THE RELATIONSHIP BETWEEN MANAGERIAL HEURISTICS AND ECONOMICS IN PRICING RETAIL MEATS

Michael R. Reed and Lynn W. Robbins

Abstract

This study develops a theoretical model of the multiproduct firm which allows for imperfect competition in the output market. Hypotheses are tested for retail meat prices concerning the degree and speed of price transmission, the effects of interfirm competition, and the interrelationship between prices within the store. Empirical results indicated that meat prices within a store were highly interrelated. Further, the firm was found to be very responsive to prices of competitors in the short run, but more responsive to wholesale price changes in the long run.

Key words: imperfect competition, meat prices, multiproduct firm, systematic pricing.

Little analytical research has been conducted to explain in economic terms what occurs in the retail food pricing process. Analytical research has been done relating aggregate farm prices to retail food prices using single (Sun; Mann and St. George; Waldorf; Daly) or simultaneous equation models (Lamm and Westcott). Levels of competition studies have provided some implications about food pricing (Marion et al.; Gray and Anderson) and several descriptive studies of the retail food pricing process have also been made (Sturgess; Gray and Anderson; Reed and Robbins; Holton; Holdren; Padberg). However, the void between what is known through description and economic theory remains.

This study attempts to fill part of that void by developing a theoretical model of retail pricing and testing the validity of the model's underpinnings. The multiproduct firm model developed here allows a more rigorous analysis of pricing efficiency at the firm level.

HYPOTHESES

It is generally accepted that supermarket managers use margin or cost-plus pricing. That is, changes in retail prices are expected to reflect changes in cost, by far the biggest element of which is the wholesale cost (Buzzel et al., pp. 85-91). Consequently, retail price fluctuations should reflect, perhaps with some lag, variations in cost.

It is also generally accepted that supermarkets use loss-leader pricing. Since consumers will frequently buy many products on each visit to a supermarket, demand curves for each good in a particular store are interrelated (Sturgess). That is, the price of some goods are expected to influence consumers to buy other goods in the same store. Consequently, it is expected that when retailers price some products, they consider the effects of these decisions on the entire store's sales. This is called a systematic pricing process.

In a market characterized by few firms, individual firms may consider the effect of competition on their pricing decisions. Many studies, Marion et al. among them, agree that individual retailers have sufficient market power to affect prices in many markets. Because the number of retailers in a local market is typically small, it is likely that retailers take the competition's prices into account in making their own price decisions.

Two further propositions discussed less frequently, but that are likely to be practiced in the retail pricing process, are also of interest to this research. The first has to do with the amount of a wholesale cost increase that is transmitted to consumers through retail prices. Some wholesale price increases might be fully passed through, others could be only partially passed through, and still

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others could be more than fully passed on to the retail level. Consumers are perceived as reacting differently to price changes depending on how frequently a product is purchased and its share of total expenditures. It is hypothesized that changes in the wholesale price would not be equally transmitted to consumers for all products. This elasticity of price transmission naturally depends heavily upon the nature of the product.

A second but related proposition is that consumers may react unfavorably to large, one time increases in the retail price. Therefore, it is hypothesized that, once confronted with the need for a higher retail price, i.e., because of wholesale price increases, retailers spread the needed change over time through some type of partial adjustment process.

THE MODEL

In order to investigate which of these hypotheses tend to depict reality, a general retail pricing model was developed using standard neoclassical economic theory. The model development starts with the assumption that the supermarket wishes to maximize profits, thereby equating marginal revenue with marginal cost. Neoclassical firm theory begins with the premise that the firm changes output level in order to maximize profit. This assumption works well in some industries, but not the retail grocery industry. Food retailers change prices in order to maximize profit, then handle the associated output determined by consumers (on the basis of those prices). In this case, the total revenue function is differentiated with respect to price, rather than output, to determine the profit-maximizing price.

