Multimarket Market Power Estimation: The Australian Retail Meat Sector

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Abstract

A new technique for estimating market power in several markets simultaneously is developed and applied to the Australian retail beef, lamb, and pork markets. The hypotheses that market power is zero and that market power is the same for each meat cannot be rejected. Nor is there evidence that market power increased over the period of analysis. Little bias is created by examining markets in isolation, rather than within a system, when markets are competitive, but that bias can be large when market power exists in some markets in the system.

I. Introduction

A new method for estimating market power in several markets simultaneously is developed. This method is used to estimate market power in retail beef, lamb, and pork in Australia.

In most structure-conduct-performance empirical studies, various measures of market structure are used to explain variations in proxies of market power (such as reported profits). In recent years, many new industrial organization studies (surveyed in Bresnahan, 1989, and Perloff, 1992) used structural models to estimate the market power rather than to use proxies. The cost of this new approach is that cross-market effects cannot be studied, as these studies are usually restricted to a single market. By developing a logically-consistent method of estimating market power in several markets at once, we can systematically examine the effects of a shock in one market on market power in another market or the effects of market structure on market power across markets.

Various methods of estimating market power have been proposed in the economics literature over recent decades. The structural method presented in Just and Chern (1980), Bresnahan (1982), and many other articles, involves estimating demand and optimality (effective marginal revenue equals marginal cost) equations. Alternative reduced-form or nonparameteric approaches -- such as Panzar and Rosse (1987) and Hall (1988) -- require less data than the structural approaches. An advantage of the structural approach is that it provides more information about market conditions, such as elasticities. At present there is no consensus on which approach is the best, though Hyde and Perloff (1995) examine the conditions under which the various methods give consistent results.

We extend the structural approach to allow estimation of the market power that exists for each good within a separable group of goods. The approach involves simultaneously estimating a demand system, a market power parameter, and the marginal cost function for each good. Using a system approach is more efficient than examining each good in isolation, which is what previous studies have done, because it makes use of information obtained from demand theory, such as price homogeneity restrictions. We use the linear approximate version of the almost ideal demand system (LA/AIDS) model (Deaton and Muellbauer, 1980) to model the demand system.

We use this method to estimate market power in retail beef, lamb, and pork markets in Australia.[1] Although there have been many previous studies of meat demand, including some for Australia (Cashin, 1991; Murray, 1984), and other studies of market power in the meat industries in other countries (Schroeter and Azzam, 1990), we are unaware of structural econometric studies examining market power in the meat-retailing sector in Australia.

There have been many studies, however, of the competitiveness of the meat-processing industry in Australia over the last several decades (New South Wales Parliament, 1972; Prices Justification Tribunal, 1978; Industry Assistance Commission, 1983; Booz-Allen and Hamilton, 1993; Industry Commission, 1993; Zhao, Griffith, and Mullen, 1996).[2] Presumably, these earlier studies concentrated on the processing sector because it is more

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[1] Poultry and fish are not included in this analysis due to inadequate data.

[2] The only other study of market power in Australian meats, Zhao, Griffith, and Mullen (1996), includes some information about the retail sector. They estimate reduced-form equations and test whether restrictions implied by competition can be rejected. Unlike Zhao *et al.*, we estimate a fully-specified structural model at the retail level and obtain explicit measures of market power.

concentrated than the retail sector. These studies find that the processing sector industry is highly concentrated, inefficient, and uncompetitive in part due to union power and restrictive government licensing arrangements that deterred development of new plants.

Recently, a number of observers have expressed concern about growing concentration and market power at the retail level. For example, Zhac, Griffith, and Mullen (1996) note, "... many analysts now believe that the supermarkets wield an unacceptable degree of market power in these [meat] industries ..." Concentration at the food retail level also has been increasing in recent years. From 1987-88 to 1992-93, the proportion of meat sold through supermarkets increased from 25% of beef and 35% of sheep meat to 33% and 38% respectively (Industry Commission, 1993). This greater concentration in the retail sector reflects the growth of market share of chain supermarkets and the decrease in the number of smaller supermarkets.

