Food Marketing Policy Center

**Estimation of Cost Pass Through
to Michigan Consumers in the
ADM Price Fixing Case**

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Table of Content

Tables and Figures

Acknowledgements

This report is based upon an affidavit presented in a consumers class action lawsuit against the leading wet corn millers: ADM, A.E. Staley, Cargill and Haarman and Reimer Corp. I would like to acknowledge the assistance of Andrew Franklin in producing this research report and the assistance of Li Yu Ma in developing the mathematical model and computing pass through rates.

Abstract

This report analyzes the economic impact of price fixing in the wet corn milling industry on consumers in the State of Michigan. Two of the companies who produce citric acid have pleaded guilty to fixing its price. In this report we assume that price fixing also occurred among HFCS producers. Given the structure of the corn wet milling industry and the direct purchaser industries, the overcharge is essentially uniform across buyers and selling arrangements. We develop an actual economic model of price transmission based upon the three facts: 1) The overcharge as a percent of the processed product value at wholesale and at retail is small, 2) Fixed proportion technology, and 3) consumers have imperfect information about prices so a small price change has no effect on their purchase behavior. These facts establish that 100 percent or more of the common overcharge will be passed through to consumers.

In a more general economic model, we analyze pass through when consumer demand is not perfectly inelastic. For different strategies (profit maximization, sales maximization subject to a target level of profit, and loss leader strategies) and for different market structures (competitive, monopoly, oligopoly), the rate of pass through is 100 percent or greater given certain documented characteristics of the industries in this case. Given the prior points consumer damages are the common overcharges for each commodity times the amount of the commodity sold during the damage period. This is a lower bound estimate of consumer damages because pass through may well be greater than 100%.

KEYWORDS: Price fixing, overcharge, cost pass through, fixed proportion production technology, flexible demand specifications, competitive structure.

1. Introduction

This report analyzes the economic impact of price fixing in the wet corn milling industry on consumers in the State of Michigan. It is based upon an affidavit presented in a consumers class action lawsuit against the leading wet corn millers: ADM, A.E. Staley, Cargill and Haarman and Reimer Corp. These leading wet corn millers produce either citric acid, high fructose corn syrup (HFCS) or both products.

Citric acid is sold to detergent manufacturers for use rather than phosphates for environmental reasons. It also is used in the manufacture or preservation of food products and pharmaceuticals. HFCS is also used in food manufacturing, primarily the soft drink industry.

Two of the companies who produce citric acid have pleaded guilty to fixing its price. In this report we assume that price fixing also occurred among HFCS producers. We will explain how one can measure the overcharge to direct purchasers (the food, beverage and detergent manufacturers), and explain how one can analyze price transmission through manufacturers and through retailers and away–from–home food purveyors, such as restaurants to determine the amount of damage suffered by consumers.

The organization of this report is as follows. Section Two contains a brief introduction to the industries involved and the marketing channels for HFCS and citric acid. Section Three covers the overcharge paid by direct purchasers. Finally, Section Four analyzes the pass through of the overcharge to Michigan consumers.

Primary conclusions are:

– Given that price fixing in the corn wet milling industry exists for citric acid and HFCS, the amount of the overcharge can be measured from business records or within the context of an economic model of the industry. There are sound economic reasons, given the structure of the corn wet milling industry and the direct purchaser industries, the overcharge is essentially uniform across buyers and selling arrangements.

– We develop an actual economic model of price transmission based upon the three facts: 1) The overcharge as a percent of the processed product value at wholesale and at retail is small, in most cases below 5 percent for HFCS and often below 0.5 percent for citric acid because so little HFCS or citric acid is used in final products; 2) Fixed proportion technology (i.e., a fixed recipe or formula) is used to produce a processed food or cleanser or pharmaceutical product; and 3) consumers have imperfect information about prices so a small price change has no effect on their purchase behavior. These facts establish that 100 percent or more of the common overcharge will be passed through to consumers.

– In a more general economic model, we analyze pass through when consumer demand is not perfectly inelastic. For different strategies (profit maximization, sales maximization subject to a target level of profit, and loss leader strategies) and for different market structures (competitive, monopoly, oligopoly), the rate of pass through is 100 percent or greater given certain documented characteristics of the industries in this case. Given the prior points consumer damages are the common overcharges for each commodity times the amount of the commodity sold during the damage period. This is a lower bound estimate of consumer damages because pass through may well be greater than 100%.

2. Description of the Citric Acid and HFCS Marketing Channels

HFCS is a sweetener produced in corn wet milling plants. It is used in various food products, primarily in soft drinks which accounts for 71% of its sales. It is produced in two principle grades, HFCS 42 and HFCS 55, which is the sweeter of the two. The HFCS market is highly concentrated with the four defendants in this action which produced it accounting for approximately 90% of the U.S. market. HFCS is a commodity, i.e., that produced by one manufacturer is treated as fungible with that produced by another. Wet corn millers have a list price for HFCS but most of it sold below list price, particularly to the larger purchasers. Food and beverage manufacturers incorporate HFCS into their products which they in turn sell to wholesalers (or larger retailers). Wholesalers sell the products to the retailers who sell to the public either in the "take home" market, i.e., grocery stores, or the "away-from-home" market, i.e., restaurants.

Citric acid is manufactured from corn by a fermentation process. Anhydrous citric acid accounts for most production, but some is produced in liquid form. It is used in soft drinks to make them tart in taste, to enhance flavor and color in canned goods, in pharmaceuticals, and in detergents as a substitute for phosphates. It, like HFCS, has a list price but is often sold at discount. Its distribution channels are similar to those for HFCS.

3. Measurement of Overcharges Paid by Direct Purchasers

The key question for this section is: if a conspiracy exists, would it commonly impact all direct purchasers and can that impact be measured? A recent district court decision allowing a merger to occur in this industry is seen by some as evidence that this industry could not establish and maintain a common overcharge through a price fixing conspiracy. (CITE) In his decision that firms in this industry could not, even after the merger, successfully coordinate prices (collude), Judge Vietor clearly did not mean to rule out illegal, conspiratorial actions. Judge Vietor's explanation of how difficult it would be for firms to legally coordinate prices via tacit collusion (price leadership, price signaling, or other facilitating devices) actually provides an incentive to engage in illegal methods to elevate price. As noted economist Douglas Greer writes:

> …only when cartelization is both *feasible* and *necessary* to achieving the profit objective are we likely to find it, given a hostile legal environment. When structural conditions are highly unfavorable, necessity and impossibility combine to produce competition. When structural conditions are highly favorable, possibility and a lack of necessity combine to produce *tacit* collusion. In between, necessity and feasibility blend, and cartelization is likely to occur (Greer 1992, p401).

