. The same is done for a single private label cereal category also identified in the data. To account for general inflation over

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[6] This distinguishes (ii) from the estimated true margins based on price reaction elasticities.

[7] Examination of the national ready-to-eat cereal market is appropriate since it was accepted as the relevant market by the judge in the 1970s FTC trial (Scherer and Ross, 1990, p. 466).

time, the unit values are deflated with the Bureau of Labor Statistics' Food and Beverage Consumer Price Index. This is centered on 1982-84 and is an average for U.S. cities, similar to the SAMI data. The 14 brands investigated in this study are the largest within the two segments examined: *Kids* and *Adult/Family*. These segments reflect the general categorization used by A.C. Nielsen, Cotterill and Haller (1997), and others.

### 3.1 Demand elasticities

The paper's focus is on supply-side pricing interactions, and in particular, estimating the size and significance of conduct parameters in this industry. It is only in the final step of the paper – when we calculate "true" price-cost margins based on price-reaction elasticities and compare them to benchmark margins – that demand elasticities are required to flesh out the full structural model. Thus we really only need a reasonable set of demand elasticities to proceed, and in this sense, widely accepted estimates such as Nevo's should be a legitimate standard for measuring departures from benchmark outcomes. Since Nevo's paper presents elasticities for the very same products we examine, we elect to use these when constructing margin estimates later in the paper.[8]

One notes this approach is distinct from studies that simultaneously estimate both the demand and supply sides of a differentiated-products oligopoly model (e.g., Bresnahan, 1987). In contrast, the current approach might be best characterized as a *quasi two-step method*.[9] In the first step, demand is estimated from a price and quantity dataset that represents the choices of consumers and firms in markets analyzed by Nevo (2001). In the second step, the demand estimates are used to calculate price-cost margins under different supply models, one of which is based upon estimated price reaction elasticities and intended to represent the true margins.

A key benefit of this two-step approach is that it is computationally easier than estimating the demand and firm sides simultaneously (and particularly so in this paper since Nevo's results can fill in for step one). This approach also provides an elegant way of estimating "true" price-cost margins under different supply models without having to re-estimate the demand system every time, as in

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[8] The possibility of generating new demand elasticities was also explored but hindered by lack of suitable identification possibilities such as brand-specific cost information, and sub-national market information. Provision of the latter was fundamental to Nevo's successful estimation strategy (2001, p. 320).

[9] The author thanks an anonymous reviewer for suggesting this characterization and making several other points in this section.

studies such as Bresnahan (1987). Relative to these approaches, the current implementation can be viewed as a conservative test of the supply side.

Of course, the approach also entails strong assumptions and certain other drawbacks. First, there are efficiency losses from not jointly estimating the demand and supply sides in a seemingly unrelated regression procedure that exploits the cross-equation correlations in the error terms. Perhaps more importantly, there are losses associated with the strong assumption that demand is identical across the Nevo IRI Infoscan and SAMI datasets. In particular, Nevo's sample does not perfectly coincide with the SAMI sample in terms of years, brands, and cities covered.[10]

While this issue would certainly be important for some types of tasks (e.g., distinguishing the relative importance of product differentiation as a source of high margins, as in Nevo, 2001), it is judged to be unproblematic for the more elemental task we have in mind: gauging the extent to which strategic pricing interactions reflect collusion versus rivalry. In turn, use of Nevo's demand elasticities makes it easier to isolate why this study reaches a different conclusion regarding the extent of strategic pricing interactions.

Elasticity estimates for the 14 cereals are not reported here for space reasons, but are in Table VII and a supplementary table of Nevo (2001). Own price elasticities among the *Kids* cereals considered for this study range from –2.227 to –3.332 (see Table 3 for the list of cereals). Cross-price elasticities range from 0.016 to 0.182. Among the *Adult/Family* cereals considered for this study, own-price elasticities range from –2.496 to –3.821. Cross-price elasticities range from 0.021 to 0.241. Positive cross-price elasticities indicate that brands are substitutes as opposed to complements. This is realistic given that consumption of one generally does not coincide with consumption of another (in contrast to complementary food items such as milk and cereal, for example).

### 3.2 Specification of price reaction functions

This section develops the empirical specification of the brand-level price reaction functions. First note that although we are interested in characterizing cereal *manufacturer* behavior, the SAMI data concern *retail* prices (unit values). One can proceed with retail prices, however, if retailers are characterized as following

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[10] Nevo's sample concerns 1988-1992 as opposed to 1975-1990. The difference in brands covered may matter because elasticities concern changes in market share. However, this is moderated by the fact that elasticities are unitless. The 11 additional brands of Nevo's IRI Infoscan data are either not fully represented in the SAMI data, are part of a different segment, or of particularly small market share. These are: Kelloggs Crispix, GM Cinnamon Toast Crunch, GM Honey Nut Cheerios, Post Honey Bunches of Oats, GM Total, GM Kix, GM Raisin Nut, Kelloggs Corn Flakes, Kelloggs Frosted Flakes, Nabisco Shredded Wheat, and Quaker 100% Natural.

a proportional markup rule. This is reasonable given that the genesis of the FTC case was market power exercised by manufacturers, not retailers, and given that retail margins are relatively small (Cotterill, 1999). Additionally, this is the approach of related studies.[11]

