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Marginal Value of Quality Attributes for Natural and Organic Beef

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Consumers are increasingly demanding food products possessing specific attributes related to production and/or processing (Barkema; Streeter, Sonka, and Hudson). One such attribute is increasing demand for natural beef products. Producers have responded by attempting to meet the demand through organized alliances. Givry found more than 30 producer-owned cooperatives or private firms marketing organic or natural beef in the United States in 1998.¹ Many beef producers are considering making investments in organic or natural beef production systems and marketing cooperatives to provide beef products to consumers.²

The USDA Small Farm Commission Report indicated that market research is a critical need for producers in these types of systems. Because producers of organic or natural beef market animals that may possess any combination of multiple attributes (e.g., organically grown, produced on small farms, no synthetic growth promotants, etc.) using contracts (e.g., Laura's Lean Beef, Coleman, etc.) or through cooperatives (e.g., Tall Grass Prairie, All Natural Beef, etc.), it is important that they have information on which attributes are most valued by consumers.

Some attributes (like breed, marbling, etc.) may be attainable through production practices such as genetic selection, becoming certified organic, or feeding grain or grass in the finishing ration. Other attributes valued by consumers might include tenderness or pasteurization labeling, which are at least influenced through processing practices such as dry aging or irradiation, respectively.

¹ The terms "natural" and "organic" are often confusing to consumers and producers. Natural is defined by the U.S. Department of Agriculture as "a product containing no artificial ingredient or added color and is only minimally processed (a process that does not fundamentally alter the raw product) may be labeled natural. The label must explain the use of the term natural (such as no added colorings or artificial ingredients or minimally processed)." Organic is in the process of being defined by USDA but is being labeled as "certified organic by (the name of the certifying agency)." The U.S. Department of Agriculture did not allow beef to be labeled as organic until February 1999. However, beef could be labeled as natural.

² It should be noted that Greene found that the number of beef cows which were considered 'organic' actually declined from 6,796 in 1992 to 4,429 in 1997. However, this likely was due to the fact that meat could not be labeled as organic. Thus, producers did not receive any economic incentives for organic certification. While it is likely that the total number of cattle under organic certification systems increased, producers did not attempt to certify them.

The value of the attribute has implications for a producer's decision to invest in a cooperative. This could help avoid potential moral hazard problems that arise in an agency theory framework whereby a firm contracts with a producer for beef with certain attributes using some premium over a commodity price but the producer does not know which attributes are most highly valued. Consequently, producers may make investments in production assets or systems that may not be needed.

Natural or organic beef and conventionally produced beef are examples of product differentiation. The product (e.g., beef) is the same across production systems but its price may differ because producers use different production methods and consumer demand varies by production practice. The variety of attributes (e.g., conventional, natural, organic, etc.) for beef products is characteristic of differentiation. The value of these attributes can be estimated by using hedonic price functions. The objective of this research is to determine the marginal value of attributes to consumers with respect to natural beef or beef produced with organic grains and sold by small producers in a chain of Midwestern supermarkets.

Background Information

The demand for beef has declined markedly since the late 1970s (Purcell). Lusk *et al.*, in reviewing the literature on factors contributing to the decline in beef demand, noted that changes in relative prices, consumer health concerns, food safety concerns, product convenience and offering, product quality and consistency, changing demographics, and evolving consumer preferences are significant factors explaining this decline. Schroeder, Marsh, and Mintert found that many of these factors adversely affected beef demand especially vis-a-vis competing meats. However, many of these factors cannot be changed solely by producers, processors, or retailers (Smith *et al.*). Integrated or tightly coordinated beef production and processing systems are able to respond to economic incentives for various product quality attributes more readily than the traditional cash market system (Schroeder *et al.*).

Producers

Beef producers are able to make improvements in genetics through selecting for traits such as improved feed conversion to reduce per unit production costs or enhanced marbling to increase per unit marketing revenues. Similarly, a producer may decide not to use cost-reducing technologies such as synthetic growth promotants or subtherapeutic antibiotics if sufficient economic incentives exist to produce natural beef products.

Sartwelle identified three categories of marketing alliances that were used by producers to increase revenue per animal: breed association-sponsored, commercial, and natural/implant-free. Depending upon the program, alliances typically seek high quality grade targets with acceptable muscling *or* acceptable quality grades with high yielding carcasses within these three categories. One breed association-sponsored program, Certified Angus Beef™, seeks high yielding carcasses and has doubled in size since 1995 to almost 500 million pounds annually. A brand for one commercial alliance, Maverick Ranches Beef Prime Beef, seeks high quality grade targets (USDA Prime).³

³ The USDA Agricultural Marketing Service identified 39 such programs as of July 2002.