Table 1 from Greer's text illustrates his logic. Greer's conclusions are based on research by Fraas and Greer (1977) of 606 illegal price fixing conspiracies from the records of all government actions brought to enforce Section 1 of the Sherman Act from 1910 to 1973 and Hay and Kelly (1974). The wet corn milling industry fits most squarely in column 2 of Table 1. Thus its structure is typical of industries that have fixed prices in the past.

Since HFCS and citric acid are commodities, i.e., products that are fungible, buyers can purchase them from any of the five firms in the industry that produce them based on price differentials alone. Prices in the industry will vary by time, form (size of lot), location, and other external factors, but for a given level of these transaction characteristics, prices will be identical; otherwise there will be arbitrage between buyers and/or sellers in this industry, i.e., the purchaser whose prices are artificially increased will through various means find a way to purchase under arrangements which are cheaper. Therefore if sellers wish to elevate the prices via a price fixing conspiracy, the overcharge must be a common increase to the price surface in time, form, and location. Moreover, the fact that the industry sells under a variety of contractual arrangements has no impact on the necessity in a successful conspiracy for a common overcharge. Since buyers can switch among the different arrangements, arbitrage will force a common overcharge to develop even if sellers want to discriminate among buyers by form of selling arrangement.

The presence of big buyers in the direct purchase industries is often cited as a reason why sellers cannot successfully coordinate price in a legal way (tacitly collude). This may be true, however, this point also increases the temptation to resort to extra legal means. By conspiring to fix prices via sharing information on transactions, setting market share targets, allocating customers, or whatever other explicit coordination method, the sellers in this industry are able to offset the power of the big buyers. Also, the fact that big buyers shop around among sellers, even if they don't share their final purchase prices with others, will ensure that any overcharge sustained by the sellers is a common elevation of the price surface. Shopping around and not buying at particular prices conveys price information. Conspiring sellers must present a common price schedule to a buyer to successfully sustain the cartel price level.

Standard forensic economic methods can be used to measure this common overcharge. First business records and pricing analysis conducted by the conspiring firms may readily provide a measure of the cartel's "success". Operation of a cartel will normally provide such records, if for no other reason than the normal business need to monitor profit performance and plan future business activity, including the setting of the cartel's prices. Second, using a "before conspiracy"–"after conspiracy" implementation model, one can measure the increase in profits due to the conspiracy by controlling for changes in other factors that determine profits. These models may be accounting based or use econometrics, i.e. statistics, to estimate more complex relationships. The end result is the same. Based upon the documented structure and observed conduct of this industry one can estimate the common overcharge produced by the price fixing conspiracy.

4. Economic Analysis Of Pass Through to Michigan Consumers

4.1 Introduction

The question is how much of this overcharge will be passed on by food manufacturers to food retailers and the away–from–home food purveyors and how much will be passed on by them to consumers in Michigan? This issue of price transmission is not new to agricultural economics or economics.

Agricultural economists have focused considerable effort upon developing theoretical models and measuring how changes in farm prices are transmitted through the marketing channel to produce changes in consumer prices (see Gardner 1975, Kinnucan and Forker 1987, Jacobson

1991). Also real world experience confirms that pass through occurs. New England dairy farmers, for example, convinced Congress in the 1995 farm law to allow them to legally cartelize the farm level price of milk through the Northeast Dairy Compact Commission. Currently the Commission is proceeding to implement a 7.6 percent increase in the New England farm level price of milk (*Hartford Courant*, May 28, 1997). In opposition, manufacturers and retailers state that this price increase will be passed on to consumers. Curtis Flynn, president of the Massachusetts Food Association, the state level trade association for food firms states:

> Ultimately any increase in cost (of farm level raw milk) will be borne by the consumers. (Griffin Report, May 1997, p84).

In economics, price transmission from commodity markets to consumer markets is closely monitored to gauge inflation pressure. An industry analyst in *Supermarket News* writes:

> The Federal Reserve Board noted recently that ongoing declines in food prices should help slow inflation in 1997, barring any weather disasters.
>
> According to the Fed's annual economic outlook, prices of farm products have dropped back from the highs of last summer, meaning that this year's rise in food prices at retail 'should be considerably smaller than that of 1996. (Owens, 1997, p38).

It is impossible to avoid the general conclusion that changes in commodity costs, including citric acid and HFCS, due to shocks such as cartelization or weather are transmitted forward through food marketing channels and have an impact on consumer prices.

Wet corn millers would suggest that since food manufacturers and others use so little citric acid or HFCS in processed food, detergent, or pharmaceutical products that changes in their prices due to overcharges are not monitored nor considered important. Wet corn millers would maintain that overcharges are absorbed rather than passed on. The very fact that most citric acid and HFCS are sold to very large buyers that go to great lengths to ensure that their procurement prices for these products are as low as possible disproves this assertion. Why would buyers be so aggressive if these product prices were unimportant to them? If the price conspiracy elevated HFCS prices by only 1 cent per pound, then a "small purchaser" e.q. 500,000lbs., may pay $5,000 more for HFCS annually. A "large purchaser who buys over a million pounds annually pays over $10 million more for HFCS. Cost increases of this dollar magnitude simply do not fall through the cracks at any firm. Moreover, cost increases due to price conspiracy are probably larger than 1 cent per pound (The monthly list price for HFCS-55 ranged from 14.25 cents/lb. to 27.0 cents/lb. during the 1985-1995 period (USDA, 1996, p47). A portion of this variation is due to factors other than the conspiracy, however, an effective conspiracy could account for more than a one cent increase.).

A variation of the "through the cracks" argument misappropriates the fact that the price increase, especially for citric acid, is but a fraction of a cent for a single unit of many finished consumer products because so little of it is used in the products. One cannot falsely infer from this fact that firms cannot raise unit prices a fraction of a cent and therefore the increase in input price is absorbed by the direct purchaser or retailers. This infinitesimal argument is specious for two reasons. First, under standard cost accounting practices, cost of inputs are summed to the total cost of production that the firm strives to cover. The very reason for cost accounting is to make sure that all costs, including costs on small ingredients as well as large, are measured and covered by the firm. A firm that, for example, uses 100 ingredients that each contribute 1 cent to the value of the final product adjusts costs upward by 1 percent if 10 of these inputs have a ten percent increase in cost. This cost accounting procedure is no different than a firm with 10 equal value inputs and one input's cost increases 10 percent. In this case total cost also increases 1 percent.