An approximation to the price reaction elasticities is estimated following the approach of Cotterill, Putsis, and Dhar (2000), Cotterill and Samson (2002), and references therein. This involves a linear, non-recursive system of simultaneous equations, with one equation per brand of cereal. The basic setup involves regressing the price of one brand of cereal on prices of other brands, and exogenous cost and demand information. Endogenous variables are the natural logarithm of the price of brand $j$ at time $t$ ($\ln p_{jt}$).[12] Since these appear on the right- as well as left-hand sides of equations, an endogeneity problem must be solved, which calls for use of instrumental variables. A three-stage least squares estimation technique is employed as it is likely the most efficient estimation process (in an asymptotic sense) and is computationally straightforward. In this procedure, endogenous variables are first regressed on the system's predetermined variables; the resulting predicted values serve as instruments in a subsequent system-wide estimation.

A goal of the specification is to distinguish between price changes occurring for strategic reasons, and those that are "barometric" in nature. Ideally one would directly observe all exogenous supply and demand forces acting upon the industry. The residual of these effects on price changes would reflect firms' competitive interactions. Unfortunately it is a very tall order to obtain direct measurements, particularly for our lengthy, historical sample. In terms of the raw ingredients used to produce cereal, data were obtained on two of the economically most important: the U.S. Midwestern wholesale price of refined sugar ($p_{SGR}$), and price of wheat ($p_{WHT}$). Together, these variables form roughly one-third of manufacturer's cost-of-goods-sold (Cotterill, 1999).[13]

Data on other manufacturing costs such as packaging and labor are unavailable for the sample time period. As a result, we draw upon the finding of Barsky et al. (2003) that the price of a "private label" equivalent or near-equivalent product is a reliable proxy for the marginal cost of nationally branded products, including cereals. This is consistent with findings by Connor (1999, p. 253), who indicates that "the sensory quality of many private-label cereals is

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[11] This is not to say that the balance of power between food manufacturers and retailers has not shifted towards the latter in recent years. However, this has largely occurred since the period of this study (Kaufman, 2000), and even with this overall shift, retail markups have not necessarily changed for breakfast cereals in particular.

[12] This variable is ultimately first-differenced in the final specification developed later.

[13] Other potential cost-of-goods-sold variables are considered in alternative specifications discussed below.

equal to or superior to that of the brands." In turn, Barsky et al. find that to the extent there are differences in the comparability of national brand and private label products, they point in the direction of private label products tending to overestimate the marginal cost of national brands. In other words, private label prices are an *upper bound* on branded cereal marginal costs of production. For these reasons, we incorporate the logged SAMI average price of private labels ($\ln p_{PL}$) as a cost-shift variable.

The price reaction specification also accounts for changes in overall demand for a cereal segment by incorporating the log of total expenditure on the brands that are analyzed ($\ln x$). This proxies for the availability and demand of rival products, such as out-of-segment cereals, toaster pastries, frozen pancakes, and breakfast items at fast-food restaurants. The coefficient is expected to be positive.

The possibility of persistence in the price adjustment process over time is also considered. Specifically, a lag of the dependent variable is included on the right hand sides of equations since the value of the dependent variable in this period may be affected by its value in the previous period. This also helps identify each equation and facilitates consistent estimation of the price reaction elasticities. In a levels version of the model this would not be possible since Breusch-Godfrey testing indicates that serial correlation is a problem for most equations.[14] However, this problem was either mitigated or eliminated entirely in a given equation by first differencing the variables. This makes it possible to use lags of the dependent variables as instrumental variables, a common practice in studies for which endogeneity is an issue and problems with serial correlation have been resolved.

In their final form, the equations are over-identified and have the following specification:

$$d\ln p_{jt} = \sum_{k\in\Theta_{-f}} \eta_{jk} d\ln p_{kt} + \beta_{1j} d_{t-1} \ln p_{jt} + \beta_{2j} d\ln p_{SGRt} + \\ + \beta_{3j} d\ln p_{WHTt} + \beta_{4j} d\ln p_{PLt} + \beta_{5j} d\ln x_t + u_{jt} . \qquad (8)$$

A "$d$" in front of a variable indicates it has been first differenced. The term "$d_{t-1}$" indicates the lag of a first differenced value. The "$t$" subscripts represent time period. In turn, if $v_{it}$ is the original disturbance term at time $t$ in the levels versions, then $u_{jt} = v_{jt} - v_{j,\,t-1}$ in (8). The instrumental variables are: $d_{t-1} \ln p_{jt}$ , $d\ln p_{SGRt}$, $d\ln p_{WHTt}$, $d\ln p_{PLt}$, and $d\ln x_t$ .

[14] This test is suitable for situations in which a lagged endogenous variable is used.

# 4. Estimation and Results

## 4.1 Price reaction elasticities

In regression equation (8) there is a specific price reaction elasticity ($\eta_{jk}$) associated with each brand $j \in \Theta_f$ of firm *f*, and each outside brand $k \in \Theta_{-f}$. Thus two brands of the same firm are not restricted to have identical price reaction elasticities with outside brands. Previous studies suggest that strategic pricing is often done at the firm level, however, as opposed to brand level. For example, Scherer's description of price changes suggests they are generally carried out simultaneously, for all products of a firm (1982, p. 203-4).[15] Cotterill, Putsis, and Dhar (2000) indicate that Post, Kellogg, and other manufacturers make price changes for all brands simultaneously and in proportion (p. 110-111). In examining the "cereal price wars" of the mid-1990s, Solman (1996) characterizes them as carried out by firms as a whole, as opposed to waged at the level of individual brands.

