



Effect of Commodity Promotion on Beef Quality by Jayson L. Lusk and Bailey Norwood, *Oklahoma State University*

Most studies that have investigated the effect of commodity promotion from producer-funded check-off programs have simplified their analyses by ignoring product quality. However, there are a number of commodities for which firms and consumers are able to substitute between differing qualities in the marketplace. The case of beef presents a perfect example. Historically, beef was marketed as a generic product making it impossible for consumers to associate an eating experience with a particular brand name. However, in recent years, a variety of branded beef products, such as Certified Angus Beef, Laura's Lean, Colman's Natural, and Hormel's Always Tender, have begun entering the market. These quality changes can also be noted by investigating U.S. Department of Agriculture data; the percentage of graded beef that was assigned the Choice quality grade fell from 90% in 1980 to 57% in 2000. Beef quality has also become increasingly important at the farm level. Some estimates suggest that by 2006 over 60% of fed cattle will be marketed on a grid, where cattle are individually priced based on quality characteristics.

The increasing importance of quality in the beef sector elevates the need for more research to assess the effect of commodity promotion on beef quality. If quality is an important part of consumers' purchasing decisions or ranchers' production decisions, then models that rest on the assumption of homogeneous quality may not provide accurate pictures of price, quantity, or revenue changes occurring for different qualities.

Further, when quality homogeneity is assumed, no inferences can be made about the effect of commodity promotion on the average quality of beef and the premium for higher quality beef. This is problematic for a number of reasons. First, demand shifts are often invoked using funds from producer-financed programs such as a checkoff program. Producer financed promotion might not have an equivalent effect on prices and quantities of high and low quality beef, implying that benefits may not be equally distributed across producers. Second, because of the increasing prevalence of grid pricing and branding, beef retailers and fed cattle producers are increasingly interested in beef quality and the effects of commodity promotion on quality levels and price premiums.

The goal of this research is three-fold. First, we develop a model that is able to capture quality heterogeneity in retail, wholesale, and farm markets. Second, the model is implemented using data from the beef sector to analyze how generic promotion affects beef quality and how the increased revenues generated by such promotion are allocated among high and low quality producers. Finally, we identify determinants of quality heterogeneity and empirically investigate the effect of these determinants on quality and premium changes.

The Model

We developed an equilibrium displacement model characterized by the horizontal linkage between high and low quality beef in addition to a vertical linkage of retail, wholesale, and farm markets.

The model is flexible in that it accounts for substitution between beef and marketing inputs and is convenient in that it provides a simple way to characterize product quality. In particular, beef is grouped by quality according to whether it grades USDA Choice or higher (hereafter, Choice) or USDA Select or lower (hereafter, Select). On the demand side, it is assumed these two qualities comprise a weakly separable group, and that demand for the two qualities can be characterized in terms of the overall elasticity of demand for beef, the elasticity of substitution between Choice and Select beef, an expenditure expansion elasticity for Choice and Select beef (the percent change in a particular quality demanded resulting from a one percent change in total beef expenditures), the expenditure share for Choice and Select beef (consumer expenditures on Choice/Select beef divided by expenditures on all beef), and an overall demand shock representing the percent change in initial equilibrium price due to an exogenous demand shift (e.g., an increase in consumer willingness-to-pay for the initial quantity of beef due to promotion). Similarly, on the demand side, supply of the two beef qualities can be characterized in terms of an overall elasticity of supply for beef, the elasticity of transformation between Choice and Select beef, supply expansion elasticities (e.g., the percent change in a particular quality of cattle supplied when the supply of all cattle increases by one percent), and cost shares. Again, the model formulation provides a convenient way of imposing quality homogeneity by imposing certain restrictions on parameter values.

Data and Model Parameterization

A nice feature of the model is that it relies on parameters, such as the overall elasticity of beef demand, for which there are many good econometric estimates. In contrast, were a model developed that was based on separate elasticities of demand for Choice and Select beef, the model would be difficult to parameterize as there are no existing estimates for these quality-specific parameters. We specified three different sets of parameters (i.e., three different models) corresponding to three different levels of heterogeneity. In one model, we assumed beef was of a homogeneous quality. Two other models were developed that entailed differing levels of beef quality heterogeneity. USDA data were used to determine relevant ranges for cost and expenditure shares. The aggregate own-price retail demand elasticity, own-price farm supply elasticity, and elasticity of substitution between beef and marketing services were taken from previously published studies. We used available wholesale-level data on prices and quantities of Choice and Select beef to draw inferences about the elasticity of substitution between Choice and Select beef. The only parameters for which there are relatively little available data are the expansion elasticities. However, intuition and previously published studies provide guidance regarding the magnitude of these parameters. In our application, the expansion elasticity was assumed to be greater for Choice than for Select at the retail level, with the opposite being the case at the farm-level. As will be discussed later, this assumption has major implications for the results.