In order to allow an imperfectly competitive environment, the model is constructed with two firms, supermarkets y and z, each with the power to set their own prices. The model can easily be extended to more firms, but a two firm framework is used in this research. Using supermarket y as the reference firm, the firm's marginal revenue function (by changing price) for a single product firm is:

$$(1)\ \frac{\partial TR_{1y}}{\partial P_{1y}} = P_{1y}\left[\frac{\partial Q_{1y}}{\partial P_{1y}} + \frac{\partial Q_{1y}}{\partial P_{1z}}\frac{\partial P_{1z}}{\partial P_{1y}}\right] + Q_{1y} = O, \text{ ΦR}$$

$$= Q_{1y}\left[\left(\frac{P_{1y}}{Q_{1y}}\frac{\partial Q_{1y}}{\partial P_{1y}} + \frac{P_{1y}}{P_{1z}}\frac{\partial P_{1z}}{\partial P_{1y}}\frac{\partial Q_{1y}}{P_{1z}}\frac{P_{1z}}{Q_{1y}} + 1\right]\text{, OR}$$

$$= Q_{1y}\ (1 + e_{1y} + r_{yz}e_{yz}),$$

where:

$TR_{1y} = P_{1y}\,Q_{1y}$

$\frac{\partial TR_{1y}}{\partial P_{1y}} = MRP_{1y} =$ supermarket y's marginal revenue for good 1 by changing good 1's price,

Q_{1y} is sales of good 1 in supermarket y,

e_{1y} is the price elasticity of the demand curve facing supermarket y for good 1,

$$\left[\frac{\partial Q_{1y}}{\partial P_{1y}}\frac{P_{1y}}{Q_{1y}}\right],$$

r_{yz} is the reaction of supermarket z to supermarket y's pricing decision,

$$\left[\frac{\partial P_{1z}}{\partial P_{1y}}\ \frac{P_{1y}}{P_{1z}},\right],$$

where P_{1z} is the price of good 1 in supermarket z,

and

e_{yz} is the cross price elasticity of demand between supermarket y and z,

$$\left[\frac{\partial Q_{1y}}{\partial P_{1z}}\ \frac{P_{1z}}{Q_{1y}},\right];\ \text{that is,}$$

how much supermarket y's sales will be affected by changes in the price at supermarket z).

Relaxation of the single product firm assumption allows for the possibility of systematic pricing, the pricing of some products below marginal cost because they increase sales of other items. The effects of changes in the price of good 1 on profits from the other N − 1 goods in supermarket y can be derived from the profit equation as follows:

$$(2)\ \pi_{ny} = P_{ny}\,Q_{ny} - TC_{ny},\ n = 2,\ldots, N$$

$$(3)\ \frac{\partial \pi_{ny}}{\partial P_{1y}} = P_{ny}\left[\frac{\partial Q_{ny}}{\partial P_{1y}}\right] - \frac{\partial TC_{ny}}{\partial Q_{ny}}\frac{\partial Q_{ny}}{\partial P_{1y}} = O$$

OR

$$\frac{\partial \pi_{ny}}{\partial P_{1y}} = (P_{ny} - MC_{ny})\frac{\partial Q_{ny}}{\partial P_{1y}} = O,$$

where:

π_{ny} is profit on sales of good n in store y,

P_{ny} is s price of good n in store y,

TC_{ny} is total cost of good n in store y, and

MC_{ny} is marginal cost of good n in store y.

There are two conflicting effects which determine the sign of $\frac{\partial Q_{ny}}{\partial P_{1y}}$. The first is a substitution or "switch-over" effect which is positive; that is, as the price of good 1 decreases (increases), purchases of other goods in the store may decrease (increase) due to the relative price change (i.e., people may decrease the amount of ground beef purchased if the price of pork loin decreases). The second is a draw effect which is negative. More people may shop at the store if the price of good 1 is decreased. When people are drawn to the store by good 1's price, they not only buy good 1, but also purchase other goods in the store. The systematic effect is the combination of these two impacts and can, therefore, be positive or negative depending on which effect dominates.