Livestock prices and retail prices in Australia for 1970-90 are strongly correlated; however, real livestock prices have fallen by 30%, 20%, and 50% for beef, lamb, and pork respectively, while real retail prices have fallen by only 10%, 0%, and 20% respectively (Industry Commission, 1993). The increased contribution of the processing and retail sectors to the final price of meats may reflect the general declining terms of trade for agricultural products, while labour, capital and other material costs have either decreased less rapidly or increased. Another contributing factor may be increased market power in the retail and processing sectors. One goal of our analysis is to determine whether the divergence in livestock and retail prices can be attributed, at least in part, to the growth of retail market power.

Increasing concentration has also been observed in both meat-processing and retail markets in the U.S. over recent years (Schroeter, 1988). Schroeter and Azzam (1990) found evidence of market power in the beef and pork industry in the United States, with about one half of the farm-retail price spread for both meats being attributable to market power. They model beef and pork as demand-related joint-products in a quantity setting oligopoly model. However, they reject the hypothesis that there are cross market effects between beef and pork.

The econometric model underlying the structural test of market power is explained in the next section, followed by a brief description of data sources. The estimation procedure is discussed in Section 4. The results of the econometric analysis are presented in Section 5. The paper concludes with a summary of the findings and directions for further research.

2. The Model

To determine market power, we simultaneously estimate a system of demand and optimality equations. We first discuss how demand is estimated and then derive the optimality equations.

Demand

To estimate the demand for the three meats — beef, lamb, and pork — we use the almost ideal demand system (AIDS) model (Deaton and Muellbauer, 1980).[3] We assume that consumers' utility functions are additively separable in all goods except meats because Alston and Chalfant (1987) found evidence of weak separability of meat demand from other goods in Australia. Our AIDS demand system consists of three budget-share equations, where the budget share for good i is $s_i = p_i q_i / X$, p_i and q_i are the price and quantity of the i^{th} good,

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[3] We assume that the parameters of this model do not vary over time. Chalfant and Alston (1988) find that one cannot reject a null-hypothesis of stable preferences for meats using a nonparametric model of Australian meat demand over a period that coincides closely with ours.

and X is the total expenditure on all meats. The budget-share equations (i = 1 for beef, i = 2 for lamb, and i = 3 for pork) are

(1) $$s_i = \alpha_i + \sum_{j=1}^{3} \gamma_{ij} \ln p_j + \beta_i \ln(X/P),$$

where α_i, γ_{ij}, and β_i are structural parameters and P is a price index defined by

$$\ln P = \alpha_0 + \sum_i \alpha_i \ln p_i + \frac{1}{2} \sum_i \sum_j \gamma_{ij} \ln p_i \ln p_j .$$

The LA/AIDS model uses Stone's (1953) geometric approximation to this price index:

$$\ln P = \sum_i s_i \ln p_i .$$

The corresponding uncompensated own-price, ε_{ii}, and expenditure elasticities, η_i, of demand (Green and Alston, 1990) are

$$\varepsilon_{ii} = -1 + \frac{\gamma_{ii}}{s_i} - \beta_i ,$$

$$\eta_i = 1 + \frac{\beta_i}{s_i}.$$

The adding up, homogeneity, and symmetry conditions imply

(2) $$\begin{gathered} \sum_{j=1}^{3} \gamma_{ij} = \sum_{i=1}^{3} \gamma_{ij} = \sum_{j=1}^{3} \beta_i = 0, \\ \sum_{j=1}^{3} \alpha_i = 1, \\ \gamma_{ij} = \gamma_{ji}. \end{gathered}$$

Cashin (1991) reports test results supporting these hypotheses for a demand model for Australian beef, lamb, pork, and chicken.