Results

After parameterizing the models, we assumed that demand shifted outward by 10%, a situation that might occur via commodity promotion. Table 1 reports the effect of such a demand shock in the three

models. As would be expected, a demand shock increases prices and quantities of both beef qualities at all marketing levels with only one exception. From a revenue enhancement standpoint, the demand shock benefits Choice producers more compared to Select producers. Although total revenues increase for both qualities, the farm quantity of Select beef falls. The reason this occurs is because the demand shock has a larger effect on Choice demand than Select demand via the larger expansion elasticity. That is, as overall beef demand increases from the 10% shock, a larger share of this aggregate demand increase is distributed to Choice through Choice beef's larger expansion elasticity. As a result, the Choice price increase is relatively large and causes the Select supply curve to shift left. The supply curve decreases so much that the new general equilibrium output in the lower quality market is lower than before the shock. Results in table 1 illustrate the fact that the homogeneous quality model is unable to provide insight into effects of changes in quality as it predicts equivalent changes in prices and quantities for both beef qualities. In terms of farm revenue changes, total revenues are similar across models, but the distribution of revenue gains across qualities are quite different.

To provide a better understanding regarding economic significance of using a homogeneous versus a heterogeneous quality model, we use the figures reported in table 1 to calculate changes in revenue caused by the demand shifts. Over 13.14 billion pounds of beef graded Choice or higher in 2002 and over 8 billion pounds of beef graded Select or Standard in 2002, with the prices of Choice and Select boxed beef averaging \$115.09/cwt and \$108.97/cwt, respectively over the same time period. These statistics imply that

total revenue for the wholesale beef sector was about \$23.84 billion in 2002. Using these statistics, and extrapolating to the farm level, we find that predicted changes in Choice beef revenue after the demand shock are \$610.9, \$408.3, and \$685.4 for models 1, 2, and 3, respectively. These results indicate that a homogenous quality model can under- or over-predict changes in revenue accruing to a particular quality by several million of dollars.

The effects of the demand shock on quality and price premiums are reported in table 2. Table 2 reports changes in the average quality of beef on the market, which we calculate by taking the difference between the percentage change in Choice beef quantity and the percentage change in Select beef quantity. As shown in table 2, the demand shock increases average quality of beef on the market—i.e., the quantity of Choice beef increases at a faster rate than the quantity of Select beef. The effect is more pronounced the greater the degree of beef heterogeneity. Table 2 also reports changes in the quality price premium, which we calculate as the difference between the percentage change in Choice beef price and the percentage change in Select beef price. Quality price premiums increase after the demand shock. That is, higher quality beef commands a higher relative price premium over lower quality beef after the demand shock. Importantly, table 2 shows that the homogeneous quality model predicts no change in quality or price premium relative to the heterogeneous quality models.

Are the changes in price premiums and quality reported in table 2 large enough to be economically important? The changes in price premiums predicted by the heterogeneous quality model are as high as 3.23%. How do these changes in price premiums compare to changes actually observed the market? Using USDA from 2001, we

calculated the difference changes in the wholesale price of Choice boxed beef and weekly price changes in the price of Select boxed beef. The average change in wholesale prices over this time period was -0.04% with a standard deviation of 1.22%, a maximum of 2.8% and a minimum of -3.4%. Assuming the changes are normally distributed, a price premium increase as high as 3.23% would be observed less than 1% of the time. Thus, the changes in price premiums predicted from the heterogeneous quality model are *economically* significant in that they represent “large” changes as compared to that typically observed from week to week.

The last step in our analysis entailed an effort to identify model parameters that have the most pronounced influence on quality and price changes following a demand shock. Because analytical model solutions were difficult to generalize, we conducted a numerical analysis in a Monte Carlo type framework to investigate the impact of varying model parameters. Results of the exercise indicate that the demand expansion elasticity has a relatively large effect on premium and quality changes. A larger supply expansion effect for Choice causes a larger change in the quality and price premiums. Our numerical analysis indicates that for a 1% increase in the Choice expansion elasticity average quality will increase an additional 5.6% at the farm level following a 10% demand shift. Other model parameters such as the elasticity of substitution between beef and marketing inputs and the elasticity of substitution between Choice also influence quality and premium changes, but by a much lower magnitude than the expansion elasticity.

Conclusions

Modeling beef quality is important to the beef sector for a number of

reasons. First, the beef sector is increasingly differentiated by quality at both the retail and farm levels. At the retail level, grocery stores are beginning to sell higher quality beef cuts such as Certified Angus Beef as well as the traditional selection of Select or store-brand beef. Understanding how price premiums change for these products is important for beef retailers. At the farm level, producers are increasingly selling cattle on a grid where animals are given premiums or discounts based on quality. For example, cattle feeders only sold 16% of fed cattle on a grid in 1996, but this figure increased to 45% in 2001. When animals are marketed on a grid, changes in prices of high versus low quality as well as the distribution of quality in a pen can have significant effects on profitability. This issue is also important because of large amounts of check-off funds spent on promotion. If beef is treated as a homogeneous commodity, it is impossible to assess the impact of potential demand shifts on surplus accrued to producers of high or low quality beef. Results of this analysis suggest that outward demand shifts will most likely increase the share of high quality beef on the market and will increase the price premium charged for higher quality beef.