The profit maximizing position for supermarket y is to equate marginal revenue from good 1 plus marginal profit from the other N - 1 goods in the store to marginal cost for good 1:

$$(4)\quad Q_{1y}\,(1 + e_{1y} + r_{yz}e_{yz}) + \sum_{n=2}^{N} (P_{ny} - MC_{ny})\,\frac{\partial Q_{ny}}{\partial P_{1y}} = \frac{\partial TC_{1y}}{\partial Q_{1y}}\,\frac{\partial Q_{1y}}{\partial P_{1y}}\,.$$

The first term in equation (4) is the expression for MRP_{1y}, which should be a function of supermarket y's and supermarket z's price of good 1. Therefore, equation (4) could be solved for the profit-maximizing price for good 1. For simplicity, it is assumed that MRP_{1y} is a linear function of P_{1y} and P_{1z}, which is consistent with a linear demand specification. It is expected that the derivative of MRP_{1y} is positive with respect to P_{1y} and negative with respect to P_{1z}. It is further assumed that the wholesale price of the product is the best measure of marginal cost because this is a shortrun pricing model and the wholesale cost of the product is approximately 80 percent of the sale price (*Progressive Grocer*). Solving for P_{1y} gives:

$$(5)\quad P^{r}_{1y} = b_0 + b_1P^{w}_{1y} + \sum_{n=2}^{N} c_n(P^{r}_{ny} - P^{w}_{ny}) + b_3P^{r}_{1z}\,,$$

where the r superscript denotes retail and the w superscript denotes wholesale.

Finally, lagged adjustments are incorporated into equation (5) assuming a partial adjustment model:

$$(6)\quad P^{r}_{1yt} = b_0 + b_1P^{w}_{1y(t-1)} + \sum_{n=2}^{N} c_n\,(P^{r}_{ny} - P^{w}_{ny})_t + b_3P^{r}_{1z(t-1)} + b_4P^{r}_{1y(t-1)},$$

where: b_1, b_3, $b_4 > 0$ and $|c_n| > 0$. Equation (6) shows the current period's retail price for good 1 being influenced by the previous period's wholesale price and competitor's price for good 1. The expected signs for coefficients are shown below the equation. Introducing the lagged retail price of good 1 as a right-hand side variable allows retail price to partially adjust to its equilibrium value, which is one of the hypotheses of this research.

PROCEDURE

The hypotheses posed earlier were tested using equation (6) and retail price data for six different meat items (ground beef, chicken, T-bone steak, pot roast, round steak, and pork loin) collected from two supermarket chains. The stores were in the same market area, Lexington, Kentucky. Meat prices were analyzed in this study because meat purchases carry the highest weight in consumer expenditures, meat is an important agricultural commodity, and the raw farm product is more easily identifiable in the final product form. Because price comparison is especially difficult with meats, special care was taken to ensure maximum product uniformity when collecting meat prices.

The sampled meat prices were intentionally chosen in order to represent a cross-sectional view of meat department pricing decisions. Some items were selected because management considered them to be loss-leaders. Others were considered because they were considered to be cost-plus priced or because they were competitively priced. Retail prices were collected on a weekly basis during a 1-year period from February, 1981, through February, 1982. Data on wholesale prices were also collected during the same period. Wholesale prices were only available for one supermarket, so retail prices at that supermarket were used as dependent variables.

The six individual product regressions were estimated using three-stage least squares. This technique was required because the regression model for each meat cut included the price of other meats as righthand side variables (through the inclusion of the margin variables). In addition, three stage least squares allows for contemporaneous correlation between errors across equations, which could be present due to omitted variables.

The prices of all other goods in the store should be included in each regression model in order to measure completely the systematic pricing process. However, this specification only allowed for a systematic pricing effect among the six meat products. This abstracts slightly from reality, but it circumvents problems with degrees of freedom and weighting of different products.

Equation (6) was estimated using two data sets. One estimation used the actual weekly observations for each of the variables. The second estimation used a 4-week moving average for each of the variables. The latter procedure allows insights into the longer run price decisions of the firm through use of the partial adjustment parameter, which is one minus the coefficient on the lagged retail price of good 1 in equation (6).

RESULTS

The wholesale price of the meat product does not play much of a role in determining the retail price on a weekly basis, Table 1. No product had a coefficient for wholesale price which was positive and larger than its standard error. Wholesale price was negatively associated with three of the six retail prices; the coefficient for round steak was also larger than its standard error.

