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The Apparent Failure of Retail Beef Prices to Respond to Supply Shocks: An Empirical Investigation

By Rodney Jones and Wayne D. Purcell*

Practitioners Abstract

Several times in recent years concerns have been expressed regarding slow and/or inadequate price adjustments in the retail beef market. In particular, industry participants have speculated that retail prices may not respond promptly or completely to supply shocks at the producer level. This study provides a detailed investigation of the wholesale - retail price spread in the beef market using weekly data over a 14 year period. The objective is to determine whether there is a deviation of this margin from the costs of providing retailing services, and if an excess margin is found to determine whether the magnitude of the deviation is related to beef, or total meat, supplies. The results of this investigation indicate that margins have become more variable in recent years. However, it is not clear that margins have deviated from the costs of providing retailing services. A comparison of an early period with a more recent period indicates that the beef retailing sector may have become even more competitive in recent years. No evidence is found to suggest that excessive wholesale - retail margins are associated with increased beef or total meat supplies. Future research will look at the other potential source of inadequate price adjustment in the beef marketing chain, the farm - wholesale margin.

Introduction

Periodically, and in particular during the recent summer of 1994, concerns have surfaced regarding the perceived failure of retail beef prices to respond with reasonable promptness and/or completeness to increased supplies. For example, between April of 1994 and July of 1994 farm level fed cattle prices decreased by approximately 20% and boxed beef cutout prices decreased by about 15%. Average retail prices, however, declined by less than 10% from the high to the low in the face of large and rapid increases in beef supplies. During calendar 1994, the changes were even more inconsistent. Several similar examples in recent years indicate that the pricing mechanism may fail to respond to increased supplies at the retail level and allow the needed increased movement into consumption at lower prices. This type of market failure, if it exists, could impede the ability of the industry to cope with supply changes, especially within year supply surges, at the producer level. The economic viability of the feedlot and producer segments of the industry could be threatened.

These most recent concerns regarding the apparent failure of prices at various levels in the beef marketing chain to move together (follow somewhat parallel paths) have come about at a

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time of very high levels of concentration and vertical coordination both at the processing and retailing levels in the beef sector. Industry participants in highly concentrated industries may have the ability to behave non-competitively and price their output at a level that differs from their marginal costs. Therefore, the structural characteristics of the beef packing and retailing sectors have continued to stimulate discussion among both livestock producers and researchers regarding whether the value of slaughter cattle correlates closely with the retail demand for beef cuts.

Previous researchers have lent credibility to the suggestion that pricing information flows from the farm level up through the system to the retail level in a markup pricing framework (Boyd and Brorsen, Schroeder and Hayenga). These researchers have suggested that retail prices may in fact be slow to respond to shocks at lower levels in the marketing chain, requiring three to five weeks to incorporate wholesale price information, and even more time to incorporate live animal price information. Industry participants are concerned not only about the time required for response, but about the size --the relative completeness-- of the response.

Available research regarding the completeness of price response at various levels of the meat marketing chain is seriously limited. In a study that used weekly data to look at the relationship between wholesale and live beef prices, Marsh and Brester found that these two price series tended to move together in response to new information, but the responses were not complete in the short run. The authors did not attempt to explain this incomplete response. Using monthly data and a relative price spread model, Brester and Musick analyzed both farm-wholesale and wholesale-retail price spreads in lamb markets. The authors found that most of the farm to retail margin increase that had occurred since the mid 1980's had occurred between the wholesale and retail levels. A measure of concentration level (CR4) included in the model was statistically significant in explaining increases in margins, but the authors pointed out that this could be attributed to either market power or to changing cost structures.

Determining the nature and determinants of wholesale to retail margin changes in the meat sectors is an important research issue, especially considering the highly concentrated structure of the industries. This study will focus on the beef industry. Further investigation is needed to better understand the wholesale to retail pricing mechanism in the beef sector. Do retail prices come down as much as they should (based on changes in costs to retailers) to allow increased movement into consumption at times of increased farm level supplies of beef? If the answer is sometimes or always no, then it is important that the conditions under which the response fails to occur be further investigated. This study looks at the relationship between the wholesale - retail margin in the beef sector, and the marginal costs associated with providing retailing services for beef. Specifically, we are interested in the deviation of this margin (price) from marginal costs and the relationship between this deviation and changes in farm (or wholesale) supplies of beef over time.

