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Implicit Value of Retail Beef Product Attributes

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To identify the value consumers place on observable characteristics of fresh beef products, primary data were collected on over 1,350 packages of beef from 66 randomly selected grocery stores located in three metropolitan areas—Oklahoma City and Tulsa, Oklahoma, and Denver, Colorado. Estimated linear and log-linear hedonic models reveal ground beef prices were significantly influenced by store location (i.e., metropolitan area) and store type, fat content, package size and type, expiration date, brand category, and special labels. Factors influencing steak prices included store location, product type, quality grade, package size and type, brand category, and special labels.

Key words: beef, brands, hedonic models, marketing, prices, retail

Introduction

Consumers make an a priori assessment of expected eating satisfaction by employing various cues when purchasing beef products (Bredahl, 2003). These cues span the spectrum of product attributes involving search attributes such as package type and expiration date, experience attributes related to taste and freshness such as a quality indicator of fat content or tenderness, and credence attributes which may relate to animal production practices such as natural beef production (Grolleau and Caswell, 2006). Specifically, retail beef products are multi-attribute goods, possessing cues that come from and reflect various aspects of the eating experience. Store reputation likely affects where consumers shop. Specific products or cuts affect menu items, cooking method, and expected eating satisfaction. Objective and subjective measures of quality are indicators of the expected eating experience. Packaging affects handling sanitation, shelf life, and storage of beef products. Retail brands may signify quality, consistency, and previous experience consumers have had with products. Special labels such as "all natural" or "guaranteed quality" may inform consumers of special handling or production measures.

Limited research exists on consumer evaluation of retail beef product attributes. However, considerable research on related issues suggests a need for determining the value consumers place on the multi-attributes of retail beef products. For example, separate studies have addressed a single attribute such as tenderness (Feldkamp, Schroeder,

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and Lusk, 2005; Feuz et al., 2004; Lusk et al., 2001; Platter et al., 2005), packaging (Menkhaus et al., 1992), or labeling (Loureiro and Umberger, 2003). Other research has addressed indirect attributes, including health, convenience, origin, visual appeal, and merchandising (Loureiro and Umberger, 2007; Lusk, Roosen, and Fox, 2003; Maynard, Burdine, and Meyer, 2003; Menkhaus et al., 1993). Most of this research has involved stated preference surveys or experimental methods.

Few studies with market data have examined the value consumers place on retail beef attributes. Again, most such research focuses on a single attribute. Brester et al. (1993) estimated the value of a new low-fat ground beef product with monthly wholesale prices. Unnevehr and Bard (1993) studied consumer preferences for varying levels of intramuscular and external fat using data on roasts and steaks from the National Market Basket Survey of sampled retail cases in 12 cities. Most recently, Parcell and Schroeder (2007) estimated the value consumers place on several beef and pork attributes with data from U.S. household consumption diaries.

Research reported here utilizes observed price data from retail grocery stores to determine the value consumers place on a wide array of fresh beef attributes. Thus, our study differs from the stated preference approach that tends to dominate the literature. In addition, this study goes beyond previous hedonic analyses by including a more exhaustive list of product attributes and by using a systematic approach to personally collect the price and attribute data. Data were collected from a sample of retail grocery stores in three metropolitan areas. Data and information collected included all information individual shoppers find on each package of beef when making purchasing decisions. Given the interest in brand marketing of beef to increase demand (Brocklebank and Hobbs, 2004; Schroeder and Kovanda, 2003), and consumers' willingness to pay for specific beef attributes (such as quality, packaging, and labeling as the above-cited studies evidence), this study provides insight into the value consumers place on multiple attributes.

Conceptual Framework

Economists have long recognized price differences between products at any point in time reflect differences in the characteristics or attributes the products possess. Hedonic prices are defined as the implied prices for product characteristics revealed from observed prices of differentiated products (Lancaster, 1966; Rosen, 1974; Ladd and Suvannunt, 1976). The hedonic method is an indirect valuation approach as it relies on differences in differentiated products' prices to infer the value consumers place on specific attributes (Taylor, 2003).