The implication is that price reaction elasticities are likely to be nearly identical for brands of the same firm. This possibility concerning $\eta_{jk}$ was tested as joint hypothesis in initial estimations of the model. Based on critical values from *F* and Wald Chi-square tests, the hypothesis that price reaction elasticities are common across brands of the same firm was not rejected for 70% of the cases.[16] Given this finding, same-firm brands are restricted to have common price reaction elasticities in the remainder of the analysis.[17]

Three-stage least squares estimates of the *Adult/Family* and *Kids* price reaction functions are presented in Tables 1 and 2, respectively. A column reports the estimated coefficients for cereal brand *j* as given by specification (8). A given entry (*i*, *j*) represents the percent by which column *j*'s price is estimated to change when row *i*'s variable increases by 1%. Estimator standard errors are in parenthesis below the estimated coefficients.

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[15] Activities that affect costs, such as dealing with input suppliers and a distribution network, often take place at the firm level as opposed to the level of individual brands. For instance, negotiations over retail shelf space and in-store promotions occur at the firm level. Furthermore, advertising is often done for the firm as a whole. Recent television advertisements for some companies emphasize heritage and feature the people who work in the plants, which is a firm-level as opposed to a brand-specific strategy.

[16] This finding is based on supply pricing equations alone; it does not account for the two-step embedded estimator from the demand side.

[17] In the cases where this restriction is rejected, a manufacturer has a different pricing strategy by brand. Imposing the above restriction masks this heterogeneity, but does have a side benefit of reducing the number of parameters to estimate, i.e., it reduces the dimensionality problem.

**Table 1. Estimation of Price Reaction Functions: Adult/Family cereals**

| | Dependent variable, equations 1 – 7 | | | | | | |
|---|---|---|---|---|---|---|---|
| | P. Raisin Bran ($d \ln p_{PRB}$) | P. Grape Nuts ($d \ln p_{PGN}$) | Kellogg R. Krisp. ($d \ln p_{KRK}$) | Kellogg Special K ($d \ln p_{KSK}$) | Kellogg Rai. Bran ($d \ln p_{KRB}$) | G Mills Cheerios ($d \ln p_{GMC}$) | G Mills Wheaties ($d \ln p_{GMW}$) |
| Post Raisin Bran ($d \ln p_{PRB}$) | – | – | 0.265*** (0.052) | 0.265*** (0.052) | 0.265*** (0.052) | -0.023 (0.084) | -0.023 (0.084) |
| Post Grape Nuts ($d \ln p_{PGN}$) | – | – | 0.265*** (0.052) | 0.265*** (0.052) | 0.265*** (0.052) | -0.023 (0.084) | -0.023 (0.084) |
| Kellogg Rice Krispies ($d \ln p_{KRK}$) | 0.422*** (0.085) | 0.422*** (0.085) | – | – | – | 0.264*** (0.083) | 0.264*** (0.083) |
| Kellogg Special K ($d \ln p_{KSK}$) | 0.422*** (0.085) | 0.422*** (0.085) | – | – | – | 0.264*** (0.083) | 0.264*** (0.083) |
| Kellogg Raisin Bran ($d \ln p_{KRB}$) | 0.422*** (0.085) | 0.422*** (0.085) | – | – | – | 0.264*** (0.083) | 0.264*** (0.083) |
| GM Cheerios ($d \ln p_{GMC}$) | -0.007 (0.135) | -0.007 (0.135) | 0.247*** (0.078) | 0.247*** (0.078) | 0.247*** (0.078) | – | – |
| GM Wheatie ($d \ln p_{GMW}$) | -0.007 (0.135) | -0.007 (0.135) | 0.247*** (0.078) | 0.247*** (0.078) | 0.247*** (0.078) | – | – |
| Lagged dependent ($d_{t-1} \ln p_j$) | -0.051 (0.058) | -0.083* (0.050) | 0.096* (0.058) | 0.013 (0.060) | -0.058 (0.050) | -0.001 (0.053) | 0.010 (0.056) |
| Sugar price ($d \ln p_{SGR}$) | 0.018 (0.016) | 0.021 (0.019) | 0.041* (0.022) | 0.022 (0.020) | -0.017 (0.018) | -0.024 (0.015) | -0.033* (0.019) |
| Wheat price ($d \ln p_{WHT}$) | 0.008 (0.019) | -0.011 (0.022) | 0.019 (0.026) | 0.003 (0.023) | -0.013 (0.021) | -0.010 (0.017) | 0.009 (0.022) |
| Private label pr. ($d \ln p_{PL}$) | 0.173** (0.080) | 0.032 (0.092) | -0.004 (0.116) | 0.007 (0.105) | -0.013 (0.091) | -0.078 (0.077) | -0.084 (0.094) |
| Segment expenditure ($d \ln x$) | -0.031** (0.013) | 0.059*** (0.015) | -0.016 (0.022) | -0.009 (0.020) | 0.009 (0.016) | 0.045** (0.014) | 0.033** (0.017) |
| $R^2$ | 0.074 | 0.169 | 0.106 | 0.128 | 0.111 | 0.095 | 0.057 |

*Notes:* Standard error in parenthesis. Price reaction elasticities concerning brands of same company are statistically equal and thus restricted to be equal. One, two, and three asterisks signify statistical significance (relative to a zero coefficient) at the 10%, 5%, and 1% level, respectively, in a two-sided test.