Using comparative statics, Holloway showed that if a retail sector is non-competitive, increases in farm supply can theoretically cause the farm to retail price spread to increase by more than will occur if the retail sector is competitive. These "excessive" margin increases can be the result of market participants taking advantage of the opportunity to exercise market power.

In this paper we test this theory with regard to the beef retailing sector.[1] This research tests for a systematic relationship between retailer margins and supply shocks in the beef industry after accounting for changes in cost structure. The analysis differs from previous work in several important ways. First, we utilize weekly (vs. quarterly or yearly) data. Second, we look at the wholesale - retail price spread in beef. Finally, we look at how this relationship has changed over time by dividing our data set into two distinct periods. The identification of factors that may be associated with any deviation of price from marginal cost in the retail beef marketing sector is an important addition to understanding the wholesale - retail pricing mechanism in the beef marketing chain.

Modeling Excess Margins as Market Power

In an ideal world, the margin between wholesale and retail prices would be equal to the costs associated with rendering those retail services. There are, of course, factors that can cause a deviation from this ideal even when market participants are behaving competitively. Such factors as risk and uncertainty, pricing inefficiency or information asymmetry, or price adjustment costs can be present. Whatever factors make up the actual components of this deviation, it is important from a practical standpoint to understand the historical nature of, and elements that may be associated with widening of any "excess" margin. The objective of this research is not to define this deviation, but rather to test for an association between this deviation and supply shocks.[2] Therefore, any systematic deviation of price from marginal cost, regardless of the definition, can be thought of as a very general definition of market power and can be modeled accordingly.

If data regarding margins, quantities, and components of costs are available, then this "market power" can be empirically modeled (Appelbaum). We consider the per - unit retail margin (retail price minus wholesale price) to be the price of providing retailing services per - unit of beef sold. The profit maximization problem of the retail sector can be written as:

$$\pi_t = P_t * Y_t - COST_t \qquad (1)$$

where Π_t is retailing sector profit in time t, P_t is the margin in time t, Y_t is the quantity of beef sold in time t (measured as federally inspected beef production), and $COST_t$ is the cost associated with providing retailing services in time t. This cost is equal to $\sum_i w_i * q_i$, with q_i

[1]While Brester and Musick were not explicitly testing this theory in their study of lamb marketing margins, they did include a term consisting of price multiplied by quantity in their model and it was highly significant in the wholesale to retail margin equation.

[2]Using similar rationale Hall looked at 7 one digit SIC industries and 26 two digit SIC industries in the U.S. and found that in general when output increased firms were able to sell output for considerably more than they paid for inputs. The most obvious explanation is monopoly or monopsony power.

representing the quantity of input i used in beef retailing and w_i representing the price associated with input i for each respective time period. For this study, it is assumed that the major inputs into beef retailing include transportation, energy, labor, and advertising. In each time period, the behavior of the retail sector is assumed to be consistent with the solution to the first order condition for profit maximization:

$$\frac{\partial \pi}{\partial Y} = P + \frac{\partial P}{\partial Y} * Y - \frac{\partial COST}{\partial Y} = 0 \qquad (2)$$

which can be re-written as:

$$P = - \frac{\partial P}{\partial Y} * Y + mc \qquad (3)$$

where mc = $\frac{\partial COST}{\partial Y}$ = marginal cost.

A generalized Leontief functional form is assumed to represent the cost function, expressed as:

$$COST = Y * \left(\sum_{i=1}^{4} \sum_{j=1}^{4} \gamma_{ij} w_i^{.5} w_j^{.5} \right) \qquad (4)$$

where w_1 is the price of transportation, w_2 is the price of energy, w_3 is the price of advertising, and w_4 is the price of labor. This function is homogeneous by definition, and symmetry is imposed by restricting $\gamma_{ij} = \gamma_{ji}$ for all input prices. The marginal cost specification for the case of four inputs is derived as:

$$\begin{aligned} mc = {} & \gamma_{11} w_1 + \gamma_{22} w_2 + \gamma_{33} w_3 + \gamma_{44} w_4 \\ & + 2\gamma_{12} w_1^{.5} w_2^{.5} + 2\gamma_{13} w_1^{.5} w_3^{.5} + 2\gamma_{14} w_1^{.5} w_4^{.5} \\ & + 2\gamma_{23} w_2^{.5} w_3^{.5} + 2\gamma_{24} w_2^{.5} w_4^{.5} + 2\gamma_{34} w_3^{.5} w_4^{.5} \end{aligned} \qquad (5)$$

