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**STRATEGIC PRICING BEHAVIOR  
UNDER ASSET VALUE MAXIMIZATION**

**AN EMPIRICAL ASSESSMENT OF THE U.S. RETAIL MARGARINE  
AND BUTTER MARKETS**

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**Keywords:** Market Value Maximization, AIDS, FIML, Model Selection.

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# Strategic Pricing Behavior under Asset Value Maximization

An Empirical Assessment of the U.S. Retail Margarine and Butter Markets

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## Abstract

This article investigates a comprehensive assessment of firm strategic behavior under financial market uncertainty. A general theoretical model of market value maximization (MVM) is constructed using a traditional capital asset pricing format. The model built on the nonlinear Almost Ideal Demand Systems (AIDS) and structural first-order conditions is developed. By full information maximum likelihood (FIML) estimation, the model evaluates pricing strategies in the U.S. margarine and butter retail markets using 4-week interval scanner data from 1998 to 2002. The profit maximization model is rejected in favor of the MVM structure, which indicates that financial market uncertainty plays an important role in the pricing behavior of this industry. We estimate the price elasticities of demand for leading brands and investigate the degree of market power in this industry.

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## Introduction

The vast majority of industrial organizational theory and empirics is constructed on the premise that firms maximize profits. In practice, however, firm managers driven by concerns with job security and incentive packages instead may focus on equity valuation, which is only partially derived by profitability. Indeed, Cable and Stiegert (2005) report that compensation shares of CEOs in the U.S. food industry since 2000 represent 40% of total compensation only. The remaining 60% is comprised of bonuses, stock offerings and stock options. While it might be difficult to tie bonuses to a single objective across all firms, managers with stock holdings and stock options have a clear personal incentive to raise the value of equity shares. Thus, instead of thinking in simplistic terms of raw profitability alone, managers may be interested in other objectives such as stability of profits and dividend flows, demonstratable growth in profits, and high anticipated earnings. As such, the firm manager may see a trade-off between short-term profit-maximizing decisions and attempting to endogenously control or minimize risk. This is not a new concept. Brealey and Myers (2000) make the point that stockholding by employees generates a conflict of interest with shareholders, and that shareholders care about market risk only because they can diversify their portfolio. Because a manager cannot diversify base salary and bonus and may be unable to dispose of company shares or out-of-the-money options, they must be concerned with both diversifiable and market risk.

This article provides a comprehensive assessment of a firm's strategic behavior under financial market uncertainty for a mature industry. The theoretical structure flows from Wang and Stiegert's (2005) market value maximization (MVM) model. The model employs an objective function derived from the traditional capital asset pricing model (CAPM), independently developed by Sharpe (1964), Lintner (1965),

and Mossin (1966). In the rapidly changing industries, opportunities for huge profit payoffs have much to do with advancing a technology and winning races in patents, R&D, and building growth options. As Fama and French (2004) point out, the CAPM has had limited success in modeling equity values in these industries. Managers in mature industries tend to observe stock cycles between underpricing (low book value to market value) and correct values when hard times come and pass. For these industries, profit levels are an important but limited objective. Thus, managers seeking to enhance the value of firm equity may look to consistent and stable growth, and to creating perceptions about stable management governance structures and other factors that increase the actual/anticipated earnings of a firm while decreasing the actual/anticipated variance of earnings.

The single-period CAPM framework came under considerable debate during the 1990s.<sup>1</sup> As pointed out in Frankfurter (1995), nevertheless, the CAPM remains an acceptable approach for evaluating and pricing financial assets when compared with all other methodologies. Obviously, if risk can be fully arbitrated, then firms would worry little about risk and could simply follow profit objectives. No anecdotal or empirical evidence suggest that risk transfer markets can now or will ever fully achieve such a theoretical objective. In this article, the CAPM structure is used primarily as a tool to describe and structure the financial market objective. Financial market risk is then allowed to enter into product market decisions in order to measure their outcome. Therefore, even if CAPM is but a rough gauge of financial market activity, the theoretical effects would not generally be overturned by the use of a better or more precise measure of financial market behavior. Empirically, the effects of financial market risk enter very simply into the demand system and follow the CAPM

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<sup>1</sup>See Fama and French (1992), Black (1993a, 1993b), and Kothari, Shanken and Sloan (1995) for details.

prescription for risk management, which allows for a direct test of financial market influence on product markets.

The above described manager behavior tends to mirror the objectives of investors looking to build an efficient portfolio of assets under the CAPM. If the manager can limit risk through *intrafirm* behavior while maintaining profit levels and subsequent stock values appreciate, he may be rewarded through stock holdings or options and job-security increases. Furthermore, lower beta values convert to greater access to capital at lower costs, thus creating a form of scale economies which drive out smaller firms (see Sherer and Ross, 1990, page 129 for a discussion and listed citations), leading to increasing concentration, increased current and future period profits, and ever-increasing equity values. As a result, managers of all firms in an industry face additional penalties for “rocking the boat” which implies that, to manage risk, firm pricing can be more collusive than standard industrial organization models (Wang and Stiegert, 2005).

We implement the MVM model for the U.S. margarine and butter retail markets using 4-week interval scanner data from 1998 to 2002 and incorporating a nonlinear Almost Ideal Demand Systems (AIDS) structure with income endogeneity. By full information maximum likelihood (FIML) estimation, the AIDS model evaluates pricing strategies, provides estimates of the price elasticities of demand for leading firms, and investigates the degree of market power in this industry. Testable hypotheses generated from the theoretical structure are evaluated. By the Wald and likelihood ratio tests, we can test if a restricted model of profit maximization differs from the unrestricted MVM model with risk considerations. We also use Vuong and Wald tests to select from a menu of benchmark equilibrium outcomes (i.e. Bertrand, Stackelberg, etc.) or a conjectural variations model as appropriate to best describe the structure of the market. Because Bertrand pricing is commonly assumed in retail markets but

was rejected in our study, the results of our model are compared to the Bertrand pricing results. The comparison indicates fairly large differences in measured outcomes of elasticities and Lerner indexes of market power. This underscores the importance of getting the market structure correct before proceeding with subsequent empirical analysis.

The remainder of this article is organized as follows. In the next section, the MVM model and demand system are presented. Discussions of the data used in this article follow. Next, all estimation procedures and empirical results are discussed and reported. Finally, the article closes with some concluding remarks and suggestions for further research.

