Measuring Market Power Effects in Differentiated Product Industries: An Application to the Soft Drink Industry

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I. Introduction

Market power is the ability of firms to elevate price above marginal cost to earn economic profits in excess of competitive levels. Industrial organization economists have developed a wide array of economic models for the measurement of market power and have estimated its effect in specific industries. Since the mid 1980's work on the exercise of market power in differentiated product industries has made significant advances due to new theory and the access to brand level economic data collected by A.C. Neilsen and Information Resources Inc. from supermarket checkout scanners. Deneckere and Davidson (1985), Levy and Reitzes (1992) and others have developed Nash-Bertrand oligopoly pricing models that demonstrate the price elevating effect of mergers in differentiated product markets. These analyses squarely place brands at the core of the analysis and require the estimation of own and cross price elasticities for brands. Empirically Baker and Breshnahan (1985, 1988) first demonstrated that one can use residual demand models to estimate brand level elasticities and evaluate mergers between brands. Hausman *et al.* (1994) and Cotterill (1994a, 1994b) have pioneered a unilateral demand system as opposed to residual demand approach. If two brands are close substitutes then a merger will internalize some of the lost sales, thereby making it more profitable to elevate the price of both brands after the merger (Levy and Reitzes 1993, Willig 1991). The Merger Guidelines and recent explanation of antitrust agency enforcement analysis suggest that if a merger allows more than a five percent elevation in price of the two brands, it violates Section 7 of Clayton Act (Baker 1996, Shapiro 1995). This unilateral as opposed to coordinated exercise of market power does not require the firm to consider the response of other firms. In terms of the original analysis of this issue by Edward Chamberlin, the firm is pricing off each brand's nonfollowship rather than followship demand curve and the merger has made each curve more inelastic so that price increases are profitable.

This paper has three objectives. First we will expand the unilateral effects model by developing it within a more general model that allows for the exercise of coordinated market power (tacit collusion). Our approach adds price reaction equations to a system of brand level demand equations to jointly estimate the price reaction elasticities as well as the demand elasticities. We will show that the residual demand approach (Baker and Breshnahan 1985, 1988) and the unilateral demand system approach (Hausman *et al.*, Cotterill, 1994a) estimate different demand elasticities that are special cases of this more general model. In section 4 we present estimation results for regular carbonated soft drinks to illustrate the use of the method. Finally we offer conclusions and suggestions for further research.

II. Measuring Brand Level Unilateral and Coordinated Market Power

Neoclassical demand analysis usually focuses upon distinctly different commodities, for example, butter versus margarine or beef versus pork, and analyzes consumer choice among these generic products. Firm or brand level demand analysis introduces the organization of the industry in a direct and unavoidable fashion. The demand estimation problem becomes particularly problematic when the industry is an oligopoly that sells differentiated products. Endogenizing brand prices is not sufficient. Price interdependence between brands complicates the specification of supply relationships. Some analysts have dealt with price interdependence by assuming Nash-Bertrand behavior, i.e. the manager of brand A conjectures that all other brand managers do not react to his price moves. This assumed conjecture, however, is often inconsistent with observed price movements. For example, the price of Pepsi does not remain constant when the price of Coke changes due to shifts in a cost variable or a desire for a higher profit margin. More formally, price reaction elasticities are not zero. As we will demonstrate below this may be due to common cost shifts, or some degree of tacit collusion (positive price conjectures). It may also be due to competitive rivalry (negative price conjectures).

Brand level analysis of demand and market power can be modeled as follows. Assume that an industry is differentiated and that Bertrand competition occurs, i.e. price is the strategic variable.[1] Then the demand for brand 1 in this industry of n brands is:

$$q_1 = q_1\,(p_1 \ldots p_n,\ \underline{D}) \qquad (1)$$

[1] See, for example, Deneckere and Davidson (1985), Levy and Reitzes (1993) Scherer and Ross 1990, p. 199-206).

Where:

q_1 = the quantity of brand 1
p_i = price of brand i
D = a vector of demand shift variables including expenditure on the industry's products.

Taking the derivative of this equation, with respect to p_1, using the chain rule to account for price interdependence, and some algebraic manipulation yield the following formula for an elasticity that we will name the observable price elasticity of demand.

$$\eta_1^O = \eta_{11} + \sum_{i=2}^{N} \eta_{1i}\varepsilon_{i1} \qquad (2)$$

where:

η_1^0	=	observable price elasticity for brand 1
η_{11}	=	partial own price elasticity of demand
η_{1i}	=	firm 1 cross price elasticity with respect to p_i
ϵ_{i1}	=	rivals' observed price reaction elasticity (the percent change in p_i when p_1 changes one percent).

Baker and Breshnahan (1988) describe this as the residual demand elasticity, i.e. the impact of a change in own price upon own quantity when the actual as opposed to conjectured price responses of all other firms are taken into account. We prefer to call it the observable own price elasticity to emphasize that it is based upon actual market observed price reactions, not conjectures, and to distinguish it from one particular method that can be used to measure it: residual demand analysis.

As Baker and Breshnahan explain, the observed elasticity is identical to a firm's conjectured elasticity if managers price conjectures are consistent, i.e. brand A manager's conjectured response of a change in price B when brand A's price increases is equal to the observed price reaction of brand B to brand A in the market (Baker and Breshnahan 1988, p. 289-90). Stakkelberg and dominant-fringe firm models are consistent, however many other oligopoly models are not. For the rest of this section we will assume consistent conjectures, however we will reexamine and relax this assumption in the next section.

Note that a brand's observable own price elasticity has two general components. The first is the familiar partial own price elasticity. In Industrial Organization analysis this is Chamberlin's nonfollowship demand elasticity because it quantifies the impact on demand for a brand when its price increases and no rival brand prices change. The nonfollowship price elasticity measures the unilateral market power of the brand in a consistent conjectures, Nash Bertrand game (i.e., when all brand managers assume and observe no reaction to their price change).

The second component of the right side of equation 2 measures the coordinated market power component of a brand's observable elasticity. If other brand managers, for example, behave in a tacitly collusive fashion and follow the elevation (or reduction) of brand one's price, then the ε_{i1} in equation 1 are positive. Assuming all products in the industry are substitutes, i.e., different brands compete with each other for customers, the cross price elasticities, η_{i1} , are also positive. Thus to the extent that coordinated market power exists, it makes the observed own price elasticity less elastic then the unilateral own price elasticity.

Three special cases are worth mentioning. The first is when all ε_{i1} are zero and is the nonfollowship case discussed above. The second special case is when tacit collusion is perfect or fully collusive. The third special case is when there is competitive rivalry. Price reaction elasticities are negative and observed elasticity becomes so elastic that only competitive profits are captured. Rivalry offsets any unilateral pricing advantage.

Figure 1 illustrates the relationships between observed, unilateral and fully collusive demand elasticities for an individual brand. Demand curves are drawn as linear approximations at point P_1Q_1 for what may be a nonlinear demand relationship.[2] Assume the market is in equilibrium at P_1Q_1 and the managers for brand 1 decide to raise price to P_2. In this example observed output decreases to Q_0. If there was perfect tacit collusion, it would have declined only to Q_c and if there was no tacit collusion output would have declined to Q_u. One can measure the degree of unilateral market power by dividing the slope of the unilateral demand curve by the slope of the collusive demand curve. This is the Rothschild Index (Greer p. 99). A more general definition that flows from our analysis is the ratio of the fully collusive elasticity, η_1^c, to the unilateral elasticity, η_{11}.

$$\text{Rothschild Index (RI)} = \frac{\eta_1^c}{\eta_{11}}$$

$$\text{and } O \leq RI \leq 1$$

[2]The double log and almost ideal demand system (AIDS) functional forms, *inter alia*, yield nonlinear demand. The former generates a constant demand elasticity estimate; the latter allows demand elasticities to vary with market share and output levels.

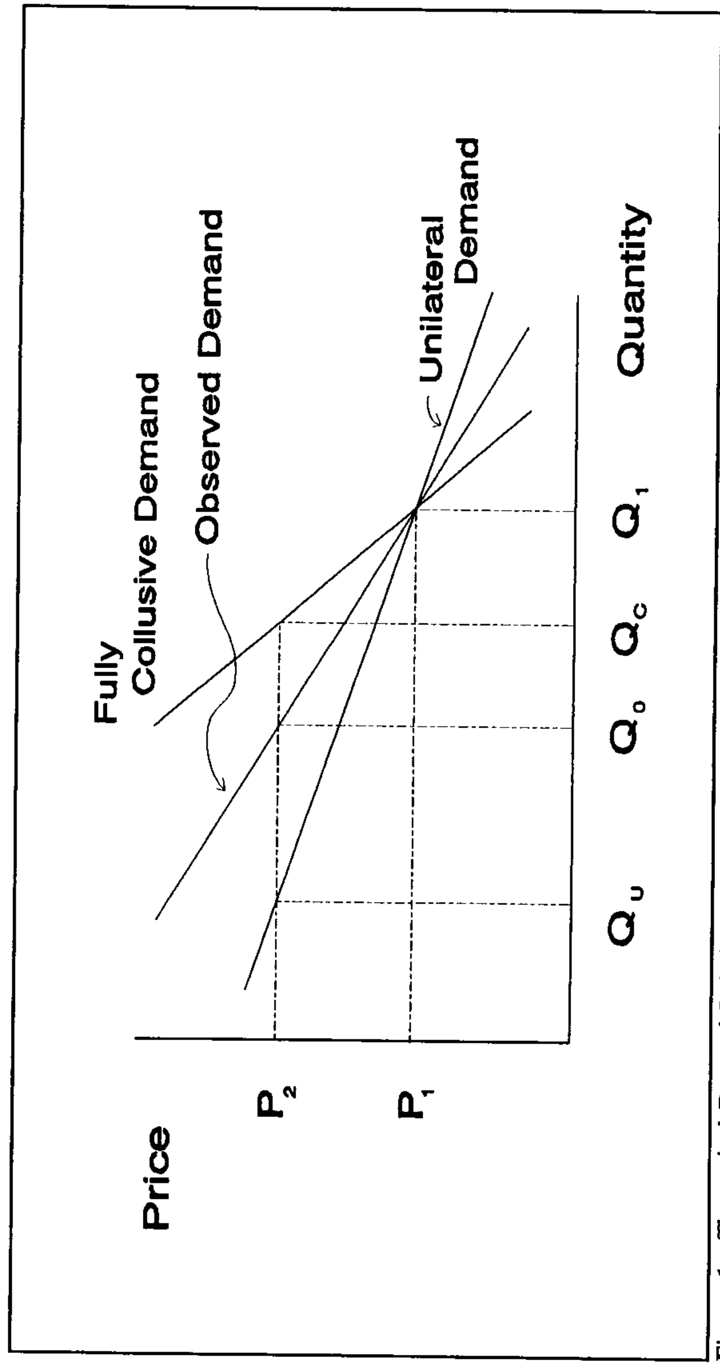

Figure 1. Theoretical Demand Relationships for a Brand in a Differentiatied Oligopoly.

Under perfect competition the slope of the unilateral demand curve would be zero (η_{11} is infinitely negative) and the Rothschild Index is zero. If the unilateral demand curve is identical to the fully collusive demand curve then all cross price elasticities of demand must be zero, and the brand effectively has a monopoly position.

We define a measure of observed (i.e., combined unilateral and coordinated) market power, by dividing the fully collusive elasticity, η_1^c, by the observed elasticity, η_1^0. If there is no unilateral or coordinated power this index is zero. It also would have value zero if unilateral power exists but is offset by competitive rivalry. In this case the observed demand curve would be flat even though the unilateral curve has slope. This index ranges to one when observed demand equals followship demand. Since this index is new to the field we will brand it the Cotterill Index. Thus, we have:

$$\text{Cotterill Index (CI)} = \frac{\eta_1^F}{\eta_1^0}$$

$$\text{and } O \leq CI \leq I$$

The Cotterill Index of observed market power may be less than, equal to or greater than the Rothschild Index of unilateral market power

Finally one can decompose observed market power into the proportion that is due to coordinated market power. We define the Chamberlin Quotient (CQ) as:

$$CQ = 1 - \frac{\textit{Rothchild Index}}{\textit{Cotterill Index}} = 1 - \frac{\eta_1^0}{\eta_{11}}$$

$$\infty \leq CQ \leq 1$$

If CQ is less than zero competitive rivalry exists. If some degree of tacit or explicit collusion exists the Chamberlin quotient ranges between zero and one then its value gives the proportion of observed market power that is due to collusion. Again this index is new to the industrial organization field, and is named in recognition of Edwin Chamberlin, the economist who gave the English language the word "oligopoly" and who squarely placed analysis of tacit collusion on the economist's agenda (1933).

Table 1 illustrates the interaction between unilateral and coordinated market power effects. Row 1 is the case when three brands are separately owned and the strategic game varies from price competitive rivalry (zero profits) to Nash-Bertrand competition (each firm assumes

Table 1. Analysis of Market Power: A Three Brand Profit Payoff Matrix for Alternative Strategies

			Coordinated Effects		
	Portfolio No.	Brands	Competitive Rivalry	Nash Bertrand	Fully Collusive
	1	A,B,C	0	1	2
Unilateral	2	(A,B)C	0	1.5	2
Effects	3	(A,B,C)	--	2	--

no reaction by other firms to its price changes) to fully collusive pricing. Profits (and prices) are progressively higher as one moves towards the latter condition. Row 2 illustrates the range of possibilities that can occur if brands A and B merged to create a two brand portfolio. Note that even if there is a positive cross price elasticity between brands A and B, if rivalry is intense, the merger has no impact on profits and prices. In the Nash-Bertrand case the merger does increase profits and prices. In the fully collusive case it has no impact on profits and prices because the brands were already jointly maximizing them. In Row 3 of Table 1 all three brands are under common ownership. Now the competitive rivalry and fully collusive strategies do not exist and the common owner jointly maximizes profits for the three brand portfolio, which gives the same profit and price result as the fully collusive result under separate brand ownership.

Table 1 can be used to compare the residual demand and unilateral demand system approaches to market power measurement and illustrate the need for the more general model developed in this paper and Cotterill (1994b). Hausman *et al.* (1994) and Cotterill (1994a) assume Nash-Bertrand behavior and estimate the unilateral own and cross price demand elasticities (η_{ij} for $i=1\ldots n, j=1\ldots n$ as defined in equation 2). Then they use them to evaluate the impact of a merger of two or more brands upon prices. Effectively this estimates column two of Table 1. The limitation of this method clearly is its assumption of Nash-Bertrand conduct, which may not exist.

Baker and Breshnahan's residual demand approach does not assume Nash-Bertrand conduct. They would evaluate the merger of brand A and B as follows. First they estimate the observed elasticity of demand for brands A and B. Their residual demand method specifies a single equation for each brand and estimates a single demand coefficient for each brand that gives the left side value of equation 2 (Baker and

Breshnahan 1988, 1985).[3] Their model is not a unilateral demand system model that estimates the η_{ij} or the more general model developed in this paper which estimates both the η_{ij} and the ϵ_{ij} that are on the right side of equation 2. The second step of the Baker and Breshnahan method is to estimate what they call "partial residual demand curves" for brand A and B (Baker and Breshnahan 1985). Again one equation for each of two brands is specified but now both brand prices are specified in each equation so that the partial residual own and cross price elasticities can be estimated. These are not the unilateral own and cross price elasticities because the "residual" price response and cross price elasticity effect of brand 3 in this example or more generally all other brands, are incorporated into the partial residual own and cross price elasticity estimates (Baker and Breshnahan, 1985, p. 432). In the third and final step Baker and Breshnahan sum each brands estimated partial residual own and cross price elasticity to estimate the post merger observable (residual) demand elasticity. If a brand's post merger observable demand elasticity is less elastic than its premerger observable elasticity estimated in step one then the merger increases the brand's market power.