The degree of deviation of price from marginal cost can then be investigated by determining the value of $-\frac{\partial P}{\partial Y}$ from equation 3.[3] Treating $-\frac{\partial P}{\partial Y}$ as a parameter to be estimated, and substituting equation 5 into equation 3, the first order condition can be specified in a form to be estimated as:[4]

$$\begin{aligned} P = {} & \beta * Y + \gamma_{11} w_1 + \gamma_{22} w_2 + \gamma_{33} w_3 + \gamma_{44} w_4 \\ & + 2\gamma_{12} w_1^{.5} w_2^{.5} + 2\gamma_{13} w_1^{.5} w_3^{.5} + 2\gamma_{14} w_1^{.5} w_4^{.5} \\ & + 2\gamma_{23} w_2^{.5} w_3^{.5} + 2\gamma_{24} w_2^{.5} w_4^{.5} + 2\gamma_{34} w_3^{.5} w_4^{.5} \end{aligned} \tag{6}$$

In order to increase the efficiency of the marginal cost parameters, the first order condition (equation 6) would ideally be supplemented with the cost function itself or factor demand equations derived via Shephard's lemma, or both, for estimation in a systems approach. Unfortunately, for this study, input quantities were not available. Therefore, to represent the first model estimated and discussed in this analysis, the first order condition (equation 6) is estimated using OLS.

The measure of the deviation of price from marginal cost (β from equation 6) can be modeled as a function of exogenous variables (such as weekly pounds of beef produced) in an attempt to find the determinants of this markup over cost. Schroeter and Azzam used a variant of this technique to model the farm to wholesale price spread in the pork industry. In the second model estimated for this analysis, β is specified as a function of federally inspected beef production (Y) in time t and federally inspected total meat production (MPROD) in time t. This alternative specification of the first order condition is expressed as follows for estimation purposes:

$$\begin{aligned} P = {} & (\alpha + \beta_1 Y + \beta_2 MPROD) * Y + \gamma_{11} w_1 + \gamma_{22} w_2 + \gamma_{33} w_3 + \gamma_{44} w_4 \\ & + 2\gamma_{12} w_1^{.5} w_2^{.5} + 2\gamma_{13} w_1^{.5} w_3^{.5} + 2\gamma_{14} w_1^{.5} w_4^{.5} \\ & + 2\gamma_{23} w_2^{.5} w_3^{.5} + 2\gamma_{24} w_2^{.5} w_4^{.5} + 2\gamma_{34} w_3^{.5} w_4^{.5} \end{aligned} \tag{7}$$

This alternative specification of the model is also estimated using OLS.

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[3]In this instance $-\frac{\partial P}{\partial Y}$ is a combination of the degree of price markup in the output (retail beef) market, and the degree of price markdown in the primary input (wholesale beef) market.

[4]Previous researchers have treated the entire $\beta * Y$ term as the price markup term and have estimated it as the product of two parameters representing a conjectural elasticity and a demand (supply) flexibility. See Appelbaum (1982) or Schroeter (1988) for a complete discussion of this technique.

Data

Retail beef price data were obtained from the Knight Ridder Financial News weekly survey of newspaper advertising in nine major U.S. cities.[5] The prices of 15 major cuts of beef are averaged across the cities, then averaged across cuts to arrive at an average retail price for the week. The time frame of availability of the retail price series constrains the entire analysis to the 1981 through 1994 time period. The wholesale price series used is the Choice 550-700 pound carcass boxed beef cutout value, reported weekly in the USDA Livestock Meat and Wool bulletin. Both retail and wholesale prices are converted to live weight equivalents using the conversion factors suggested by White et al. Nominal retail prices are divided by 2.402 and nominal wholesale prices are divided by 2.103 to obtain the live-weight equivalent prices. Both weekly U. S. federally inspected beef production and weekly U. S. federally inspected total meat production were obtained from the USDA Livestock Meat and Wool bulletin.

Monthly commercial electricity prices were obtained from the Department of Energy-Energy Information Administration, monthly energy review reports. The labor price data are from the Average Earnings report of the United States Department of Labor-Bureau of Labor Statistics, summarized by month. Monthly motor gasoline retail prices (a weighted average of all types) were obtained from the Energy Information Administration, historical monthly energy review series. This series represents the price of transportation. For each of the monthly price series the same value is included in the data set for each week of each respective month.