**Table 2. Estimation of Price Reaction Functions: Kids cereals**

| | Dependent variable, equations 1 – 7 | | | | | | |
|---|---|---|---|---|---|---|---|
| | G Mills Trix ($d \ln p_{GMT}$) | GM Luck. Charm ($d \ln p_{GML}$) | Kellogg Frst. MW ($d \ln p_{KFM}$) | Kellogg Corn Pops ($d \ln p_{KCP}$) | Kellogg Fr. Loops ($d \ln p_{KFL}$) | Q. Cap N Crun. ($d \ln p_{QCC}$) | Quaker Life ($d \ln p_{QL}$) |
| G Mills Trix ($d \ln p_{GMT}$) | – | – | 0.419*** (0.090) | 0.419*** (0.090) | 0.419*** (0.090) | 0.355*** (0.138) | 0.355*** (0.138) |
| GM Lucky Charms ($d \ln p_{GML}$) | – | – | 0.419*** (0.090) | 0.419*** (0.090) | 0.419*** (0.090) | 0.355*** (0.138) | 0.355*** (0.138) |
| Kellogg Frosted MW ($d \ln p_{KFM}$) | 0.280*** (0.071) | 0.280*** (0.071) | – | – | – | -0.071 (0.110) | -0.071 (0.110) |
| Kellogg Corn Pops ($d \ln p_{KCP}$) | 0.280*** (0.071) | 0.280*** (0.071) | – | – | – | -0.071 (0.110) | -0.071 (0.110) |
| Kellogg Froot Loops ($d \ln p_{KFL}$) | 0.280*** (0.071) | 0.280*** (0.071) | – | – | – | -0.071 (0.110) | -0.071 (0.110) |
| Quaker Cap N Crunch ($d \ln p_{QCC}$) | 0.231* (0.130) | 0.231* (0.130) | -0.117 (0.147) | -0.117 (0.147) | -0.117 (0.147) | – | – |
| Quaker Life ($d \ln p_{QL}$) | 0.231* (0.130) | 0.231* (0.130) | -0.117 (0.147) | -0.117 (0.147) | -0.117 (0.147) | – | – |
| Lagged dependent ($d_{t-1} \ln p_j$) | -0.002 (0.048) | -0.039 (0.051) | -0.001 (0.064) | -0.071 (0.064) | 0.050 (0.055) | 0.043 (0.055) | 0.012 (0.058) |
| Sugar price ($d \ln p_{SGR}$) | 0.000 (0.016) | 0.004 (0.016) | -0.019 (0.019) | -0.020 (0.017) | 0.006 (0.019) | 0.001 (0.018) | 0.000 (0.018) |
| Wheat price ($d \ln p_{WHT}$) | -0.009 (0.017) | -0.005 (0.018) | 0.015 (0.023) | 0.021 (0.021) | 0.011 (0.021) | 0.004 (0.019) | -0.009 (0.019) |
| Private label pr. ($d \ln p_{PL}$) | -0.018 (0.087) | 0.014 (0.088) | 0.018 (0.106) | 0.130 (0.099) | 0.099 (0.102) | -0.031 (0.096) | -0.025 (0.095) |
| Segment expenditure ($d \ln x$) | -0.005 (0.011) | -0.010 (0.011) | -0.021 (0.014) | 0.006 (0.013) | 0.028** (0.013) | 0.025** (0.012) | -0.019* (0.012) |
| $R^2$ | 0.152 | 0.170 | 0.085 | 0.088 | 0.073 | 0.032 | 0.065 |

*Notes:* Standard error in parenthesis. Price reaction elasticities concerning brands of same company are statistically equal and thus restricted to be equal. One, two, and three asterisks signify statistical significance (relative to a zero coefficient) at the 10%, 5%, and 1% level, respectively, in a two-sided test.

The estimated price reaction elasticities are in the uppermost ( $7 \times 7$ ) block of cells in Tables 1 and 2. The effect of the restrictions mentioned earlier should be readily apparent: brands of the same firm have identical price reaction elasticities with respect to the brands of other firms.

In both segments, four out of six elasticities are statistically different from zero, generally at the 1% level (Tables 1 and 2). These elasticities range from 0.247 to 0.422. So when one firm raises prices and restricts output, others follow suit to some degree. For example, when Kellogg raises its *Adult/Family* cereal prices by 1%, Post tends to respond by 0.422%, and General Mills by 0.264%. In the *Kids* segment, when General Mills raises its prices by 1%, Kellogg tends to respond by 0.419%, and Quaker by 0.355%.

Note that price reactions are asymmetric, that is, price changes by certain firms draw proportionately more response from rivals, than vice-versa. This is consistent with findings in a number of previous studies (Kadiyali, Vilcassim, Chintagunta, 1996).