Baker and Breshnahan's method estimates a move from row 1 to row 2 in Table 1 without identifying where the brands are located on the coordinated effects spectrum. This uses the change in observed elasticities. If the level is inelastic then the brand is differentiated and/or there is extensive tacit collusion among brands. One may see a trade-off between these types of market power or find that firms exercise both jointly. Alternatively if the level of observed elasticity before and after the merger is very elastic then the brand is located near the competitive rivalry end of the coordinated effects spectrum. The development of a more general model to estimate the unilateral and coordinated components of observable market power provides more complete guidance to the court than the residual demand or unilateral demand system approach.

III. Model Specification

The task at hand is to develop an economic model that can be tested with brand level data to provide parameter estimates for the unilateral

[3] Here we are assuming price is the strategic variable. Baker and Breshnahan actually assume quantity is the strategic variable and estimate inverse elasticities or price flexibility coefficients (Baker and Breshnahan 1988 p.289). This difference has no effect on our analysis of alternative methods of market power measurement.

demand and price reaction elasticities in equation 2. We will then know the degree of market power each brand possesses and the proportion that comes from unilateral and coordinated effects. The estimates also allow us to estimate the impact of a merger between two or more brands on prices and profits.

To estimate price reaction elasticities one must specify and estimate the brand systems' set of price reaction curves. Incorporating the general demand specification given as equation 1 into a generalized Bertrand oligopoly model where price is the strategic variable and price conjectures are assumed to be nonzero, allows one to derive the general form of the price reaction equations. Each brands price is a function of other prices, demand shift variables and cost shift variables. The estimation challenge is to select a particular functional form for the demand system that is 1) sufficiently flexible to capture variations in demand behavior especially the demand elasticity as output changes (Werden and Froeb 1995, p. 19), 2) allows the imposition of restrictions derived from consumer demand theory (symmetry and homogeneity), and 3) allows for the derivation of the functional form for corresponding price reaction equations.

Some work in this area has used logit or nested logit models to estimate the unilateral elasticities for unilateral demand systems (Werden and Froeb). Logit models, however, have a major flaw. They assume that cross price elasticities are proportional to the market shares of the other brands in the full model or the defined nests. This amount to assuming symmetric or Chamberlin product differentiation. For example, if one elevates the price of coca cola, one loses volume to all other sodas (or colas in a cola nest) in proportion to their share divided by one minus Coke's share.[4] The opposite possibility is spatial or Hoteling differentiation wherein coke would only lose share to the closest brands on Hotellings beach, e.g. Pepsi on one side, Royal Crown (RC) on the other and no one else. The true pattern of substitution lies somewhere between these extremes and a functional form for the demand equations must be flexible enough to estimate the corresponding cross price elasticities.[5]

The Almost Ideal Demand System (AIDS) is sufficiently flexible to

[4] This also is described as the independence of irrelevant alternatives (IIA) property in the literature.

[5] Willig makes this point explaining that brand market shares in differentiated product industries generally say very little about the ability to exercise market power (Willig 1991, p. 304). Others, including Berry et al., have focused upon generalizations of the discrete choice model that avoid the share related constraint discussed above however to date they have not incorporated price reaction analysis. They assume Nash-Bertrand behavior.

allow estimation of nonconstant demand elasticities and spatial as well as symmetric differentiation. Moreover one can impose demand theory constraints and one can derive the corresponding functional form for the price reaction system.

In the three brand case the AIDS demand system is:

$$\begin{aligned} s_1 &= \alpha_1 + \beta_1 \ln \bar{X} + \gamma_{11} \ln p_1 + \gamma_{12} \ln p_2 + \gamma_{13} \ln p_3 \\ s_2 &= \alpha_2 + \beta_2 \ln \bar{X} + \gamma_{21} \ln p_1 + \gamma_{22} \ln p_2 + \gamma_{23} \ln p_3 \\ s_3 &= \alpha_3 + \beta_3 \ln \bar{X} + \gamma_{31} \ln p_1 + \gamma_{32} \ln p_2 + \gamma_{33} \ln p_3 \end{aligned} \tag{3}$$

Demand Restrictions:

symmetry $\gamma_{ij} = \gamma_{ji}$ *for* $i \neq j,\ i=1,2,3,\ j=1,2,3$

homogeneity $\gamma_{i1} + \gamma_{i2} + \gamma_{i3} = 0$ *for* $i=1,2,3$

adding up $\gamma_{1j}+\gamma_{2j}+\gamma_{3j}=0$ *for* $j=1,2,3$

$\alpha_1+\alpha_2+\alpha_3=0$

$\beta_1+\beta_2+\beta_3=0$

where:

s_i = the dollar market share of brand ***i=1, 2, 3***.

p_i = the price of brand ***i=1, 2, 3***.

$\bar{X}$ = real category expenditures which are the nominal expenditures on the three brand category, ***X***, divided by Deaton and Muellbauer's exact price index ***P***. The natural logarithm of P is:

$$\ln P = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j \quad (i,j=1,2,3)$$

Turning now to the supply side of the model, we must derive the price reaction equations. Assuming Bertrand competition, i.e., price not quantity is the strategic choice variable, in the three brand example one has:

$$\underset{wrt\ p_i}{MAX\pi_i} = p_i q_i - c_i(q_i, \underline{r}_i) \ for\ i=1,2,3 \tag{4}$$

where:

$c_i\ (q_i,\ \underline{r}_i)$ is the brand i total cost function

$(\underline{r}_i)$ is the brand i input price vector

Substituting the AIDS demand function for brand 1 into the profit function gives:

$$\begin{aligned} \pi_1 = Xs_1 - c_1 = X[\alpha_1 &+ \gamma_{11}\ln p_1 + \gamma_{12}\ln p_2 + \gamma_{13}\ln p_3 + \beta_1 \ln X - \beta_1(\alpha_o + \alpha_1 \ln p_1 + \alpha_2 \ln p_2 + \\ &\alpha_3 \ln p_3 + \frac{1}{2}\gamma_{11}\ln p_1^2 + \frac{1}{2}\gamma_{12}\ln p_1 \ln p_2 + \frac{1}{2}\gamma_{13}\ln p_1 \ln p_3 + \frac{1}{2}\gamma_{21}\ln p_2 \\ &\ln p_1 + \frac{1}{2}\gamma_{22}\ln p_2^2 + \frac{1}{2}\gamma_{23}\ln p_2 \ln p_3 + \frac{1}{2}\gamma_{31}\ln p_3 \ln p_1 + \frac{1}{2}\gamma_{32}\ln p_3 \\ &\ln p_2 + \frac{1}{2}\gamma_{33}\ln p_3^2 \Big) \Big] - c_1 \end{aligned} \tag{5}$$

Note that *X* is nominal category expenditure so it is a function of prices. The first order condition for the above equation is:

$$\begin{aligned} \frac{\partial \pi}{\partial p_1} = X \Bigg[&\frac{\gamma_{11}}{p_1} + \gamma_{12}\frac{\partial \ln p_2}{\partial p_1} + \gamma_{13}\frac{\partial \ln p_3}{\partial p_1} - \beta_1 \Bigg(\frac{\alpha_1}{p_1} + \alpha_2 \frac{\partial \ln p_2}{\partial p_1} + \alpha_3 \frac{\partial \ln p_3}{\partial p_1} + \\ &\gamma_{11}\frac{\ln p_1}{p_1} + \frac{1}{2}\gamma_{12}\left(\frac{\ln p_2}{p_1} + \ln p_1 \frac{\partial \ln p_2}{\partial p_1} \right) + \frac{1}{2}\gamma_{13}\left(\frac{\ln p_3}{p_1} + \right. \\ &\left. \ln p_1 \frac{\partial \ln p_3}{\partial p_1} \right) + \frac{1}{2}\gamma_{21}\left(\frac{\ln p_2}{p_1} + \ln p_1 \frac{\partial \ln p_2}{\partial p_1} \right) + \gamma_{22}\ln p_2 \frac{\partial \ln p_2}{\partial p_1} + \\ &\frac{1}{2}\gamma_{23}\left(\ln p_2 \frac{\partial \ln p_3}{\partial p_1} + \ln p_3 \frac{\partial \ln p_2}{\partial p_1} \right) + \frac{1}{2}\gamma_{31}\left(\frac{\ln p_3}{p_1} + \ln p_1 \frac{\partial \ln p_3}{\partial p_1} \right) + \\ &\frac{1}{2}\gamma_{32}\left(\ln p_3 \frac{\partial \ln p_2}{\partial p_1} + \ln p_2 \frac{\partial \ln p_3}{\partial p_1} \right) + \gamma_{33}\ln p_3 \frac{\partial \ln p_3}{\partial p_1} \Bigg) \Bigg] - \frac{\partial c_1}{\partial p_1} + \\ &s_1 \left(q_1 + q_2 \frac{\partial p_2}{\partial p_1} + q_3 \frac{\partial p_3}{\partial p_1} + p_1 \frac{\partial q_1}{\partial p_1} + p_2 \frac{\partial q_2}{\partial p_1} + p_3 \frac{\partial q_3}{\partial p_1} \right) \end{aligned} \tag{6}$$

Multiplying by p_1 and dividing by X, the first order condition changes to:

$$
\begin{aligned}
\frac{\partial\pi}{\partial p_1}\frac{p_1}{X} = {} & \gamma_{11}+\gamma_{12}\frac{\partial \ln p_2}{\partial \ln p_1}+\gamma_{13}\frac{\partial \ln p_3}{\partial \ln p_1}-\beta_1\Bigg[\alpha_1+\alpha_2\frac{\partial \ln p_2}{\partial \ln p_1}+\alpha_3\frac{\partial \ln p_3}{\partial \ln p_1}+\gamma_{11}\ln p_1+ \\
& \frac{1}{2}\gamma_{12}\left(\ln p_2+\ln p_1\frac{\partial \ln p_2}{\partial \ln p_1}\right)+\frac{1}{2}\gamma_{13}\left(\ln p_3+\ln p_1\frac{\partial \ln p_3}{\partial \ln p_1}\right)+\frac{1}{2}\gamma_{21}\Bigg(\ln p_2+ \\
& \ln p_1\frac{\partial \ln p_2}{\partial p_1}\Bigg)+\gamma_{22}\ln p_2\frac{\partial \ln p_2}{\partial \ln p_1}+\frac{1}{2}\gamma_{23}\left(\ln p_2\frac{\partial \ln p_3}{\partial \ln p_1}+\ln p_3\frac{\partial \ln p_2}{\partial \ln p_1}\right)+ \\
& \frac{1}{2}\gamma_{31}\left(\ln p_3+\ln p_1\frac{\partial \ln p_3}{\partial \ln p_1}\right)+\frac{1}{2}\gamma_{32}\left(\ln p_3\frac{\partial \ln p_2}{\partial \ln p_1}+\ln p_2\frac{\partial \ln p_3}{\partial \ln p_1}\right)+ \\
& \gamma_{33}\ln p_3\frac{\partial \ln p_3}{\partial \ln p_1}\Bigg]-\frac{\partial c_1}{\partial q_1}\frac{\partial q_1}{\partial p_1}\frac{q_1}{q_1}\frac{p_1}{X}\frac{c_1}{c_1}+s_1\Bigg(\frac{p_1q_1}{X}+\frac{p_2q_2}{X}\frac{p_1}{p_2}\frac{\partial p_2}{\partial p_1}+ \\
& \frac{p_3q_3}{X}\frac{p_1}{p_3}\frac{\partial p_3}{\partial p_1}+\frac{p_1q_1}{X}\frac{p_1}{q_1}\frac{\partial q_1}{\partial p_1}+\frac{p_2q_2}{X}\frac{p_1}{q_2}\frac{\partial q_2}{\partial p_1}+\frac{p_3q_3}{X}\frac{p_1}{q_3}\frac{\partial q_3}{\partial p_1}\Bigg)=0 \qquad (7)
\end{aligned}
$$

Define the price conjecture elasticity for brand price i with respect to changes in brand price j as

$$\varepsilon_{ij}=\frac{\partial \ln p_i}{\partial \ln p_j}.$$

Define the partial own and cross price elasticities for $i=1,2,3$, $j=1,2,3$ as

$$\eta_{ij}=\frac{\partial q_i}{\partial p_j}\frac{p_j}{q_i}.$$

Finally define the marginal cost elasticity as

$$\eta_{mc}=\frac{\partial c_1}{\partial q_1}\frac{q_1}{c_1}.$$

Also note that by the symmetry assumption $\gamma_{ij}=\gamma_{ji}$. Some mathematical manipulations give:

$$
\begin{aligned}
& \beta_1(\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{13}\varepsilon_{31})\ln p_1=\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{13}\varepsilon_{31}-\beta_1(\alpha_1+\alpha_2\varepsilon_{21} \\
& +\alpha_3\varepsilon_{31})-\beta_1(\gamma_{21}+\gamma_{22}\varepsilon_{21}+\gamma_{23}\varepsilon_{31})\ln p_2-\beta_1(\gamma_{13}+\gamma_{23}\varepsilon_{21}+\gamma_{33}\varepsilon_{31})\ln p_3 \\
& -\eta_{mc}\eta_{11}\frac{c_1}{X}+s_1(s_1+s_2\varepsilon_{21}+s_3\varepsilon_{31}+s_1\eta_{11}+s_2\eta_{21}+s_3\eta_{31})
\end{aligned}
\qquad (8)
$$

Solving for $\ln p_1$ as a function of other prices and its own share gives the following:

$$
\begin{aligned}
\ln p_1 = {} & \frac{1}{\beta_1}-\frac{\alpha_1+\alpha_2\varepsilon_{21}+\alpha_3\varepsilon_{31}}{\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{31}\varepsilon_{31}}-\frac{\gamma_{12}+\gamma_{22}\varepsilon_{21}+\gamma_{23}\varepsilon_{31}}{\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{13}\varepsilon_{31}}\ln p_2- \\
& \frac{\gamma_{13}+\gamma_{23}\varepsilon_{21}+\gamma_{33}\varepsilon_{31}}{\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{13}\varepsilon_{31}}\ln p_3-\frac{\eta_{mc}\eta_{11}c_1}{\beta_1(\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{13}\varepsilon_{31})X}+ \\
& \frac{s_1(s_1+s_2\varepsilon_{21}+s_3\varepsilon_{31}+s_1\eta_{11}+s_2\eta_{21}+s_3\eta_{31})}{\beta_1(\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{13}\varepsilon_{31})}
\end{aligned}
\qquad (9)
$$

From demand theory the Cournot aggregation condition states (Raunikar and Huang, p. 7):

$$s_1\eta_{11}+s_2\eta_{21}+s_3\eta_{31}=-s_1 \qquad (10)$$

substituting this in equation (9) gives:

$$
\begin{aligned}
\ln p_1 = {} & \frac{1}{\beta_1}-\frac{\alpha_1+\alpha_2\varepsilon_{21}+\alpha_3\varepsilon_{31}}{\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{31}\varepsilon_{31}}-\frac{\gamma_{12}+\gamma_{22}\varepsilon_{21}+\gamma_{23}\varepsilon_{31}}{\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{13}\varepsilon_{31}}\ln p_2- \\
& \frac{\gamma_{13}+\gamma_{23}\varepsilon_{21}+\gamma_{33}\varepsilon_{31}}{\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{13}\varepsilon_{31}}\ln p_3-\frac{\eta_{mc}\eta_{11}c_1}{\beta_1(\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{13}\varepsilon_{31})X}+ \\
& \frac{s_1(s_2\varepsilon_{21}+s_3\varepsilon_{31})}{\beta_1(\gamma_{11}+\gamma_{12}\varepsilon_{21}+\gamma_{13}\varepsilon_{31})}
\end{aligned}
\qquad (11)
$$

Note the next to the last term is a function of c_1/X, which is brand 1's total cost divided by category expenditure. We approximate brand 1's total cost as:

$$c_1=c'_1(\underline{r}_1)q_1 \qquad (12)$$

where $c'_1(\underline{r}_1)$ is a function of input prices but is constant with respect to the change in output, i.e. average cost equals marginal cost.