A close look at the price data for round steak revealed that the retailer periodically made substantial cuts in the retail price of round steak without substantial changes in other variables. Many times these large price changes would occur simultaneously with a small wholesale price change in the opposite direction. Therefore, correlation exists, but it is doubtful that a causal link is present.

There is certainly no evidence of a consistent, substantial link between wholesale and retail meat prices on a weekly basis, Table 1. Critics of the retail grocery industry have made this charge for a long time and have ridiculed the industry for its lack of price efficiency. The contention is that a price efficient market would show a strong positive correlation between retail and wholesale prices.

The systematic pricing effects are measured by the coefficients on margins for the meat products in Table 1. Over three-fourths of the margin coefficients (24 of 30) are larger than their standard errors, indicating that retailers follow systematic pricing rules. If the draw effect dominates, the margin coefficient is negative, which is the case for eleven of the variables whose coefficients are greater than their standard error. If the substitution effect dominates, the margin coefficient is positive, which is the case for thirteen of the variables whose coefficients are greater than their standard error. Note that these coefficients for the systematic pricing effect are net effects. Each individual commodity will have a draw and substitution effect; the coefficient measures the net of the two effects.

Each price equation has at least one product margin with a substantial net draw effect. Hamburger has the most margins with a net draw effect (three), followed by chicken, T-bone steak, and round steak (two each). The largest negative systematic effect is for T-bone where a 10-cent increase in hamburger's margin would decrease the price of T-bone by over 1.5 cents. Each price equation also had at least one substantial net substitution effect. Pot roast and pork loin have the most (three), followed by ground beef, chicken, and T-bone steak (two each). The largest positive systematic effect was between T-bone steak price and chicken margin, where a 10-cent decrease in chicken margin would decrease the T-bone steak price by over 2 cents.

There is a great deal of pairwise consistency for the systematic influences. If product A has a substantial net draw effect with product B, product B would either have a substantial net draw with product A or no substantial effect at all. The two meat products most frequently thought of as draw items, ground beef and chicken, have substantial net draw effects, but the coefficients are relatively small. Thus, the draw effects may be large, but the substitution effects for ground beef and chicken are almost as large. The two largest net draw effects, for T-bone and round steak, indicate that ground beef sales increase as the price of those meat products fall.

Four of the coefficients on lagged retail price were negative, which means that retail prices overadjust to changes in other right-hand-side variables. All of those coefficients were greater than their standard error. This overadjustment cannot continue in the long run without an unstable solution for retail

TABLE L. RETAIL PRICE EQUATIONS USING WEEKLY DATA; SELECTED MEAT ITEMS; LEXINGTON, KENTUCKY; 1981-82

Retail price for meat item	Intercept	Wholesale price	Margin for ground beef	Margin for chicken	Margin for t-bone	Margin for pot roast	Margin for round steak	Margin for pork loin	Competitor's price	Lagged retail price
Ground beef	1.69[a]	0.02	—	0.55	−0.18	−0.12	−0.15	0.53	0.42	−0.28
	(0.18)	(0.11)		(0.11)	(0.04)	(0.04)	(0.03)	(0.09)	(0.13)	(0.06)
Chicken	0.62	−0.07	0.36	—	0.10	−0.11	−0.02	−0.38	0.23	−0.14
	(0.25)	(0.24)	(0.11)		(0.03)	(0.06)	(0.04)	(0.11)	(0.08)	(0.13)
T-bone	3.08	−0.15	−1.73	2.26	—	0.10	−0.31	1.28	0.20	0.14
	(0.86)	(0.18)	(0.56)	(0.71)		(0.32)	(0.17)	(0.51)	(0.12)	(0.10)
Pot roast	1.73	0.42	−0.23	1.27	0.19	—	0.25	−0.36	0.17	−0.55
	(0.59)	(0.50)	(0.36)	(0.71)	(0.08)		(0.10)	(0.28)	(0.08)	(0.12)
Round steak	7.19	−2.22	−1.05	0.52	−0.44	0.20	—	1.72	−0.05	−0.13
	(1.91)	(1.09)	(0.57)	(0.71)	(0.16)	(0.33)		(0.44)	(0.21)	(0.09)
Pork loin	0.83	0.02	0.43	−0.53	0.07	0.03	0.10	—	0.15	0.10
	(0.12)	(0.04)	(0.08)	(0.10)	(0.02)	(0.05)	(0.03)		(0.03)	(0.06)

[a]Figures in parentheses are standard errors.