The price of advertising is represented by the Media Cost Index, obtained from USDA-ERS. These data are only available on a quarterly basis. Therefore, weekly values for both the Newspaper and Network TV advertising cost indices are obtained by a cubic spline interpolation of the quarterly data using the EXPAND procedure in SAS. The average of these two series is used in the final data set.

For this analysis, the wholesale - retail margin is calculated as the retail price in week t, minus the wholesale price in week t-1. It is assumed that retailers are, on average, selling meat in one week that they purchased the prior week.[6] Table 1 reveals the mean and standard deviation of this margin, both for the entire period of 1981 through 1994, as well as for an early period consisting of 1981 through 1987 and a more recent period of 1988 through 1994.

It is clear that the margin has become more variable in recent years, as indicated by the higher standard deviation of the margin for the second period reported in Table 1. What is not clear is whether or not the margin is excessive, or whether or not there is a systematic relationship between the margin and other factors such as beef quantities.

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[5]The survey included only eight major cities prior to the last week of April in 1982.

[6]The analysis was also performed with the margin calculated using contemporaneous wholesale prices, and using wholesale prices lagged 2 weeks. There were no significant differences in the results using the alternative margin calculations.

Table 1. Mean and Standard Deviation Of The Live Weight Equivalent Wholesale to Retail Beef Margin.

Period	Mean	Standard Deviation
Full Data Set 1981 - 1994	39.82	4.92
Early Period 1981 - 1987	36.35	2.76
Recent Period 1988 - 1994	43.67	4.09

Results of Model Estimation

Table 2 reveals the results of the estimation of model 1 (equation 6) for the entire time period, as well as for each of the shorter time periods. The market power parameter (β) is not statistically significant at the .05 level for any time period. This indicates that retailers perceive or assume an infinitely elastic demand curve for beef, and an infinitely elastic supply curve for boxed beef. This model provides no evidence to suggest that retailers are enjoying "excess" margins. Though the model estimation results in an acceptably high R^2 in each instance, few of the marginal cost function parameters are significantly different from zero at the .05 level. The efficiency of these parameter estimates is likely quite low due to the fact that the cost function or factor demand equations are not included in the estimation process.

Table 2. Results of the Estimation of Model 1 (Equation 6).

Parameter	Data Period		
	Full (1981-94) N=730 R^2= .72	Early (1981-87) N=365 R^2= .37	Recent (1988-94) N=364 R^2= .55
β	-0.0036	-0.006	0.003
	(-0.04)*	(-1.44)	(0.48)
γ_{11}	0.172	-0.987	0.028
	(0.83)	(-1.71)	(0.05)
γ_{22}	-16.343	37.997	-91.122
	(-0.72)	(0.87)	(-1.10)
γ_{33}	10.377	-108.005	20.115
	(0.72)	(-2.48)	(1.08)
γ_{44}	0.887	2.249	3.068
	(0.80)	(1.23)	(1.36)
γ_{12}	2.980	6.995	25.645
	(1.81)	(2.39)	(3.67)
γ_{13}	-6.792	-18.982	-1.218
	(-4.53)	(-5.54)	(-0.25)
γ_{14}	0.173	1.149	-3.599
	(0.43)	(1.93)	(-2.40)
γ_{23}	40.734	112.767	19.340
	(2.58)	(3.94)	(0.66)
γ_{24}	-3.623	-21.016	-3.277
	(-0.80)	(-2.71)	(-0.26)
γ_{34}	-3.110	4.355	-4.251
	(-0.79)	(0.58)	(-0.72)

* Numbers in parenthesis are t statistics associated with each respective parameter.

Table 3 reveals the results of the estimation of model 2 (equation 7) for all time periods investigated. Included in Table 3 are implied values of the market power term calculated using the mean values of federally inspected beef production and federally inspected meat production over each respective time period used in the analysis.

Table 3. Results of the Estimation of Model 2 (Equation 7).