## Conceptual Model

*Assumptions:* Because the fully-flexible AIDS model and structural first-order conditions are highly nonlinear, some assumptions on the supply/cost side are required in order to reduce the complexity of analysis and make the empirical implementation more tractable. Therefore, the model used in this study operates under the following assumptions:

- (1) Demand shifters are exogenous.
- (2) Marginal cost is constant.
- (3) Firms have full information about own/rivals' pricing strategies and cost.
- (4) Firms play pure strategies only.
- (5) Firms use the same pricing strategies in the study period.
- (6) The demand uncertainty is additively linear.

Assumption 1 does not apply to the endogeneity of expenditures. Assumption 2 simplifies the supply of raw material and promotion expenditure used to determine marginal costs and subsequently the output-market's structural characteristics. This

assumption is common and performs reasonably well in structural market analysis, for example, Gasmi, Laffont, and Vuong (1992) and Vilcassim, Kadiyali, and Chintagunta (1999). Assumptions 3 through 5 are implemented to facilitate the analysis of firms' strategies. With full information on own/rivals' pricing strategies and cost, we need not deal with games with incomplete information. Assumption 4 eliminates the need for formal tests of mixed strategies. Assumption 5 implies neither mergers nor acquisitions are considered. For example, this study does not consider the well-known case of Dairy Farmers of America's (DFA) proposal to purchase Sodiaal North America brands in the Philadelphia and New York metropolitan market area in year 2000.

Uncertainty about demand must be incorporated into the MVM analysis. Because we assume the managers of each firm know both the pricing strategies of other firms (i.e., market structure is known) and the prices of raw materials, so any uncertainty reflects varying quantities demanded only. To facilitate the analysis, by assumption 6 the uncertainty is additively linear, i.e., demand is defined by  $\tilde{X} = X + \tilde{e}$ , and random variable  $\tilde{e}$  is normally distributed, with a mean of zero.

*The Objective Function:* Following Wang and Stiegert (2005), the MVM model assumes a decision maker maximizing the firm's equilibrium value in the capital market. To model this, capital value is priced according to the capital asset pricing model (CAPM) posited by Sharpe (1964), Lintner (1965) and Mossin (1966). Thus, the MVM firm  $i$  maximizes

$$V_i = \frac{1}{1+r} [E(\tilde{\pi}_i) - \lambda \text{COV}(\tilde{\pi}_i, \tilde{r}_m)], \quad (1)$$

where  $r$  is the risk-free interest rate,  $\tilde{\pi}_i$  is the stochastic perpetual flow of net earnings,  $\lambda$  is the equilibrium shadow price of market risk reduction, defined by  $\lambda = [E(\tilde{r}_m) - r]/\sigma_m^2$ , and  $\tilde{r}_m$  is the stochastic rate of return of the market portfolio.

Firm  $i$ 's profits are given by

$$\tilde{\pi}_i = (p_i - c_i)(X_i + \tilde{e}_i) - U_i, \quad (2)$$

where  $p_i$  is price of goods  $X_i$ ,  $c_i$  is marginal cost, and  $U_i$  is firm  $i$ 's fixed cost. Firm  $i$  faces demand function  $X_i = X_i(p_i, p_{-i})$ , where  $X_i(\cdot)$  can be derived from AIDS equation (16) discussed below;<sup>2</sup>  $p_{-i}$  is the pricing strategy of all rival firms other than firm  $i$ .

The first-order conditions in price of MVM are given by

$$X_i - \lambda \text{COV}(\tilde{e}_i, \tilde{r}_m) = -(p_i - c_i) \sum_{j=1}^n \frac{\partial X_i}{\partial p_j} \frac{\partial p_j}{\partial p_i}, \quad \forall i. \quad (3)$$

The pricing conjectural variation  $\eta_{ji} = \partial p_j / \partial p_i$  is given by firm  $i$ 's conjecture of firm  $j$ 's price response. Note that  $\eta_{ji} = 0$ ,  $\forall j \neq i$  under the Bertrand competition in price. Under the set-up of additively linear uncertainty  $\tilde{X} = X + \tilde{e}$ , the difference between MVM and profit maximization is the second term on the left side of the equation. Next, we introduce an additional parameter  $\theta$  to construct a general MVM presentation of first-order conditions.

$$X_i - \theta \lambda \text{COV}(\tilde{e}_i, \tilde{r}_m) = -(p_i - c_i) \sum_{j=1}^n \frac{\partial X_i}{\partial p_j} \frac{\partial p_j}{\partial p_i}, \quad \forall i, \quad (4)$$

where  $\theta$  measures the financial component's impact on the product market. A positive  $\theta$  implies that the decision maker considers financial market risk when making product market decisions. Equation (4) turns out to nest two benchmark objectives that firms could pursue. If  $\theta = 1$ , the market outcome is consistent with a full incorporation of the CAPM styled financial objectives. If  $\theta = 0$ , the market data reveals behavior consistent with pure profit maximization. By restricting  $\theta = 0$ , we can derive a straightforward likelihood ratio test of whether or not profit maximization is a valid assumption.

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<sup>2</sup>For notational simplicity, drop subscripts wherever doing so does not cause confusion.

*Marginal Costs:* We assume a constant linear marginal cost specification. This is a common approach and performs reasonably well in structural market analysis as mentioned above. The total cost function is

$$TC_i = U_i + c_i X_i, \quad (5)$$

where  $U_i$  is the firm-specific unobservable cost component and is assumed fixed (i.e., does not vary at the mean of the data).  $c_i$  is the observable marginal cost component and is specified as

$$c_i = \mu_0 + \mu_1 UPV_i + \sum_{j=1}^2 \mu_{2j} MCH_{ij}, \quad (6)$$

where  $UPV_i$  is the unit per volume and represents the average size of the purchase, and  $MCH_{ij}$  is in-store marketing, including price reductions and all other merchandising components (display and feature). This setting differs from that in the model with no cost information, for example, Nevo (2001). Nevo (2001) uses the information on the demand side to recover the constant cost by assuming the Bertrand competition, while the current study uses in-store marketing as a proxy to estimate the marginal cost. The latter provides flexibility in modeling the market structure and admits the empirical tests among the competing models.

*Demand:* In the New Empirical Industrial Organization (NEIO) literature, strategic behavior of firms is typically modeled by estimating demand and subsequently, the departure of demand from marginal costs. In many cases, researchers simplify the structural model by specifying ad-hoc or approximated demand specifications, and utilize reduced form conditions because of the prohibitive complexity of flexible demand and cost functions. However, ad-hoc demand specifications fail to satisfy all the requirements of consumer theory. Pioneered by Deaton and Muellbauer (1980a, b), the AIDS approach has been extensively used in the economics, marketing and

agricultural economics literature.<sup>3</sup> Recently, Dhar, Chavas, and Gould (2003) [DCG] estimated a NEIO pricing system for the U.S. carbonated soft drink industry and rejected the commonly applied assumption of expenditure exogeneity. The demand system in this study uses DCG as a key point of departure. In particular, we begin with the AIDS structure, which provides a fully flexible functional form for the purpose of demand estimations, and then incorporate risk concerns into the demand system. We also estimate expenditures as endogenous to the system.