While the above results would seem to rule out Nash-Bertrand behavior, note that for each segment, two of the six coefficients are *not* statistically different from zero. Among *Adult/Family* cereals, the two cases in which price reaction elasticities are statistically zero involve General Mills and Post (Table 1). If Post raises its prices by 1%, General Mills does not respond in a consistent way, and vice-versa. Among *Kids* cereals, it is Quaker and Kellogg which have no robust pricing interaction. If Kellogg raises its prices by 1%, for example, Quaker does not have a uniform response. This is consistent with an observation by Scherer (1982, p. 204) that Quaker tends to operate somewhat independently of Kellogg.

### 4.2 Coefficients on instrumental variables

The remaining coefficients in Tables 1 and 2 correspond to instrumental variables that ensure identification and account for other factors affecting cereal price changes. Consider first the coefficients on the lagged dependent variable ($d_{t\text{-}1} \ln p$). In two cases (Post Grape Nuts and Kellogg Rice Krispies) the coefficient is statistically different from zero at the 10% level (Table 1). These coefficients tend to be small, however, suggesting that price movements do not carry over from one month to the next.

The coefficients on supply and demand variables ($d \ln p_{SGR}$, $d \ln p_{WHT}$, $d \ln p_{PL}$, $d \ln x$) are at best moderately important in explaining the variation in brand price changes. For example, only two of the coefficients on the sugar and wheat price variables ($d \ln p_{SGR}$ and $d \ln p_{WHT}$) are statistically different from zero at a 10% level of significance. This general lack of statistical significance is robust to different definitions of wheat and sugar (e.g., whether the latter is wholesale refined beet sugar prices in the Midwest versus the price of raw sugar, duty-fee paid, in New York).

There is only one coefficient on private label price ($d \ln p_{PL}$) that has a sizable coefficient and is statistically different from zero at a 5% level of significance (Post Raisin Brand: coefficient is 0.173). Figure 1 sheds light on why the price changes of private label cereals have little relation to price changes for branded cereals. (Recall that Barsky et al. determine that private label prices are an upper bound on branded cereal marginal costs.) Average cereal prices for the four largest brand manufacturers are displayed along with the prices of private label cereals.[18] During the second half of the 1970s, all five price series are stable or slightly trending downward. After 1980 the prices of branded cereals begin a strong upward trend, however, while private label prices remain stable – particularly after 1984. Overall, branded prices increase an average of 35% between 1975 and 1990, while private-label cereals increase only 8%. Figure 1 makes clear that branded cereal prices have little to do with private label prices, and by extension, with the basic costs of cereal production (i.e., grains, sweetener, packaging, labor, capital).[19]

With regard to overall demand for each of the two segments, the differenced total expenditure on the group of cereals ($d \ln x$) has statistical significance in about half of the brands (Tables 1 and 2). For example, the elasticity of Post Raisin Bran and Grape Nuts with respect to overall segment demand is –0.031 and –0.059, respectively, with 5% and 1% levels of significance. While the negative signs are unexpected, the smallness of these and the other coefficients suggests that overall segment demand has little role in the brand price changes over the sample period.

Of course, $d \ln x$ is an imperfect representation of how new cereal brand introductions and other competing breakfast products affected the demand for the brands considered. However, Figure 1 suggests that even if a better measure could be found, it would make little difference. Between 1975 and 1990, introduction of competing products (e.g., new cereals, frozen waffles, toaster

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[18] Time-series plots of individual *brand* prices for the two segments are very similar to those of Figure 1. They are not presented because this would involve two figures instead of just one, and because the increased number of price series in each figure makes them harder to examine.

[19] One notes that the dramatic rise in branded cereal prices coincides with the 1981 dismissal of the FTC case against the industry. It is tempting to hypothesize that once the industry was no longer under the spotlight of the investigation, tacit collusion intensified, allowing firms to further raise prices above competitive levels. This possibility was considered by estimating price reaction functions over the corresponding subsets of the sample time period. (A truly rigorous test may be out of reach due to the small number of observations after splitting the sample.) The nature and magnitude of parallel pricing appears to be similar between the two periods. In other words, firms' *rule of thumb* regarding joint price movements changed little over time.

pastries, breakfast items at fast-food restaurants) should if anything have *suppressed* demand for the cereals analyzed here. Although this could have happened to some extent, branded cereal prices increased greatly over this period (Figure 1). Whether these higher prices can be considered profit, or are related to more intensive mass-media promotion, for example, is beyond the scope of this study. In any case it is clear that branded cereal price changes have little to do with private label price changes – and by extension, manufacturer's cost-of-goods-sold.