Second, food manufactures or retailers can vary the terms of sale and trade promotions to fine tune sales of hundreds of cases of the product to cover costs that are a fraction of a cent only when viewed on a per unit of product basis. Retailers, for example, purchases truckloads of product at a time under complex pricing arrangements (*Progressive Grocer*, Dec. 1992 p.28). Retailers recover such cost increases by changing the length and depth of price promotions as well as by changing the everyday shelf price of the product.

4.2 The Actual Price Transmission Model

In an economic model of price transmission, if one can document:

– that consumers have imperfect information about retail prices of these products so that small price changes essentially go unnoticed and consumer purchase behavior does not change,

– then the fact that processed food, pharmaceutical, and cleaning products are produced using fixed proportion production technology,

– and the fact that the monetary value of the citric acid or HFCS used in processed products is very small relative to the retail value of the products so only small retail price changes result from the full pass through of overcharge

– ensure that 100% of any overcharge for citric acid and/or HFCS will be passed on to consumers.

It is undisputed that 100 percent pass through of overcharges for citric acid and HFCS produces small percent changes in consumer prices because their value is a small percent of the products' retail value. One should not infer that there is no damage to consumers when retail price changes on products with citric acid or HFCS only go up by a "small" amount so that consumers do not change their purchase behavior. Consumer damages accrue to substantial amounts precisely because their purchases did not decrease and overcharge per unit aggregates to tens of millions of dollars of damages when one aggregates across time and products. According to *Progressive Grocer*, southern Michigan consumers in the Grand Rapids and Detroit market areas purchased 268 million dollars of soft drinks for the 12 month period ending 10/9/94 (*Progressive Grocer*, 1995, p.696, 698).

In this case, there are very strong reasons for arguing that all firms perceive their demand to be totally inelastic when considering the transmission of the conspiracy overcharge down the food marketing channel to consumers. If this is true, then one does not need to document constant returns to scale and constant supply prices for other inputs, and one does not need to address structural and strategic pricing issues since 100% price transmission does not change consumer behavior. All firms will maintain their prior profit level and continue any sales or loss leader strategies that were in play.

Publicly available studies that, for manufacturers and bottlers, the cost of HFCS by itself accounts for less than 3% of net sales. Thus, a 10% overcharge on HFCS would amount to less than a *0.3%* increase in the cost of most regular soft drinks. Given this fact, food firms can quietly fold this small cost increase into the general rise in price that consumers expect due to inflation in the economy without causing them to change their purchase behavior.

Firms can pass on the overcharge with no fear of impact on their volume of shipments because consumers have imperfect information on food prices. Consumer research studies have shown that consumers do not discern price changes of the magnitude of the overcharge in this price conspiracy case. Writing on information imperfections in local consumer markets, Maynes states:

> ...many, perhaps most, local consumer markets will be characterized by substantial information imperfections. The 'culprits' behind this expectation are three. First, there is the technical complexity and multi-component nature of products. These factors make it difficult for consumers to assess both quality and price accurately. Second, there is affluence which has increased both the consumption possibilities and the consumer's information problem. Specifically, affluence has: (1) enlarged the number of average purchases that each family can make; (2) enlarged the set of products, brands, models, retailers from which choices are to be made; and (3) increased the value of individual's time and hence reduced the extent of his shopping/search actions. Finally, agricultural productivity and the automobile together have made urbanization possible and thus increased the set of products, brands, models, and retailers to which a consumer has access. Maynes, p77).

Progressive Grocer reports that on average only 29 percent of shoppers who repeatedly buy a product could identify selling price within 5 percent of the actual selling price. Among non buyers, on average, only 20 percent could place the price within 5 percent of current selling price. Only 19 percent of shoppers, for example, know the price of Coca Cola within 5 percent of the actual price. Table 2 reproduces the *Progressive Grocer* results.

Several other studies have examined the effect of increasing consumer information on food prices (Devine and Marion 1979, Devine 1978, Uhl et al. 1981). These reports generally confirm that price levels and price dispersion among chains for individual products dropped when price information for several dozen products at all supermarket chains in a city was regularly published in the local newspaper. Devine and Marion report that price levels dropped on average 7.1 percent, with higher priced stores dropping prices more than lower priced stores (1979, p230) and that the mean dispersion in price decreased from 9.71 percent to 7.83 percent after price reporting (p232). These changes were statistically significant. The other research on price information also documents that consumers normally have imperfect information. The 9.7 percent price decline and the 1.88 percent reduction in price dispersion reported by Devine and Marion are two measures of the degree of imperfect information. This suggests that prices can vary from 1.88 to 9.7 percent before consumers switch to other products, in this case other stores offering the same set of products.

Recall that a 10 percent overcharge in the HFCS market produces only a 0.3 percent increase in the retail price of soft drinks. Since 100 percent pass through of the overcharges in the wet corn milling industry produces retail price elevation well below the *Progressive Grocer* 5 percent and the Devine and Marion 2-10 percent range, there will be no change in consumer purchase patterns due to 100% pass through in this case. In other words, consumer demand in the small range of retail price changes due to the conspiracy is totally inelastic. This small price change phenomena can hold even when larger price changes generate changes in purchase behavior so that one can actually observe and estimate a demand curve that has elasticity (negative slope). In other words, the fact that one can estimate a retail demand curve that shows consumers are sensitive to large changes in price does not negate this small price change argument.

Another factor, unrelated to imperfect consumer information, that also contributes to inelastic demand for small price changes is the fact that citric acid and HFCS are common cost ingredients to many products that are close substitutes for each other. As Levy and Reitzes (1993) have shown, a joint increase in the prices of such products due to common cost increases because of the overcharge (or collusion) prevents consumers from substituting one product for another in this group. The common cost increases elevate the prices of all products in the group, and consumers perceive "inflation" in price of the general product category.

Given totally inelastic demand for small price changes and full pass through of any total cost increase, how much will total cost go up if the costs of citric acid and/or HFCS increase? It is undisputed that one has a fixed proportion "recipe" technology, one cannot substitute other inputs for citric acid and/or HFCS and maintain the constant identity and quality (taste, color, freshness, softness for foods, effectiveness for cleansers and pharmaceuticals, and environmental impact for cleansers). This means the increase in total costs equals the overcharge due to the conspiracy. Part of the overcharge is not offset by switching to other inputs. Thus firms that increase prices to cover the increase in total costs are recovering the overcharge due to conspiracy.