The choice of farming system is another factor producers may use to enhance revenues. Economies of size and scope exist among various enterprises (e.g., cow-calf production, feedlot) and a producer may choose a production system that utilizes more labor than capital (e.g., cow-calf to finishing). Organic beef production is primarily done through cow-calf to finishing systems rather than cow-calf and feedlot systems. However, it is unclear whether consumers will provide large enough economic incentives to offset potential higher production and processing costs associated with tightly controlled organic beef systems. Organic certification vis-a-vis natural beef labeling may or may not be a valuable attribute to consumers.

The choice of feed ingredients is another controllable factor. Grain has long been known to increase marbling in beef relative to grass-fed beef. Although marbling level is reflected in the USDA quality grade, perceptions of other beef quality attributes associated with grain-fed beef may make it have greater value to consumers.

Processors

Many of the factors affecting beef demand are related to product quality attributes. In particular, lack of tenderness is one such attribute commonly cited by processors and retailers (Smith *et al.*). Many studies have found that tenderness is the most important attribute of beef palatability (Dikeman; Huffman *et al.*). Tenderness is a function of several things including genetics, length of time cattle are fed, processing, aging, and product cooking and preparation (Miller *et al.*). Beef processors have numerous techniques they can use to influence beef product tenderness including aging and various methods of mechanical tenderizing.

Wet-aged or vacuum-packaged beef has been the industry standard since development of commercial vacuum-packaging technology in the late 1960s. This has decreased processing costs due to lower inventory costs. Dry-aging is more costly relative to other conventional processing methods, but aging tenderizes beef naturally (Huffman *et al.*). However, the additional time required in refrigerated coolers and estimated shrink loss of at least 10 percent significantly increases the cost of producing dry-aged beef.

Unnevehr and Bard determined that the more external fat and seam fat beef table cuts had, the lower was consumer demand for those cuts. They also found that higher levels of marbling were preferred for loin steaks, but discounted in chuck roasts. The current USDA quality grading system uses intramuscular fat or marbling as a primary measure of quality. However, this is poorly correlated with tenderness (Wheeler, Cundiff, and Koch). Consequently, tenderness or similar attributes have not been a component of most beef value-based marketing programs. However, several technologies exist that have potential for measuring and/or changing tenderness and could be used in a value-based marketing program (Miller *et al.*, Shackelford, Wheeler, and Koohmaraie).

Schroeder, Marsh, and Mintert found that a large increase in the number of beef recalls results in a significant decline in beef demand. Although it is difficult to obtain quantitative evidence on consumer attitudes towards food safety concerns, traceability or identity-preservation has clearly become a more important attribute in recent years. Labeling beef that has been produced under such systems may help alleviate consumer concerns over safety and therefore have increased value to consumers.

Description of the Model

Ladd and Martin's model of processor demand describes the value of inputs that are observable (e.g., corn, soybean meal, etc.) and composed of attributes that are unobservable (e.g., tenderness, etc.). That information is important to processors. However, using that information in a value-based marketing program may be difficult. For example, Sartwelle noted that value-based marketing programs for cattle are based on total carcass revenue which is adjusted for various quality targets. The goal of a beef processor seeking to form an alliance with producers to meet consumer demand for various quality attributes is to devise a value-based marketing program that uses the information on the value of unobservable attributes and convey that information to producers using economic incentives.

In order to accomplish this, a processor may contract various inputs that contain attributes with producers or provide quality targets similar to those noted by Sartwelle. In either case, it is important for a processor to devise a value-based marketing program that best provides economic incentives to producers to use inputs that enable it to meet consumer demand for various attributes.

Data

Data for natural and organic beef sales on 630 beef cattle marketed from May 1996 to December 1999 were obtained from a collaborating producer-owned cooperative. The first three months of data (55 carcasses) were not used because of wide variability in live weight as the program was getting started. Another 97 carcasses had incomplete information. Thus, data on 478 carcasses are used in this analysis. The production system used by these producers are typical of the small farms as defined by Gebremedhin and Christy and USDA's Small Farms Commission in that they likely have less than \$40,000 a year in sales and have an integrated livestock and cropping system that is highly dependent upon their own and family labor. The majority of producers market under 25 head of cattle per year.

The beef was sold through a value-based marketing program based upon weight of the primal cuts. The retailer pays producers wholesale prices for each cut based on a negotiated rate for that week. A net carcass price per pound based on the weighted average of the primal cut weights and prices is also reported to producers. Slaughter and processing are contracted on a per head basis by the marketing cooperative. Producers receive no credit for byproducts, but these are used by the processor. The contract processing fee is reduced by the value of byproducts, hide, bones, and similar inedibles.