The first order condition for brand 1's profit maximization also gives the following relationship:

$$\frac{p_1 - c'_1}{p_1} = -\frac{1}{\eta_1^0} \qquad (13)$$

here η_1^0 is the brand 1's observable own price elasticity of demand. Multiplying the numerator and denominator by q_1 and solving for total cost gives:

$$c_1 = c'_1 q_1 = \frac{p_1 q_1}{\eta_1^0} + p_1 q_1 \qquad (14)$$

Since $\frac{p_1 q_1}{X}$ equals s_1, $\frac{c_1}{X}$ can be expressed as:

$$\frac{c_1}{X} = s_1\left(1 + \frac{1}{\eta_1^0}\right) \qquad (15)$$

Now define: $\frac{\alpha_1 + \alpha_2\varepsilon_{21} + \alpha_3\varepsilon_{31}}{\gamma_{11} + \gamma_{12}\varepsilon_{21} + \gamma_{13}\varepsilon_{31}} = \Gamma_{11}$,

$$\frac{\gamma_{12} + \gamma_{22}\varepsilon_{21} + \gamma_{23}\varepsilon_{31}}{\gamma_{11} + \gamma_{12}\varepsilon_{21} + \gamma_{13}\varepsilon_{31}} = \Gamma_{12},$$

$$\frac{\gamma_{13} + \gamma_{23}\varepsilon_{21} + \gamma_{33}\varepsilon_{31}}{\gamma_{11} + \gamma_{12}\varepsilon_{21} + \gamma_{13}\varepsilon_{31}} = \Gamma_{13},$$

$$\frac{\eta_{mc}\eta_{11}}{\beta_1(\gamma_{11} + \gamma_{12}\varepsilon_{21} + \gamma_{13}\varepsilon_{31})} = \Gamma_{14},$$

and $\frac{s_2\varepsilon_{21} + s_3\varepsilon_{31}}{\beta_1(\gamma_{11} + \gamma_{12}\varepsilon_{21} + \gamma_{13}\varepsilon_{31})} = \Gamma_{15}$.

Substituting equation (15) and these Γ parameters into equation (11), we obtain:

$$\ln p_1 = \frac{1}{\beta_1} - \Gamma_{11} - \Gamma_{12}\ln p_2 - \Gamma_{13}\ln p_3 - \Gamma_{14}\left[s_1\left(1 + \frac{1}{\eta_1^0}\right)\right] + \Gamma_{15}s_1 \qquad (16)$$

Substituting the AIDS demand equation for the share of brand 1 gives:

$$\ln p_1 = \frac{1}{\beta_1} - \Gamma_{11} - \Gamma_{12}\ln p_2 - \Gamma_{13}\ln p_3 + \left[\Gamma_{15} - \Gamma_{14}\left(1 + \frac{1}{\eta_1^0}\right)\right] (\alpha_1 + \beta_1\ln\bar{X} + \gamma_{11}\ln p_1 + \gamma_{12}\ln p_2 + \gamma_{13}\ln p_3) \qquad (17)$$

Finally solving for $\ln p_1$ gives the price reaction function:

$$\ln p_1 = \frac{\frac{1}{\beta_1} - \Gamma_{11} + (\alpha_1 + \beta_1\ln\bar{X})\left[\Gamma_{15} - \Gamma_{14}\left(1 + \frac{1}{\eta_1^0}\right)\right]}{1 + \gamma_{11}\left[\Gamma_{14}\left(1 + \frac{1}{\eta_1^0}\right) - \Gamma_{15}\right]} + \frac{\gamma_{12}\left[\Gamma_{15} - \Gamma_{14}\left(1 + \frac{1}{\eta_1^0}\right)\right] - \Gamma_{12}}{1 + \gamma_{11}\left[\Gamma_{14}\left(1 + \frac{1}{\eta_1^0}\right) - \Gamma_{15}\right]}\ln p_2 + \frac{\gamma_{13}\left[\Gamma_{15} - \Gamma_{14}\left(1 + \frac{1}{\eta_1^0}\right)\right] - \Gamma_{13}}{1 + \gamma_{11}\left[\Gamma_{14}\left(1 + \frac{1}{\eta_1^0}\right) - \Gamma_{15}\right]}\ln p_3 \qquad (18)$$

If we assume that the intercept terms for AIDS demand equations are generalized intercepts equal to a constant plus the demand shift variable as below, then

$$\alpha_i = \alpha_i^1 + \underline{\alpha}_{i1}\,\underline{D} \quad \textit{for } i=1,2,3 \qquad (19)$$

the first term in equation (18) captures demand shift effects. Changes in input cost prices affect the marginal cost elasticity, η_{mc}, in Γ_{14}.

Perhaps the most important implication of this derivation is that the price reaction functions in the generalized Bertrand model with the Almost Ideal Demand System specification are logarithmic in prices. The coefficients on prices are price reaction elasticities. Note that these are extremely complex functions of the model's structural parameters. In a much simpler but overly restrictive model (linear demand specification for two brands) one can impose cross equation restrictions to identify and estimate the underlying conjectural variations (eg. Liang 1987). That is not possible in the model, nor is it necessary for the current task, measurement of observed market power.

If competition is Nash-Bertrand, the price conjecture elasticities ε_{ij} for $i \neq j = 1,2,3$, are zero and the reaction function becomes more tractable but it is still complex. It reduces to:

$$\ln p_1 = \frac{\frac{1}{\beta_1} - \frac{\alpha_1}{\gamma_{11}} - (\alpha_1 + \beta_1 \ln \bar{X})\left[\frac{\eta_{mc}}{\beta_1 \gamma_{11}}(1+\eta_{11})\right]}{1 + \left[\frac{\eta_{mc}}{\beta_1}(1+\eta_{11})\right]} - \frac{\gamma_{12}\left[\frac{\eta_{mc}}{\beta_1 \gamma_{11}}(1+\eta_{11})\right] + \frac{\gamma_{12}}{\gamma_{11}}}{1 + \left[\frac{\eta_{mc}}{\beta_1}(1+\eta_{11})\right]} \ln p_2 - \frac{\gamma_{13}\left[\frac{\eta_{mc}}{\beta_1 \gamma_{11}}(1+\eta_{11})\right] + \frac{\gamma_{13}}{\gamma_{11}}}{1 + \left[\frac{\eta_{mc}}{\beta_1}(1+\eta_{11})\right]} \ln p_3 \quad (20)$$

Equation 20 demonstrates that this model is not necessarily a consistent conjecture model. When price conjectures are zero, the reaction coefficients are zero only if:

$$\frac{\eta_{mc}}{\beta_1 \gamma_{11}}(1+\eta_{11}) + \frac{1}{\gamma_{11}} = 0 \quad (21)$$

or

$$\gamma_{12} = \gamma_{13} = 0 \quad (22)$$

Since the second condition implies that the three brands are in separate markets, generally it is not binding.

Baker and Breshnahan recognized the same lack of consistent conjectures in their general residual demand models (Baker and Breshnahan 1988, p. 290). For the residual approach as well as our work it means that observed and estimated price reaction elasticities

may not be equal to the price conjecture elasticities that managers theoretically follow when maximizing profits. Estimating a unilateral demand system as Hausman *et al.* and Cotterill (1994a) do, ignores rather than resolves the lack of consistency in Nash Bertrand models. Perhaps economic theorists can equate observed price reactions with more advanced, possibly dynamic models of price conjectures. For empirically oriented analysts who are seeking to measure observed demand responses and observed exercise of market power the observed price reaction and the price reaction elasticities that can be estimated from them are sufficient to analyze brand level pricing and profitability. The minds of profit maximizing managers are beyond measurement and beyond the market oriented analysis of applied Industrial Organization research.

IV. Estimation Methods and Computation of Unilateral, Observed, and Fully Collusive Demand Elasticities

In the three brand example one estimates two demand equations and recovers the coefficients and standard errors for the third from the adding up condition of the demand system. Adding the three price reaction equations gives a five equation, simultaneous system with two market shares and three prices as endogenous variables. Three stage least squares can be used to estimate parameters. Following most other researchers who have estimated AIDS model we will avoid nonlinear estimation by substituting Stone's price index for the exact price index. It is the market share weighted sum of the natural log of prices. When researchers have compared the two methods they are quite similar, if prices are highly correlated as is the case here, and the gain in ease of estimation is substantial (Deaton and Muellbauer, 1980 p. 76).

Another estimation issue is the need to reduce the number of parameters to be estimated. In most differentiated product industries there are several, often dozens of, brands. To conserve degrees of freedom Baker and Breshnahan use residual demand approach that reduces estimation to four equations and less than a dozen parameters when analyzing the merger of two brands. Given the massive increase in scanner data, larger system models such as Hausman *et al.* and our demand and price reaction model make use of observed segmentation in a market such as soft drinks to construct a multi-stage model. We assume that consumers' decision to buy soft drinks is structured and sequential. First a consumer decides whether to buy soft drinks or some other beverage. This is a function of the general price level of soft drinks and alternative beverages and income. Then the consumer decides whether to purchase diet or regular soda which is a function of the price of regular sodas, diet sodas, and expenditures on all soda. Then within the regular category the consumer chooses to purchase cola or clear sodas, private label soda or all other regular soda. These decisions are functions of the prices of these different categories and expenditures on regular sodas. Finally in the cola segment consumers choose among Coke, Pepsi, RC Cola, and Dr. Pepper. In the clear sector they choose between Sprite, Seven-Up and Mountain Dew. This four stage budget model is illustrated in Figure 2.

Our estimation procedure reduces the number of own and cross price elasticity parameters from 90 to 41 and the number of price reaction elasticities from 72 to 30. For comparison we estimate the full regular soft drink model, i.e. with no segmentation, and report results in the Appendix Table A5.

Before proceeding to variable specification and empirical results, computation procedures for the unilateral, observable and fully collusive elasticities need to be presented. In the linear approximate AIDS model used here the within segment (conditional) unilateral own and cross price elastics are:

$$\eta_{ij} = -1 + \frac{\gamma_{ii}}{S_i} - \beta_i \qquad (23)$$

$$\eta_{ij} = \frac{\gamma_{ij}}{S_i} - \frac{\beta_i S_j}{S_i} \qquad (24)$$

A brand's expenditure elasticity is:

$$y_i = 1 + \frac{\beta_i}{S_i} \qquad (25)$$

The observed own price elasticities are given by equation 2.

Calculation of the fully collusive elasticities is more complicated. To compute them in the three brand case assume that all three brands are managed by the same firm and the firm chooses P_1, P_2, P_3 jointly to maximize profits. One can solve it a first order condition for the three fully collusive elasticities as follows:

The profit function for the firm is:

$$\pi = p_1 q_1 + p_2 q_2 + p_3 q_3 - c(q_1, q_2, q_3) \qquad (26)$$

here p_i is the price for brand i and q_i is the quantity demanded for

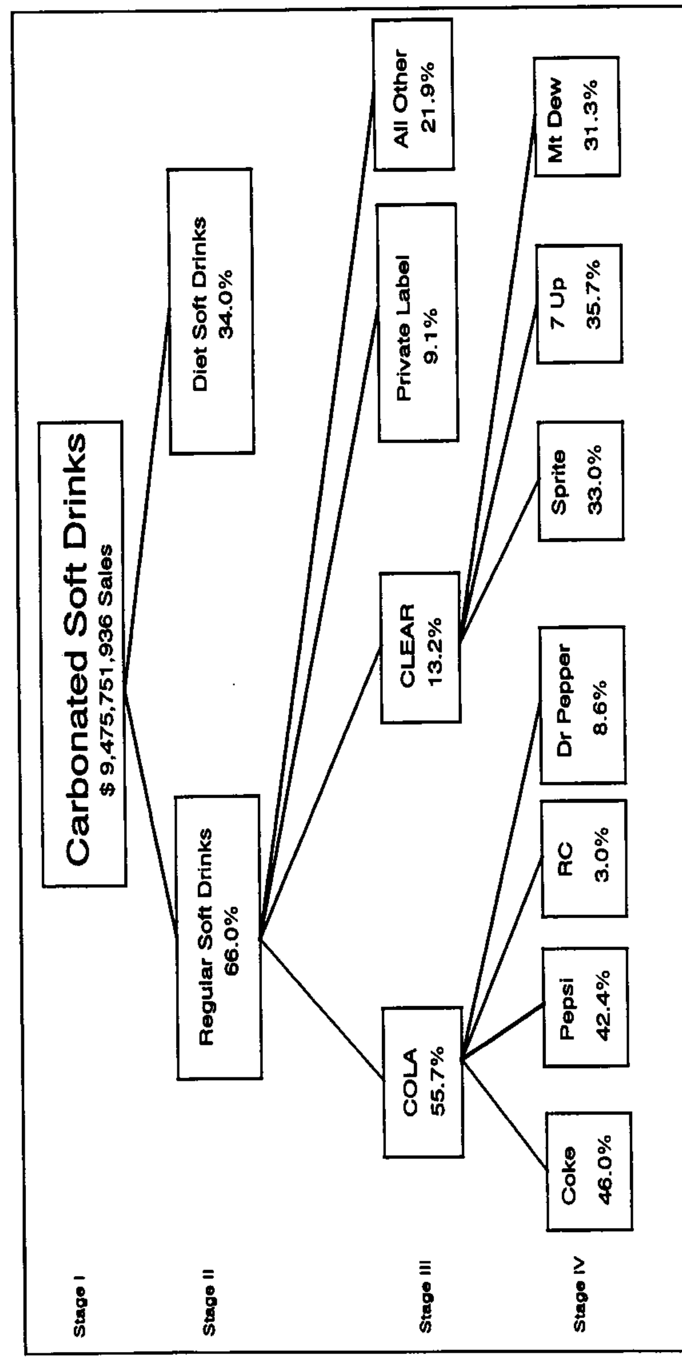

Figure 2. 1992 Dollar Market Share: A Four Stage Segmented Model of Consumer Purchase Decisions. Source: Calculated from IRI data base, Food Marketing Policy Center, University of Connecticut.

brand i where $i=1,2,3$. The term $c(q_1, q_2, q_3)$ is the cost function for producing brand 1,2,3.