Hedonic pricing theory is a convenient but appropriate way to characterize the concept that consumers purchase products with multiple attributes. It is assumed consumers derive utility from the attributes a product possesses and choose the bundle of attributes that maximize utility given income constraints and bundle prices. Similarly, sellers maximize profits by choosing the amount of each attribute to produce given production technology and the prices of product bundles. In equilibrium, the supply of each attribute must equal the demand for each attribute, such that the equilibrium price of a bundle of attributes $z = z_1, z_2, \ldots, z_n$ is equal to $P(z)$. The derivative of this hedonic price function with respect to attribute i, $\partial P(z)/\partial z_i$, indicates the marginal implicit price of the attribute i. As shown by Rosen (1974), optimality conditions of the consumer maximization problem require that consumers' marginal willingness to pay

for attribute i equals the marginal implicit price of attribute i. This implies that by constructing a hedonic price function, $P(z)$, where bundle prices are specified as a function of individual attributes, z, one can infer consumers' willingness to pay for an attribute. In this particular application, the bundle prices, $P(z)$, refer to the prices for packages of beef and the attributes, $z_1, z_2, \ldots, z_n$, correspond to factors such as the size (weight) of the product, package type, fat content, brands or labels, etc.

Previous Literature

Several studies using various methods, such as surveys, experiments, and hedonic analyses, have identified factors important to consumers in making beef purchases. A sample of relevant literature is summarized in what follows.

A consumer survey by Purcell (1993) identified several factors which influence consumers' buying behavior. Consumers rated taste, fat content, and cholesterol level among the most important, followed by ease of preparation and price. Menkhaus et al. (1993) also relied on survey data to determine consumers' assessment of steak quality and respondents' overall opinion of fresh beef. Consistent with the findings by Purcell, they found the following characteristics to be important to consumers: health (cholesterol, fat, and artificial ingredients), convenience (ease of preparation and storage), and merchandising (appearance, packaging, and price).

Marbling and tenderness attributes have been known to be important to consumers and have been the subject of considerable recent research (Killinger et al., 2004; Lusk, Roosen, and Fox, 2003; Lusk et al., 2001; Platter et al., 2005). The beef industry, too, has recognized the increased importance consumers place on tenderness and has been more active in assessing the tenderness of beef available in retail and food service outlets and the reaction by consumers (Voges et al., 2007).

In addition to these more concrete physical attributes, several studies have identified various credence attributes that are valuable to consumers. For example, Lusk, Roosen, and Fox (2003), using stated preferences from mail surveys, found U.S. consumers were willing to pay large premiums for steaks from cattle that were not fed genetically modified feed or that had been administered growth hormones. Lusk, Feldkamp, and Schroeder (2004) confirmed with experimental auction data that some consumers are willing to pay significant premiums for steaks from cattle that were not administered growth hormones relative to generic, unlabeled steaks. Loureiro and Umberger (2003, 2007) used survey methods to conclude consumers were willing to pay for mandatory country-of-origin labeling and traceability. Blind taste tests, surveys, and focus groups enabled Maynard, Burdine, and Meyer (2003) to estimate consumer willingness to pay premiums for meat labeled "locally produced."

In addition to these and other survey and experimental studies, some research has analyzed actual market prices. For example, using hedonic methods applied to wholesale beef prices, Brester et al. (1993) found a 1% increase in the leanness of ground beef was associated with a price premium of $0.02/lb. Unnevehr and Bard (1993) used hedonic methods applied to roasts and steaks in a nationwide market basket survey of retail meat cases. They found buyers significantly discounted external and seam fat, but did not place a consistent value on intramuscular fat. Loureiro and McCluskey (2000) conducted a hedonic analysis on meat prices in Spain and found a significant premium for a particular origin label for certain quality cuts.