Producers are required to complete information on each animal marketed through the cooperative as part of their identity-preserved system. The producer variables include *Age* which is the life of the animal measured in months, live weight (measured in pounds), *Days Fed Grain* which is the number of days that the animal was fed a finishing ration to help promote marbling, *Feed Type* or principal type of feed in the finishing ration (corn, barley or milo, hay or pasture grasses), *Breed* type (measured as Angus crosses or European breed crosses), *Gender* (steer or heifer), lot number, and eartag number.⁴

⁴ ³USDA regulations require products that have been certified organic to be labeled as such. Natural labeling has no such certification program and does not require such labeling.

The majority of animals that were sold initially on this program were solely grass-fed because the retailer indicated a preference for a very lean product. However, the retail supermarket soon asked the producers to increase the amount of marbling in the primal cuts because the beef was too lean. Thus, *Feed Type* was measured to provide information to the retailer regarding tradeoffs between leanness (grass-fed) and marbling (corn-fed). *Days Fed Grain* was used to provide information to both producers and the retailer on leanness and marbling. If animals are grain-fed long periods of time, they may develop excessive marbling for consumers desiring lean beef. On the other hand, a finishing ration that is fed for too short a period of time likely will not provide sufficient marbling desired by consumers. The weight, as measured by *Carcass Weight*, also is used as a measure to ensure that the animals have the desired muscling.

The cooperative contracts slaughter, processing, and dry aging of the beef with several local processing plants. The processor variables include *Organic Label* if the animal was produced under a certified organic system; *USDA Grade* measured as Prime, Choice, or Select; and *Number of Days Aged* which represents how long each primal cut is aged (measured as the number of days from slaughter until placed in the retail supermarket counter). Other variables collected but not used in this analysis include the weight (in pounds) of the primal cuts (Shoulder Clod, Top Butt, Tenderloin, Flank Steak, Inside Round, Gooseneck, Knuckle, Brisket, Strip, Mock Tender, and Rib Eye), weight of the trimmings and ground beef, liver, tail, and other byproducts.

Thus, in this analysis, there are 10 variables (*Days Fed Grain*, *Days Fed Grain squared*, *Breed*, *Age*, *Feed Type*, *Carcass Weight*, *USDA Grade*, *Number of Days Aged*, *Gender* and *Organic Label*) that are used to explain the price of 11 inputs (Rib Eye, Brisket, Mock Tender, Tenderloin, Strip, Top Butt, Inside Round, Gooseneck, Knuckle, Shoulder Clod, and Flank Steak). These 11 inputs (plus byproducts) determine the quantity of wholesale beef produced from each carcass.

Another variable, *Choice Price_x*, was added to account for changes in aggregate beef price over time. This variable is the Choice U.S. Department of Agriculture price for each respective beef subprimal for the week the producer sold the animal. In addition, the U.S. Department of Agriculture Choice Wholesale boxed beef cutout carcass equivalent price was collected and used in analyzing the prices received by producers per entire carcasses.

Summary statistics of the variables and live weight are reported in Table 1. In Table 2, the wholesale price per pound paid to producers for each primal cut and the USDA prices are reported. A producer's total carcass revenue was calculated by multiplying the wholesale prices in Table 2 by their respective weight as measured in pounds. Each of the wholesale prices paid to producers in Table 2 were regressed on the variables in table 1 (excluding live weight) and the USDA prices for each animal using ordinary least squares to determine the marginal implicit value of each. The same process was used to regress carcass revenue on the variables and a USDA choice boxed beef price.

Results

The relative ability of the variables to explain the variability in the system was 0.64. In general, statistical significance was noted in five or more of the models (except *Breed*) for variables that producers have some control over such as *Days Fed Grain*, *Gender*, *Age*, and type of feed (*Corn*, *Hay* or *Pasture Grasses*, *Milo* or *Barley*). However, the economic significance was small

relative to variables that a processor had some control over such as *Number of Days Aged* and *Choice Price*.

For example, *Days Fed Grain* was statistically significant (linear, quadratic, or both terms) for 6 of the 11 cuts. All of the roast type cuts (except Shoulder Clod and Gooseneck) had significant *Days Fed Grain* parameter estimates. The most notable price impact was for the strip where the optimal number of days on feed (i.e., the point where the highest premium was paid) increased at a decreasing rate with a maximum premium relative to zero days fed of approximately \$1.03 per pound at about 180 days on feed. The Top Butt and Inside Round had similar patterns to the Strip but with smaller premiums at the optimal number of days. The Rib Eye, Knuckle, and Flank Steak had declining prices the longer the animal was on feed (for at least up to 200 days on feed). The largest discounts were realized at about 260 days on feed with discounts as large as \$1.09 per pound for Rib Eye and small discounts for the other cuts.