Optimality

If all the firms in a market form a cartel, they equate the marginal revenue corresponding to the market demand curve to the marginal cost. If the firms are price takers, they equate price and marginal cost. Other market structures lie between these two extremes.

One convenient way to capture an entire family of possible equilibria is to equate marginal cost with a measure of *effective* marginal revenue (Bresnahan 1982):

$$p_i + \lambda_i\, p_i'(q_i)q_i,$$

where $\lambda_i \in [0, 1]$ is a parameter that reflects market power. If $\lambda_i = 0$, the effective marginal revenue equals price and the market is perfectly competitive. If $\lambda_i = 1$, effective marginal revenue equals the marginal revenue corresponding to the market demand curve and the market is perfectly collusive. There are many possible intermediate cases where λ_i lies strictly between 0 and 1. For example, in a Cournot equilibrium with n identical firms, $\lambda_i = 1/n$. In general, the optimality equation for good i is

$$p_i + \lambda_i \frac{\partial p_i}{\partial q_i} q_i = C_i'(q_i), \tag{3}$$

where $C_i(q_i)$ is the total cost function and $C_i'(q_i)$ is marginal cost.

Although λ can be given a conjectural variations interpretation, we do not do so. Rather, we view it only as a measure of the gap between marginal cost and price. This gap is created by some unknown game. For example, the gap could result from a folk-theorem equilibrium that lies between the collusive and Cournot equilibria.

This approach, summarized in Equation 3, has been widely used to study a single market. We now generalize this approach to study several markets at once. For specificity, we assume that the marginal cost for each good reflects constant returns to scale and is linear in wholesale price and wages:[4]

(4) $$C_i'(q_i) = a_i + b_i v_i + d_i w,$$

where v_i is the wholesale price of meat i, w is an index of retail wage costs common for all meats, and a_i, b_i, and d_i are parameters.

In the LA/AIDS model, the slope of each demand curve, holding total expenditure on all goods, X, and other prices p_j, $j \neq i$, constant, is

(5) $$\frac{\partial p_i}{\partial q_i} = \frac{p_i}{q_i}\left[\delta_{ii} - \frac{\gamma_{ii}}{s_i} + \beta_i \frac{s_j}{s_i}\right]^{-1},$$

where δ_{ij} refers to the Kronecker δ. In the case where each firm sells all three goods, as we assume here, Equation 3 generalizes to

(6) $$p_i + \lambda_i \sum_{j=1}^{3} q_j \frac{\partial p_j}{\partial q_i} = C_i'(q_i).$$

By substituting Equations 4 and 5 into the optimality condition, Equation 6, and rearranging terms, we obtain the optimality equation we use in estimation,

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4 Constant returns to scale (the coefficient on a quantity term in the marginal cost equation is zero) cannot be rejected for lamb and pork. There is some weak evidence of increasing returns to scale for beef. Increasing returns, however, is inconsistent with competition, so we assume constant returns so as to allow for a full range of possible market structures.

$$p_i = \left[a_i + b_i v_i + d_i w - \frac{\lambda_i s_i}{q_i} \sum_{j \neq i} \frac{p_j q_j}{\gamma_{ij} - \beta_i s_j} \right] \left(1 - \frac{\lambda_i}{1 - \frac{\gamma_{ii}}{s_i} + \beta_i} \right)^{-1}. \tag{7}$$

Our structural model is obtained by estimating the LA/AIDS demand system, Equations 1, subject to the price-homogeneity restrictions, Equations 2, together with the optimal pricing conditions for each industry, Equations 7. All the parameters in this system, including λ_i, are identified. Because of the homogeneity restrictions on the demand system, one demand equation may be omitted, leaving a total of five equations to be estimated.

One might hypothesize that retail market power is identical for each meat. Market power is determined by market structure and the elasticity of demand. The retail market structure for all meats is presumably identical because all supermarkets and butcher shops sell all three meats, and most estimates (including ours) show relatively small differences across meat elasticities.