4.3 The General Price Transmission Model

Based upon analysis of the facts in this case, consumer purchase behavior is invariant to 100% pass through of overcharges for citric acid and HFCS, however, one can analyze pass through under less than totally inelastic demand conditions as well. When retail price increases are of a size that trigger reduction in consumer purchases, the analysis of pass through is more complicated. Yet if one has, in addition to fixed proportions, the fact that the prices of inputs other than citric acid and/or HFCS do not change when output drops due to higher retail prices, and one has constant returns to scale, then firm total costs increase by the amount of the overcharge. Furthermore, under commonly observed demand elasticity conditions, the structure of the market (competitive, oligopoly, and monopoly) and the pricing strategy of the firm (profit maximization, sales or market share maximization given an acceptable level of profits) do not reduce the pass through rate below 100%.

A necessary economic condition for 100% pass through in the general model of price transmission is constant returns to scale (CRTS). When CRTS holds, decreasing all inputs 1 percent reduces output 1 percent, not more, not less. Connor et al. (1985) summarize research on economies of scale in food manufacturing at the plant and multi plant level. The minimum efficient scale (MES) of a plant is defined as the volume that the plant must obtain to achieve constant returns to scale. At smaller volumes than MES one gets more than a 1 percent increase in output for a 1 percent increase in all inputs, i.e., there are increasing returns to scale. Connor et al. summarize research for the 46 food manufacturing industries, writing:

> only two industries had MES estimates over 10 percent (of industry shipments); Chewing gum was the extreme with 19.8%...One fifth of the industries had MES estimates over 5 percent of industry shipments. (Connor et al., 1986, p94).

Thus 80 percent of all food manufacturing industries attain constant returns to scale production level in plants that produce less than 5 percent of their industries total shipments. Studies of multi plant economies for beer, cigarettes, and breakfast cereal by Scherer (1975, p334-335; 1982) indicate that multi plant economies of scale are not that great. A firm with 2 or 3 plants exhausts them and therefore has constant returns to scale. Other food industries are similar. Therefore one can conclude that manufactured food products in the U.S. are produced by firms that enjoy constant returns to scale.

Since food products using citric acid and HFCS are manufactured in plants and firms with constant returns to scale, then output reduction due to higher consumer prices does not affect the physical relationship between input and output. The change in output cost, other factors remaining the same, is equal to the change in input cost. If products are produced in plants or firms operating below MES, then when output decreases due to pass through of the overcharge, one also needs more of each input to produce a given output so that costs go up by more than the overcharge in citric acid and/or HFCS. Even if all other conditions point to 100% pass through, pass through of the overcharge to total firm costs would be greater than 100% if firms are on the increasing returns to scale portion of their cost curves.

The other production condition concerning the relationship of the overcharge to manufacturers costs in the general model is whether the supply price of other inputs used is constant. There is a commonly acknowledged fact for most individual industries. These food manufacturing industries use only a very small proportion of other inputs produced by the economy. One must be careful not to confuse this fact with the fact that a small amount of citric acid and/or HFCS go into a processed product. Here one is focusing on that fact that a small amount of the total economy's labor, for example, goes into industries that use citric acid and HFCS. Thus since small changes in the retail price of these products generate at most small changes in the quantity sold. There are only small changes in the demand for these other inputs, and since these industries total demand for other inputs is very small relative to their total supply, there is no discernable change in the supply price of these other inputs when the overcharge is passed on to consumers. Therefore, any increase in costs due to the overcharge which reduces output is not offset by saving via lower prices of other inputs.

Given fixed proportions production, constant returns to scale, and elastic other input supply, a change in the price of citric acid or HFCS due to price conspiracy produces an equal change in the total cost of the food manufacturing firms. Also, with constant returns to scale, average variable cost (total variable cost divided by the number of units produced) and marginal costs (the incremental cost of producing another item) are constant and equal to each other. An increase in the price of citric acid and HFCS shifts these flat cost curves up by a constant amount that equals the increase in the price of citric acid or HFCS times the amount used to produce one unit of processed product.

Given that one has 100% price transmission of the overcharge to manufacturing firm costs, the next step is to ask how much of the cost increase in the general price transmission model is transmitted to the wholesale (manufacturers) price for the processed product? The answer to this question depends upon three factors: the elasticity of demand for the firm's product, the market structure of the industry, and the pricing strategy of the firm.

Defendants in cases such as this typically claim that 1) pass through is less than 100 percent in food industries, even if they price do maximize profits, because they are not competitively structured and 2) firms in food industries pursue strategies other than profit maximization and that these strategies somehow "overwhelm" the firms desire to recover cost increases through price increases. Harris and Sullivan (1979) provide the most complete analysis of price pass through under these different scenarios, however, it is not comprehensive. In Appendix A, we expand their analysis and apply the results, as they suggest, to determine the rate of pass through under different elasticity, structural and strategic conditions. Readers desiring formal mathematical analysis of pass through are referred to the appendix.

If food manufacturing industries are competitively structured and firms maximize profits, then the rate of pass through of costs to wholesale prices is 100%, irrespective of the value of the market elasticity of demand. The shift up in the industry supply curve is equal to the shift in marginal costs and the new equilibrium wholesale market price is higher by the same amount (Harris and Sullivan, Figure 2 p. 284).

If the food manufacturing industry is a monopoly, demand for its product is linear (i.e., the demand curve is a straight line, see Figure 1), and it maximizes profits, then pass through is less than 100%. Harris and Sullivan stopped their analysis of noncompetitive market structures at this point leaving readers (including defendants) with the implication that pass through is always less than 100% in such industries. As shown in Appendix A this is not the case. Harris and Sullivan's result depends upon the linear demand assumption.

If demand is nonlinear and the profit maximizing monopolist faces constant elasticity over the relatively small range of price variation that occurs due to the citric acid or HFCS overcharge, the rate of pass through is greater than 100%. As this constant elasticity increases in value (e.g. from 2 to 4 to $+\infty$) the industry is becoming effectively more competitive and the pass through rate decreases and converges to 100%. A monopolist facing an infinitely elastic demand curve essentially is not a monopolist but a competitive firm in a broader industry because any price increase causes buyers to switch to some other perfect substitute product.