Following the traditional Barten-Gorman AIDS model,<sup>4</sup> let  $V(p, M)$  and  $E(p, u)$  denote indirect utility and expenditure functions defined by

$$\begin{aligned} V(p, M) &= \max_x \{U(x) : p'x \leq M\}, \\ E(p, u) &= \min_x \{p'x : u(x) \geq u\}, \end{aligned}$$

where  $U(x)$  is the direct utility function,  $x$  is the consumption bundle of a representative consumer and  $x = (x_1, \dots, x_n)$ ,  $p$  is a corresponding  $n \times 1$  price vector,  $M$  is income, and  $u$  is a reference utility level. By duality,

$$E(p, V(p, M)) = M, \quad x_i(p, M) = h_i(p, V(p, M)), \quad i = 1, \dots, n, \quad (7)$$

where  $x_i(p, M)$  is Marshallian demand and compensated (Hicksian) demand  $h_i(p, u) = \partial E(p, u) / \partial p_i$  obtained via Shephard's lemma.

It is generally desirable that a demographically modified demand system works through scaling (Barten, 1964) and translating (Gorman, 1976). The Barten-Gorman modifications used here are given by:

$$w_i(M, p, d) = t_i(d) + s(d)w_i(M^*(p, d), p, d), \quad (8)$$

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<sup>3</sup>For example, Blanciforti and Green (1983), Alessie and Kapteyn (1991), Taube and MacDonald (1991), Browning (1991), Hunt-McCool, Kiker, and Ng (1994), and Cotterill, Putsis, and Dhar (2000).

<sup>4</sup>More discussions on the Barten-Gorman AIDS model can be found in Perali (2003).

where  $t_i(d)$  is a translating function,  $s(d)$  is a budget share scaling function,  $d$  is a vector of demographic variables, and  $M^*(p, d)$  is modified income.

The expenditure function for the demographically modified AIDS posited by Deaton and Muellbauer (1980a, b) is:

$$E(p, u, d) = \left[ a(p, d) (\Psi(u))^{b(p, d)} \right] p^T(p, d). \quad (9)$$

Applying the logarithm to equation (9) yields

$$\ln E(p, u, d) = [\ln a(p, d) + b(p, d) \ln (\Psi(u))] + \ln p^T(p, d). \quad (10)$$

In equation (10), the household-specific price index  $\ln a(p, d)$  is defined as

$$\ln a(p, d) = \delta + \sum_{i=1}^n \alpha_i \ln(p_i^*) + \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^n \gamma_{ij}^* \ln(p_i^*) \ln(p_j^*). \quad (11)$$

In addition,  $b(p, d)$  is a Cobb-Douglas price aggregator and specified as

$$b(p, d) = \exp \left[ \sum_{i=1}^n \beta_i \ln(p_i^*) \right], \quad (12)$$

and the logarithm of overhead function is given by

$$\ln p^T(p, d) = \sum_{i=1}^n t_i(d) \ln p_i^*. \quad (13)$$

The corresponding Barten-Gorman AIDS indirect utility function can be obtained from equation (10) by duality,

$$\begin{aligned} \ln V &= \ln (\Psi(u)) = \frac{\ln M^* - \ln a(p, d)}{b(p, d)} \\ &= \frac{\ln M^* - \left[ \delta + \sum_{i=1}^n \alpha_i \ln(p_i^*) + \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^n \gamma_{ij}^* \ln(p_i^*) \ln(p_j^*) \right]}{\exp \left[ \sum_{i=1}^n \beta_i \ln(p_i^*) \right]}, \end{aligned}$$

where  $\gamma_{ij} = (\gamma_{ij}^* + \gamma_{ji}^*)/2$ ,  $\ln M^* = \ln M - \sum_{i=1}^n t_i(d) \ln p_i^*$ , and  $p_i^* = p_i m_i(d)$ . Note that  $m_i(d)$  is a scaling demographic function. Therefore, the Barten-Gorman AIDS

ordinary budget share obtained via Roy's identity is

$$w_i = \alpha_i + t_i(d) + \sum_{j=1}^n \gamma_{ij} \ln(p_j^*) + \beta_i [\ln M^* - \ln a(p, d)]. \quad (14)$$

In the empirical implementation, the translating demographic function  $t_i(d)$  and the scaling demographic function  $m_i(d)$  are generally specified as

$$t_i(d) = \sum_{r=1}^R \tau_{ir} \ln(d_r), \quad m_i(d) = \exp \left[ \sum_{r=1}^R \kappa_{ir} \ln(d_{ir}) \right], \quad \forall r = 1, \dots, R. \quad (15)$$

However, the choice of the functional form of the demographic function is not restricted to any particular format. With the Barten-Gorman AIDS ordinary budget share equation (14), we incorporate demographic variables into the demand system.

In particular:

$$m_i(d_{ilt}) = \left[ \sum_{l=1}^L \sum_{t=1}^T d_{ilt} \right]^{-1}, \quad t_i(d) = \sum_{k=1}^K \lambda_{ik} Z_{klt},$$

where  $Z_{klt} = \ln [d_{klt} m_k(d_{klt})]$ .

Therefore, the modified AIDS model is:

$$w_{ilt} = \alpha_{0i} + \sum_{k=1}^K \lambda_{ik} Z_{klt} + \sum_{j=1}^n \gamma_{ij} \ln(p_{jlt}) + [\beta_i \ln(M_{lt}) - \beta_i \ln(P_{lt})], \quad (16)$$

$$i = 1, \dots, n; l = 1, \dots, L; t = 1, \dots, T;$$

where  $w_{ilt} = p_{ilt} X_{ilt} / M_{lt}$  is the market share for the product of firm  $i$  consumed in city  $l$  at time  $t$ ,  $X$  is consumer goods,  $p$  is goods price for  $X$ , and  $M$  is total expenditure on  $n$  goods.  $Z_{klt}$  is the  $k^{th}$  socio-demographic variable, and  $\gamma_{ij}$  is a cross-effect of firm  $j$ 's price on the market share of firm  $i$ .  $\beta_i$  can be interpreted as the slope of demand function, while  $P$  is a price index defined by

$$\ln(P_{lt}) = \delta + \sum_{m=1}^n \alpha_m \ln(p_{mlt}) + \sum_{m=1}^n \sum_{k=1}^K \lambda_{mk} Z_{klt} \ln(p_{mlt}) + \frac{1}{2} \sum_{m=1}^n \sum_{j=1}^n \gamma_{mj} \ln(p_{mlt}) \ln(p_{jlt}). \quad (17)$$