Accordingly, we estimate two versions of the model. In the *unconstrained* model, we allow the market power parameters, λ_i, to vary across the three meats. In the *constrained* model, we impose the restriction that $\lambda_1 = \lambda_2 = \lambda_3 = \lambda$.

As noted in the introduction, one might expect market power to rise over the period due to shifts in concentration. We allow for the possibility that market power is different in the second half of our period than in the first half. For example, in the constrained model, we rewrite the market power parameter as $\lambda = \lambda_0 + \lambda_1 D$, where D is a time dummy that equals zero in 1971-79 and one in 1980-88.

3. Data

The data set includes 72 quarterly observations, 1970:1 to 1988:4, for retail price (¢/kg) and the apparent consumption quantity data (kg/capita) for each of the three meat groups.[5] The consumer price index is used to convert nominal to real values. The consumption data are from the Australian Bureau of Agricultural and Resource Economics. For a detailed explanation of the construction and sources of these data, see Cashin (1991).

The data on retail and wholesale prices and labour costs were kindly provided by Garry Griffith and are described in Griffith *et al.* (1991). The retail prices are from selected outlets in the Sydney area. The wholesale prices are from the Homebush market in Sydney. Wholesale prices have been adjusted for byproducts, waste, and shrinkage. We use national per capita consumption data as data from the Sydney markets were not available. Thus, we implicitly assume that there is a high correlation between changes in local Sydney consumption and consumption elsewhere in Australia.

We use as instruments the Australian Treasury 10-year bond rate, per unit electricity costs, Australian money supply (M3), Australian GNP, Australian CPI, Australian population, total Australian production of each meat, and time. The sources for these data are the Australian Meat and Livestock Corporation, the Australian Bureau of Statistics, and the dX data base (*dX for Windows, Version 2, Users Guide*, 1996, Econdata).

4. Econometric Procedure

We use nonlinear three-stage least squares to estimate the system consisting of Equations 1, 2, and 7. The pork-share equation was dropped to ensure that the system is not overidentified due to the adding-up restriction, $\Sigma_i \alpha_i = 1$, in Equations 2. Starting values for the nonlinear procedure were obtained by estimating the demand system and then taking these parameters as given when estimating the optimality equations individually.

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[5] Apparent consumption is the difference between production and the carcass weight equivalent of net exports plus the reduction in the quantity of frozen stocks.

Autocorrelation correction terms for the share equations and the optimality equations were estimated using a grid search. A fourth-order autocorrelation correction was included in the share equations of the demand system. Cashin (1991) suggests a fourth-order correction because of the quarterly and seasonal nature of the data.[6] Consistent with theory, the autocorrelation parameters were constrained to be equal for a given lag across share equations. The estimated autocorrelation correction terms on the share equations are (ρ_1, ρ_2, ρ_3, ρ_4) = (0.43, 0.08, 0.18, 0.55), where ρ_j is the coefficient on the error term lagged *j* periods. Using different price data, Cashin (1991) used a diagonal AR(4) specification to estimate a LA/AIDS system of four meat demands in Australia and found similar parameter values.

First-order corrections were included in the optimality equations. The estimated autocorrelation terms for the optimality equations were 0.20 for beef, 0.55 for lamb, and 0.95 for pork.

5. Results

Results for the model where the market power parameters, λ_i, were free to vary by meat are reported in the Appendix (Tables A1 and A2). The Appendix has a brief explanation of the model specification and reports the results of tests of the restrictions that the market power terms are equal. On the basis of a Wald test statistic of 0.11, we cannot reject the hypothesis that $\lambda_1 = \lambda_2 = \lambda_3 \equiv \lambda$ at the 0.05 confidence level. Thus, because we expect retail market power to be equal across meats and because we cannot reject this hypothesis, we now impose this constraint.