Differentiating the above equation with regard to all the prices, one obtains first order conditions:

$$\begin{aligned}
\frac{\partial\pi}{\partial p_1} &= q_1 + p_1\frac{\partial q_1}{\partial p_1} + p_2\frac{\partial q_1}{\partial p_1} + p_3\frac{\partial q_3}{\partial p_3} - \frac{\partial c}{\partial q_1}\frac{\partial q_1}{\partial p_1} - \frac{\partial c}{\partial q_2}\frac{\partial q_2}{\partial p_1} - \frac{\partial c}{\partial q_3}\frac{\partial q_3}{\partial p_1} = 0 \\
\frac{\partial\pi}{\partial p_2} &= q_2 + p_1\frac{\partial q_1}{\partial p_2} + p_2\frac{\partial q_2}{\partial p_2} + p_3\frac{\partial q_3}{\partial p_2} - \frac{\partial c}{\partial q_1}\frac{\partial q_1}{\partial p_2} - \frac{\partial c}{\partial q_2}\frac{\partial q_2}{\partial p_2} - \frac{\partial c}{\partial q_3}\frac{\partial q_3}{\partial p_2} = 0 \qquad (27) \\
\frac{\partial\pi}{\partial p_3} &= q_3 + p_1\frac{\partial q_1}{\partial p_3} + p_2\frac{\partial q_2}{\partial p_3} + p_3\frac{\partial q_3}{\partial p_3} - \frac{\partial c}{\partial q_1}\frac{\partial q_1}{\partial p_3} - \frac{\partial c}{\partial q_2}\frac{\partial q_2}{\partial p_3} - \frac{\partial c}{\partial q_3}\frac{\partial q_3}{\partial p_3} = 0
\end{aligned}$$

Now define $$s_i = \frac{p_i q_i}{\sum p_i q_i},$$

$$mc_i = \frac{\partial c}{\partial q_i},$$

and $$pcm_i = \frac{p_i - mc_i}{p_i},$$

where i=1,2,3. Some mathematical manipulation gives:

$$\begin{aligned}
s_1 + s_1\eta_{11}pcm_1 + s_2\eta_{21}pcm_2 + s_3\eta_{31}pcm_3 &= 0 \\
s_2 + s_1\eta_{12}pcm_1 + s_2\eta_{22}pcm_2 + s_3\eta_{32}pcm_3 &= 0 \qquad (28) \\
s_3 + s_1\eta_{13}pcm_1 + s_2\eta_{23}pcm_2 + s_3\eta_{33}pcm_3 &= 0
\end{aligned}$$

For a given set of market shares and a corresponding matrix of unilateral demand elasticities one can solve this three equation system for the profit maximizing price cost margins. In equilibrium each of the three margins are equal to the corresponding inverse of the negative fully collusive elasticity:

$$\frac{p_i - mc_i}{p_i} = -\frac{1}{\eta_i^c} \qquad (29)$$

One solve these for η_i^c, $i=1,2,3$. Once one has unilateral, observable and fully collusive elasticities one can analyze brand level market power in a more comprehensive fashion than with either the residual demand or unilateral demand system approach.

Our current empirical analysis does not estimate the top two stages of the four stage system in Figure 2. Rather we estimate jointly the 19 equations of the bottom two stages. This means that reported elasticities understate own price elasticity and overstate cross price elasticities because a higher coke price increases cola prices which increase regular soft drink prices and all soft drink prices. These last two price increases cause consumers to shift expenditures to diet soda and other beverages. That reduction in expenditures would reduce the quantity of regular soda, colas, and Coke purchased making the coke own price elasticity more elastic. It would reduce the cross price effect of a coke price increase upon, for example Pepsi, because reduced expenditures on colas due to shifts to diet soda and other beverages would reduce purchases of Pepsi.

V. Estimation Results

Table 2 identifies the 19 equations in our two stage model of the regular soft drink market. Figure 3 is a key that identifies each of the variables used. The estimated system has 3 cola demand equations, 4 cola price reaction equations, 2 clear demand equations, 3 clear price reaction equations, 3 segment demand equations and 4 segment price reaction equations for a total of 19 equations.

The typical brand demand equation has market share as the dependent variable. Explanatory variables include brand prices, price adjusted "real" expenditures for the segment, the percent of population that is Hispanic, and a set of city 44 binary variables (C1...C44) to control for excluded local market variables in this panel data set (fixed effects model). The data set has 45 cities with 20 quarters (1988-1992) for a total of 900 observations. All prices in the demand and price eaction equations are natural logs.

The typical price reaction equation has own brand price as the dependent variable, other prices as endogenous explanatory variables, real segment expenditures, percent Hispanic, and a set of cost shift variables. Units per 192 ounces of soft drink volume eg. U/Vol_{co} for coke, measures the average size of the purchase unit for each brand. Because six packs are considered one unit, and they are heavier than quart or two quart bottles, a higher value of units per volume actually measures the sale of more quart or two quart bottles. Since these are less costly per 192 ounces, we hypothesize that U/Vol is negatively related to price.

Average price reduction (PrRed) and percent volume (% Merc) sold with any form of merchandising measure temporary price promotion campaigns to sell product. These activities are the vehicles food

Table 2. A Two Stage Budget Model of the Regular Carbonated Soft Drink Market

Cola Brand Demand and Price Reaction Equations

$$S_{co} = \alpha_1 + \gamma_{11} P_{co} + \gamma_{12} P_{pe} + \gamma_{13} P_{rc} + \gamma_{14} P_{dr} + \beta_1 Exp_{cola} + \alpha_{10} \%Hisp + \alpha_{11} C1 \ldots \alpha_{1,44} C44$$
$$S_{pe} = \alpha_2 + \gamma_{21} P_{co} + \gamma_{22} P_{pe} + \gamma_{23} P_{rc} + \gamma_{24} P_{dr} + \beta_2 Exp_{cola} + \alpha_{20} \%Hisp + \alpha_{21} C1 \ldots \alpha_{2,44} C44$$
$$S_{rc} = \alpha_3 + \gamma_{31} P_{co} + \gamma_{32} P_{pe} + \gamma_{33} P_{rc} + \gamma_{34} P_{dr} + \beta_3 Exp_{cola} + \alpha_{30} \%Hisp + \alpha_{31} C1 \ldots \alpha_{3,44} C44$$
$$P_{co} = \rho_1 + \rho_{12} P_{pe} + \rho_{13} P_{rc} + \rho_{14} P_{dr} + \beta_{11} Exp_{cola} + \rho_{15} \%Hisp + \rho_{16,1} C1 \ldots \rho_{16,44} C44 + \rho_{17} U/Vol_{co} + \rho_{18} PrRed + \rho_{19} \%Merc + \rho_{1,10} Sw + \rho_{1,11} Sup/Groc + \rho_{1,12} CR_4 + \rho_{1,13} Capt_{co}$$
$$P_{pe} = \rho_2 + \rho_{21} P_{co} + \rho_{23} P_{rc} + \rho_{24} P_{dr} + \beta_{12} Exp_{cola} + \rho_{25} \%Hisp + \rho_{26,1} C1 \ldots \rho_{26,44} C44 + \rho_{27} U/Vol_{pe} + \rho_{28} PrRed + \rho_{29} \%Merc + \rho_{2,10} Sw + \rho_{2,11} Sup/Groc + \rho_{2,12} CR_4 + \rho_{2,13} Capt_{pe}$$
$$P_{rc} = \rho_3 + \rho_{31} P_{co} + \rho_{32} P_{pe} + \rho_{34} P_{dr} + \beta_{13} Exp_{cola} + \rho_{35} \%Hisp + \rho_{36,1} C1 \ldots \rho_{36,44} C44 + \rho_{37} U/Vol_{rc} + \rho_{38} PrRed + \rho_{39} \%Merc + \rho_{3,10} Sw + \rho_{3,11} Sup/Groc + \rho_{3,12} CR_4$$
$$P_{dr} = \rho_4 + \rho_{41} P_{co} + \rho_{42} P_{pe} + \rho_{43} P_{rc} + \beta_{14} Exp_{cola} + \rho_{45} \%Hisp + \rho_{46,1} C1 \ldots \rho_{46,44} C44 + \rho_{47} U/Vol_{dr} + \rho_{48} PrRed + \rho_{49} \%Merc + \rho_{4,10} Sw + \rho_{4,11} Sup/Groc + \rho_{4,12} CR_4$$

Clear Brand Demand and Price Reaction Equations

$$S_{sp} = \alpha_4 + \gamma_{41} P_{sp} + \gamma_{42} P_{su} + \gamma_{43} P_{md} + \beta_4 Exp_{clear} + \alpha_{40} \%Hisp + \alpha_{41} C1 \ldots \alpha_{4,44} C44$$
$$S_{se} = \alpha_5 + \gamma_{51} P_{sp} + \gamma_{52} P_{su} + \gamma_{53} P_{md} + \beta_5 Exp_{clear} + \alpha_{50} \%Hisp + \alpha_{51} C1 \ldots \alpha_{5,44} C44$$
$$P_{sp} = \rho_5 + \rho_{52} P_{su} + \rho_{53} P_{md} + \beta_{21} Exp_{clear} + \rho_{54} \%Hisp + \rho_{55,1} C1 \ldots \rho_{55,44} C44 + \rho_{56} U/Vol_{sp} + \rho_{57} PrRed + \rho_{58} \%Merc + \rho_{59} Sw + \rho_{5,10} Sup/Groc + \rho_{5,11} CR_4 + \rho_{5,12} Capt_{co}$$
$$P_{su} = \rho_6 + \rho_{61} P_{sp} + \rho_{63} P_{md} + \beta_{22} Exp_{clear} + \rho_{64} \%Hisp + \rho_{64,1} C1 \ldots \rho_{65,44} C44 + \rho_{66} U/Vol_{su} + \rho_{67} PrRed + \rho_{68} \%Merc + \rho_{69} Sw + \rho_{6,10} Sup/Groc + \rho_{6,11} CR_4$$
$$P_{md} = \rho_7 + \rho_{71} P_{sp} + \rho_{73} P_{su} + \beta_{23} Exp_{clear} + \rho_{74} \%Hisp + \rho_{75,1} C1 \ldots \rho_{75,44} C44 + \rho_{76} U/Vol_{md} + \rho_{77} PrRed + \rho_{78} \%Merc + \rho_{79} Sw + \rho_{7,10} Sup/Groc + \rho_{7,11} CR_4 + \rho_{7,12} Capt_{pe}$$

Segment Demand and Price Reaction Equations

$$S_{cola} = \alpha_6 + \gamma_{61} P_{cola} + \gamma_{62} P_{clear} + \gamma_{63} P_{pl} + \gamma_{64} P_{ao} + \beta_6 Exp_{soda} + \alpha_{60} \%Hisp + \alpha_{6,1} C1 \ldots \alpha_{6,44} C44$$

$$S_{clear} = \alpha_7 + \gamma_{71} P_{cola} + \gamma_{72} P_{clear} + \gamma_{73} P_{pl} + \gamma_{74} P_{ao} + \beta_7 Exp_{soda} + \alpha_{70} \%Hisp + \alpha_{7,1} C1 \ldots \alpha_{7,44} C44$$

$$S_{pl} = \alpha_8 + \gamma_{81} P_{cola} + \gamma_{82} P_{clear} + \gamma_{83} P_{pl} + \gamma_{84} P_{ao} + \beta_8 Exp_{soda} + \alpha_{80} \%Hisp + \alpha_{8,1} C1 \ldots \alpha_{8,44} C44$$

$$P_{cola} = \rho_8 + \rho_{82} P_{clear} + \rho_{83} P_{pl} + \rho_{84} P_{ao} + \beta_{31} Exp_{soda} + \rho_{85} \%Hisp + \rho_{86,1} C1 \ldots \rho_{86,44} C44 + \rho_{87} U/Vol_{cola}$$
$$+ \rho_{88} PrRed + \rho_{89} \%Merc + \rho_{8,10} Sw + \rho_{8,11} Sup/Groc + \rho_{8,12} CR_4 + \rho_{8,13} Capt_{Cola}$$

$$P_{clear} = \rho_9 + \rho_{91} P_{cola} + \rho_{93} P_{pl} + \rho_{94} P_{ao} + \beta_{32} Exp_{soda} + \rho_{95} \%Hisp + \rho_{96,1} C1 \ldots \rho_{96,44} C44 + \rho_{97} U/Vol_{clear}$$
$$+ \rho_{98} PrRed + \rho_{99} \%Merc + \rho_{9,10} Sw + \rho_{9,11} Sup/Groc + \rho_{9,12} CR_4 + \rho_{9,13} Capt_{Clear}$$

$$P_{pl} = \rho_{10} + \rho_{10,1} P_{cola} + \rho_{10,2} P_{clear} + \rho_{10,4} P_{ao} + \beta_{33} Exp_{cola} + \rho_{10,5} \%Hisp + \rho_{10,6,1} C1 \ldots \rho_{10,6,44} C44$$
$$+ \rho_{10,7} U/Vol_{pl} + \rho_{10,8} PrRed + \rho_{10,9} \%Merc + \rho_{10,10} Sw + \rho_{10,11} Sup/Groc + \rho_{10,12} CR_4$$

$$P_{ao} = \rho_{11} + \rho_{11,1} P_{cola} + \rho_{11,2} P_{clear} + \rho_{11,3} P_{pl} + \beta_{34} Exp_{soda} + \rho_{11,5} \%Hisp + \rho_{11,6,1} C1 \ldots \rho_{11,6,44} C44$$
$$+ \rho_{11,7} U/Vol_{ao} + \rho_{11,8} PrRed + \rho_{11,9} \%Merc + \rho_{11,10} Sw + \rho_{11,11} Sup/Groc + \rho_{11,12} CR_4$$

Figure 3. Variables Specified in the Model

S_i	Market Share
P_i	Price
Exp_i	Expenditure
$\%Hisp_j$	Percent Hispanic
U/Vol_i	Units per Volume
$PrRed_i$	Average Price Reduction
$\%Merc_i$	Percent Volume with Any Merchandising
$Capt_i$	Captive Bottler Binary
Sw	Cost of Sweetener
$CR4_j$	Market Four-firm Concentration
$Sup/Groc_j$	Supermarket to Grocery Store Ratio
Ck	Fixed Effect Binary Variables

where: i =

Cola Brands	
co	Coke
pe	Pepsi
rc	Royal Crown
dr	Dr. Pepper
Cola	Cola segment aggregate
Clear Brands	
sp	Sprite
su	7 Up
md	Mountain Dew
Clear	Clear Segment aggregate
pl	Private Label
ao	All Other Soda Brands

j= 1 to 45 identifies values for the 45 local markets.
k= 1 to 44 identifies 44 local markets

manufacturers use to communicate price reductions to consumers. Simply lowering the shelf price with no aisle end display or local newspaper ad telling consumer the product is "on special" does not effectively communicate the price change to consumers. As such they represent shifts in the supply relation that allow consumers to move down along their demand curves. To test the sensitivity of the model we will also estimate the system without these variables and report the results in Appendix Table A2.

The cost of sweetener (high fructose corn syrup) is a major ingredient in all regular soft drinks so sweetener (Sw) is included in each price reaction equation as a cost shift variable. Since the prices used in this study are retail prices and soft drink bottlers sell at wholesale to retailers we have included the supermarket to grocery store sales ratio (Sup/Groc) as a proxy for lower retail distribution costs when supermarkets account for a larger share of grocery sales. The retail grocery four firm concentration ratio (CR_4) is included to capture possible price enhancing effects from high retail concentration in local markets.