Allowing animals to become more mature (*Age*) results in small price increases for Rib Eye, Mock Tender, Top Butt, and Shoulder Clod but decreases price for Tenderloin. As an animal gets heavier, muscling increases at a faster rate than live weight. Thus, older animals tend to have more muscling which is a desirable trait because many consumers value boneless cuts for convenience in cooking. It is more cost efficient to remove the bone from larger primal cuts of meat.

Corn and Hay were used as dummy variables in measuring *Feed Type*. Using mostly corn in the finishing ration increases the price (relative to using milo) of Rib Eye, Top Butt, Shoulder Clod, and Flank Steak but decreases Tenderloin and Gooseneck prices. Conversely, using mostly hay in the finishing ration increases the price (relative to using milo) of Brisket, Top Butt, and Inside Round and decreases Strip, Gooseneck, and Knuckle prices.

Choice Price was significant in all eleven models. An increase in the price of the USDA Choice price for each primal cut, *ceteris paribus*, is associated with an increase in the price of each cut. The greatest change was for the *Choice Price* of Tenderloin where a one dollar increase in the USDA Choice price resulted in a \$0.96 increase in the Tenderloin price. Gooseneck had the lowest increase in price (\$0.21) for a one dollar increase in *Choice Price*.

Number of Days Aged was statistically significant in nine of the models. An increase in *Number of Days Aged*, *ceteris paribus*, yielded an increase in the price of Top Butt, and Inside Round. The largest increase was Top Butt where a one day increase in the number of days aged resulted in a \$0.031 per pound increase in price. The price of Rib Eye, Mock Tender, Tenderloin, Gooseneck, Knuckle, Shoulder Clod, and Flank Steak decrease when *Number of Days Aged* increased. These primal cuts are primarily roast type products where tenderness is of less value relative to higher valued steak cuts such as Rib Eye and Strip. This result also could be a reflection that as the inventory of these cuts increases, price may adjust downward as new inventories arrive. Steak primal cuts are aged about ten days longer than roast type products (Table 1).

Under this particular value-based marketing program, prices were lower (relative to USDA Select) for Rib Eye, Tenderloin, and Inside Round if the animal graded USDA Choice relative to Select. Prices also are lower (relative to USDA Select) if the animal graded USDA Prime for Gooseneck and higher (relative to USDA Select) for Top Butt. Discounts for higher levels of

marbling reflect this particular program where leanness is preferred and certainly are not reflective of national wholesale beef markets. Prices of Rib Eye, Gooseneck, and Knuckle increase when produced (and labeled) under organic production (*Organic Label*) but Top Butt and Inside Round have a decrease in price.

The relative ability of the variables to explain the variability in total carcass revenue was 0.83. *Days Fed Grain*, *Gender*, *Carcass Weight*, and *USDA Boxed Beef Price* had significant parameter estimates. The optimal number of days to feed the cattle in terms of highest price per pound was 221 days. Of course, this needs to be considered jointly with the discounts for increased carcass weights and marginal costs of adding weight. A one dollar per pound increase in the *USDA Boxed Beef Price* increased total carcass revenue \$41.90. Carcass revenue increased for heavier carcasses while steers had a higher value relative to heifers. Clearly, a processor could develop a value-based marketing program using carcass weight, boxed beef price, and an animal's gender to further provide economic incentives to producers.

Implications

The results suggest that producers under this particular natural/implant-free marketing alliance should market high yielding animals rather than high quality grade animals. It is evident that consumers of this beef value tenderness, as measured by dry aging, and leanness, as measured by USDA Select grade. From the processor's perspective, these two variables contributed the most after the USDA Choice price. The economic magnitudes of the variables under a producer's control were small relative to those that could be controlled by a processor. This suggests that a processor desiring natural beef might seek to coordinate production (e.g., contracts or integration) with producers. Carcass weight, gender, and less marbling would be a significant part of a value-based marketing program between this processor and these producers. Producers would need to invest in the processor in order to share in any positive returns from dry aging of the beef.

These results are specific to this particular alliance and are not generalizable to all producers or all alliances. However, this demonstrates clearly that some consumers value beef attributes that differ from aggregate market signals. Prime and Choice wholesale beef are always at premiums to the market relative to Select. However, consumers patronizing this particular alliance apparently value leanness over marbling and prefer to rely on aging to improve tenderness. Whether the producer is certified organic is not important to these consumers. Other consumer groups likely value different attributes in different ways from those in this study. This suggests that when beef producers target specific consumer segments, they need to know the particular consumers' preferences and realize they may differ from aggregate market signals.