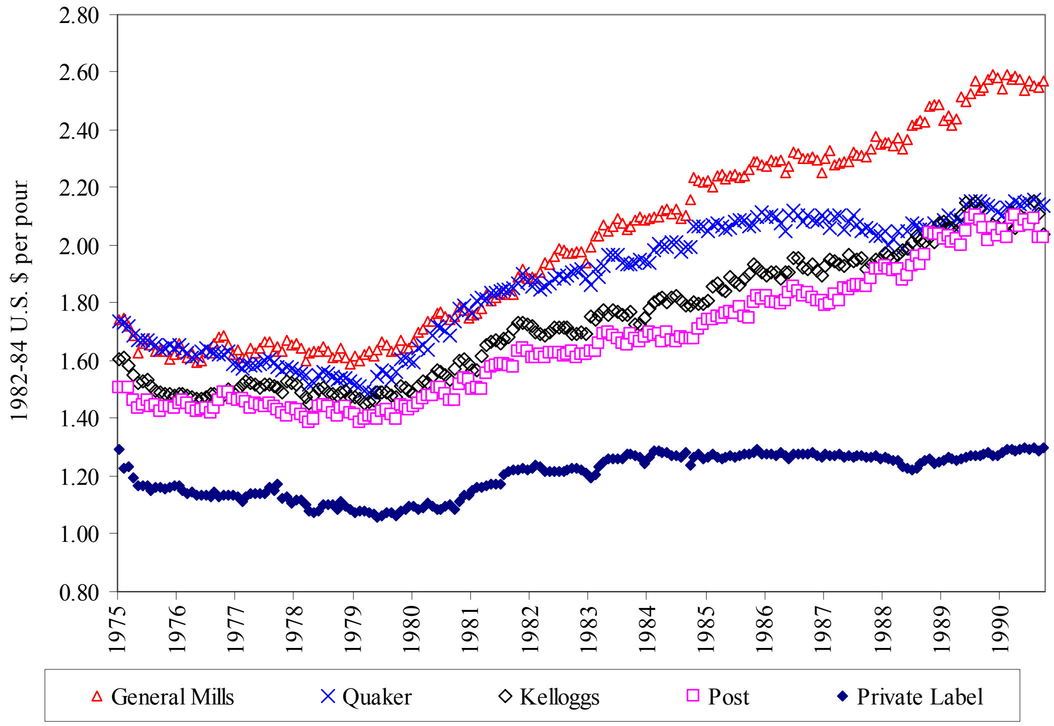


**Figure 1. Ready-to-Eat Cereal Prices Over Time**

*Notes*: These are unit values from Selling Area Markets, Inc. (SAMI), normalized on the Bureau of Labor Statistics U.S. average Food and Beverage Consumer Price Index (1982-84 base).

Finally, the rightmost column of Tables 1 and 2 reports an $R^2$ value for each equation. These vary from 0.057 to 0.169 among *Adult/Family* cereals, and from 0.032 to 0.170 among *Kids* cereals. While some of these $R^2$ values are very low, this is common among first-differenced models, since some information about the co-movements of variables is necessarily lost.

### 4.3 Discussion

While (8) is the preferred specification, a number of alternatives were considered to examine how sensitive the results are to modeling assumptions and data. It is important to stress that across a range of alternative specifications, the salient results from above are robust. In any given specification, most price reaction elasticity estimates range from 0.2 to 0.5 and are statistically different from zero.

Alternative specifications included a levels versions of the model (with an approach to adjusting for serial correlation due to Pagan, 1974), as well as examination of different subsets of the sample time period. In both types of alternative specifications, the estimated price reaction elasticities generally had signs and magnitudes similar to the preferred specification.

Another potential concern is the omission of price-adjustment determinants that are observable to firms but not to the researcher. The use of instrumental variables in (8) is intended to guard against such bias, and additional specifications were developed to help examine their validity. Alternative specifications had additional proxies for marginal costs, including distribution and transportation costs (based on Bureau of Labor Statistics price indices), and the prices of other major ingredients (including corn and various sweeteners). In no case did the major results of the regression differ significantly from the preferred specification. Since costs related to transportation, for example, form a small share of overall costs (and since private label prices are already there to proxy for many of these variables), they are left out of the final specification.

Separate estimation of the *Kids* and *Adult/Family* cereal segments also provides a robustness check on the results. Recall that price reaction elasticities are generally about the same across all brands of a firm. As a result, we should expect that a given price reaction elasticity estimate between two particular firms is similar across the two segments (*Kids* and *Adult/Family*). In this analysis, two firms in our sample – Kellogg and General Mills (GM) – have brands at the top of each segment, so for these two (only) we can check whether price reaction elasticities are consistent across the two segments. Looking at Table 1, when Kellogg raises its *Adult/Family* prices by 1%, GM responds by 0.264%. In the *Kids* segment (Table 2) the corresponding figure is 0.280%, which is quite similar. This is as should be expected, and bodes well for the specification. On the other hand, when GM raises its *Adult/Family* prices by 1%, GM responds by 0.247% (Table 1). In the *Kids* segment the corresponding figure is 0.419% (Table 2). This is off by about 0.17 percentage points, yet importantly, both elasticities are positive and statistically significant from zero. These findings underscore the basic soundness of the results.

Two points on the interpretation of the price reaction elasticities need to be revisited at this stage. First, the price reaction elasticity estimates are subject to the Corts critique that oligopolistic pricing interactions may be biased downward. While direct tests of this issue suggest that the bias tends to be very small, and certainly smaller than most of the sundry other biases that can arise (Genesove and Mullin, 1998), the results are perhaps best interpreted as being a *lower bound* on actual pricing interactions within this industry. Second, it cannot be said with certainty whether the price reaction elasticities represent collusion versus other forms of behavior, such as rivalry. The fact that the price reaction elasticities are generally positive is suggestive of cooperation on price. However, as discussed earlier, the estimated price reaction elasticities need to be plugged back into the structural model to aid in interpretation.