Finally for Coke and Sprite the Coke capture ($Capt_{Co}$) variable is a binary variable that has value 1 if the bottler for that local market is vertically integrated (owned by Coca Cola Enterprises). $Capt_{pe}$ is a similar variable for Pepsi and Mountain Dew. During the 1970s the FTC attacked vertical mergers in the soft drink industry maintaining that they increased Coke and Pepsi market power. In 1981 the U.S. Congress passed a law granting to the soft drink industry special antitrust exemption for vertical mergers. Recently Muris *et al.* (1992) analyzed the impact of vertical mergers and conclude that they do not increase market power. We include these measures of vertical penetration to see if markets served by "captive" wholesale operations have higher prices due to increased market power or lower prices due to vertical efficiencies in distribution and promotion.

Table 3 reports regression results for the two stage budget model for regular soft drinks. The first page (Table 3.1) reports results for the cola brands, the second page (Table 3.2) reports clear brands, and the third page (Table 3.3) gives results for the segment level demand and reaction curves. The first four columns Table 3.1 report demand estimation results for Coke, Pepsi, RC, and Dr. Pepper. All own price coefficients are negative and highly significant as hypothesized. All cross price coefficients are positive and, except for the two RC and Dr. Pepper cross price coefficients, are statistically significant. This result suggests that Dr. Pepper, a specialty Cola, RC a secondary brand that is almost a private label cola in most markets, are not close substitutes. Change in real per capita expenditures on colas has no significant impact on the shares of Coke or Pepsi, but it does significantly increase the share of Dr. Pepper and reduce the share of RC. This means Dr. Pepper is a luxury i.e. the corresponding expenditure elasticity is greater than one; and, RC is a necessity (the corresponding expenditure elasticity is less than one). This confirms that Dr. Pepper is a specialty product and RC is a second tier cola brand. Coke and Dr. Pepper market shares are high where the percent of population that is Hispanic is high. Pepsi and RC shares are lower in those markets.

The last four columns of Table 3.1 report the price reaction estimation results for the cola brands. All price reaction elasticities except RC's response to Pepsi price changes which is negative and insignificant, are positive. Nine of these eleven positive coefficients are statistically significant at the 5 percent level or higher. Note that the price response elasticities are not very large. A one percent change in Pepsi price leads to a .236 percent change in Coke price, and a 1 percent change Coke price leads to a .163 percent change in the price of Pepsi. Note that Dr. Pepper has the strongest pattern of price followship with another brand. Its price increasing .335 percent when Pepsi goes up 1 percent.

The real expenditure per capita variable (EXP_{Cola}) has a uniformly negative impact on brand prices and is significant for three of the four brands. Since real expenditure are computed by dividing normal expenditures by prices to purge the variable of price effects, this is not due to reverse causality wherein lower prices increase expenditures.

Only Coke prices are related to the percent Hispanic variable. They are significantly higher when Hispanic are a larger proportion of the population. Thus both Coke's market share and price are higher in markets with larger relative Hispanic population.

The units per volume cost shift variables for each brand are negative as hypothesized and statistically significant for three of the four brands. Price per ounce is lower in larger bottles as opposed to six packs, reflecting, lower costs per ounce.

The average weighted price reduction and percent volume sold with any merchandising variables are all negatively related to price as hypothesized and significant in 7 out of 8 cases. These variables capture the impact of in store trade promotions upon price. When consumers are alerted to the fact that brands are available at especially low prices they increase their purchases. This increase in the quantity sold occurs in this simultaneous system because a lower price feeds into the brand's demand equation causing consumers to move down that brands demand curve. It is not due to a shift in the demand curve. Statistically significant for Pepsi and RC. The supermarket grocery store ratio variable is insignificant for Pepsi and RC. For Coke and Dr. Pepper it has a statistically significant positive effect on price which counter to the hypothesized negative impact.

Retail four firm concentration was included to test whether branded soft drink prices are higher in more concentrated markets. For three of the four cola brands, Pepsi, RC, and Dr. Pepper, this seems to be the case. Each has a positive and statistically significant coefficient for retail concentration. Coke prices are not related to retail concentration, possibly because large chains use them as "loss leaders" in concentrated markets.

The captive bottler binary variable for Coke ($Capt_{Co}$) has positive impact on Coke price and is significant at this five percent level. Although this supports the FTC hypothesis that vertical integration increases market power, the captive bottler binary variable for Pepsi

Table 3.1 Cola Brands: Two Stage Budget Model for Regular Soft Drinks

	Dependent Variable							
	S_{Co}	S_{Pe}	S_{RC}	S_{Dr}	P_{Co}	P_{Pe}	P_{RC}	P_{Dr}
P_{Co}	-0.6711	0.5253	0.0864	0.0594		0.1626	0.0657	0.0688
	(-19.65)**	(18.44)**	(7.400)**	(4.750)**		(3.935)**	(0.703)	(1.049)
P_{Pe}	0.5253	-0.6112	0.0396	0.0463	0.2360		-0.1246	0.3349
	(18.44)**	(-20.80)**	(3.677)**	(3.998)**	(7.310)**		(-1.460)	(5.606)**
P_{RC}	0.0864	0.0396	-0.1359	0.0099	0.1082	0.0711		0.2098
	(7.400)**	(3.677)**	(-16.91)**	(1.533)	(4.353)**	(2.376)*		(4.749)**
P_{Dr}	0.0594	0.0463	0.0099	-0.1157	0.0616	0.1599	0.1701	
	(4.750)**	(3.998)**	(1.533)	(-12.00)**	(2.444)**	(5.363)**	(2.691)**	
Exp_{Cola}	-0.0030	-0.0041	-0.0070	0.0140	-0.0932	-0.0949	-0.0078	-0.0489
	(-0.428)	(-0.668)	(-2.591)*	(5.391)**	(-9.641)**	(-8.705)**	(-0.394)	(-3.373)**
%Hisp	0.0113	-0.0122	-0.0014	0.0024	0.0054	-0.0024	-0.0019	-0.0024
	(7.502)**	(-9.353)**	(-2.754)**	(4.535)**	(2.722)**	(-1.176)	(-0.524)	(-0.928)
U/Vol_{Co}					-0.0174			
					(-2.906)**			
U/Vol_{Pe}						-0.0130		
						(-2.022)*		
U/Vol_{RC}							-0.0155	
							(-2.007)*	
U/Vol_{Dr}								0.0080
								(1.113)
$AvWtPRed_{Co}$					-0.0025			
					(-12.96)**			
$AvWtPRed_{Pe}$						-0.0021		
						(-9.299)**		
$AvWtPRed_{RC}$							-0.0003	
							(-0.962)	
$AvWtPRed_{Dr}$								-0.0014
								(-5.464)**
$\%VolMer_{Co}$					-0.0021			
					(-11.00)**			
$\%VolMer_{Pe}$						-0.0014		
						(-7.309)**		
$\%VolMer_{RC}$							-0.0010	
							(-7.348)**	
$\%VolMer_{Dr}$								-0.0017
								(-11.10)**
Sw					0.0005	0.0013	0.0014	0.0007
					(1.184)	(2.788)**	(1.832)*	(1.157)
Sup/Groc					0.0005	-0.0002	-0.0002	0.0013
					(2.118)*	(-0.628)	(-0.510)	(3.820)**
CR_4					0.00009	0.0008	0.0019	0.0017
					(0.334)	(2.643)**	(3.633)**	(4.476)**
$Capt_{Co}$					0.0180			
					(2.073)*			
$Capt_{Pe}$						0.0004		
						(0.079)		

($Capt_{Pe}$) does not. It is effectively zero and not significant.

Table 3.2 reports results for the clear brand segment. The first three columns are demand equations for Sprite, Seven-Up, and Mountain Dew. All own and cross price coefficients have the hypothesized sign and are highly significant. The coefficients for real per capita expenditures on clear sodas (Exp_{Clear}) are also highly significant. Increases in Expenditure increase the market shares of Sprite and Mountain Dew (luxuries) and reduce the share of Seven-Up (necessity). Percent Hispanic has a similar pattern.

The last three columns on Table 3.2 are the price reaction equations for the clear brands. For Sprite the price reaction coefficients for Seven-Up and Mountain Dew are positive and significant. Seven-Up has a positive and significant price reaction coefficient for Sprite; but, Seven-Up price is not significantly effected by changes in Mountain Dew price. Mountain Dew price is not significantly related to Sprite price; but, it is negatively and significantly (5 percent level) related to Seven-Up price. This is the first (and only) example of observed price rivalry in our model. The effect, however, is not large. A 1 percent increase in Seven-Up price leads to only a .066 percent reduction in Mountain Dew price.

As in the cola segment, real per capita expenditures on clear soda has a highly significant negative impact on the prices of clear brands. Percent Hispanic has significant positive impact on Sprite price, reflecting a similar significant positive impact on Sprite market share. It has a significant negative impact on Seven-Up price reflecting a similar significant negative impact on Seven-Up share. Percent Hispanic has no significant impact on Mountain Dew price.

The units per volume, average weighted price reduction, percent volume merchandising sweetener and supermarket grocery sales ratio variables all behave in a fashion similar to the Cola segment results. Retail concentration has a positive and significant impact on Sprite and Seven-Up prices. It has a significant, negative impact on Mountain Dew price. Neither of the captive bottler binary variables are significant.

Table 3.3 reports estimation results for the first stage of our two stage budget model. Segment level variables for the Cola, Clear, and All Other regular soda categories are market share weighted average values. IRI reports similar aggregate Private Label values for regular soda and they are used here. The first four columns report segment demand equation results. All own and cross price coefficients have the hypothesized signs and are highly significant except for the cross price coefficients between private label and all other regular soda. Since private label sodas are primarily colas and clear sodas, this seems plausible. Real per capita expenditures on regular soda (Exp_{Soda}) has a positive impact on the share of Cola, Clear and Private Label but is only for significant Cola and Private Label. All other soda shares are significantly lower when real soda expenditures increase.

Percent Hispanic has a significant positive impact on cola, clear and private label shares. It has a significant negative impact on all other regular soda.

The last four columns in Table 3.3 are the segment price reaction equations. We will only discuss significant price reaction coefficients. The price of cola reacts positively to the price of clear soda and negatively to the fringe "all other soda" category. A one percent increase in clear soda prices leads to a .355 percent increase in Cola prices. A one percent increase in the price of all other soda leads to a .142 percent decrease in Cola prices. The price of clear soda reacts positively to Cola prices with a 1 percent change in the latter inducing .491 percent change in clear prices. All other soda also has a positive .303 percent impact on Clear Soda price. Private Label, however, is rivalrous with a weak -.059 percent impact. Private label soda price reacts negatively to clear soda price with a -.445 price reaction elasticity; and, positively to all other soda price with a +.816 price reaction elasticity. All other soda reacts positively to changes in clear and private label soda with price reaction elasticities of +.339 and +.112 respectively.

To summarize, private label and clear soda are rivalrous. Each responds to the other price increase with a price cut. Colas are rivalrous with the fringe "all other" brands but the fringe tends to ignore the colas. Colas and Clears follow each other and private label and fringe brands follow each other.

The real expenditure per capita variable for all regular soda has a significant negative impact on the price of Cola and all other soda. It has no impact on Clear Soda and a significant positive impact on private label price. When consumers increase their consumption of regular soda, it increases the share and price of private label soda. During the 1988-1992 period private label penetration in the market did increase as Cott Corporation and others made a significant commitment to improving the quality taste of private label sodas.

Percent Hispanic has a significant positive impact on Cola prices. When this result is compared to the impact of Hispanic on shares, it appears that supermarket chains in Hispanic markets have been able to differentiate colas, increasing share and prices. Percent Hispanic has no impact on private label price, and a significant negative impact on clear and all other prices. The units per volume, average weighted price reduction, and percent volume sold with any merchandising

Table 3.2 Clear Brands: Two Stage Budget Model for Regular Soft Drinks

	Dependent Variable					
	S_{Sp}	S_{Su}	S_{Md}	P_{Sp}	P_{Su}	P_{Md}
P_{Sp}	-0.4628	0.2955	0.1673		0.2347	0.0160
	(-14.90)**	(11.76)**	(7.406)**		(7.553)**	(0.518)
P_{Su}	0.2955	-0.5671	0.2717	0.1361		-0.0662
	(11.76)**	(-16.84)**	(11.89)**	(5.125)**		(-2.554)*
P_{Md}	0.1673	0.2717	-0.4390	0.1730	-0.0490	
	(7.406)**	(11.89)**	(-17.17)**	(4.324)**	(-1.237)	
Exp_{Clear}	0.0611	-0.1637	0.1025	-0.0770	-0.0953	-0.1382
	(8.168)**	(-16.07)**	(13.74)**	(-5.996)**	(-8.150)**	(-13.65)**
%Hisp	0.0049	-0.0170	0.0121	0.0061	-0.0189	-0.0006
	(2.518)*	(-6.491)**	(6.399)**	(2.392)*	(-7.637)**	(-0.026)
U/Vol_{Sp}				-0.0234		
				(-3.627)**		
U/Vol_{Su}					-0.0245	
					(-3.132)**	
U/Vol_{Md}						0.0082
						(1.084)
$AvWtPRed_{Sp}$				-0.0029		
				(-12.39)**		
$AvWtPRed_{Su}$					-0.0016	
					(-7.031)**	
$AvWtPRed_{Md}$						-0.0023
						(-9.525)**
$\%VolMer_{Sp}$				-0.0023		
				(-13.72)**		
$\%VolMer_{Su}$					-0.0030	
					(-22.13)**	
$\%VolMer_{Md}$						-0.0024
						(-20.25)**
Sw				0.0015	0.0029	0.0003
				(2.732)**	(5.396)**	(0.058)
Sup/Groc				0.0008	0.0012	-0.0001
				(2.308)*	(3.657)**	(-0.435)
CR_4				0.0010	0.0007	-0.0010
				(2.812)**	(1.819)*	(-2.900)**
$Capt_{Co}$				0.0148		
				(1.425)		
$Capt_{Pe}$						-0.0034
						(-0.619)

Table 3.3 Segments: Two Stage Budget Model for Regular Soft Drinks

Segments

	Dependent Variable							
	S_{Cola}	S_{Clear}	S_{pl}	S_{ao}	P_{Cola}	P_{Clear}	P_{pl}	P_{ao}
P_{Cola}	-0.6564	0.0371	0.0915	0.5278		0.4911	-0.1139	-0.0583
	(-25.89)**	(3.789)**	(7.224)**	(21.18)**		(17.40)**	(-1.274)	(-1.063)
P_{Clear}	0.0371	-0.2184	0.0374	0.1439	0.3548		-0.4446	0.3391
	(3.789)**	(-26.03)**	(6.595)**	(14.68)**	(18.95)**		(-6.432)**	(9.333)**
P_{pl}	0.0915	0.0374	-0.1166	-0.0124	-0.0091	-0.0590		0.1122
	(7.224)**	(6.595)**	(-10.33)**	(-0.839)	(-0.496)	(-2.757)**		(3.364)**
P_{ao}	0.5278	0.1439	-0.0124	-0.6593	-0.1416	0.3030	0.8160	
	(21.18)**	(14.68)**	(-0.839)	(-20.74)**	(-4.623)**	(10.63)**	(9.691)**	
Exp_{Soda}	0.0230	0.0050	0.0216	-0.0496	-0.1098	-0.0021	0.0602	-0.1234
	(3.085)**	(1.860)*	(4.618)**	(-5.976)**	(-11.87)**	(-0.224)	(2.752)**	(-9.413)**
%Hisp	0.0052	0.0019	0.0049	-0.0120	0.0086	-0.0072	0.0004	-0.0063
	(3.544)**	(3.582)**	(5.706)**	(-7.443)**	(4.893)**	(-4.468)**	(0.121)	(-2.698)**
U/Vol_{Cola}					-0.0061			
					(-1.024)			
U/Vol_{Clear}						0.0116		
						(1.702)		
U/Vol_{pl}							0.0063	
							(3.540)**	
U/Vol_{ao}								-0.0068
								(-4.092)**
$AvWtPRed_{Cola}$					-0.0025			
					(-12.54)**			
$AvWtPRed_{Clear}$						-0.0013		
						(-6.562)**		
$AvWtPRed_{pl}$							-0.0007	
							(-2.795)**	
$AvWtPRed_{ao}$								0.0002
								(0.666)
$\%VolMer_{Cola}$					-0.0001			
					(-3.101)**			
$\%VolMer_{Clear}$						-0.0028		
						(-22.30)**		
$\%VolMer_{pl}$							-0.0018	
							(-11.83)**	
$\%VolMer_{ao}$								-0.0010
								(-6.511)**
Sw					0.00008	0.0031	0.0044	-0.0019
					(0.228)	(8.196)**	(5.856)**	(-4.154)**
Sup/Groc					0.0004	0.0007	0.0004	-0.0003
					(2.045)*	(3.371)**	(1.021)	(-1.050)
CR_4					0.0009	0.0004	-0.0002	0.0012
					(3.611)**	(1.493)	(-0.465)	(3.774)**
$Capt_{Cola}$					-0.0029			
					(-0.445)			
$Capt_{Clear}$						-0.0058		
						(-0.975)		

** significant at 1%
* significant at 5%

merchandising perform in a fashion similar to their brand level counterparts. Another cost shift variable, sweetener has the hypothesized positive sign for cola, clear, and private label and is significant for the last two. The cost of sweetener, however has a significant negative impact on the price of all other soda. Currently we have no explanation for this unexpected result.