If food manufacturing industries are oligopolies and each firm independently maximizes profits (no collusion), the same general result holds. As the number of firms in the industry decreases, the pass through rate converges to the monopoly rate. Therefore all firms in non competitively structured industries that face a constant elasticity market demand curve have a pass through rate which is greater than 100%. If one relaxes the constant demand elasticity assumption and allows demand to become more elastic as price increases, the pass through rate for profit maximizing monopolists and oligopolists decreases. Figure 1 illustrates how the shape of the demand curve affects the pass through rate. There is some intermediate shaped demand curve (between linear and constant elasticity) where pass through is 100%.

The key conclusion from this illustration is that one must know more than the fact that the demand curve has negative slope. (All curves in Figure 1 have negative slope.) One must know its curvature as well.

Although economic textbooks use linear demand curves, empirically economists know that real world demand curves are nonlinear. Often constant elasticity demand curves are estimated (e.g., Hausman 1994, Cotterill 1994). Increasingly, however, flexible functional forms such as the Almost Ideal Demand System (Hausman 1994, Cotterill et al. 1996) are used to estimate non constant elasticity demand curves. From the standpoint of price transmission this is crucial, because it allows us to estimate a pass through rate that can range from zero to rather than restrict it, *a priori*, to the linear (less than 100%) or constant elasticity case (greater than 100%). Using estimation results for the soft drink industry from Cotterill, Franklin, and Ma (1996, Table A5, p57), I have computed the pass through rates for the top 7 brands and private label soda in the industry. They are listed in Table A1 of Appendix A and reproduced in Table 3 below. A market share weighted average for all of these brands produces an estimate of the pass through rate for this industry. It is 100%.

More generally it counters common sense to believe that competitive industries have more power to pass through cost increases than monopolies or oligopolies. It suggests that economic power resides with competitive firms and that monopolies and oligopolies are victims of price fixers and market shocks that increase their costs. Baumol (1972, p.327) explains that firms in noncompetitive markets will use non price strategies such as advertising to influence the shape of the demand curve. Other economists has also developed theories and documented that product differentiation strategies influence consumer demand relationships (Scherer and Ross, 1990, Chapter 16, especially pp580-588). Thus firms in oligopolies and monopolies ensure that pass through is 100 percent or greater. If they can't do this, then the industry would crumble into a competitive industry to ensure pass through. This later phenomenon has not been observed in food industries. In fact, seller concentration has increased (fewer firms with larger market shares) in food industries (Connor et al. 1985, Franklin and Cotterill, 1993).

Food firms can pursue strategies other than short run profit maximization. A firm may, for example, seek to maximize sales or market share given an acceptable (target) level of profits is achieved. A loss leader strategy is a special case where the profit level is negative. Defendants would often have us believe that this pursuit "overwhelms" a firm's desire to cover small input cost increases with price increases. Using the model developed by Baumol (1972, p325-327), we show in Appendix A that firms will still pass through 100% or more of an increase in input costs. This holds for firms in an oligopoly as well as a monopoly.

Now that we have shown that manufacturers pass on 100 percent (or more) of this overcharge. The remaining link in the price transmission process is to explicitly incorporate the away-from-home and food retailing industries into the model. Away-from-home purveyors are straightforward because these firms operate in competitive markets. Any increase in their costs is passed through at the 100 percent rate in the general as well as the actual price transmission model. One cannot argue that consumers may buy affected products as part of a meal, e.g., catsup and tomatoes used to make chili, and that the restaurant may not pass through cost increases on components of a meal is not correct. A restaurant is a firm with inputs and outputs just like the food manufacturing firm analyzed previously. The same input cost analysis holds. Increases in input costs for meals that have a 1) fixed recipe, 2) prices for other inputs that are not affected by output variation due to the price conspiracy, and 3) constant returns to scale, are completely passed on. However, increasing returns to scale would increase the rate of pass through.

A similar analysis of the relationship between the wholesale price of products with citric acid and/or HFCS and food retailers' cost of supplying such products to consumers holds whether food retailers are competitive or oligopolistic and whether they maximize short run profits or pursue market share or loss leader strategies. Under all of these scenarios, pass through is 100 percent or higher if demand is totally inelastic due to imperfect information. In the general case where consumers demand is less than totally inelastic, we have shown that the weighted average pass through rate was 100% for soft drinks. Moreover, that pass through rate was estimated using retail price and quantity data. So it includes the combined effect of manufacturers and retailers conduct.

There is one other distinct price strategy. Retailers and manufactures may jointly cooperate and manage the food supply chain to maximize profits at a level above that possible with independent pricing by successive firms in the channel. Types of vertical coordination that achieve this increase in total channel profits are legal and are achieved through implementation of "category management" programs (Harris and McPartland, 1993, pp.5-8.). Research on the structure of food retailing channels has effectively established that food manufactures have market power (i.e., they can raise prices above costs) and that food retailers also have market power in local market areas (see Connor et al. 1985, Marion et al. 1979, Cotterill 1986). In this successive "monopoly" situation, economists have shown that profit maximization by firms at the manufacturing level independent of profit maximization by firms at the retail level leads to less than maximum total channel profits. Through vertical coordination via category management both manufacturers and retailers can increase their profits. Moreover, this move lowers prices to consumers (Tirole 1988, p174-176, McCorriston and Sheldon 1997).

This strategy increasingly dominates the trade press under the rubric of the need for improved trade relations. *Progressive Grocer's Marsh Super Study* (December 1992, p. 28 and Bennett, 1993, p. 89-92) explain how carbonated soft drink bottlers use trade promotions to improve channel profits. Price specials, loss leaders, and display articles are rotated through the category to maximize category profit. Gerstner and Hess (1991, p. 872-886) in an *American Economic Review* article titled "A Theory of Channel Price Promotions" present a formal model that shows how the use of coupons distributed directly to consumers and trade promotions (price reductions including loss leaders, display, and local newspaper advertisements) can increase retailer and manufacturer profits. From the standpoint of this case, the key question is, does this vertical channel coordination strategy "overwhelm" the incentives of manufacturers and retailers to pass on overcharges from the wet corn milling industry? In fact, as is the case for horizontal monopoly and oligopoly pricing games, the channel coordination game is independent of cost impacts on prices. Gerstner and Hess state:

> Costs of manufacturing, retailing, and processing of push [trade promotions] and pull promotions (consumer coupons) are all irrelevant for the arguments made below, so they are assumed for simplicity to be zero. (Gerstner and Hess, 1991, p. 873)

The ultimate conclusion is that the strategic game that retailers and manufacturers play, independently or cooperatively, is predicated upon external cost and demand conditions. The game does not influence them, nor does it under the conditions documented in this case influence the pass through rate for the overcharge.