## 5. Price-cost margins

This section examines the interpretation and economic significance of the parallel pricing behavior uncovered in the above section. A "true" price-cost margin is calculated based on the above estimated price reaction elasticities, in conjunction with information on which firms hold what brands, and demand elasticities from Nevo (2001). This information is plugged into equation (7) to determine the estimated actual margin for each brand. This margin embodies three potential types of market power: product differentiation, the portfolio effect, and strategic pricing interactions.

While these are characterized as "true" margins, this term is really just for expository convenience; these margins are only intended for comparison to the three hypothetical benchmark margins also calculated. As discussed earlier, these concern market power arising from: (i) product differentiation alone (one brand per firm); (ii) product differentiation plus the portfolio effect (actual brand-to-firm correspondences, and a Nash-Bertrand game in prices); and (iii) joint profit maximization of all brands by a single agent. We seek to measure the direction and extent that the "true" price-cost margins depart from these scenarios. The fact that the price reaction elasticities are generally positive makes it likely we are somewhere between scenario (ii) and (iii).

Readers are referred back to equation (7) for the specifics on how the margins are calculated. Table 3 presents the estimated true margins for individual cereals along with bootstrapped 95% confidence intervals that account for estimator standard error with respect to the price reaction elasticities. The margins associated with the hypothetical scenarios are also presented.

The average estimated true margins for *Adult/Family* and *Kids* cereals are 35.5% and 42.3%, respectively (Table 3). Confidence intervals for the estimated true margins indicate there is little uncertainty surrounding the estimates. This reflects the small standard errors of most of the price reaction elasticity estimators (Tables 1 and 2).

**Table 3. Price-Cost Margins (%)**

| | Estimated "true" margin based on price reaction elasticities | | Hypothetical margin associated with: | | |
|---|---|---|---|---|---|
| | | | Benchmark scenario (i) | Benchmark scenario (ii) | Benchmark scenario (iii) |
| **Adult/Family cereals** | | | | | |
| Post Raisin Bran | 42.0 | (41.8 - 42.1) | 40.1 | 40.5 | 44.3 |
| Post Grape Nuts | 31.2 | (31.1 - 31.4) | 28.8 | 29.8 | 35.4 |
| Kellogg Rice Krispie | 35.7 | (35.4 - 35.9) | 31.0 | 32.4 | 36.4 |
| Kellogg Special K | 36.7 | (36.3 - 37.1) | 30.4 | 31.8 | 34.7 |
| Kellogg Raisin Bran | 44.4 | (44.1 - 44.8) | 38.8 | 40.2 | 44.5 |
| G Mills Cheerios | 28.7 | (28.6 - 28.8) | 27.3 | 27.9 | 33.0 |
| G Mills Wheaties | 29.7 | (29.4 - 30.0) | 26.2 | 27.5 | 31.2 |
| *Average* | *35.5* | *(35.4 - 35.6)* | *31.8* | *32.9* | *37.1* |
| **Kids cereals** | | | | | |
| GM Trix | 46.8 | (46.3 - 47.3) | 39.1 | 40.4 | 46.9 |
| GM Lucky Charms | 46.7 | (46.2 - 47.1) | 39.4 | 40.8 | 49.4 |
| Kellogg Frost. MW. | 33.6 | (33.3 - 33.9) | 30.0 | 31.9 | 35.2 |
| Kellogg Corn Pops | 43.8 | (43.5 - 44.1) | 40.8 | 42.3 | 49.6 |
| Kellogg Froot Loops | 45.2 | (45.0 - 45.4) | 42.7 | 44.0 | 50.3 |
| Quakr Cap N Crunch | 46.5 | (46.1 - 46.8) | 43.9 | 46.0 | 60.4 |
| Quaker Life | 33.6 | (33.3 - 33.9) | 31.7 | 33.2 | 38.7 |
| *Average* | *42.3* | *(42.1 - 42.5)* | *38.2* | *39.8* | *47.2* |
| *Overall average* | *38.9* | *(38.8 - 39.1)* | *35.0* | *36.4* | *42.2* |

*Notes*: Scenario (i) is single-brand profit-maximizing firm operating in isolation. Scenario (ii) is a multi-brand profit-maximizing firm operating in isolation. Scenario (iii) is the joint profit maximizing outcome for the segment as a whole. Estimated "true" margins are based on a multi-brand profit-maximizing firm in which inter-firm interaction is given by the price reaction estimates. Actual firm-to-brand correspondences underlie the "true" model and the scenario (ii) model only. Values in parenthesis are bootstrapped 95% confidence intervals.

Note that *Kids* margins tend to be higher than *Adult/Family* margins. This has little to do with the price reaction elasticities. Rather, *Kids* cereals tend to have higher markups because demand for them tends to be more inelastic than for *Adult/Family* cereals.[20]

[20] This is an artifact of using demand elasticities from Nevo (2001), and is unrelated to our analysis of strategic pricing interactions.

If we look at Table 3's results on a brand-by-brand basis, we see that in every case but Kellogg's Special K, the estimated true margin falls between the margins associated with second and third benchmark scenarios (i.e., the multi-product Nash-Bertrand model and joint profit maximization). This is also the case when one looks at the *averages* of each segment. The estimated true margins clearly exceed the level associated with scenario (ii), in which unilateral and portfolio market power are exercised, but firms price according to a Nash-Bertrand game.