Parameter	Data Period: Full (1981-94) N=730 R^2 = .73	Early (1981-87) N=365 R^2 = .40	Recent (1988-94) N=364 R^2 = .56
α	-0.016 (-1.25)*	0.114 (4.08)	-0.005 (-0.26)
β_1	0.00003 (1.63)	-0.0001 (-4.16)	0.00003 (1.09)
β_2	-0.00001 (-2.38)	-0.00001 (-0.90)	-0.00002 (-2.42)
Implied β Calculated at Means	-0.010	.051	-.008
γ_{11}	0.252 (1.11)	-0.720 (-2.12)	0.131 (0.21)
γ_{22}	-13.014 (-0.57)	63.980 (1.49)	-108.520 (-1.30)
γ_{33}	16.907 (1.15)	-38.533 (-0.85)	31.019 (1.56)
γ_{44}	1.217 (1.09)	4.043 (2.20)	2.995 (1.31)
γ_{12}	2.968 (1.81)	6.667 (2.31)	26.235 (3.77)
γ_{13}	-6.635 (-4.43)	-13.692 (-3.85)	-0.654 (-0.13)
γ_{14}	0.111 (0.27)	0.746 (1.27)	-3.808 (-2.54)
γ_{23}	45.192 (2.83)	114.607 (4.11)	17.797 (0.59)
γ_{24}	-4.528 (-0.99)	-25.088 (3.28)	-0.901 (-0.07)
γ_{34}	-4.570 (-1.13)	-5.780 (-0.75)	-5.545 (-0.92)

* Numbers in parenthesis are t statistics associated with each respective parameter.

Since one would expect $\frac{\partial P}{\partial Y}$ to be negative if there is a significant departure of price from marginal cost, one would expect the implied value of β ($-\frac{\partial P}{\partial Y}$) to be positive. As can be seen from Table 3, this result is not always attained though the negative values are relatively small. The implied values do not have a clear interpretation in their raw form. Since they represent the slope of the perceived demand curve, they can be converted to a perceived flexibility measure by multiplying by mean values of ($\frac{Y}{P}$). This calculation results in a perceived flexibility of .108 for the full period, -.598 for the early period, and .080 for the most recent time period. This interpretation suggests that retailers may have enjoyed excess margins during the early 1980's.

The β_1 and β_2 parameters are of particular interest for this study because they provide an indication of the impact of increased beef (or total meat) supplies on the ability of retailers to garner excess margins. For the entire time period, the results suggest that changes in federally inspected total meat production are associated with changes in the ability of retailers to obtain margins that deviate from marginal costs, as indicated by the statistically significant value (.05 level) of the β_2 parameter. The negative sign of this parameter is, however, contrary to the hypothesis of widening margins being associated with increased meat supplies. The results of this model indicate that the ability to exercise market power actually decreases as meat production increases.

For the early time period the implied value of β is positive, indicating the possibility of a deviation of the margin from the cost of providing retailing services. The negative and significant (.05 level) value of the β_1 parameter indicates that the deviation of the actual margin from the cost of providing the services in the retail sector tends to decrease as federally inspected beef production increases. This finding is also inconsistent with the hypothesis of widening excess margins being associated with increasing beef supplies.

For the most recent time period the significant negative value of the β_2 parameter indicates that excess margins may have decreased as meat supplies increased over the most recent time period. As is the case for the model 1 results, many of the marginal cost parameters are not statistically significant at the .05 level. Again, this can be attributed to high variance of the parameter estimates.

Conclusions

It is crucial that industry participants and policy makers understand the pricing mechanism and pricing dynamics as the industry structure evolves and changes over time. Unfortunately, this study does not provide conclusive findings regarding the magnitude of the "excess" wholesale - retail margin. Margins have become more variable in recent years. However, we find little evidence to suggest that the deviation of the wholesale - retail margin from the costs associated with providing retailing services has increased in recent years. In fact, the results of model 2 indicate that the magnitude of the excess margin was considerably larger in the early years of the data than in the later time period.

We find no evidence to suggest that the deviation of the wholesale - retail margin from the costs associated with providing that margin increases with increased beef or meat supplies. In contrast, we find some evidence to suggest that increased meat supplies may in fact decrease

this "excess" margin. Given the level of interest in this important topic, further research is warranted. A richer data set including alternative measures of input prices, and quantities associated with those inputs, would allow a more accurate estimation of marginal costs. In addition, with a better data set, alternative model specifications could be explored. Finally, an obvious extension would be to look closely at the other link in the farm - retail marketing chain, the farm - wholesale margin.

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