The most similar study to the present investigation is that by Parcell and Schroeder (2007). They utilized Meat Panel Diary (MPD) data, which included consumers' self-reported meat purchases from 1992 to 2000. Purchased meat products were differentiated based on the following attributes: cut of meat, package weight, whether or not the product was discounted, USDA quality grade, and fat content. In their hedonic regressions for beef, Parcell and Schroeder discarded all observations that were reported as "other brand" or "not reported," leaving approximately 2,300 observations. They found each additional pound of ground beef per package reduced the purchase price by $0.23/lb., and a 1% increase in leanness increased price by $0.04/lb. For roasts, each additional pound of package weight increased price by $0.28/lb. Steak prices declined $0.74/lb. for each additional pound of package weight. Steaks were divided into three groups of varying degrees of quality: low, medium, and high. Consumers paid a $0.27/lb. premium for high quality (i.e., USDA Prime) steaks compared with steaks of medium quality. They paid $0.04/lb. less for USDA Select steaks when compared to steaks that did not designate the USDA grade. Parcell and Schroeder showed the implicit price for brand was statistically different from zero for roasts and steaks; however, brand was not statistically significant for ground beef. The brand premium for roasts was $0.34/lb. compared to store branded roasts. Similarly, the premium for branded steaks was $0.76/lb. to $1.26/lb. compared to store branded steaks.

This study differs from previous research in several important ways. First, we rely on retail market prices rather than on hypothetical surveys or experimental markets to infer consumers' values. Second, as compared to previous hedonic analyses related to beef, we focus on a considerably larger set of attributes expected to influence consumer choice. Third, rather than relying on consumers' self-reported meat purchases (as in Parcell and Schroeder, 2007), we collected all price and attribute data directly from sampled retail grocery stores, ensuring a high level of consistency in characterizing beef quality attributes and price. In so doing, we capture all the information available to consumers when purchasing a package of retail fresh beef.

Sampling Methodology and Data

Data were collected from retail grocery stores in three metropolitan areas (Oklahoma City and Tulsa, Oklahoma, and Denver, Colorado) during July-August 2006 (Dutton, 2007). These three metropolitan areas were chosen based in part on interests of the parties funding this research. The Denver area represents a large, ethnically and socio-economically diverse population, whereas Oklahoma City and Tulsa are more regional population centers.

Careful attention was devoted to developing an appropriate procedure for sampling beef products from the population of beef products to be included in this study (ground products, roasts, and steaks) that exist in these metropolitan areas. First, we estimated the total number of ground products, roasts, and steaks we could expect to find in each metropolitan area. Supermarket visits in the region enabled estimating the typical number of packages per store. Then, telephone book yellow pages were consulted to identify the total number of grocery stores in each metropolitan area: 125 in Oklahoma City, 65 in Tulsa, and 150 in Denver. Multiplying the total number of stores in each location by the estimated number of product packages per store provided an estimate of the total population of beef packages for the products included in the study in each

metropolitan area. This population size was then plugged into a standard statistical formula to determine the minimum sample size required to estimate the mean price of each type of beef product within a ±3% level of accuracy with 95% confidence (www.aboriginemundi.com/ssc/). Calculations revealed data from at least 14.8 stores in each metropolitan area would be required in order to obtain the desired level of sampling error.

Erring on the side of caution (Kupper and Hafner, 1989), we chose to collect data for beef products from 20 randomly selected stores within each metropolitan area. That is, from the entire population of stores given by the lists compiled from the yellow pages, we randomly selected 20 stores from Oklahoma city, 20 stores from Tulsa, and 20 stores from Denver. Once the samples were drawn, we identified the location of each store on a map and noted the geographic distribution and types of stores within each metropolitan area. Each metropolitan area was divided into four quadrants (northeast, northwest, southeast, and southwest). If no stores in the sample were in one quadrant, an additional store was drawn for inclusion in the sample from the population of stores in that quadrant.

Sampled stores were placed into one of four categories: specialty, conventional supermarket, discount (including limited-assortment stores and supercenters), and warehouse club stores. Specialty stores are food stores that specialize in one type of product such as a meat market, bakery, or organic food store. Supermarkets are grocery stores that are primarily self-service, providing all major food departments. Conventional supermarkets offer major food departments, nonfood grocery products, limited general merchandise, and may also offer a bakery, service deli, or fresh meat butchers. Discount stores include limited-assortment stores that offer few products at economy prices and supercenters which have a combination of general merchandise and grocery items, where grocery items account for up to 40% of floor space. Warehouse club stores usually require a fee-based membership, and both grocery and general merchandise items are offered in large and multi-pack sizes. If one store group was not represented by any stores in the sample, an additional store was drawn for inclusion in the sample from the population of stores in that metropolitan area.