The supermarket grocery store sales ratio has a significant positive impact on the cola and clear segments price. Retail grocery concentration has a significant positive impact on Cola and All Other prices. Thus, except for Coke, Mountain Dew and private label, regular soda prices appear to be higher in more concentrated retail markets. Supermarket operators in more concentrated markets seem to increase brand prices but not their own private label prices. Finally the captive supplier binary variables have no impact on Cola or Clear segment level prices.

Two alternative specifications to the model presented in Table 3.1 are reported in the Appendix. The first (Tables A2, A3, A4) is a two stage budget model without average price reduction and percent volume with merchandising specified in the price reaction equations. Excluding them does have a major impact on the own and cross price coefficients because those variables have a major significant impact on prices in Table 3.1. The second specification (Tables A5, A6, A7) contains the same variables as our primary model but eliminates the two stage aspect of the model. All brands, private label and all other soda demand and price reaction equations (8 demand and 9 price reaction equations are estimated jointly in a "full system" model. One obtains less elastic demand curves and a few more complements emerge. Based on industry practices and observed consumer conduct we continue to maintain our working assumption that the cola, clear, private label and "all other" market segmentation and a two stage approach are the most appropriate results.

Using the estimation results from Table 3 we have computed the unilateral elasticities for all brands and segments at their mean market share values. The reported unilateral brand elasticities include not only the loss of volume to other brands in the segment (the elasticity given no change in cola expenditures); they also include the segment stage effect that arises from a reduction in cola expenditure due to an increase in the cola price index when a cola brand price increases. Since all expenditure elasticities are positive, such total or unconditional unilateral own price elasticities are more elastic than within segment or conditional own price elasticities. Total or unconditional unilateral cross price elasticities are lower than within segment or conditional cross price elasticities.

The reported segment elasticities are conditional elasticities because they are computed for a given level of regular soda expenditures. If we had estimated the first two stages of the four stage model given in Figure 2 we would be able to compute fully unconditional elasticities by incorporating the loss of volume to diet sodas, and to beverages other than carbonated soft drinks when the price of a brand such as Coke increases. This means that the reported unilateral own price elasticities in Table 4 are slightly less elastic and the reported cross price elasticities are slightly higher than the fully unconditional elasticities. Our results are restricted by this important caveat.

Examining the diagonal in Table 4 indicates that all brand and segment level own price elasticities are negative and statistically significant. Except for RC with an own price elasticity of -5.08 all other brand elasticities range between -2.68 and -3.4. The average price elasticity is -3.3. These results are about one half what Hausman *et al.* (1994) report for 15 brands of beer. The average own price elasticity is that study was -5.0 with a range from -3.7 to -6.2. In an analysis of 20 RTE breakfast cereals Cotterill (1994a) reports an average own price elasticity of -2.4 with a range of -1.4 to -3.5. In a working paper Hausman (1994) reports own price elasticities for 9 brands of breakfast cereals that average -2.3 with a range from -1.9 to -3.7. All three of these studies are multi-stage budget and unilateral demand systems model, i.e. no price reaction equations are estimated so only unconditional unilateral, not observed, elasticities are available.

Segment own price elasticities in Table 4 exhibit nearly as great a range as brand level elasticities. Cola own price elasticity is lowest at -2.21; Clear is -2.75; Private Label is -2.48 and the fringe all other categories is -3.69. This supports that assumption that grouping into segments is not random. If grouping was random then each group would have similar elasticities. Different segments in this study clearly have different levels of unilateral market power.

The first row in Table 4 gives cross price impacts on Coke volume. Since all of these cross price elasticities are positive, all other brands are substitutes for Coke. As expected changes in the price of Pepsi have the highest impact on Coke volume. A 1 percent increase in Pepsi price increases Coke volume .64 percent. RC is the next best substitute with a .156 cross price elasticity. Both are statistically significant at the 1 percent level, as are smaller positive cross price elasticities for Sprite, Seven-Up and Mountain Dew.

The second and third rows report similar cross price effects for Pepsi and RC, respectively. Dr. Pepper is somewhat different from the other cola brands with no significant cross price effects. The estimated price coefficients are nonetheless positive for Coke and RC and larger

Table 4. Unilateral Elasticities for Regular Soft Drinks: Two Stage Budget Model

Quantity	Price: Coke	Pepsi	RC	Dr Pepper	Sprite	Seven Up	Mt Dew
Coke	-3.0178	0.6429	0.1556	0.0454	0.0229	0.0262	0.0178
	(-39.23)**	(9.270)**	(5.958)**	(1.611)	(3.791)**	(3.791)**	(3.791)**
Pepsi	0.6455	-2.8858	0.0536	0.0182	0.0228	0.0262	0.0178
	(9.568)**	(-41.29)**	(2.197)*	(0.694)	(3.778)**	(3.778)**	(3.778)**
RC	2.2463	0.8604	-5.0810	0.2422	0.0182	0.0209	0.0142
	(6.675)**	(2.655)**	(-20.92)**	(1.246)	(3.516)**	(3.516)**	(3.516)**
Dr. Pepper	0.1283	-0.0439	0.0962	-2.8204	0.0277	0.0319	0.0217
	(0.708)	(-0.253)	(0.996)	(-19.78)**	(3.762)**	(3.762)**	(3.762)**
Sprite	0.1592	0.1545	0.0105	0.0256	-3.0822	-0.0360	-0.1185
	(3.789)**	(3.789)**	(3.789)**	(3.789)**	(-32.07)**	(-0.481)	(-1.662)
Seven Up	0.0790	0.0767	0.0052	0.0127	0.5499	-2.6831	0.5260
	(3.706)**	(3.706)**	(3.706)**	(3.706)**	(7.546)**	(-30.97)**	(8.095)**
Mt Dew	0.1899	0.1843	0.0125	0.0305	-0.2439	0.0347	-3.4072
	(3.789)**	(3.789)**	(3.789)**	(3.789)**	(-2.492)*	(0.378)	(-32.22)**

(continued)

Table 4. *(continued)*

	COLA	CLEAR	PL	AO
COLA	-2.2078	0.0618	0.1619	0.9426
	(-47.47)**	(3.473)**	(6.987)**	(21.151)**
CLEAR	0.2748	-2.7530	0.2962	1.1417
	(3.499)**	(-40.73)**	(6.434)**	(14.79)**
PL	0.9939	0.4337	-2.4776	-0.2192
	(6.217)**	(6.089)**	(-17.34)**	(-1.212)
AO	2.3048	0.6230	-0.0348	-3.6872
	(21.40)**	(15.07)**	(-0.561)	(-28.40)**

** significant at 1%
* significant at 5%

than significant cross price effects with clear brands. The results suggest that Dr. Pepper is a highly differentiated brand with few close or significant substitutes. Coke, Pepsi and RC on the other hand appear to be significant substitutes for each other.

In the Clear sector, Seven-Up price increases cause no increase in Sprite or Mountain Dew volumes. One can see this by examining the cross price elasticities for Seven-Up price in the Seven-Up column. They are not significantly different from zero for Sprite or Mt. Dew. This suggests that Seven-Up has significant unilateral market power because any losses due to price elevation in this model are only to other segments and not to nearby competitors.

Increases in Sprite price, however, have a significant positive effect on Seven-Up volume and a marginally significant negative effect on Mt. Dew volume. This latter result is the only significant complement in the study. Although we question its validity, it predicts that increases in Seven-Up price leads consumers to cut back on purchases of Mt. Dew as well as Sprite. We would sooner expect to see colas and clears are complements because a household may have only a fixed amount to spend on the two categories and a desire for variety (possibly to satisfy different household members' tastes) may lead the shopper to cut back on both to maintain family peace if the price of one group is high. Since its "crazy" advertising campaign positions Mt. Dew as the teenager's brand, perhaps it is differentiated from Seven-Up (the adult, uncola brand) and households regard them as complements.

Another way to examine the clear elasticities is by row. Note that Sprite and Mt. Dew volumes have no significant positive cross price effects with the prices of other clear sodas, but Seven-Up has very large positive cross price effects with Sprite and Mt. Dew price. Seven-Up appears to truly be the dominant uncola because price increases in Sprite and Mt. Dew cause consumers to shift to Seven-Up but price increases in Seven-Up do not cause them to shift to Sprite or Mt. Dew. All three brands capture volume from colas.

At the segment level 10 of 12 unilateral cross price elasticities are positive and significant. The two negative cross price coefficients are for private label and all other soda and they are insignificant. Private label sodas really do not compete with the fringe brands. This is probably the case because private label sodas are copy cat brands of the leading cola and clear brands.

Table 5 reproduces the brand level unilateral own prices elasticities and reports the corresponding observed and fully collusive elasticities for each brand. All observed elasticities (column 2 in Table 5) are computed at average market share levels and they are unconditional elasticities. The price reactions at the segment level due to an increase, for example in the price of Coke, are incorporated via the impact of a coke price increase upon cola price. The cola price increase leads to price reactions by other segment prices which affect cola expenditures that in turn affect Coke volume via the Coke expenditure elasticity. Note that all brand observed elasticities are lower in absolute value than their corresponding unilateral elasticities and are highly significant. This means that price followship dominates price rivalry in this industry. As reported in Table 3 only 4 of 30 price reaction elasticities at the brand or segment level are significantly negative.

Fully collusive elasticities are also computed at average market share levels, using the reported unilateral own and cross price elasticities. The four Cola brands are regarded as one set and the three clear brands as a second set for computing brand level fully collusive elasticities. Doing a single seven brand set is straight forward and would produce lower fully collusive elasticities.

The test command for computing t ratios for observed elasticities (and the indices reported in Table 5 columns 4-6) becomes so large that it exceeds the limit in the Shazam ver 7 computer program. Given the significance levels of the unilateral and observed elasticities, however, one can safely infer that the Rothschild and Cotterill Indices reported in Table 5 are significantly different from zero.

The last three columns identify the degree of market power each brand has and the proportion that arises from unilateral or coordinated effects. The Rothschild index measures unilateral market power. Coke, for example, has sufficient product differentiation to exercise

Table 5 Brand Level Elasticities and Indices of Market Power

	(1) Unilateral	(2) Observed	(3) Fully Collusive	(4) Rothschild Index (col3/col1)	(5) Cotterill Index (col3/col2)	(6) Chamberlin Quotient 1-(col2/col1)
Coke	-3.0178 (-39.23)**	-2.825 (-37.95)**	-2.2004	0.7291	0.7789	0.0639
Pepsi	-2.8858 (-41.29)**	-2.6013 (40.04)*	-2.1778	0.7547	0.8372	0.0986
RC	-5.0810 (-20.92)**	-4.6367 (-20.72)**	-2.0253	0.3986	0.4368	0.0874
Dr Pepper	-2.8204 (-19.78)**	-2.6581 (-20.89)**	-2.2107	0.7838	0.8317	0.0575
Sprite	-3.0822 (-32.07)**	-2.7903 (-30.97)**	-2.5056	0.8129	0.8980	0.0947
Seven Up	-2.6831 (-30.97)**	-2.5545 (-30.66)**	-2.6628	0.9924	1.0424	0.0479
Mt Dew	-3.4072 (-32.22)**	-3.3312 (-32.70)**	-2.6284	0.7714	0.7890	0.0223

unilateral pricing power equivalent to 72.9 percent of the pricing power it would have if it jointly managed all four cola brands. In fact all other brands except the secondary cola brand, RC, have Rothschild indices that are above Coke. Seven-Up effectively exercises unilaterally the same level of market power it could exercise if it jointly managed all three clear brands. Returning to Figure 1, for Seven-Up the unilateral and observable demand curves are effectively the same as the fully collusive demand curve.

Column 5 in Table 5 reports the Cotterill Index. It measures the degree of observed combined unilateral and coordinated market power in the market. All brands have some coordinated power due to net price followship in addition to unilateral power. The Cotterill Index for Seven-Up is above its limit value of one because the observed elasticity, which is based upon price reactions for among all seven brands, is less in absolute value than the four brand collusive value. This would probably be reversed if all seven brands were used to compute fully collusive elasticities. The final column in Table 5 gives the Chamberlin Quotient for each brand. In all cases coordinated market power effects are less than 10 percent of observed market power.

VI. Summary and Conclusions

This paper explains the relationship between residual demand, unilateral demand system, and full system estimation of market power. Using the latter we have demonstrated that one can decompose observed market power into its unilateral and coordinated components. Using the Rothschild Index and two new indices, the Cotterill Index and the Chamberlin Quotient one can measure the amount of unilateral power, observed market power and the relative importance of unilateral and coordinated effects.

The significance of this more general demand and price reaction model is more than a new way to evaluate mergers. It clearly indicates that most market power is due to product differentiation, not collusion. When used as a method for merger analysis, this means that the antitrust laws are now positioned to attack a type of market power that was heretofore difficult to address. For example, the shared monopoly case in the RTE breakfast cereal industry was argued during the 1970s solely upon the industry's ability to tacitly collude. The new Bertrand pricing approach to differentiated product markets suggest the brand level unilateral effect, as empirically documented by Cotterill (1994a), is a second source of market power in the cereal industry.

Although we stated earlier that brand level market share is not necessarily a good measure of unilateral market power, this approach does suggest a new theoretical underpinning for the use of firm level market shares in industries with many brands. In RTE cereal, for example as a firm assembles brands in a portfolio, it internalizes cross price effects thereby reducing the unilateral and observed own price elasticities and moves towards the fully collusive level. This means that price levels of all brands in an industry will increase as firm market shares (portfolios) increase and the Herfindahl index increases. Thus, brand level analysis supplements rather than replaces the more traditional structural analysis of market power in many differentiated product industries. Unilateral power, based upon advertising and market segmentation, however, may well be more important, as industrial organization economists have long suspected (Chamberlin 1957, Schmalensee 1978, Sutton, 1990) than tacit or explicit collusion.