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Table 1. Outline of Conditions Affecting the Incidence of Cartelization: Graded on the Basis of Feasibility and Necessity

Market Condition or Characteristic	(1) Feasibility: Excellent; Need: Unnecessary (Tacit Collusion)	(2) Feasibility: Good; Need: Helpful (Cartel)	(3) Feasibility: Poor; Need: Essential (Competition)
Number of Firms	Very few (2-5)	Several (5-25)	Many (30+)
Concentration Ratio	Very High	High-medium	Low
Type of Product	Standardized	Slightly different	Differentiated
Rate of Technological change	None	Slow-moderate	Rapid
Frequency (and size) of sales	Frequent (small)	Often (medium)	Lumpy (large)
Opportunity for secret deals	None	Some	Great
Rate of Growth	Slow	Medium	Rapid
Elasticity of Demand	Low (less 0.5)	Medium	High (2+)
Production costs across firms	Identical	Similar	Diverse

Source: Greer, D. F. 1992. *Industrial Organization and Public Policy*, 3rd ed. New York: MacMillan Publishing Company. p. 403.

Table 2. How Customers' Estimates Compare with Actual Prices

Item	% of Customers Identifying Correct Price Within " 5%		
	Buyers	Non-buyers	Combined Estimates
Marlboro cigarettes (Kings, carton)	71	36	44
Land-O-Lakes butter (1 lb.)	54	41	48
Scott Paper towels (1 roll, 100 sq. ft.)	52	34	49
Fab detergent (giant, 49 oz.)	50	21	31
Private label coffee (1 lb.)	47	20	26
Private label fruit cocktail (16 oz.)	46	25	35
Private label orange drink (46 oz.)	42	26	30
Pillsbury Hungry Jack pancake mix (32 oz.)	41	14	24
Carnation Evaporated Milk (13 oz.)	38	23	28
Heinz catsup (14 oz.)	37	32	36
Private label flour (5 lbs.)	36	20	25
Private label bleach (1/2 gal.)	36	26	31
Private label mayonnaise (qt.)	36	28	31
Dole sliced pineapple (20 oz., 3 in.)	35	22	31
Ivory bar soap (large, 9.5 oz.)	33	19	25
Campbell tomato soup (10.75 oz.)	33	20	30
Kleenex facial tissue (200 2-ply)	33	23	30
Domino sugar (5-lb. bag)	33	32	33
SOS soap pads (10 count)	32	10	27
Private label canned milk (13 oz.)	31	16	19
Morton chocolate cream pie	29	10	18
B&M baked pea beans (28 oz. can)	28	19	24
Breck regular shampoo (11 oz.)	28	20	23
Kraft Miracle Whip salad dressing (qt.)	28	29	28
Del Monte fruit cocktail (17 oz.)	26	24	25
Coca-Cola (8-pack 12 oz. cans)	26	13	19
Dixie cup 5-oz. refills (100 count)	26	27	26
Armour bacon (1lb. sliced)	25	21	24
Tide XK detergent (giant, 49 oz.)	24	19	21
Kraft Soft Parkay margarine (1 lb.)	24	16	19
Nestle Quik cocoa (1 lb.)	24	16	21
Private label salad dressing (1 qt.)	19	20	20
Crisco shortening (3 lbs.)	18	15	16
Clorox bleach (1/2 gal.)	18	12	16
Ken-L-Ration dog food (15.5 oz.)	17	12	13
Private label apple sauce (25 oz.)	16	14	15
Milk Bone biscuits (26 oz.)	15	9	11
Green Giant Niblets corn (12 oz.)	15	17	16
Pillsbury Best XXXX flour (5 lbs.)	14	28	24
Private label frozen orange juice (6 oz.)	14	9	11
Kellogg's corn flakes (12 oz.)	12	7	10
Crest toothpaste (3 oz.)	10	11	11
Maxwell House instant coffee (6 oz.)	9	6	7
Saran Wrap (100 sq. ft.)	8	21	13
Average of All Items	29	20	24

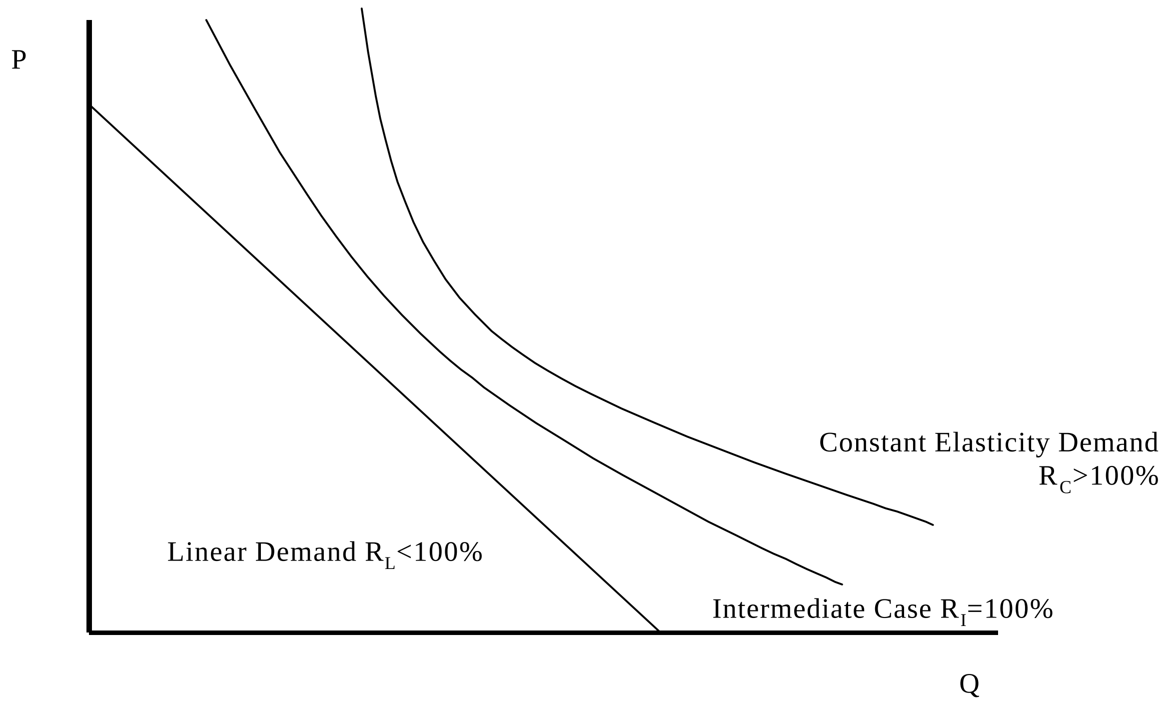
Source: *Progressive Grocer*, Nov. 1974, pp. 39-41.