The theoretical structure implies symmetry restrictions (Equation (18a)) and homogeneity restrictions (Equation (18b)):

$$\gamma_{ij} = \gamma_{ji}, \forall i \neq j. \quad (18a)$$

$$\sum_{i=1}^n \alpha_{0i} = 1; \quad \sum_{i=1}^n \lambda_{ik} = 0, \forall k; \quad \sum_{i=1}^n \gamma_{ij} = 0; \quad \sum_{i=1}^n \beta_i = 0. \quad (18b)$$

To maintain theoretical consistency with the AIDS model, additional restrictions are applied to the demographic translating parameters

$$\alpha_{0i} = \sum_{r=1}^9 \nu_{ir} D_r, \quad \sum_{r=1}^9 d_{ir} = 1, \quad i = 1, \dots, n, \quad (18c)$$

where  $\nu_{ir}$  is the parameter for firm  $i$  associated with the regional dummy variable  $D_r$  for region  $r$ . As a result, the demand equations have no intercept terms. The parameter  $\delta$  may be difficult to estimate and is often set to some predetermined value. We follow the approach suggested by Moschini, Moro, and Green (1994) and set  $\delta = 0$ .

From assumption 6, it turns out that the demand system incorporating the uncertainty is given by

$$\tilde{w}_{ilt} = w_{ilt} + \tilde{\varepsilon}_{ilt}, \quad i = 1, \dots, n; \quad l = 1, \dots, L; \quad t = 1, \dots, T, \quad (19)$$

where  $w_{ilt}$  is defined in Equation (16) and  $\tilde{\varepsilon}_{ilt} = p_{ilt} \tilde{e}_{ilt} / M_{lt}$ , capturing the level of uncertainty of the market share facing the firms.

Moreover, following Blundell and Robin (2000) and DCG, to control expenditure endogeneity, the reduced form expenditure equation is specified as

$$\begin{aligned} M_{lt} &= f(\text{time trend, income}) \\ &= \xi Trend_t + \sum_{r=1}^9 \zeta_r D_r + \psi_1 INC_{it} + \psi_2 INC_{it}^2, \quad t = 1, \dots, T, \end{aligned} \quad (20)$$

where  $Trend_t$  is a linear time trend, capturing any time-specific unobservable effect on consumers' butter and margarine expenditures. The variable  $INC_{it}$  is median

household income in city  $l$  at time  $t$ , and is used to capture the effect of income differences on purchases of butter and butter substitutes.

## Data

The data sets for this study are from Information Resources, Inc. (IRI), Current Population Survey (CPS), and Center for Research in Security Prices (CRSP). Table 1 contains appropriate descriptive statistics for all the data used in this study.

The data set from IRI includes different measures of sales and prices, and in-store marketing activities. The information contains all UPC-coded products in the margarine and butter category from retail store scanners for 32 cities/markets<sup>5</sup> across the United States. It measures 58 periods based on 4-week intervals from January 25, 1998<sup>6</sup> to June 9, 2002. As a result, there are 13 periods in 1998-2001 and 6 periods in 2002.

In IRI's main dataset, 744 brands represent 134 parent companies,<sup>7</sup> with the butter category containing 351 brands and butter substitutes containing 385 brands, including margarine, spreads, and butter blends. There exist no explicit data on individual private labels; instead, IRI provides the aggregations of all branded products and private labels. Subject to the data availability and obvious computational limitation, the estimation involved the top three firms, an aggregate "all others" group, and private labels. Both private labels and all others are treated as two individual firms. That is, firms of private labels and all others are assumed to behave coordinately,

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<sup>5</sup>They are Atlanta, Baltimore/Washington, Boise, Boston, Buffalo/Rochester, Chicago, Columbus, Dallas/Ft Worth, Denver, Des Moines, Detroit, Indianapolis, Jacksonville, Kansas City, Little Rock, Memphis, Milwaukee, Minneapolis/St. Paul, New Orleans/Mobile, New York City, Oklahoma City, Philadelphia, Phoenix/Tucson, Pittsburgh, Portland (OR), Raleigh/Greensboro, Richmond/Norfolk, Salt Lake City, San Diego, San Francisco/Oakland, Seattle/Tacoma, and Tampa/St. Petersburg.

<sup>6</sup>The first period runs from December 29, 1997 to January 25, 1998.

<sup>7</sup>We drop some unreasonable data and analyze only 736 brands from 130 firms.

with the same pricing and marketing strategies within their own categories. Though not shown here, graphical depiction of the market share data indicates stable market shares in most weeks for all aggregate firms and private labels. The market appears quite mature in its overall structure. Twelve dummy variables (*Season*) were added to adjust for seasonality across the 13 4-week intervals. Firm 3 charges relatively high prices because its major product is butter. We add a dummy variable (*Butter*) to control for this quality difference.

To maintain a balanced panel only 28 of the 32 cities are investigated.<sup>8</sup> Because there are 58 observations in each city, each firm has 1624 ( $=58 \times 28$ ) complete data observations. The variables used in the analysis include price, volume sales, dollar sales, unit sales, volume per unit, in-store marketing variables such as price reduction, and all other merchandising components (feature and display).<sup>9</sup>

The demographic data include two components: (1) 9 division binaries are from Census Bureau Geography,<sup>10</sup> and (2) 7 other demographic variables are from Current Population Survey – Annual Demographic Survey (March CPS Supplement)<sup>11</sup> and IRI for 1998-2002. The CPS data can be obtained by using DataFerrett<sup>12</sup> provided by the US Census Bureau.

The second part includes PERLT10K (percentage of households earning less than \$10,000), PERGT50K (percentage of households earning more than \$50,000), HUN-  
DER15 (average number of people under age 15), H\_NUMBER (average household size), A\_AGE (median household age), FSPANISH (percentage of Hispanics), and POPU (overall population).<sup>13</sup>

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<sup>8</sup>Those with missing values are excluded.

<sup>9</sup>In-store marketing is measured in dollars-per-pound.

<sup>10</sup>See Reference Resources for Understanding Census Bureau Geography. The website is <http://www.census.gov/geo/www/reference.html>.

<sup>11</sup>See [http://www.nber.org/data/cps\\_basic.html](http://www.nber.org/data/cps_basic.html).

<sup>12</sup>See <http://dataferrett.census.gov/>.