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Table A1. Descriptive Statistics

NAME	MEAN	ST. DEV	MINIMUM	MAXIMUM
Share of Regular Soft Drinks				
S_{CO}	23.620	7.7979	8.2040	48.161
S_{PE}	23.031	6.2662	6.9120	40.578
S_{RC}	2.0200	1.6483	0.0730	9.7560
S_{DR}	3.5877	3.3598	0.2460	21.956
S_{SP}	3.9587	1.3766	1.3530	9.4000
S_{Su}	4.7037	2.4741	1.1020	14.190
S_{Md}	3.1004	2.3677	0.3870	12.621
S_{PL}	11.943	7.1442	0.3280	41.861
S_{AO}	23.710	7.4016	9.1570	45.135
Budget Share of Cola Segment				
S_{CO}	0.45233	0.11770	0.23047	0.78592
S_{PE}	0.44622	0.12764	0.11458	0.70968
S_{RC}	0.03347	0.02604	0.00192	0.16650
S_{DR}	0.06798	0.05435	0.00714	0.35644
Budget Share of Clear Segment				
S_{SP}	0.35139	0.14550	0.12417	0.72817
S_{Su}	0.39241	0.14803	0.12445	0.77707
S_{Md}	0.25620	0.13838	0.04202	0.54716
P_{Co}	3.7082	0.30871	2.7700	4.9330
P_{Pe}	3.6484	0.37114	2.6650	5.4600
P_{RC}	3.3122	0.43078	2.2310	5.5000
P_{Dr}	3.9696	0.45856	2.8450	5.5800
P_{Sp}	3.6212	0.32332	2.6020	4.9180
P_{Su}	3.7241	0.37407	2.8280	5.0470
P_{Md}	3.8813	0.41358	2.8620	5.3210
P_{PL}	2.3436	0.26526	1.6590	3.9460
P_{AO}	3.5523	0.39812	2.1000	5.0140
P_{Cola}	3.6749	0.32016	2.7714	5.1110
P_{Clear}	3.7089	0.32148	2.8075	4.9382
U/Vol_{Co}	2.1910	0.35786	1.1287	3.3943
U/Vol_{Pe}	2.1882	0.35237	1.0829	2.8659
U/Vol_{Su}	2.4933	0.27387	1.4742	3.2787

(continues)

Table A1. *(continued)*

NAME	MEAN	ST. DEV	MINIMUM	MAXIMUM
U/Vol_{RC}	2.4496	0.38113	1.2307	3.7838
U/Vol_{Sp}	2.2864	0.30654	1.0904	3.6707
U/Vol_{Dr}	2.2880	0.32699	0.93088	2.8221
U/Vol_{Md}	2.2277	0.35738	1.0735	2.8534
U/Vol_{PL}	5.6037	2.2363	2.3534	13.237
U/Vol_{AO}	3.5548	0.85705	2.1660	7.1323
U/Vol_{Cola}	2.2030	0.33797	1.1351	2.8564
U/Vol_{Clear}	2.3400	0.29695	1.2197	3.0162
%HISP	7.3196	9.6600	0.40000	48.700
Sup/Groc	75.824	5.7905	59.200	95.300
CR_4	64.520	13.145	23.900	88.100
S_w	21.682	3.0434	14.400	27.000
Exp_{Soda}	1.5181	0.20275	0.90873	2.1822
Exp_{Clear}	-0.63749	0.33530	-1.5960	0.18534
Exp_{Cola}	0.88285	0.26293	0.15409	1.6025
$AvWtPRed_{CO}$	27.306	6.7890	5.7960	81.507
$AvWtPRed_{Pe}$	26.990	6.6076	7.5230	45.417
$AvWtPRed_{RC}$	21.945	7.3842	0.00000	51.043
$AvWtPRed_{Dr}$	24.595	7.1114	7.4620	44.995
$AvWtPRed_{Sp}$	27.320	6.9804	9.5530	73.659
$AvWtPRed_{Su}$	25.874	6.9809	9.6640	47.599
$AvWtPRed_{Md}$	25.593	6.5842	10.840	45.378
$AvWtPRed_{PL}$	21.237	6.8341	5.9910	62.974
$AvWtPRed_{AO}$	23.595	4.9822	10.472	49.315
$AvWtPRed_{Cola}$	26.858	6.1395	7.3195	52.004
$AvWtPRed_{Clear}$	26.551	6.1673	10.971	41.676
$\%VolMer_{Co}$	33.454	41.272	0.00000	99.230
$\%VolMer_{Pe}$	83.664	8.0280	55.966	99.728
$\%VolMer_{RC}$	64.080	21.256	0.00000	96.628
$\%VolMer_{Dr}$	63.235	18.263	2.6050	95.333
$\%VolMer_{Sp}$	79.544	9.5659	35.503	97.152
$\%VolMer_{Su}$	69.313	13.632	13.080	96.355
$\%VolMer_{Md}$	71.165	13.219	10.208	94.400
$\%VolMer_{PL}$	50.222	20.453	1.4210	98.347
$\%VolMer_{AO}$	54.589	11.060	24.085	88.707
$\%VolMer_{Cola}$	60.154	20.739	19.653	98.592
$\%VolMer_{Clear}$	74.891	9.5882	31.175	94.589
$Capt_{Coke}$	0.43111	0.49551	0.00000	1.0000
$Capt_{Pep}$	0.56222	0.49639	0.00000	1.0000
$Capt_{Cola}$	0.51535	0.39891	0.00000	1.0000
$Capt_{Clear}$	0.51382	0.40715	0.00000	1.0000

Table A2.1. Cola Brands: Two Stage Budget Model for Regular Soft Drinks (no Average Weighted Price Reduction or Percent Volume with any Merchandising.

	Dependent Variable							
	S_{Co}	S_{Pe}	S_{RC}	S_{Dr}	P_{Co}	P_{Pe}	P_{RC}	P_{Dr}
P_{Co}	-1.0656	0.7537	0.1768	0.1351		1.0369	-1.7733	1.4744
	(-10.08)**	(9.479)**	(6.363)**	(3.602)**		(20.68)**	(-5.967)**	(11.32)**
P_{Pe}	0.7537	-0.7638	-0.0415	0.0516	0.7577		0.9372	-0.7229
	(9.479)**	(-10.47)**	(-1.831)	(1.775)	(21.15)**		(3.842)**	(-5.165)**
P_{RC}	0.1768	-0.0415	-0.0840	-0.0513	-0.1908	0.1448		0.4133
	(6.363)**	(-1.831)	(-5.972)**	(-3.645)**	(-4.220)**	(2.519)*		(6.373)**
P_{Dr}	0.1351	0.0516	-0.0513	-0.1354	0.4575	-0.3445	1.3376	
	(3.602)**	(1.775)	(-3.645)**	(-5.615)**	(11.09)**	(-5.367)**	(9.681)**	
Exp_{Cola}	-0.0196	0.0076	-0.0146	0.0242	0.0195	-0.0382	0.0314	-0.0024
	(-1.888)	(1.318)	(-4.168)**	(6.185)**	(1.637)	(-2.783)**	(1.206)	(-0.121)
%Hisp	0.0140	-0.0136	-0.0023	0.0019	0.0100	-0.0100	0.0183	-0.0137
	(6.601)**	(-8.786)**	(-3.730)**	(2.565)*	(4.430)**	(-3.820)**	(3.883)**	(-3.918)**
U/Vol_{Co}					0.0034			
					(3.085)**			
U/Vol_{Pe}						0.0035		
						(1.984)*		

(continues)

Table A2.1. *(continued)*.

	Dependent Variable							
	S_{Co}	S_{Pe}	S_{RC}	S_{Dr}	P_{Co}	P_{Pe}	P_{RC}	P_{Dr}
U/Vol_{RC}							-0.0036	
							(-0.423)	
U/Vol_{Dr}								-0.0045
								(-1.361)
Sw					-0.0003	0.0006	-0.0025	0.0005
					(-0.775)	(1.293)	(-2.340)*	(0.673)
Sup/Groc					-0.00005	-0.0001	-0.0014	0.0008
					(-0.227)	(-0.586)	(-2.466)*	(2.120)*
CR_4					-0.0011	0.0012	-0.0011	0.0013
					(-4.051)**	(3.847)**	(-1.575)	(2.980)**
$Capt_{Co}$					0.0012			
					(0.775)			
$Capt_{Pe}$						0.0006		
						(0.562)		

Table A2.2 Clear Brands: Two Stage Budget Model for Regular Soft Drinks (no Average Weighted Price Reduction or Percent Volume with any Merchandising.

	Dependent Variable					
	S_{Sp}	S_{Su}	S_{Md}	P_{Sp}	P_{Su}	P_{Md}
P_{Sp}	-0.0108	0.0975	-0.0868		1.3009	0.2003
	(-0.180)	(2.359)*	(-2.036)*		(18.61)**	(2.931)**
P_{Su}	0.0975	-0.6219	0.5244	0.5683		-0.0607
	(2.359)*	(-12.17)**	(15.847)**	(19.75)**		(-1.302)
P_{Md}	-0.0868	0.5244	-0.4376	0.2587	-0.0641	
	(-2.036)*	(15.85)**	(-10.279)**	(3.885)**	(-0.627)	
Exp_{Clear}	0.0529	-0.1674	0.1145	-0.0288	0.0037	-0.1521
	(6.195)**	(-15.67)**	(12.746)**	(-1.861)	(0.176)	(-10.05)**
%Hisp	-0.0016	-0.0153	0.0169	0.0141	-0.0223	-0.0044
	(-0.714)	(-5.623)**	(7.329)**	(5.188)**	(-6.328)**	(-1.697)

(contiues)

Table A2.2. (*Continued*)

	Dependent Variable					
	S_{Sp}	S_{Su}	S_{Md}	P_{Sp}	P_{Su}	P_{Md}
U/Vol_{Sp}				-0.0074 (-1.322)		
U/Vol_{Su}					-0.0035 (-0.420)	
U/Vol_{Md}						0.0010 (0.118)
Sw				0.0012 (2.442)*	0.0010 (1.629)	-0.0028 (-5.509)**
Sup/Groc				0.0003 (0.908)	-0.0002 (-0.442)	-0.0011 (-3.563)**
CR_4				0.0008 (2.316)*	-0.0007 (-1.722)	-0.0003 (-0.752)
$Capt_{Co}$				0.0007 (0.101)		
$Capt_{Pe}$						-0.0037 (-0.663)

Table A2.3 Segments: Two Stage Budget Model for Regular Soft Drinks (no Average Weighted Price Reduction or Percent Volume with any Merchandising.

Segments	Dependent Variable							
	S_{Cola}	S_{Clear}	S_{pl}	S_{ao}	P_{Cola}	P_{Clear}	P_{pl}	P_{ao}
P_{Cola}	-0.8631 (-24.20)**	0.1271 (9.939)**	0.1270 (6.968)**	0.6090 (17.88)**		1.5481 (27.59)**	0.7965 (6.706)**	-0.8487 (-12.27)**
P_{Clear}	0.1271 (9.939)**	-0.2593 (-24.88)**	0.0597 (7.202)**	0.0724 (5.340)**	0.5060 (23.42)**		-0.8034 (-11.47)**	0.6315 (21.46)**
P_{pl}	0.1270 (6.968)**	0.0597 (7.202)**	-0.0122 (-0.703)**	-0.1745 (-8.325)**	0.1301 (4.087)**	-0.5650 (-10.23)**		0.5362 (12.75)**
P_{ao}	0.6090 (17.88)**	0.0724 (5.340)**	-0.1745 (-8.325)**	-0.5070 (-11.664)**	-0.4540 (-9.613)**	1.1852 (21.51)**	1.2710 (15.05)**	
Exp_{Soda}	0.0190 (2.049)*	-0.0014 (-0.460)	0.0003 (0.046)	-0.0179 (-1.856)	-0.1576 (-12.28)**	0.2661 (13.02)**	0.1939 (7.668)**	-0.1912 (-12.08)**
%Hisp	0.0079 (4.301)**	0.0008 (1.572)	0.0047 (4.793)**	-0.0134 (-7.334)**	0.0072 (3.366)**	-0.0138 (-4.165)**	-0.0131 (-3.663)**	0.0083 (3.115)**
U/Vol_{Cola}					-0.0030 (-0.668)			
U/Vol_{Clear}						0.0030 (0.525)		

(*continues*)

Table A2.3 (*continued*).

Segments	Dependent Variable							
	S_{Cola}	S_{Clear}	S_{pl}	S_{ao}	P_{Cola}	P_{Clear}	P_{pl}	P_{ao}
U/Vol_{pl}							-0.0008	
							(-0.498)	
U/Vol_{ao}								-0.0008
								(-0.718)
Sw					-0.0016	0.0054	0.0056	-0.0045
					(-3.349)	(7.589)**	(7.517)**	(-8.331)**
Sup/Groc					0.0001	-0.0002	-0.0003	-0.0005
					(0.465)	(-0.374)	(-0.768)	(-0.145)
CR_4					0.0005	-0.0011	-0.0006	0.0010
					(1.791)	(-2.249)*	(-1.222)	(2.755)**
$Capt_{Cola}$					0.0015			
					(0.266)			
$Capt_{Clear}$						0.0041		
						(0.579)		

** significant at 1%
* significant at 5%

Table A3. Unilateral Elasticities, Two Stage Model, (no Average Weighted Price Reduction and Percent Volume with any Merchandising)

	Price						
	Coke	Pepsi	RC	Dr Pepper	Sprite	Seven Up	Mt Dew
Quantity							
Coke	-4.0164	1.0255	0.3474	0.1921	0.0753	0.0865	0.0588
	(-17.67)**	(5.534)**	(5.576)**	(2.287)**	(9.699)**	(9.699)**	(9.699)**
Pepsi	0.9520	-3.4274	-0.1419	-0.0028	0.0805	0.0924	0.0629
	(5.374)**	(-20.37)**	(-2.754)**	(-0.043)	(9.799)**	(9.799)**	(9.799)**
RC	5.0792	-1.4354	-3.5227	-1.5665	0.0444	0.0510	0.0347
	(6.373)**	(-2.093)*	(-8.271)**	(-3.714)**	(4.696)**	(4.696)**	(4.696)**
Dr. Pepper	0.8614	-0.3353	-0.8298	-3.1712	0.1068	0.1226	0.0834
	(1.612)	(-0.770)	(-3.959)**	(-8.889)**	(9.122)**	(9.122)**	(9.122)**
Sprite	0.5342	0.5185	0.0353	0.0859	-1.9024	-0.7220	-0.9255
	(9.754)**	(9.754)**	(9.754)**	(9.754)**	(-10.65)**	(-6.206)**	(-7.238)**
Seven Up	0.2662	0.2584	0.0176	0.0428	-0.0096	-2.8861	1.1268
	(8.815)**	(8.815)**	(8.815)**	(8.815)**	(-0.083)**	(-22.44)**	(12.33)**
Mt Dew	0.6719	0.6521	0.0444	0.1081	-1.4152	0.8155	-3.5412
	(9.770)**	(9.770)**	(9.770)**	(9.770)**	(-8.052)**	(6.372)**	(-20.38)**

(*continues*)