The final sample consisted of 22 stores in the Oklahoma City area, 20 stores in the Tulsa area, and 24 stores in the Denver area. Data were collected once from each of the 66 stores. Within each store, we recorded price and attribute information for every package of ground beef, chuck and round roast, and ribeye, sirloin, round, and T-bone steak in the fresh meat case. Data were obtained on 462 packages of ground beef, 175 roasts, and 749 steaks.

Specific data collected on each package of beef consisted of various types of information which consumers have available to them when making purchasing decisions. Store-level data included store type (specialty, supermarket, discount, and warehouse club), store name, and location. Product-level data included product type (ground, roast, or steak), cut or product name, price per pound, package weight, package material (chub, foam tray, case-ready, custom-cut, and vacuum-sealed), USDA quality grade (Prime, Choice, Select, Standard, and no grade indicated) for roasts and steaks, fat/lean content for ground products, price discounts (if any), brand category, brand name, special label (no antibiotics added, no hormones added, all natural, source verified, and guaranteed quality), and expiration date.

Table 1. Means and Standard Deviations for Continuous Variables by Product Group

	Ground Products		Roast/Steak Products	
Variable	Mean	Std. Dev.	Mean	Std. Dev.
Retail Price ($/lb.)	2.74	1.10	5.87	3.02
Package Weight (lbs.)	2.45	1.83	1.92	1.36
Discount per Package ($/lb.)	0.12	0.33	0.33	0.78
Number of Observations	460		924	

Branded beef was divided into four brand categories (special, program, store, and other), plus an additional generic or unbranded category. Special brands were those that carried special labels related to production practices such as "all natural" (e.g., Coleman's Natural). It should be noted that not all products with a special label were branded products. Program brands were breed-specific, often national brands (e.g., Certified Angus Beef). Store brands were those unique to a certain store or store chain (e.g., Blue Ribbon). Other brands were those that could not be classified readily into one of the previous three brand categories.

Table 1 reports the means and standard deviations for continuous variables and table 2 shows the frequency distribution for all discrete variables.

Empirical Model

A hedonic pricing model was specified and estimated to determine the value of retail beef attributes. The general model is:

$$P_{it} = \sum_{j} V_j C_{ij} + \sum_{k} R_k S_{tk}, \tag{1}$$

where P_{it} is the price/lb. for the ith beef package in the tth store, C_{ij} is the level of the jth beef attributes associated with the ith package, S_{jt} is the level of the kth store attribute in store t, and V_j and R_k are coefficients to be estimated corresponding to the marginal implicit price of product and store attributes.

Including store attributes in equation (1) is consistent with the notion that one of the product attributes a consumer is purchasing when buying ground beef is the overall shopping experience, which is measured by store characteristics. Although equation (1) represents the general specification of the model, we empirically estimated several variants based on equation (1). In particular, we report estimations using both the price level and its natural logarithm as the dependent variable. We also estimated separate models for ground products and for roasts/steaks (i.e., muscle cuts). Ground products differ from roast and steak products in terms of quality measure (percentage fat or lean for ground products vs. USDA grade for roasts and steaks) and packaging (chub packaging for ground products but not roasts and steaks).

Given the nature of the data, i.e., repeated observations obtained from each store, it was assumed heteroskedasticity would be found in the data. This led to the following model specification for estimation purposes:

Table 2. Frequency Distribution of Package Observations for Discrete Variables, by Product Group

Variable	Percent of Total	
	Ground Products	Roast/Steak Products
Store Type:		
Specialty	2.2	2.4
Supermarket	47.5	55.3
Discount	47.1	36.7
Warehouse Club	3.2	5.6
Metropolitan Area:		
Tulsa	36.9	38.7
Oklahoma City	33.6	28.8
Denver	29.5	32.5
Product Name:		
Ground Beef	70.3	NA
Ground Chuck	29.7	NA
Chuck Roast	NA	9.2
Round Roast	NA	9.7
Ribeye Steak	NA	20.7
Sirloin Steak	NA	19.4
Round Steak	NA	27.9
T-bone Steak	NA	13.1
Brand Category:		
Special	6.5	3.6
Program/Breed	5.9	12.8
Store	7.4	27.7
Other	2.8	5.5
None/Generic	77.4	50.4
Percent Lean:		
96% or more	9.1	NA
90%–95%	21.7	NA
85%–89%	5.9	NA
80%–84%	28.8	NA
Less than 80%	22.3	NA
None indicated	12.2	NA
Quality Grade:		
USDA Standard	NA	0.2
USDA Select	NA	1.7
USDA Choice	NA	26.5
USDA Prime	NA	2.0
None indicated	NA	69.0
Package Type:		
Chub	25.0	NA
Foam Tray	35.8	64.3
Case-Ready	30.6	25.3
Custom-Cut	7.2	7.6
Vacuum-Sealed	1.5	2.8

(continued . . .)