<sup>13</sup>Population data is from IRI.

We merged the CPS data with IRI data by using the GMMSA variable (Geography - MSA or PMSA FIPS Code) in the CPS database. The areas covered by CPS and IRI are approximately the same. Furthermore, because the March CPS Supplement database is annual, linear projection is used to obtain the 4-week interval data.

For the financial components of the model, several data sources were used. The annual rate of return of the market portfolio ( $\tilde{r}_m$ ) and the annual risk-free rate ( $r$ ) were available from the Center for Research in Security Prices (CRSP). The annual rate of return of the market portfolio is computed from CRSP Indices on the S&P 500. The annual risk-free rate is based on actual 90 Day Bill Returns reported by the U.S. Treasury. The uncertainty term,  $\tilde{e}_i$  is simulated using a Monte Carlo method. Therefore,  $\tilde{e}_i$  is a random drawing from a standard normal distribution  $N(0, 1)$ , and the moment matching technique is used to adjust the samples. To match the first and second moments we calculate the mean of samples,  $E(\tilde{e}_i)$ , and the standard deviation of the samples,  $\sigma_i$ . The adjusted samples is given by  $[\tilde{e}_i - E(\tilde{e}_i)]/\sigma_i$ ,  $i = 1, 2, \dots, N$ , where  $N$  is the sample size. These adjusted samples have the correct mean of zero and the correct standard deviation of 1. The adjusted samples are used for all calculations. We estimate each model 30 times with different draws of  $\tilde{e}_i$  and assume this approach is sufficient to eliminate any noticeable error.

## Procedures and Results

The estimating model included four sets of equations: AIDS demand (16), expenditure (20), MVM first order condition (4), and marginal cost (6). Table 2 contains details about each set of equations estimated and a description of the parameters. The system was estimated in GAUSS, version 6.0 using full information maximum likelihood. The structural model essentially measures the wedge between price and marginal costs while simultaneously accounting for revenue uncertainty through the

CAPM structure. The estimation is run for 3 firms, an aggregate category for all other firms, and a final category for private label firms, in which firms 1 and 2 produce margarine and firm 3 produces butter only, while All Others and Private Labels produce both butter and margarine. Starting values are determined from a linearized version of the demand equations, and the convergence criterion for the gradients is set at 0.0001.

Note that, by definition,  $\sum_{i=1}^5 w_i = 1$ , where  $w_i$  is the expenditure share of good  $i$ . Thus, the dependent variables are linearly dependent, implying the singularity of the variance of the error terms. This singularity problem can be handled by dropping one equation, thus estimating the remaining four demand equations. The parameters from the equation dropped can be recovered from the homogeneity restrictions. As a result, the FIML estimation in this study consists of 10 equations in the system, including 4 demand equations, 5 first-order conditions, and 1 equation for expenditure endogeneity.

With regard to the number of parameters in the estimation, there are 91 demand-related parameters from equation (16), 12 expenditure endogeneity parameters from equation (20), and 20 marginal cost parameters from equation (6). For equation (4) the parameters include one finance component and the price conjectural variation (CV) whose number depends on the market structure specified in each competing model. See Table 2 for more details.

Our first goal was to evaluate the general MVM model versus a restricted version that assumes profit maximization. The general MVM presentation in equation (4) nests pure MVM ( $\theta = 1$ ) and profit maximization ( $\theta = 0$ ). One can test these two hypotheses by conducting the likelihood ratio test or Wald test. The likelihood ratio

statistic for model selection is given by

$$LR = -2 [\ln L(\mathbf{b}^*) - \ln L(\mathbf{b})],$$

where  $\mathbf{b}^*$  is the vector of parameter estimates from the restricted version of the MVM that presumes profit maximization;  $\mathbf{b}$  is the vector of parameter estimates of the general model; and  $\ln L(\cdot)$  is the log value of the likelihood function.  $LR$  has an asymptotic  $\chi^2(q)$  distribution, where  $q$  is the number of restrictions imposed. That is, the degrees of freedom equal to the difference between the number of parameters in the general model and the restricted model (pure MVM or profit maximization). For the current work,  $q = 1$ . The alternative Wald test can also evaluate nested models. We use both likelihood ratio and Wald tests to demonstrate the robustness of the model selection results. At this stage, because the correct market structure had not been identified, the LR and Wald tests were performed across the entire menu of structures (see below for details). Although not reported, the MVM-profit test did not depend on any structure.

Results of the LR and Wald tests from the best-fitted model (see below for details on best-fitted model) are presented in Table 3. The range of estimated  $\theta$  was from 0.3252 to 0.3751, while the mean was estimated at 0.3456. The Wald statistics are more than 1000 and the  $LR$  statistics are more than 250 in all draws, which demonstrates the statistical significance of the financial component. Thus, a significant finding is that financial market risk (as perceived through the CAPM) has an important role in shaping the strategic interaction among firms in the margarine and butter market. This is a crucial finding because we reject profit maximization in favor of the unrestricted MVM model. The structure of our test is driven by the fact that most traditional industrial organization models presume profit maximization. It is also worth pointing out, however, that the mean of estimated  $\theta$ , 0.3456, is also

statistically different from the “pure” CAPM result of  $\theta = 1$ .

Several plausible reasons exist for this outcome. First, the firm may be able to internally manage risk using a portfolio of products or owning assets in other industries. As a result, managing diversification issues through single product pricing should be less than fully prevalent for a multiproduct firm. Second, equity valuation is an inexact science based primarily on expected outcomes for profit and risk. It is reasonable to assume that not all managers can effectively forecast equity market behavior and translate that to product market pricing. Third and perhaps most obvious, there will likely be periods in which demand and supply conditions supersede a goal of an industry-level equity value maximization. Pure strategies in pricing or quantity games are rarely observed over long periods of time, thus it would seem equally unlikely that other more complex benchmark outcomes would be observable empirically.