Table A3. *(continued)*

	COLA	CLEAR	PL	AO
COLA	-2.5768	0.2252	0.2264	1.0909
	(-39.69)**	(9.663)**	(6.799)**	(17.902)**
CLEAR	1.0234	-3.0732	0.4786	0.5823
	(10.064)**	(-36.49)**	(7.110)**	(5.4722**
PL	1.5840	0.7451	-1.1520	-2.1803
	(6.992)**	(7.133)**	(-5.260)**	(-8.508)**
AO	2.5691	0.3100	-0.7185	-2.0862
	(17.605)**	(5.415)**	(-8.136)**	(-11.759)**

** significant at 1%
* significant at 5%

Table A4. Brand Level Elasticities and Indices of Market Power, Two Stage Syystem (no PRed or %Merc)

	(1) Unilateral	(2) Observed	(3) Fully Collusive	(4) Rothschild Index (col3/col1)	(5) Cotterill Index (col3/col2)	(6) Chamberlin Quotient 1-(col2/col1)
Coke	-4.0164 (-17.67)**	-2.6923 (-12.74)**	-2.5735	0.6408	0.9559	0.3297
Pepsi	-3.4274 (-20.37)**	-2.5046 (-19.32)*	-2.5457	0.7428	1.0164	0.2692
RC	-3.5227 (-8.271)**	-5.3473 (-10.68)**	-2.2446	0.6372	0.4198	-0.5180
Dr Pepper	-3.1712 (-8.889)**	-3.6069 (-8.125)**	-2.6015	0.8204	0.7213	-0.1374
Sprite	-1.9024 (-10.65)**	-1.6825 (-14.18)**	-2.8632	1.5051	1.7018	-0.1156
Seven Up	-2.8861 (-22.44)**	-2.7514 (-24.62)**	-3.0527	1.0577	1.1095	0.0467
Mt Dew	-3.5412 (-20.38)**	-3.8827 (-16.81)**	-3.1659	0.8940	0.8154	-0.0964

Table A5. Regression Results for Full Regular Soda System

Demand Equations

	Dependent Variable								
	S_{Co}	S_{Pe}	S_{RC}	S_{Dr}	S_{Sp}	S_{Su}	S_{Md}	S_{pl}	S_{ao}
P_{Co}	-0.3638	0.2169	0.0189	0.0116	-0.0439	0.0146	0.0079	0.0330	0.1048
	(-13.29)**	(10.46)**	(2.351)*	(1.326)	(-5.206)**	(1.503)	(0.947)	(2.504)*	(3.918)**
P_{Pe}	0.2169	-0.4461	-0.0014	0.0285	0.0444	-0.0303	0.0402	-0.0016	0.1494
	(10.46)**	(-17.31)**	(-0.177)	(3.209)**	(5.549)**	(-3.125)**	(4.387)**	(-0.128)	(6.009)**
P_{RC}	0.0189	-0.0014	-0.0598	0.0181	0.5773	-0.0052	0.0143	-0.0236	0.0329
	(2.351)*	(-0.177)	(-10.16)**	(3.962)**	(1.384)	(-1.169)	(3.029)**	(-5.171)**	(3.278)**
P_{Dr}	0.0116	0.0285	0.1807	-0.0515	0.0102	-0.0238	0.0028	0.0167	-0.0127
	(1.326)	(3.209)**	(3.962)**	(-7.381)**	(2.263)*	(-4.898)**	(0.560)	(3.393)**	(-1.182)
P_{Sp}	-0.0439	0.0444	0.0058	0.0102	-0.0666	0.0118	0.0095	0.0186	0.0102
	(-5.206)**	(5.549)**	(1.384)	(2.263)**	(-11.00)**	(2.674)**	(1.926)	(4.310)**	(1.086)
P_{Su}	0.0146	-0.0303	-0.0052	-0.0238	0.0118	-0.1058	-0.0013	-0.0235	0.1634
	(1.503)	(-3.125)**	(-1.169)	(-4.898)**	(2.674)**	(-15.21)**	(-0.272)	(-3.881)**	(14.10)**
P_{Md}	0.0079	0.0402	0.0143	0.0028	0.0095	-0.0013	-0.0454	0.0161	-0.0443
	(0.947)	(4.387)**	(3.029)**	(0.560)	(1.926)	(-0.272)	(-5.591)**	(3.558)**	(-4.344)**
P_{pl}	0.0330	-0.0016	-0.0236	0.0167	0.0186	-0.0235	0.0161	-0.1067	0.0708
	(2.504)*	(-0.128)	(-5.171)**	(3.393)**	(4.310)**	(-3.881)**	(3.558)**	(-8.189)**	(3.986)**
P_{ao}	0.1048	0.1494	0.0329	-0.0127	0.0102	0.1634	-0.0443	0.0708	-0.4745
	(3.918)**	(6.009)**	(3.278)**	(-1.182)	(1.086)	(14.10)**	(-4.344)**	(3.986)**	(-11.156)**
Exp_{Soda}	0.0066	0.0230	-0.0003	0.0042	0.0064	-0.0121	0.0126	0.0271	-0.0675
	(1.113)	(4.219)**	(-0.159)	(2.085)*	(-3.489)**	(-4.828)**	(6.637)**	(5.506)**	(-8.169)**
%Hisp	0.0041	-0.0061	-0.0002	0.0011	0.0011	-0.0151	0.0003	0.0059	-0.0047
	(4.014)**	(-6.889)**	(-0.659)	(3.605)**	(3.977)**	(-4.033)**	(1.167)	(7.219)**	(-3.466)**

Price Reaction Equations

	Dependent Variable								
	P_{Co}	P_{Pe}	P_{RC}	P_{Dr}	P_{Sp}	P_{Su}	P_{Md}	P_{pl}	P_{ao}
P_{Co}		0.2211	-0.2169	-0.1907	-0.3503	-0.3302	0.0384	0.0712	0.1145
		(3.703)**	(-1.795)	(-2.154)*	(-4.734)**	(-3.967)**	(0.703)	(0.674)	(1.749)
P_{Pe}	0.4351		0.2814	0.5258	0.6197	-0.1908	0.3246	-0.2783	0.1075
	(7.241)**		(2.206)*	(5.746)**	(7.029)**	(-2.243)*	(6.513)**	(-2.567)*	(1.577)
P_{RC}	0.0344	0.1211		0.0063	-0.0561	0.1146	0.0283	-0.1113	0.0345
	(0.826	(2.881)**		(0.104)	(-0.985)	(2.046)*	(0.735)	(1.605)	(0.825)
P_{Dr}	-0.0219	0.2160	-0.0247		-0.0441	-0.1007	0.0556	0.1454	0.1390
	(-0.557)	(5.340)**	(-0.311)		(-0.809)	(-1.864)	(1.509)	(2.150)*	(3.452)**
P_{Sp}	-0.0573	0.0554	-0.0573	0.0880		0.3889	0.0095	-0.0534	-0.0814
	(-1.469)	(1.159)	(-0.663)	(1.347)		(6.724)**	(0.231)	(-0.689)	(-1.807)
P_{Su}	0.0555	-0.1205	0.0740	-0.0964	0.2653		-0.0251	-0.0705	0.3056
	(1.557)	(-3.249)**	(1.048)	(-1.868)	(5.837)**		(-0.769)	(1.134)	(9.174)**
P_{Md}	-0.2153	0.1333	-0.3427	-0.5930	-0.2485	-0.0688		0.0568	0.0638
	(-3.826)**	(2.262)**	(-3.074)**	(-7.015)**	(-3.128)**	(-0.899)		(0.600)	(1.117)
P_{pl}	0.0147	0.0270	-0.1687	0.1331	-0.0234	0.0710	0.0821		0.1206
	(0.428)	(0.745)	(-2.546)*	(2.672)**	(-0.513)	(1.512)	(2.633)**		(3.320)**
P_{ao}	0.358	0.1867	0.5570	0.9182	0.3312	1.0850	0.2818	0.3482	
	(4.866)**	(2.357)*	(3.760)**	(8.860)**	(3.273)**	(12.50)**	(4.123)**	(2.593)**	
Exp_{Soda}	-0.0471	-0.0123	0.0031	-0.0276	-0.0414	0.0322	-0.0374	0.0424	-0.0590
	(-3.233)**	(-0.766)	(0.113)	(-1.392)	(-2.153)*	(1.692)	(-2.998)**	(1.714)	(-4.370)**

(continued)

Table A5. *(continued)*

Price Reaction Equations

	Dependent Variable								
	P_{Co}	P_{Pe}	P_{RC}	P_{Dr}	P_{Sp}	P_{Su}	P_{Md}	P_{pl}	P_{ao}
U/Vol_{Co}	-0.0200 (-2.995)**								
U/Vol_{Pe}		0.0030 (0.376)							
U/Vol_{RC}			-0.0157 (-1.509)						
U/Vol_{Dr}				-0.0029 (-0.335)					
U/Vol_{Sp}					-0.0268 (-3.218)**				
U/Vol_{Su}						-0.0244 (-2.350)*			
U/Vol_{Md}							0.0103 (1.478)		
U/Vol_{pl}								0.0127 (6.697)**	
U/Vol_{ao}									-0.0052 (-2.193)*
$AvWtPRed_{Co}$	-0.0027 (-11.92)**								
$AvWtPRed_{Pe}$		-0.0024 (-7.555)**							
$AvWtPRed_{RC}$			-0.00004 (-0.117)						
$AvWtPRed_{Dr}$				-0.0022 (-6.712)**					
$AvWtPRed_{Sp}$					-0.0031 (-10.38)**				
$AvWtPRed_{Su}$						-0.0018 (-6.091)**			
$AvWtPRed_{Md}$							-0.0018 (-7.647)**		
$AvWtPRed_{pl}$								-0.0007 (-2.433)*	
$AvWtPRed_{ao}$									-0.0010 (3.134)**
$\%VolMer_{Co}$	-0.0035 (-14.03)**								
$\%VolMer_{Pe}$		-0.0024 (-8.168)**							
$\%VolMer_{RC}$			-0.0018 (-10.57)**						
$\%VolMer_{Dr}$				-0.0022 (-11.82)**					
$\%VolMer_{Sp}$					-0.0039 (-15.32)**				
$\%VolMer_{Su}$						-0.0028 (-12.89)**			
$\%VolMer_{Md}$							-0.0022 (-16.96)**		
$\%VolMer_{pl}$								-0.0016 (-9.956)**	

(continues)

Table A5. *(continued)*

%VolMer$_{ao}$									-0.0005
									(-2.652)**
Sw	0.0013	0.0029	0.0025	0.0027	0.0023	0.0030	0.0016	0.0033	-0.0031
	(2.903)**	(6.125)**	(2.944)**	(4.138)**	(3.911)**	(4.822)**	(3.841)**	(4.336)**	(-7.323)**
Sup/Groc	0.0003	0.0002	-0.0005	0.0012	0.0002	0.0020	-0.0001	0.0003	-0.0005
	(1.121)	(0.735)	(-1.014)	(3.379)**	(0.613)	(6.061)**	(-0.525)	(0.664)	(-1.945)
CR$_4$	0.0004	0.0005	0.0020	0.0015	0.0013	-0.0004	-0.0002	0.00005	0.0002
	(1.318)	(1.521)	(3.602)**	(3.679)**	(3.143)**	(-1.014)	(-0.058)	(0.100)	(0.872)
Capt$_{Co}$	0.0140				0.0308				
	(1.207)				(1.899)				
Capt$_{Pe}$		-0.0020					0.0001		
		(-0.386)					(0.028)		

** significant at 1%
* significant at 5%

Table A6. Unilateral Elasticities, Full System

	Price								
	Coke	Pepsi	RC	Dr Pepper	Sprite	Seven Up	Mt Dew	PL	AO
Quantity									
Coke	-2.4465	0.8519	0.0743	0.0450	-0.1748	0.0563	0.0305	0.1284	0.4086
	(-22.67)**	(10.31)**	(2.328)*	(1.294)	(-5.242)**	(1.464)	(0.921)	(2.429)*	(3.899)**
Pepsi	0.8694	-2.8606	-0.0076	0.1136	0.1789	-0.1294	0.1624	-0.0142	0.5926
	(10.22)**	(-26.79)**	(-0.230)	(3.105)**	(5.434)**	(-3.231)**	(4.306)**	(-0.272)	(5.869)**
RC	1.0131	-0.0717	-4.1905	0.9651	0.3088	-0.2752	0.7650	-1.2566	1.7586
	(2.365)*	(-0.166)	(-13.30)**	(3.966)**	(1.386)	(-1.160)	(3.035)**	(-5.102)**	(3.351)**
Dr. Pepper	0.2649	0.6883	0.4507	-2.2937	0.2512	-0.6023	0.0677	0.4111	-0.3424
	(1.208)	(3.075)**	(3.933)**	(-13.13)**	(2.224)*	(-4.920)**	(0.533)	(3.280)**	(-1.297)
Sprite	-1.1042	1.0397	0.1372	0.2413	-2.6238	0.2799	0.2258	0.4394	0.2102
	(-5.414)**	(5.322)**	(1.351)	(2.207)*	(-17.83)**	(2.594)**	(1.884)	(4.135)**	(0.938)
Seven Up	0.3544	-0.5496	-0.0995	-0.4699	0.2485	-3.1164	-0.0169	-0.4532	3.3465
	(1.825)	(-2.803)**	(-1.114)*	(-4.799)**	(2.789)**	(-22.19)**	(-0.183)	(-3.672)**	(14.58)**
Mt Dew	0.1394	1.0906	0.4134	0.0688	0.2643	-0.0551	-2.3448	0.4444	-1.3897
	(0.568)	(4.023)**	(2.971)**	(0.461)	(1.820)	(-0.405)	(-9.852)**	(3.292)**	(-4.715)**
PL	0.3263	-0.1022	-0.3007	0.1956	0.2186	-0.3102	0.1901	-2.3590	0.8031
	(1.995)*	(-0.652)	(-5.266)**	(3.167)**	(4.056)**	(-4.100)**	(3.351)**	(-14.30)**	(3.683)**
AO	0.5059	0.6881	0.1417	-0.0414	0.0539	0.6921	-0.1744	0.3164	-1.9023
	(4.537)**	(6.601)**	(3.393)**	(-0.929)	(1.381)	(14.34)**	(-4.114)**	(4.226)**	(-10.92)**

** significant at 1%
* significant at 5%

Table A7. Brand Level Elasticities and Indices of Market Power, Full System

	(1) Unilateral	(2) Observed	(3) Fully Collusive	(4) Rothschild Index (col3/col1)	(5) Cotterill Index (col3/col2)	(6) Chamberlin Quotient 1-(col2/col1)
Coke	-2.4465 (-22.67)**	-2.1831 (-21.23)**	-1.5743	0.6435	0.7211	0.1077
Pepsi	-2.8606 (-26.79)**	-2.1689 (-21.01)*	-1.7538	0.6131	0.8086	0.2418
RC	-4.1905 (-13.30)**	-3.9849 (-12.63)**	-1.7333	0.4136	0.4349	0.0491
Dr Pepper	-2.2937 (-13.13)**	-2.4202 (-15.50)**	-1.1656	0.5082	0.4816	-0.0550
Sprite	-2.6238 (-17.83)**	-1.8717 (-13.41)**	-2.2012	0.8389	1.1760	0.2866
Seven Up	-3.1164 (-22.19)**	-2.0969 (-12.51)**	-2.8423	0.9120	1.3555	0.3271
Mt Dew	-2.3448 (-9.852)**	-2.5373 (-9.698)**	-2.0766	0.8856	0.8184	-0.0820

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