TABLE 2. RETAIL PRICE EQUATIONS USING FOUR WEEK MOVING AVERAGE DATA; SELECTED MEAT ITEMS; LEXINGTON, KENTUCKY; 1981-82

Retail price for meat item	Intercept	Wholesale price	Margin for ground beef	Margin for chicken	Margin for t-Bone	Margin for pot roast	Margin for round steak	Margin for pork loin	Competition's price	Lagged retail price
Ground beef	0.42[a]	0.42	—	0.06	0.03	0.05	0.06	−0.02	−0.29	0.46
	(0.16)	(0.11)		(0.13)	(0.01)	(0.04)	(0.03)	(0.03)	(0.07)	(0.07)
Chicken	−0.03	0.37	−0.20	—	−0.03	0.22	0.04	0.01	−0.01	0.51
	(0.14)	(0.18)	(0.14)		(0.01)	(0.03)	(0.04)	(0.04)	(0.05)	(0.11)
T-bone	1.08	−0.14	−1.41	2.61	—	−0.95	0.29	−0.15	0.12	0.84
	(0.24)	(0.13)	(0.38)	(0.55)		(0.17)	(0.09)	(0.12)	(0.11)	(0.06)
Pot roast	−1.23	0.96	−0.19	0.15	0.11	—	0.17	−0.15	0.28	0.67
	(0.50)	(0.33)	(0.34)	(0.68)	(0.05)		(0.08)	(0.12)	(0.10)	(0.18)
Round steak	2.61	−0.40	0.62	−2.10	0.20	0.43	—	0.32	−0.53	0.53
	(1.46)	(0.85)	(0.63)	(0.75)	(0.13)	(0.25)		(0.19)	(0.21)	(0.10)
Pork loin	0.06	0.05	0.26	−0.77	0.05	0.12	−0.19	—	0.07	0.91
	(0.17)	(0.04)	(0.13)	(0.16)	(0.02)	(0.05)	(0.04)		(0.05)	(0.10)

[a]Figures in parentheses are standard errors.

meat prices. The negative coefficients using weekly data simply reinforce the fact that retail prices are highly volatile and the previous week's price is a poor estimate for the next week's price.

The results of the model using a 4-week moving average for each variable are shown in Table 2. This procedure allows an investigation of the longer run influences on retail meat prices. The results using averaged data are quite different from weekly data for some variables. Wholesale meat prices are much more important in explaining retail price movements with this longer run analysis. Only the round steak price variable had a coefficient on the wholesale price which was less than its standard error. The coefficient on wholesale price for both ground beef and chicken were slightly less than 0.50, indicating that the retailer absorbs more than one-half of the wholesale price movements for those two meats during the first period. The retail price of pot roast essentially moved in concert with its wholesale price.

There were almost as many substantial systematic coefficients using the 4-week moving average data as with the weekly data (twenty-three versus twenty-four). However, all margin coefficients for the ground beef equation and three of the margin coefficients for chicken and T-bone are smaller in absolute value using the averaged data. T-bone is still a strong, net draw for ground beef and round steak is a strong, net draw for chicken using the averaged data. T-bone remains a strong net substitute for chicken.

The influence of the competitor's price was much less pronounced with the smoothed data. T-bone, pot roast, and pork loin had positive coefficients on the competitor's price which were larger than their standard error. Retail ground beef and round steak prices were found to be negatively related to the competitor's price. This indicates that the retailer consistently tried to use these product prices to differentiate his store from the competitor's. Ground beef and round steak were probably major features in the store's advertising campaign when their prices were lowered relative to the competition. This competition was more pronounced using the averaged data.

The coefficients for lagged retail price using the averaged data confirm the partial adjustment hypothesis for ground beef, chicken, pot roast, and round steak. The results suggest that about 50 percent of the movement to equilibrium will be made during a month's time. Two of the more expensive meat cuts, T-bone and pork loin, exhibited very long adjustment patterns with retail price moving only about 10 to 20 percent of the amount needed to reach equilibrium in one period. These results contrast sharply with the results from weekly data and lend further evidence that retail prices are much less volatile on a monthly basis than on a weekly basis.