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[6] Including separate seasonal dummies did not substantially affect the coefficients on other variables or the fit of the equation.

The estimated coefficients for the restricted model are reported in Table 1. This model fits the data reasonably well. For example, the correlation coefficients between actual and estimated market shares are 0.81 for beef, 0.72 for lamb, and 0.79 for pork.

The own-price, ε_{ii}, and expenditure, η_i, elasticities for each meat are of the expected sign and all are statistically significantly different than 0 at the 5% level, as Table 2 shows. The demand elasticity estimates are close to those reported by Cashin (1991).

Our estimate of market power in the first half of the sample, $\lambda_0 = 0.00007$, indicates a virtually perfectly competitive market (as does the corresponding Lerner Indexes, which are also virtually zero). The market power measure does not increase in the second half of the sample ($\lambda_1 = 0.0006$ with an asymptotic standard error of 0.001).

Following Griffith, Green, and Duff (1991), the wholesale price and wage costs have been included as the determinants of retail marginal cost for each meat. Labour costs are over 50% of total retail costs. Presumably much of labour is involved in sales and other operations for which all three meats are treated essentially the same (Griffith, Green, and Duff, 1991).

As we expected, wholesale price makes a positive contribution to retail marginal cost for each meat. We hypothesize that the coefficient on wholesale price should equal one, because the meat 'production process' at the retail level is particularly simple: A pound of meat bought is a pound of meat sold (wholesale prices are retail-weight-equivalent, having been adjusted for byproducts, waste, and shrinkage). This hypothesis cannot be rejected for beef at the 5% level, but is rejected for lamb and pork. The point estimates show a negative relationship between wage costs and retail marginal cost for beef and lamb, but these coefficients are not statistically significantly different from zero.

We also tested whether the retail marginal cost function for each meat is identical: $a_1 = a_2 = a_3$, $b_1 = b_2 = b_3$, and $c_1 = c_2 = c_3$. The Wald test statistic is 6.88 with 6 degrees of freedom, so we cannot reject this hypothesis at the 0.05 level. Thus, although there are physical differences between the carcasses of the three meats, they apparently are treated identically and hence affect retail marginal costs in the same way.

LM tests were performed to identify the existence of autocorrelation in each equation. Thus, using e_{t-k} to denote the error term lagged k periods, the equation $e_t = \phi_0 + \phi_1 e_{t-1} + \phi_2 e_{t-2} + \phi_3 e_{t-3} + \phi_4 e_{t-4}$ was estimated for each share equation. The equation estimated for each of the optimality equations was $e_t = \phi_0 + \phi_1 e_{t-1}$. To test the hypothesis that $\alpha_i = 0$, for all i in each equation, the statistic (see Godfrey 1988) $T \times R^2 = 72R^2$ was computed and compared to the critical value at the 1% and 5% level, using χ_4^2 for the share equations and χ_1^2 for the optimality equations. The LM statistics obtained for the beef share, lamb share, beef optimality, lamb optimality, and pork optimality equations were 5.39, 7.75, 10.54, 7.34, and 6.02.

We can use these general-equilibrium estimates to simulate the effects of a shock in one market, such as an increase in a factor price, on price and market power in another market. Moreover, simulations of the effect of a shock within one market on the Lerner Index for that market may be biased if one uses a single-equation instead of a system approach. Given our estimates that there is virtually no market power, however, we find there is little loss in using single-equation models for such simulation. The reason we observe no loss is that, given constant returns to scale and competition, the equilibrium price is determined by only the marginal cost in that market. Thus, a demand shock in one market has no price effects in that or other markets.

In the absence of competition, the equilibrium price is also determined by demand conditions in all markets (Equation 7), so shocks in one market affect other markets, and the general-equilibrium results may differ substantially from the single equation ones. With substantial market power in each market (λ_1 = 0.43, λ_2 = 0.13, and λ_3 = 0.72), a 10% demand shock to beef, resulted in a 25% overestimate of the beef Lerner index when the markets are analyzed in isolation compared to the results obtained from the system approach. Thus, although, due to the existence of competition, our empirical results do not illustrate this point, our simulations make it clear that large errors in the estimates of the degree of market power in an industry can result from ignoring general equilibrium effects.