Table 3 Pass Through Rates for Leading Soft Drinks.

Brand	Pass Through Rate
Coke	107%
Pepsi	93%
RC	73%
Dr Pepper	114%
Sprite	98%
Seven-Up	85%
Mountain Dew	107%
Private Label	110%
Share Weighted Average	100%

This table is based on results from Table A1 in Appendix A.

Figure 1. The Relationship Between Demand Curve Shape and the Pass Through Rate (R)



Appendix A

Analysis of Price Transmission (Pass Through) Under Different Behavior and Structure Conditions [1]

Case 1: Profit Maximization

Under this behavior assumption, a firm maximizes its profits which are equal to total revenue minus total costs.

Case 1.1 Competitive Market

Harris and Sullivan (1979, p284) analyze the rate of pass through graphically for firms in a competitive industry. Their supply and demand curve analysis rest upon assumption that Kinnucan and Forker explicitly state. The agricultural input is used in fixed proportion with other inputs and there are constant returns to scale. These conditions hold for the industries that use citric acid and HFCS because the recipe for a particular product requires a certain amount of these ingredients. That amount and the amount of other inputs necessary for the processing of a product do not vary for changes in the range of output under analysis in this case. A 12 oz. can of Coke contains 39 gram of HFCS. Given these verified assumptions, following Gardner (1975), Kinnucan and Forker (p290, footnote) define the down channel price transmission elasticity as the ratio of percent change in the retail price of a product, for example, that contains HFCS to the percent change in the price of HFCS due to supply side shocks such as a price fix by wet corn millers. Since we have fixed proportion production technology, the elasticity of substitution for HFCS with other ingredients, e.g., water, is zero. The price transmission elasticity is then given by:

$$E = \frac{S_a}{1 - \frac{S_b}{e_b} h} \qquad (1)$$

where:

E= the price change in retail price for a 1 percent change in the input price,

S_a = the input industry's share of the consumer price,

S_b = 1-S_a = other inputs share of the consumer price,

e_b = the supply elasticity of all other inputs,

h = the retail market elasticity of demand.

Note that if market demand elasticity in totally inelastic (h=0) then E=S_a and the percent change in the retail price equals S_a times the percent change in the input price. Using an example, if a product uses 1 pound of HFCS and if HFCS goes up in price from 20 cents/lb to 24 cents/lb, a 20% increase, and if HFCS costs are 5% of the retail price ($4.00), then the price of the retail product goes up (.2x.05=.01) one percent to $4.04. When demand is totally inelastic, one has 100% pass through of the 4 cents/lb increase in HFCS price. (This is Harris and Sullivan, Figure 2D).

Alternatively if the demand curve has negative slope, then h ...0 but if e_b, the elasticity of supply of other inputs is infinitely elastic, then E=S_a and pass through also is 100 percent. (This is Harris and Sullivan, Figure 2A). Infinite supply elasticity for inputs means that for the variation in output experienced in this case due to price fixing, the price of other inputs do not change. This means that the increase in marginal costs is equal to the increase in HFCS price and is not possibly offset by lower prices of other inputs when higher retail prices reduce demand for the product.

Monopoly: Constant Market Demand Elasticity

Assume only one firm in the market and the monopolist maximizes profits Π by choosing quantity Q.

$$\text{Max} \quad \Pi = P(Q)\,Q - C(Q) \qquad (1)$$

where $P(Q)$ is the inverse demand curve (price is a function of quantity) and $C(Q)$ is total cost as a function of quantity.

The first order condition necessary for a profit maximum is:

$$\frac{d\Pi}{dQ} = P + Q\frac{\partial P}{\partial Q} - \frac{\partial C}{\partial Q} = 0 \qquad (2)$$

The first two terms are marginal revenue (*MR*) and the last term is marginal cost (*MC*). Thus profit maximization requires the monopolist to set *Q* so that *MR=MC*.

To analyze passing of an increase in marginal cost rewrite equation 2 as:

$$P + Q\frac{\partial P}{\partial Q} = MC \qquad (3)$$

Multiplying the second term on the left by *P/P* gives:

[1] The assistance of Li Yu Ma is gratefully acknowledged.

$$P + P \frac{\partial P}{\partial Q}\frac{Q}{P} = MC \qquad (4)$$

Define demand elasticity h as $h = \frac{-\partial Q}{\partial P}\frac{P}{Q}$ and substitute h into equation 4 gives:

$$P - P\frac{1}{h} = MC \qquad (5)$$

solving for *P* gives:

$$P = \left(\frac{1}{1-\frac{1}{h}}\right) MC \qquad (6)$$

Taking the derivative of *P* with regard to *MC* allows us to analyze the change in price that a monopolist must make to sustain profit maximization when marginal cost changes.

$$\frac{dP}{d\,MC} = \left(\frac{1}{1-\frac{1}{h}}\right) \qquad (7)$$

Given the fact that profit maximization monopolist always prices on the elastic portion of a market demand curve, i.e., $h > 1$, the monopolist's rate of passing through is always greater than 1.

Case 1.3 Oligopoly: Constant Market Demand Elasticity

One can generalize the above case to *n* firms in a market where each firm maximizes its own profits and has same marginal cost structure. The profit maximization for firm *i* can be expressed as:

$$\Pi_i = P(Q)\, q_i - c(q_i) \qquad (8)$$

here *Q* is the market total demand and q_i is the demand for firm *i*. $C(q_i)$ is the firm's cost function. Firm *i* differentiates with respect to quantity to obtain the first order condition:

$$\frac{d\,\Pi_i}{d\,q_i} = P + \left(\frac{dP}{dQ}\right) q_i - MC = 0 \qquad (9)$$

with steps analogous to the monopoly case, this can be manipulated into:

$$P = \left(\frac{1}{1-\frac{1}{n\,h}}\right) MC \qquad (10)$$

Therefore, the rate of passing through for firm *i* is:

$$\frac{dP}{dMC} = \left(\frac{1}{1-\frac{1}{nh}}\right) \qquad (11)$$

As long as the number of firms $n > 1$ or the market demand elasticity of firm *i* is greater than 1, the passing through rate is greater than one. Note that if *n*=1, one has the monopoly result. Also note that for a given market demand elasticity, h, price transmission is lower in an oligopoly that a monopoly. As *n* approaches infinity, perfect competition, transmission converges from above to 100 percent.