Our findings indicate that models assuming homogenous quality will, in some circumstances, provide poor indicators of changes in price premiums and quantity associated with a demand shock. Whether future research should incorporate quality heterogeneity depends on the magnitudes of the elasticities of substitution between qualities at the retail and farm levels as well as potential differences in expansion elasticities for different qualities. Our numerical analysis suggests that if expansion elasticities differ significantly across models, then a

homogeneous quality model will likely provide erroneous predictions of changes in quality, price premiums, and distribution of changes in revenue. This finding points to an important step for future research. Because market-level data are unavailable to determine expansion elasticities for beef quality, future research might focus on finding other means for estimating these parameters. Experimental economics or survey methods could be used to determine how Choice and Select beef demand would expand as overall beef expenditures increase. This is particularly important because if it were found that the Select expansion elasticity were larger than Choice, many of the conclusions drawn in this preliminary research would be incorrect. Another important area for future research relates to measuring the welfare effects of quality changes. Producers of high and low quality beef, which pay equivalent per-unit fees into the check-off program, are not likely to share equally in the benefits of promotion. We are currently working on expanding our model to incorporate factors of production that are not mobile across Choice and Select producers (e.g., high and low quality genetics) such that welfare accruing to those independent factors of production could be calculated.

Although we abstract away from welfare, this paper offers several contributions. It is intuitive that a heterogeneous model generates different results than a homogeneous quality model; however, it is not entirely clear *how* results will be different. A homogenous quality model is silent regarding the effect of exogenous shocks on changes in quality and price premiums. This research provides insight into the direction and magnitude of quality and price premiums that might be expected after commodity promotion.

Table 1 – Change in Beef Prices and Quantities due to an Upward Shift in Beef Demand^a

Variable	Percentage Changes by Model		
	Heterogeneous Quality Model 1 ^b	Heterogeneous Quality Model 2 ^b	Homogeneous Quality Model 3 ^b
<i>Percent Change in Endogenous Variables</i>			
Choice Retail Quantity	4.146%	4.892%	3.850%
Select Retail Quantity	3.300%	1.914%	3.850%
Choice Wholesale Quantity	2.288%	2.817%	2.060%
Select Wholesale Quantity	1.636%	0.654%	2.060%
Choice Farm Quantity	1.256%	1.664%	1.065%
Select Farm Quantity	0.711%	-0.046%	1.065%
Choice Retail Price	3.244%	3.623%	3.125%
Select Retail Price	2.905%	2.201%	3.125%
Choice Wholesale Price	5.898%	6.587%	5.682%
Select Wholesale Price	5.282%	4.002%	5.682%
Choice Farm Price	7.372%	8.234%	7.103%
Select Farm Price	6.603%	5.002%	7.103%
<i>Percent Change in Revenue at Farm Level</i>			
Choice Beef	8.721%	10.035%	8.244%
Select Beef	7.361%	4.953%	8.244%
Total Revenue	8.245%	8.257%	8.244%

^a Based on a 10% increase in consumers' willingness-to-pay relative to initial price.

^b Model 1 allows some heterogeneity in beef quality, Model 2 allows greater heterogeneity in quality, while Model 3 assumes beef is a homogeneous good.

National Institute for Commodity Promotion Research and Evaluation

DIRECTOR
Harry M. Kaiser, Professor
 Phone: 607-255-1598
 e-mail: hmk2@cornell.edu

RESEARCH ASSOCIATE
Diansheng Dong
 Phone: 607-255-2985
 e-mail: dd66@cornell.edu

RESEARCH ASSOCIATE
Todd M. Schmit
 Phone: 607-255-3015
 e-mail: tms1@cornell.edu

RESEARCH ASSOCIATE
Kent D. Messer
 Phone: 607-255-4223
 e-mail: kdm22@cornell.edu

ADMINISTRATIVE ASSISTANT
Anita S. Vogel
 Phone: 607-255-1620
 e-mail: av69@cornell.edu

RESEARCH AIDE
Donna M. Eaton
 Phone: 607-255-2687
 e-mail: dme22@cornell.edu

Table 2 – Changes in Beef Quality and Price Premium Caused by 10% Demand Shift

Variable	Percentage Changes by Model		
	Heterogeneous Quality Model 1 ^b	Heterogeneous Quality Model 2 ^b	Homogeneous Quality Model 3 ^b
<i>Quality Changes</i>			
Change in Retail Quality ^a	0.846%	2.978%	0.000%
Change in Wholesale Quality ^a	0.652%	2.163%	0.000%
Change in Farm Quality ^a	0.545%	1.710%	0.000%
<i>Premium Changes</i>			
Change in Retail Premium	0.338%	1.422%	0.000%
Change in Wholesale Premium	0.615%	2.586%	0.000%
Change in Farm Premium	0.769%	3.232%	0.000%

^a Statistics represent the percent change in Choice quantity minus the percent change in Select quantity.

^b Statistics represent the percent change in Choice price minus the percent change in Select price.