6. Discussion

Using a new structural model, we can estimate market power simultaneously in several markets at once. The model is used to estimate market power in Australian retail meat markets.

The system approach has three benefits. First, using a properly specified multimarket model should increase the efficiency of estimation.

Second, by using a general-equilibrium approach, we can simulate the effects of a shock in one market on other markets, or more accurately determine the effect of a shock in a market on the Lerner Index for that market. Failing to ignore these general equilibrium effects can lead to substantial biases.

Third, one could use this approach to examine why market power varies across markets. By estimating such a model where the market power parameters are written as functions of market structure variables, we can examine how market structure affects performance. Ideally, one would use exogenous market structure variables such as measures of barriers to entry. Alternatively, one could use traditional structure-conduct-performance variables such as advertising and concentration measures, which are endogenous. Including such variables in our model would allow one to achieve the ends of both the new industrial organization structural approach in estimating [illegible] power and the structure-conduct-performance approach in determining why market power varies across industries.

Unfortunately, we were unable to obtain reliable measures of barriers to entry or advertising for our data set. Moreover, for these particular markets, we argue that there is no structural or other reason to expect variation across markets. Thus, in this study, we only estimate market power, and do not attempt to model why market power varies across industries. Our estimates of market power in Australian beef, lamb, and pork retail markets appear to be plausible. The magnitudes of the own-price and expenditure elasticities in this study and in Cashin's (1991) meat demand in Australia study are similar.

Our results indicate that meat retailing is competitive. Because retailing has become more concentrated in Australia over time, we might expect market power to rise. Our results show, however, that market power has not increased. One reason may be that butcher shops still account for a large proportion of meat sales in Australia (60%, Industry Commission, 1993). Thus, the increase in the differential between livestock and retail prices seems unlikely to be due to increasing market power at the retail level.

Our research has implications for a number of issues concerning the Australian meat market. For example, Griffith (1991) and McDonald and Spindler (1987) suggest that price leveling is practiced in Australian wholesale and retail markets. Price leveling refers to the smoothing of prices over time, so that not all cost movements are passed on to customers. Attempts to explain such behavior (e. g., Parish, 1966) are based on limited information by consumers, which creates market power for firms. Previous analyses of price leveling use reduced-form equations that avoid assumptions about the structure of the market. For example, Griffith (1991) estimates reduced-form equations in which the retail price-cost spread is assumed to depend on the lagged spread, present and lagged wholesale price, other retail costs, turnover, and retail price-cost spreads of substitute meats.

Our structural analysis of the Australian retail meat market informs us about the environment in which any price leveling occurs. As we find strong evidence that the retail market for each meat is competitive, the question arises as to how price leveling can be a profit-maximizing strategy for retail firms. Competitive firms bid price down to marginal cost, implying that a firm that holds price above marginal cost (for the purposes of price leveling) will suffer short-run losses. If price leveling is to avoid long-run losses, firms must be able to maintain sales when price is above marginal cost in order to recoup losses incurred over the period when price is below marginal cost. If consumers are loyal to retailers, though, it is difficult to explain why they do not exercise market power. It seems that further work is needed in order to reconcile our results with previous results indicating that price leveling is practiced. Extension of the structural model we have used seems the most promising approach, as this will allow simultaneous determination of market structure and price leveling, so that an internally consistent view of the two issues can emerge.

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Appendix

The results for the unconstrained model where the market power parameters are allowed to vary across meats are shown in Tables 1A and 2A. Table 1A reports the demand, marginal cost, and market power parameter estimates, and Table 2A reports the own-price and expenditure elasticities. The estimated elasticities are all of the expected signs and of plausible magnitude. All are significantly different from zero except the pork expenditure elasticity.