Our second goal is to statistically select the best-fitted model from four benchmark oligopoly outcomes (Stackelberg Leadership, Stackelberg followership, non-cooperative Nash-Bertrand, and collusion), or an unrestricted conjectural variations (CV) model. It turns out that there are  $4^5$  possible combinations of benchmark pricing strategies that could be investigated. The procedure for choosing the best-fitted model is greatly simplified by the fact that all of the pure strategy equilibriums except for collusion are nested in an unrestricted CV model. Thus, we first choose from the unrestricted CV models with five possible collusion schemes using the Vuong test (VT) and augmented with tests using Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC). For the Vuong test, let the likelihood ratio

$$LR_t(\hat{\mathbf{b}}_i, \hat{\mathbf{b}}_j) = \ln \left( \frac{f_i(y_t | \mathbf{x}_t)}{f_j(y_t | \mathbf{x}_t)} \right),$$

where  $f_k(y_t | \mathbf{x}_t)$  is the probability that the random variable  $\mathbf{Y}$  equals  $y_t$  when the

assumed distribution is  $f_k(y_t|\mathbf{x}_t)$ , for  $k = i, j$ . Vuong's statistic for the non-nested hypothesis test of model  $F_i$  against model  $F_j$  is given by

$$V = \frac{\sqrt{n} [\frac{1}{n} \sum_{t=1}^n LR_t]}{\sqrt{\frac{1}{n} \sum_{t=1}^n (LR_t - \overline{LR_t})^2}}. \quad (21)$$

Vuong (1989) shows that  $V$  is standard normal asymptotically. If  $|V|$  is below the critical value, no conclusion can be drawn from the test; otherwise, model  $F_i$  is preferred by large  $V$ , while model  $F_j$  is preferred by small (negative)  $V$ . This implies that the Vuong statistic not only tells us whether the models are significantly different from each other but also that the sign of the test statistic indicates which model is appropriate.

The non-nested test results are presented in Table 4. Five possible market conditions were considered, including C0 (each firm operates non-collusively), C1 (firm 1+firm 2 collude), C2 (firm 1+firm 3 collude), C3 (firm 2+firm 3 collude), and C4 (firm 1+firm 2+firm 3 collude). We did incorporate All Others or Private Labels in the collusion schemes because each consists of hundreds of individual brands. Further, we assume that those firms outside the collusion play CV strategies since the CV model is unrestricted and convenient for nesting most pure strategy games. We should further note that in order to simplify the analysis we assume that only one collusion can exist. That is, we do not deal with cases where more than two coalitions exist in the market. Because the statistics all exceed 1.96, the Vuong test and its adjustments (AIC and SIC) indicate that model C0 is the best-fitted model, in which each firm operates non-collusively in price.

Having eliminated all collusive schemes that seemed reasonable, we now turn to the tests of pure strategy equilibriums nested in the general CV model. We tested for Bertrand pricing (B), Stackelberg leadership for the top three firms (S1, S2 and S3), the All Others (SAO), the Private Labels (SPL), and consistent conjectures (CS)

in pricing strategies. Because B, S1-S3, SAO, SPL, and CS are nested in the CV model, we may use the Wald test to test different combinations of Bertrand, Stackelberg leader, Stackelberg follower, and consistent conjectures. To test the Stackelberg and consistent conjectures games, the slopes of reaction functions must be estimated before the Wald test can be implemented.

Table 5 shows that all the various combinations of Bertrand, Stackelberg leadership, and consistent conjectures for the pricing strategies are rejected. This result implies that the CV model for pricing strategies in model C0, where each firm operates non-collusively in price, is the final winner. After the best-fitted model is determined, we then work on the price and expenditure elasticities<sup>14</sup> derived from this model, as presented in Tables 6 and 7.

In Table 6, all own price elasticities are significantly negative. The elasticities of all highly differentiated products maintain inelastic demand. Since All Others and Private Labels are aggregated from hundreds of differentiated niche-type products, it is not surprising that this group of products is relatively inelastic in price. Firm 1 is more inelastic than firms 2 and 3, which supports the notion that this dominant firm may have strong customer loyalty and strategies to differentiate these lines have been successful. Firms 2 and 3 are relatively more price sensitive than the other firms in the study. This may signal relatively lower firm loyalty, poor differentiation strategies, and/or other factors that limit these firms from improving their market position relative to firm 1 or private labels.

Moving to cross elasticities, firms 1 and 2 are found to be substitutes, which was not surprising given that both are margarine lines. Meanwhile, there exist no clear relationships between either firms 1 and 3 or firms 2 and 3. The negative

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<sup>14</sup>The elasticity estimates can be derived from the AIDS model. They are all computed at the means of relevant variables and the associated standard errors are obtained by the delta method.

cross elasticities of the rest of the products imply that they are roughly complements of each other. The result is consistent with Gould, Cox, and Perali (1991), where different food fats and oils, including butter, margarine, short, cooking, and lard are generally complements. Alternatively, the negative cross elasticities might emerge because retail firms control final prices and have no true complementary relationship. For example, when branded products are offered at lower prices, supermarkets can instantaneously react by lowering the price of their own private labels.

The expenditure elasticities are reported in Table 7. All are positive and statistically significant. Recall that firm 3, All Others, and Private Labels all have significant butter components aggregated within, while firms 1 and 2 are lower priced, margarine firms. Private Labels, All Others, and firm 3 are above unity, consistent with the finding that these items contain butter products and generally charge relatively higher prices.

Table 8 provides a key set of results with respect to Lerner indexes. The Lerner indexes for the best-fitted model (MVM-conjectural variations) are presented in column 1. The Lerner indexes range from 0.0092 and no statistical significance (All Others) to 0.2821 (firm 3). The lowest Lerner index of All Others is consistent with the smaller market shares of these firms and possible fringe market positioning. The major firms (firms 1, 2, and 3) all operate with considerably higher margins indicating superior levels of market power. Private labels also have a high Lerner index and similar to the major firms. This is consistent with the growing concerns about market power of supermarkets.

To examine the importance of model specification, two added experiments are presented in terms of Lerner indexes. Because Bertrand pricing is oftentimes an operational assumption of retail market studies, Column 2 contains the MVM-Bertrand result and column 4 shows, in percentage terms, the difference between Lerner indexes

between column 2 and column 1. Because Bertrand pricing is a stable benchmark that essentially drives a wedge between marginal cost and demand, the cost of imposing this restriction emerges in the form of higher Lerner indexes. In all cases except the All Others category, the error is around 35% and in a range of 25% to 45%. These results underscore the importance of getting the correct model assumptions in place and casts doubt on using a Bertrand-pricing assumption without a formal statistical test of its validity. What is particularly troubling is the estimated Lerner index for the All Others category. The Bertrand assumption leads to a result that the All Others category operates with a statistically significant Lerner index of 0.4, an egregious 99% error versus the correct model and generating a Type I error. In this case, the Bertrand assumption leads the researcher into believing this is the most troubling category when it is the least troubling.

Columns 3 and 5 present a similar comparison as columns 2 and 4, but here, we impose the restriction that firms maximize profits. In all cases except the All Others category, the restriction of profit maximization causes Lerner Indexes to rise by about 4.74% with a range of 1.10%-7.39%. These results are consistent with the theoretical findings in Wang and Stiegert (2005) which suggest that Lerner indexes are overstated under profit maximization. For the All Others category, assuming profit maximization generates a very large error (51.09%) relative to MVM, but it was not statistically different from zero (thus, no Type I error). While the restriction of profit maximization generated some errors in precision relative to MVM, they are far less problematic than in the case of presuming the wrong market structure.