Case 1.4 Monopoly and Oligopoly: Non Constant Demand Elasticity

As Harris and Sullivan explain (p296), when market demand is linear, pass through by monopoly is less than 100%. This is also true for a firm in an oligopoly whose firm level demand curve is linear. Less than 100% pass through occurs because linear demand becomes more elastic as price increases, thereby reducing the ability of the firm to pass on price increases. The pass through properties of non constant elasticity demand curves can be analyzed in a more general fashion. Specifically one can show that pass through of 100% or more does occur for a class of non constant elasticity demand curves. To analyze the passing on effect under non constant demand elasticity, one can rewrite equation 5 as:

$$F(p, MC) = P - \frac{P}{h(P)} - MC = 0 \qquad (12)$$

Using implicit function theorem, the derivative of *P* with regard to *MC* is:

$$\frac{dP}{dMC} = -\frac{F_{MC}}{F_P} = -\frac{-1}{1-\dfrac{h(p) - P\dfrac{\partial h(P)}{\partial P}}{h^2}} \qquad (13)$$

The pass through rate is greater than one if the following condition holds:

$$h(P) - P\frac{\partial h(P)}{\partial P} > 0 \qquad (14)$$

The above condition implies that, for the rate of pass through to be greater than one, the percentage change in elasticity should be less than the percentage change of price. Thus the elasticity of the elasticity matters for the rate of pass through. In the linear demand curve special case $\partial h(p) / \partial p$ is very high and (14) does not hold.

Case 2: Constrained Sales Maximization

A firm might choose to maximize its sales given that it earns a desired target level of profits. Baumol (1972 p.325-327) presents this type of model. It fits retailers conduct when they undertake sales promotion campaigns to expand market share, such as those documented in the soft drink industry (Progressive Grocer, 1992, p28; 1993, p88-89).

Case 2.1 Competitive Market

In a competitive market, a firm's price is determined by market and it can not set any profit target for itself. There, sale maximization with a target level of profits does not exist in this market structure. Alternatively the only sales maximization solution feasible is one with zero profits.

Monopoly

Under this market structure, a firm maximizes its revenue (R) subject to the profit constraint:

$$\begin{aligned} \text{Max} \quad & R = P(Q)\,Q \\ s.t. \quad & P(Q)\,Q - MC\,Q = \Pi^* \end{aligned} \qquad (15)$$

here Π^* is the target profit for the monopoly. Therefore, one can rewrite the above equation as:

$$\text{Max}\ \overline{R} = P(Q)Q - MC\,Q + l\,(\Pi - P(Q)\,Q + MC\,Q) \qquad (16)$$

where l is a Lagrange multiplier. To find the maximum, one differentiates equation 16 with regard to Lagrange multiplier as well as Q. This gives the following first order condition:

$$\frac{\partial \overline{R}}{\partial l} = \Pi^* - P(Q)Q + MC\,Q = 0 \qquad (17)$$

If marginal cost MC increases from MC_1 to MC_2, then quantity Q will decrease from Q_1 to Q_2. Furthermore, the profit target is binding both before and after the cost change. Therefore, one has:

$$\Pi^* = P_1 Q_1 - MC_1 Q_1 = P_2 Q_2 - MC_2 Q_2 \qquad (18)$$

This translates into:

$$\begin{aligned} & (P_1 - MC_1)Q_1 = (P_2 - C_2)Q_2 \\ & \rightarrow \frac{P_1 - MC_1}{P_2 - MC_2} = \frac{Q_2}{Q_1} < 1 \\ & \rightarrow P_2 - MC_2 > P_1 - MC_1 \\ & \rightarrow P_2 - P_1 > MC_2 - MC_1 \\ & \rightarrow dP > dMC \\ & \rightarrow \frac{dP}{dMC} > 1 \end{aligned} \qquad (19)$$

Therefore, the passing through rate is greater than one.

Case 2.2 Oligopoly

The above analysis can be easily generalized to a n firm oligopoly. If each firm sets its own profit target and these profit targets are binding before and after any cost change, then each firm should have the similar first order condition as in equation 20. Therefore, after a derivation similar to the one above, one obtains a pass through rate greater than one.

Case 2.3 Loss Leader

A loss leader strategy is simply a constrained sales maximization strategy with a negative profit rate. Thus the analyses in cases 2.1 and 2.2 cover the loss leader strategy.

Table A1 Estimated Pass Through Rates for Soft Drinks *

	Coke	Pepsi	RC	Dr. Pepper	Sprite	Seven-Up	Mt. Dew	Private Label	Average Rate
P	3.7082	3.6484	3.3122	3.9696	3.6212	3.7241	3.8813	2.3436	
∂P	0.0371	0.0365	0.0331	0.0397	0.0362	0.0372	0.0388	0.0234	
$\partial \ln P$	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
S_{old}	0.2527	0.2427	0.0187	0.0399	0.0412	0.0497	0.0341	0.0801	
γ_{ii}	-0.3638	-0.4461	-0.0598	-0.0515	-0.0666	-0.1058	-0.0454	-0.1067	
∂S	-0.003638	-0.004461	-0.000598	-0.000515	-0.000666	-0.001058	-0.000454	-0.001067	
S_{new}	0.2491	0.2382	0.0181	0.0394	0.0405	0.0486	0.0036	0.0790	
$\partial \eta$	0.02081	0.03472	0.10601	0.01638	0.02672	0.04818	0.01981	0.01855	
η	2.4465	2.8606	4.1905	2.2937	2.6238	3.1164	2.3448	2.3590	
$\frac{\partial P}{\partial MC}$	107%	93%	73%	114%	98%	85%	107%	110%	100%

* This table is based on 1 percent change in the price and uses results from Table A5 in Cotterill, Franklin, and Ma (1996). P stands for the mean price. S_{old} is a brand's mean share. γ_{ii} is a brand's own price coefficient in the demand function and η is the demand elasticity.

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