We cannot reject the null-hypothesis of zero coefficients for any of the variables in the optimality equations. On the basis of asymptotic t-tests, perfect competition cannot be rejected for any meat at the 0.05 level. Further, we cannot reject the hypothesis that market power has remained constant over time.

The Wald hypothesis test statistic on the restriction that the market power parameters are equal, $\lambda_1 = \lambda_2 = \lambda_3$, is 0.11. Thus, the restriction can be rejected at the 5% significance level if the test statistic is distributed chi-squared.

Table 1: Constrained Model Estimates

	Coefficient	*Asymptotic Standard Error*
Demand		
α_1	0.168	0.102
γ_{11}	-0.157*	0.028
γ_{12}	0.133*	0.029
γ_{13}	0.024*	0.006
β_1	0.143*	0.034
α_2	0.233*	0.083
γ_{22}	-0.144*	0.031
γ_{23}	0.011	0.024
β_2	-0.014	0.028
α_3	0.599*	0.088
γ_{33}	-0.036	0.025
β_3	-0.129*	0.030
Marginal Cost		
a_1	2.323*	1.112
b_1	0.979*	0.237
d_1	-0.646	0.586
a_2	2.690*	1.044
b_2	0.600*	0.180
d_2	-0.515	0.517
a_3	2.283*	0.900
b_3	0.369*	0.122
d_3	-0.089	0.405
Market Power		
λ_0	0.00007	0.0001
λ_1	0.0006	0.001

* Statistically significantly different from 0 at the 5% level based on a one-tailed test.

Table 2: Constrained Model Estimates of Elasticities

	Coefficients	*Asymptotic Standard Errors*
Own Price Elasticities		
ε_{11}	-1.411*	0.053
ε_{22}	-1.714*	0.168
ε_{33}	-1.037*	0.123
Expenditure Elasticities		
η_1	1.244*	0.057
η_2	0.928*	0.141
η_3	0.405*	0.138

* Statistically significantly different from 0 at the 5% level based on a one-tailed test. Elasticities are calculated at mean prices and quantities.

Table A1: Unconstrained Model Estimates

	Coefficient	*Asymptotic Standard Error*
Demand		
α_1	0.040	0.139
γ_{11}	-0.101*	0.043
γ_{12}	0.154*	0.045
γ_{13}	-0.053	0.031
β_1	0.191*	0.046
α_2	0.208	0.171
γ_{22}	-0.153*	0.051
γ_{23}	-0.0009	0.009
β_2	-0.006	0.055
α_3	0.752*	0.126
γ_{33}	0.054	0.030
β_3	-0.185*	0.043
Marginal Cost		
a_1	0.564	2.634
b_1	1.082	0.608
d_1	-0.059	1.210
a_2	2.511	9.592
b_2	2.803	2.218
d_2	-1.898	4.701
a_3	0.723	50.602
b_3	2.212	6.981
d_3	0.174	22.755
Market Power		
λ_0^1	0.102	0.344
λ_1^1	0.036	0.096
λ_0^2	-0.00006	0.0005
λ_1^2	0.0004	0.004
λ_0^3	0.043	0.356
λ_1^3	0.003	0.233

* Statistically significantly different from 0 at the 5% level based on a one-tailed test.

Table A2: Unconstrained Model Estimates of Elasticities

	Elasticity	*Asymptotic Standard Error*
Own-Price Elasticities		
ε_{11}	-1.363*	0.053
ε_{22}	-1.767*	0.301
ε_{33}	-0.564*	0.164
Expenditure Elasticities		
η_1	1.326*	0.079
η_2	0.972*	0.278
η_3	0.141	0.197

* Statistically significantly different from 0 at the 5% level based on a one-tailed test.
Elasticities are calculated at the means of prices and quantities.