## **Concluding Remarks**

Industrial organization research has a major focus of trying to determine how prices are formed when only a few competitors exist in defined markets. Usually, the op-

erational assumption is that firms try to maximize profits. However, it is readily apparent that not all managers are compensated in ways consistent with simply increasing profits. In this article, we investigate an objective function of (equity) market value maximization (MVM) in product market behavior for the U.S. margarine and butter retail market. We develop and implement a model of oligopoly retail pricing using a nonlinear Almost Ideal Demand Systems and structural first-order conditions derived from a CAPM based objective function. The data included retail scanner data from 1998-2002 over 28 demographic market areas in the U.S.

Two key objectives of the study were met. First and foremost, the model was constructed to incorporate a simple likelihood ratio or Wald test to determine if a restricted profit maximization version of the model was appropriate. The restricted model was soundly rejected and we concluded that financial market factors have an important role in determining the pricing behavior of firms in this industry. Second, a menu approach was used to search for the market structure that best describes the data. The MVM model using a general conjectural variations assumption was selected over several benchmark oligopoly structures such as Bertrand pricing, various Stackelberg leadership models, and various forms of collusion. This is not an overly surprising result. While static benchmark results are useful theoretical guides, they are hard to sustain over long periods of time and across different cities.

The best-fitted MVM model was also used to compare Lerner indexes when incorrect assumptions were used. In the case of assuming firms maximize profits, Lerner indexes were slightly higher for four of the firms with an average overstatement of about 4.74%. For the aggregated All Others category, the overstatement was much larger, but neither the MVM nor the profit maximization Lerner indexes were different from zero. Many retail oligopoly studies simply presume a Bertrand market structure. When the MVM model was restricted to Bertrand pricing, the results

pointed to a much larger problem. In this case, the restriction generated 25% to 45% errors in the case of four firms and a 99% error for the All Others. Further, the MVM-Bertrand model generated a Type I error for the All Others in that it was found to be statistically different from zero. This result underscores the importance of statistically validating the market structure before moving forward with studies of imperfect competition.

The research in this study provides several important additions and extensions to the literature. We are not aware of any previous attempt to estimate a flexible demand system while introducing financial market risk into the market structure. The results offered here push the literature toward a richer model of firm behavior that links equity market objectives and product market behavior. Future research should attempt to consider similar linkages to the equity markets. For example, it is usually presumed that firms vertically integrate and/or vertically contract to gain efficiencies and improve profitability, but an additional factor may lie in managerial incentives to stabilize profit streams and increase the value of equity. The research also points to a reconsideration of how supra-normal profits are measured. While the discipline of finance has a long tradition in normalizing returns against risk exposure, the industrial organization field has struggled to define a clear or easy way to make this normalization process tractable for antitrust enforcement. Doing so would be a major advancement in merger analysis.

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**Table 1 Descriptive Statistics**

Firms	Price (\$/lb)		Market Share (%)		Expenditure share (%)		Total Revenue (\$M/city)	
F1 (M)	1.18	(0.17)	37.50	(6.85)	29.81	(6.26)	40.75	(29.64)
F2 (M)	1.05	(0.22)	15.66	(9.69)	13.66	(7.48)	15.06	(8.99)
F3 (B)	3.40	(0.62)	9.60	(4.46)	16.43	(7.62)	29.69	(37.94)
AO (M&B)	2.19	(0.51)	13.29	(8.80)	14.59	(10.59)	26.87	(42.01)
PL (M&B)	1.85	(0.52)	23.95	(6.64)	25.51	(7.38)	41.11	(37.14)

Firms	Unit Per Volume		All Merchandising (%)		Price Reduction (%)		All Others (%) [Display & Feature]	
F1 (M)	0.77	(0.07)	24.37	(9.03)	9.57	(6.90)	14.80	(8.32)
F2 (M)	0.91	(0.06)	31.21	(13.75)	12.56	(8.74)	18.65	(12.66)
F3 (B)	1.13	(0.06)	36.89	(23.42)	17.50	(16.04)	19.39	(20.49)
AO (M&B)	1.06	(0.08)	24.45	(15.42)	13.17	(9.84)	11.28	(12.60)
PL (M&B)	0.90	(0.09)	38.53	(21.41)	16.20	(13.97)	22.33	(17.73)

**Mean Values of Other Explanatory Variables**

Variables	Units	Mean		Variables	Units	Mean	
PERLT10K	%	8.64	(3.22)	Median Income	\$	44317.32	(6484.37)
PERGT50K	%	44.03	(6.63)	Per Capita Expenditure	\$	0.72	(0.19)
HUNDER15	#	0.58	(0.09)	$r_m$	%	7.35	(18.80)
H_NUMBER	#	2.57	(0.16)	$r_f$	%	5.23	(0.78)
A_AGE	Years	34.01	(2.42)				
FSPANISH	%	13.40	(10.74)				
POPU	#	3651213	(3361325)				

Note:

- (1) Product produced: M=margarine; B=butter.
- (2) Standard errors are in parentheses.
- (3) F1~F3: Firm 1~Firm 3, AO: All Others, PL: Private Labels.

**Table 2 Numbers of Parameters in FIML Estimation**

<b>Equation</b>	<b>Parameter</b>	<b>Number</b>	<b>Note</b>
16	$\nu_r$	36	division binary, $r = 1 \dots 9$ .
	$\lambda_k$	28	socio-demographic variable, $k = 1 \dots 7$ .
	$\beta$	4	income term in AIDS
	$\gamma$	10	cross price effect in AIDS
	<i>Season</i>	12	seasonality dummy
	<i>Butter</i>	1	butter dummy
20	$\zeta_r$	9	regional dummy in income, $r = 1 \dots 9$ .
	$\xi, \psi_1, \psi_2$	3	time trend, median income and its square
6	$\mu_0$	5	intercept term
	$\mu_1$	5	unit per volume
	$\mu_{21}$	5	all other merchandising
	$\mu_{22}$	5	price reduction
4	$\eta$	*	CV in price
	$\theta$	1	finance component

\* Numbers depend on the market structure. See column (4) in Table 4.