Short and longrun coefficients for the wholesale price for each of the meat products using the averaged data are shown in Table 3. The estimates were derived from the reduced-form equations using the coefficients for the wholesale price and the partial adjustment parameter (from the lagged retail price coefficient).

Four of the six shortrun partial derivatives were between zero and one. The coefficient for T-bone steak was essentially zero and the coefficient for round steak was negative. In the long run, three of the six partial derivatives were between zero and one, with all being between 0.70 and 0.80. Pot roast's partial derivative exceeded one. Changes in wholesale ground beef, chicken, and pork loin are not totally passed on to consumers in the form of retail prices, even in the long run. The retailer must feel that retail price stability for these products is so important that the store will suffer lower margins if wholesale prices rise, but enjoy larger margins if wholesale prices fall.

When the partial derivatives are converted to elasticity form, which is consistent with a markup pricing decision, the magnitudes are slightly smaller in absolute value than the partial derivatives. The three meat products with the highest sales volumes (ground beef, chicken, and pork loin) had elasticities around .65. A constant markup pricing scheme implies an elasticity of wholesale price on retail price of 1.0. Retail price changes for

TABLE 3. PARTIAL DERIVATIVES AND ELASTICITIES OF CHANGES IN THE WHOLESALE PRICE ON THE RETAIL PRICE USING AVERAGED DATA; SELECTED MEAT ITEMS; LEXINGTON, KENTUCKY, 1981-82[a].

Meat product	Shortrun	Longrun	Longrun elasticity
Ground beef	.44	.79	.62
Chicken	.43	.80	.67
T-bone	−.01	−.04	.02
Pot roast	.96	2.67	1.37
Round steak	−.38	−.79	−.43
Pork loin	.11	.73	.60

[a] These partial derivatives and elasticities are derived from the reduced-form coefficients.

these high volume meats are less than would be expected from a perfect markup pricing model; retail pot roast prices change more than expected.

The retailer tends to increase margins on some meat cuts if wholesale prices are rising and tends to decrease margins in other meat cuts. Because overall meat prices tend to move together, especially individual types of meat (i.e., beef), the retailer can follow this strategy in the meat department and still keep the department's overall margin at an acceptable level.

The signs for partial derivatives and the elasticity are all negative for T-bone and round steak. All the numbers are very close to zero for T-bone steak. As indicated earlier, the result for round steak is due to the lack of variation in wholesale prices, coupled with aggressive retail pricing in some weeks. The coefficient of variation for the wholesale round steak price was the smallest of the six products while that for the retail round steak price was the largest of the six products. If there were more substantial changes in wholesale round steak prices, the results would probably be more consistent with theoretical expectations.

CONCLUDING REMARKS

Results of this study allow some interesting observations concerning retail price decisionmaking in the food industry. The firm follows a short and longrun systematic pricing strategy which is product specific. Management takes into consideration the draw and substitution impacts of price changes for individual products. Some meat products, especially T-bone, have larger net draw effects than the traditional loss leader meats, ground beef and chicken. The reason is that ground beef and chicken have large substitution effects which tend to lessen the net draw.

The studied firm seems to follow two additional strategies, depending on the time frame. In the short run, the firm prices its meat products so that they are competitive with the other major store in town. For most meat products, any changes in the competitor's price elicits a similar, but smaller change in the studied retailer's price.

In the longer run, the firm seems to pay much more attention to the movement of wholesale prices, rather than its competitor's price. This longrun strategy is much more price efficient than the short run strategy. Another aspect of wholesale price movements is that the retailer responds quite differently to wholesale price changes depending on which meat product is involved. This strategy is clearly less efficient in economic terms, but is probably better than no linkage between wholesale and retail prices.

The most important finding is that store managers act in a manner which is consistent with the theoretical development. They not only react to wholesale price increases (on a longterm basis), but also consider the impacts of individual price fluctuations on the store's total sales volume.

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