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Table 1. Summary Statistics for non-Price Independent Variables Used to Explain Beef Primal Cut Prices

| Variable | Average | Std. Dev. | Min | Max |
|---------------------------------|---------|-----------|------|-------|
| Live weight (100 pounds) | 11.80 | 0.97 | 9.20 | 18.00 |
| Carcass Weight (100 pounds) | 7.32 | 0.89 | .52 | 1.03 |
| Age (months) | 21.21 | 3.21 | 15 | 30 |
| Corn ^a | 0.78 | 0.41 | 0 | 1 |
| Milo ^a | 0.10 | 0.30 | 0 | 1 |
| Hay ^a | 0.12 | 0.32 | 0 | 1 |
| Prime ^b | 0.01 | 0.12 | 0 | 1 |
| Choice ^b | 0.47 | 0.50 | 0 | 1 |
| Select ^b | 0.51 | 0.51 | 0 | 1 |
| Breed ^c | 0.21 | 0.41 | 0 | 1 |
| Days Fed Grain (100 days) | 1.93 | 0.40 | 1.05 | 3.00 |
| Days Aged - steaks ^d | 15.56 | 1.32 | 14 | 19 |
| Days Aged - roast ^e | 6.20 | 1.12 | 5 | 9 |
| Organic Label ^f | 0.12 | 0.32 | 0 | 1 |
| Gender ^g | 0.56 | 0.50 | 0 | 1 |

^aCorn, Milo, and Hay are binary variables equal to 1 if that was the predominant finishing ration and 0 otherwise.

^bPrime, Choice, and Select are binary variables equal to 1 if the carcass was that quality grade and equal to 0 otherwise.

^cBreed is a binary variable where 0 is an Angus cross and 1 is other European crosses.

^dSteaks are flank, brisket, mock tender, tenderloin, rib eye, and strip.

^eRoast includes shoulder clod, inside round, top butt, knuckle, and gooseneck.

^fOrganic labeling is a binary variable where 0 = non-organic labeled and 1 = organic labeled.

^gGender is a binary variable where 0 = heifer and 1 = steer.

Table 2. Summary Statistics of Actual Wholesale Prices Paid to Producers in Cooperative and USDA Wholesale Choice Price, P_x (\$ per pound)^a

| Variable | Mean | Standard Deviation | Minimum | Maximum |
|---------------------------------|------|--------------------|---------|---------|
| <u>Prices paid to producers</u> | | | | |
| Rib Eye | 4.04 | 0.62 | 3.08 | 5.38 |
| Shoulder Clod | 0.98 | 0.09 | 0.83 | 1.25 |
| Brisket | 0.90 | 0.13 | 0.72 | 1.23 |
| Mock Tender | 1.48 | 0.13 | 1.23 | 1.98 |
| Tenderloin | 7.41 | 0.94 | 6.24 | 10.12 |
| Strip | 3.31 | 0.41 | 2.52 | 4.22 |
| Top Butt | 1.26 | 0.15 | 1.05 | 1.88 |
| Inside Round | 1.07 | 0.11 | 0.83 | 1.35 |
| Gooseneck | 1.09 | 0.04 | 0.86 | 1.16 |
| Knuckle | 1.33 | 0.08 | 1.15 | 1.53 |
| Flank Steak | 2.53 | 0.22 | 2.22 | 3.20 |
| <hr/> | | | | |
| <u>USDA Prices</u> | | | | |
| Rib Eye | 4.01 | 0.51 | 3.27 | 5.20 |
| Shoulder Clod | 0.94 | 0.06 | 0.83 | 1.09 |
| Brisket | 0.89 | 0.12 | 0.73 | 1.24 |
| Mock Tender | 1.25 | 0.11 | 1.02 | 1.50 |
| Tenderloin | 7.10 | 1.02 | 5.14 | 10.33 |
| Strip | 3.03 | 0.39 | 2.47 | 3.98 |
| Top Butt | 1.73 | 0.21 | 1.43 | 2.21 |
| Inside Round | 1.15 | 0.05 | 1.04 | 1.27 |
| Gooseneck | 1.07 | 0.04 | 0.81 | 1.11 |
| Knuckle | 1.21 | 0.06 | 1.05 | 1.37 |
| Flank Steak | 2.40 | 0.22 | 2.12 | 2.97 |
| Boxed Beef | 1.05 | 0.07 | 0.94 | 1.20 |

^aWe acknowledge Rob Murphy, Sparks Inc., for providing USDA Wholesale prices.