The average true margins exceed those of scenario (ii) by 2.6 and 2.5 percentage points for *Adult/Family* and *Kids* cereals, respectively (calculations are made as follows: 2.6 = 35.5 − 32.9; 2.5 = 42.3 − 39.8.) If we are conservative and use the *lower* bounds of the estimated true margin confidence intervals, they are still more than two percentage points higher than scenario (ii) levels. Strategic pricing interactions clearly increase the margins by statistically significant levels.

We can improve our interpretation of the strategic pricing interactions if we compare the contribution that they make to the margins, versus the contribution that the most extreme form of cooperation could make: perfect collusion. The largest contribution that perfect collusion can add to the margin is 5.8 percentage points on average. This figure comes from subtracting the overall average of the scenario (ii) margin (36.4%) from the overall average joint profit maximization margin (42.2%). In turn, the *actual* contribution that strategic pricing interactions add to the margin is 2.5 percentage points. This is the difference between the estimated average true margin (38.9%) and the scenario (ii) average margin (36.4%). When we divide the actual contribution (2.5) by the amount theoretically possible (5.8), we find that strategic pricing interactions boost margins by about 43% of the amount that a perfect price-fixing agreement could do.[21] Thus we are roughly midway on the continuum between Nash-Bertrand pricing behavior and the shared monopoly outcome.

This result differs from Nevo (2001) primarily because he uses an accounting-based margin to represent the average true price-cost margin. This margin corresponds to an average of Kellogg's cereals for a particular period of time, and is most consistent with the average margin for Nevo's multi-product Bertrand-Nash scenario, in which firms do not interact on price.

This study, however, looks at the supply side of the industry in more detail. Firm pricing interactions are estimated directly, controlling for price movements associated with common reactions to changing overall market conditions. The estimated "true" margins are based on price reaction elasticities, and are generated

[21] One notes that the principal source of high price-cost margins is product differentiation. Yet the effect of strategic pricing interactions is robust, and certainly part of any complete description of conduct in this industry.

within the *same* framework as the benchmark margins, corresponding to precisely the same set of brands.[22]

## 6. Concluding Remarks

This study seeks to mend a gap in the literature on conduct among ready-to-eat cereal manufacturers. While some studies find that firms' pricing behavior is consistent with a Nash-Bertrand game, other studies report that pricing is highly collusive. This study brings new evidence to bear on this issue by estimating price reaction functions that distinguish between price movements occurring for strategic reasons, and price movements occurring in response to changing overall market conditions. Estimates of price reaction elasticities – which represent the observed tendency for a brand's price to be changed when a competitor's is changed – suggest that pricing is consciously parallel as opposed to Nash-Bertrand in nature.

To further interpret the price reaction elasticities, they are plugged into the Bertrand differentiated-products oligopoly model from which they are derived, along with independently estimated demand elasticities from Nevo (2001). This allows price-cost margins based on the estimated price reaction elasticities to be calculated and compared to hypothetical scenarios of industry conduct.

In doing so, firms' strategic price interactions are found to increase the margins relative to a multi-product Nash-Bertrand scenario by an average of 2.5 percentage points. This contribution is robust in a repeated sampling context, and constitutes about 43% of the maximum possible contribution that an overt price-fixing agreement could make.

This level of cooperation is approximately halfway between the Nash-Bertrand outcome reported by Nevo (2001) and the collusive outcome suggested in Scherer (1982) and Scherer and Ross (1990). As such, the industry's pricing conduct may be best characterized as *approximately cooperative*, which coincides with how Schmalensee (1978, p. 315) once characterized the industry's pricing.

That said, this study leaves unanswered a number of important questions regarding cereal industry market conduct. For example, are the pricing interactions rightfully characterized as collusive price leadership, as Scherer and Ross (1990) have suggested? In turn, to the extent that the striking increase in

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[22] If an outside margin is used as the measure of truth, there are other estimates that may be worthy of consideration. For example, Barsky et al. (2003, Table 7) report margin estimates for several cereals. Connor et al. (1985, p. 291) also report cereal margin estimates. However, such measures may be of limited relevance for empirical models of market conduct. Such measures are defined differently (e.g., they may differ in treatment of capital costs) and concern distinct sets of brands and periods of time.

branded cereal prices in Figure 1 reflects increases in manufacturer gross margin, does this correspond to an increase in operating profits, or reflect strategic considerations, such as increased marketing expenses? Investigating such questions will require more recent data sets, for which certain key variables are more likely to be available. Provision of more detailed data is also key for improving the econometric specification and being able to jointly estimate the supply and demand sides, something that proved infeasible for the study at hand.

Note also that the current study focuses on the exercise of market power by cereal *manufacturers* as opposed to retailers. In the years since this study's sample period, retailers have increasingly applied slotting fees, charges for promotions, and performance requirements to manufacturers' products. This has become possible through retailer consolidation, and new information gathering techniques such as electronic scanners (Kaufman, 2000). An interesting topic for future work is to investigate the effect this has on pricing and profitability at different stages of the cereal market channel.

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