**Table 3 Wald Test and Likelihood Ratio Test for Financial Component  
(MVM versus Profit Maximization in Pricing System)**

<b>Draw</b>	<b>Estimates</b>	<b>Standard Error</b>	<b>Wald statistic</b>	<b>LR statistic</b>
1	0.3569	0.0098	1338.04	354.49
2	0.3527	0.0087	1630.99	365.42
3	0.3458	0.0075	2142.03	355.11
4	0.3330	0.0082	1654.55	381.26
5	0.3783	0.0063	3633.31	252.00
6	0.3690	0.0079	2178.67	289.22
7	0.3669	0.0103	1258.21	442.44
8	0.3208	0.0078	1698.22	395.88
9	0.3451	0.0083	1712.88	355.79
10	0.3301	0.0082	1611.63	367.73
11	0.3676	0.0095	1503.89	462.89
12	0.3346	0.0078	1820.77	392.40
13	0.3442	0.0076	2054.92	366.42
14	0.3467	0.0090	1468.48	432.95
15	0.3517	0.0074	2230.45	327.26
16	0.3336	0.0070	2245.63	382.20
17	0.3510	0.0096	1344.35	365.03
18	0.3751	0.0101	1387.73	287.55
19	0.3573	0.0073	2365.81	356.31
20	0.3480	0.0091	1468.77	429.54
21	0.3255	0.0083	1536.45	391.12
22	0.3458	0.0080	1863.96	383.16
23	0.3372	0.0077	1922.31	384.77
24	0.3322	0.0071	2187.97	369.22
25	0.3408	0.0083	1681.56	403.32
26	0.3252	0.0076	1807.23	379.63
27	0.3472	0.0081	1854.66	445.08
28	0.3348	0.0073	2102.72	385.18
29	0.3385	0.0106	1028.39	387.52
30	0.3331	0.0091	1339.98	361.41

Note: The critical values at the 5% level of significance are 3.84 for both the Wald test and the LR test.

**Table 4 Vuong Test (Model C0 versus Others)**

<b>Model</b>	<b>(1) VT</b>	<b>(2) AIC</b>	<b>(3) SIC</b>	<b>(4) # of CV</b>
<b>C0</b>	0.0000	0.0000	0.0000	20
<b>C1</b>	6.7337	6.7256	6.7038	18
<b>C2</b>	8.0815	8.0730	8.0501	18
<b>C3</b>	7.5138	7.5052	7.4822	18
<b>C4</b>	13.7437	13.7193	13.6537	14

Note:

- (1) C0: each brand operates non-collusively  
C1: Firm 1+Firm 2  
C2: Firm 1+Firm 3  
C3: Firm 2+Firm 3  
C4: Firm 1+Firm 2+Firm 3
- (2) The numbers in columns (1)-(3) indicate the Vuong statistics under the different criteria, which measure how model C0 is superior to the others. For example, the three entries of model C1 indicate that model C0 is better than model C1 by those amounts. The critical values for the 5% level of significance are -1.96 and 1.96.

**Table 5 Wald Test Statistic (Model C0)**

<b>Type of Game</b>	<b>Wald Statistic</b>
<b>B</b>	19663.67
<b>S1</b>	45089.97
<b>S2</b>	59223.93
<b>S3</b>	15605.38
<b>SAO</b>	71549.50
<b>SPL</b>	23739.80
<b>CS</b>	151885.26

Note:

- (1) The degree of freedom for all tests is 20 and the critical value is 31.41 at the 5% level of significance.
- (2) **B** indicates Bertrand, **S<sub>i</sub>** signifies that brand *i* is a Stackelberg leader, and **CS** indicates consistent conjectures.

**Table 6 Price Elasticity Matrix (MVM)**

<b>Firms</b>	<b>F1</b>	<b>F2</b>	<b>F3</b>	<b>AO</b>	<b>PL</b>
<b>F1</b>	<b>-0.5561</b> (0.0096)	<b>0.1327</b> (0.0033)	<b>0.0425</b> (0.0027)	<b>-0.0348</b> (0.0036)	<b>-0.2733</b> (0.0097)
<b>F2</b>	<b>0.3329</b> (0.0081)	<b>-0.7873</b> (0.0055)	<b>0.1086</b> (0.0045)	<b>-0.1183</b> (0.0073)	<b>-0.0734</b> (0.0115)
<b>F3</b>	<b>-0.0714</b> (0.0030)	-0.0013 (0.0023)	<b>-0.8383</b> (0.0064)	<b>-0.0524</b> (0.0025)	<b>-0.1868</b> (0.0075)
<b>AO</b>	<b>-0.2514</b> (0.0063)	<b>-0.2169</b> (0.0059)	<b>-0.0800</b> (0.0032)	<b>-0.0925</b> (0.0242)	<b>-0.6212</b> (0.0250)
<b>PL</b>	<b>-0.5071</b> (0.0119)	<b>-0.1441</b> (0.0059)	<b>-0.1662</b> (0.0057)	<b>-0.3811</b> (0.0144)	<b>-0.1659</b> (0.0188)

**Table 7 Expenditure Elasticity Matrix**

<b>Firms</b>	<b>Estimates</b>
<b>F1</b>	<b>0.6872</b> (0.0105)
<b>F2</b>	<b>0.6315</b> (0.0162)
<b>F3</b>	<b>1.2220</b> (0.0057)
<b>AO</b>	<b>1.2711</b> (0.0170)
<b>PL</b>	<b>1.2648</b> (0.0160)

Note:

- (1) Standard errors are in parentheses.
- (2) Highlighted numbers are significant at the 5% level of significance.
- (3) F1~F3: Firm 1~Firm 3, AO: All Others, PL: Private Labels.

**Table 8 Estimated Lerner Index in Pricing System**

<b>Firms</b>	<b>(1) MVM</b>	<b>(2) MVM Bertrand</b>	<b>(3) Profit Maximization</b>	<b>(4) [(2)-(1)]/(1)*100%</b>	<b>(5) [(3)-(1)]/(1)*100%</b>
<b>F1</b>	0.2694 (0.0165)	0.3492 (0.0140)	0.2893 (0.0129)	29.62	7.39
<b>F2</b>	0.2471 (0.0252)	0.3095 (0.0234)	0.2621 (0.0214)	25.25	6.07
<b>F3</b>	0.2821 (0.0088)	0.4084 (0.0097)	0.2852 (0.0077)	44.77	1.10
<b>AO</b>	0.0092 (0.0983)	0.4001 (0.0382)	0.0139 (0.1232)	4248.91	51.09
<b>PL</b>	0.2478 (0.0172)	0.3527 (0.0186)	0.2587 (0.0136)	42.33	4.40

Note:

(1) Standard errors are in parentheses.

(2) F1~F3: Firm 1~Firm 3, AO: All Others, PL: Private Labels.