Table 2. Continued

Variable	Percent of Total	
	Ground Products	Roast/Steak Products
Special Label:		
No antibiotics added	5.6	2.4
No hormones added	6.1	4.6
All natural	33.2	3.4
Source verified	3.2	2.0
Guaranteed quality	6.9	7.0
None	37.7	80.6
Expiration Date:		
Today or past expiration date	6.9	1.7
1–7 days	69.0	81.7
8 days or more	15.6	8.1
None indicated	8.5	8.5

$$(2)\quad Price_{it} = \alpha + \sum_{j=1}^{4} \beta_{1j} StoreType_{ij} + \sum_{j=1}^{3} \beta_{2j} Metro_{ij} + \sum_{j=1}^{k} \beta_{3j} Product_{ij} + \sum_{j=1}^{5} \beta_{4j} Brand_{ij} + \sum_{j=1}^{k} \beta_{5j} Quality_{ij} + \sum_{j=1}^{k} \beta_{6j} PkgType_{ij} + \sum_{j=1}^{6} \beta_{7j} SpecLabel_{ij} + \sum_{j=1}^{4} \beta_{8j} ExpirDate_{ij} + \beta_9 PkgWeight_i + \beta_{10} Discount_i + \nu_t + \varepsilon_{it},$$

where $E[\nu_t] = E[\varepsilon_{it}] = 0$, $\mathrm{Var}[\nu_t] = \sigma_t^2$, and

$$\mathrm{Var}[\varepsilon_{it}] = \sigma_{it}^2 \exp\left[\sum_{j=1}^{4} \beta_{1j} StoreType_{ij} + \sum_{j=1}^{3} \beta_{2j} Metro_{ij} + \sum_{j=1}^{k} \beta_{3j} Product_{ij} + \sum_{j=1}^{5} \beta_{4j} Brand_{ij} + \sum_{j=1}^{k} \beta_{5j} Quality_{ij} + \sum_{j=1}^{k} \beta_{6j} PkgType_{ij} + \sum_{j=1}^{6} \beta_{7j} SpecLabel_{ij} + \sum_{j=1}^{4} \beta_{8j} ExpirDate_{ij} + \beta_9 PkgWeight_i + \beta_{10} Discount_i \right],$$

where ν_t represents a store-specific error term, and where ε_{it} is the overall variance term, which is parameterized to vary by product and store characteristics.

In equation (2), $Price_{it}$ is the price per pound for the ith beef product in the tth store. *StoreType* is a series of zero-one dummy variables identifying type of retail outlet; *Metro* is a series of zero-one dummy variables for metropolitan area; *Product* is a series of zero-

Table 3. Definitions of Variables for Hedonic Models

Variable	Definition
Dependent Variable:	
$Price_i$	Retail beef price ($/lb.) for the ith package
Independent Variables:	
$StoreType_j$	Zero-one dummy variable for store type: j = 1–4, where 1 = specialty, 2 = supermarket, 3 = discount, and 4 = warehouse club; base = specialty
$Metro_j$	Zero-one dummy variable for metropolitan area: j = 1–3, where 1 = Tulsa, 2 = Oklahoma City, and 3 = Denver; base = Denver
$Product_j$	Zero-one dummy variable for product: ‣ Ground Beef Model: j = 1–2, where 1 = ground beef and 2 = ground chuck ‣ Roast and Steak Model: j = 1–6, where 1 = chuck roast, 2 = round roast, 3 = ribeye steak, 4 = sirloin steak, 5 = round steak, and 6 = T-bone steak; base = ribeye steak
$Brand_j$	Zero-one dummy variable for brand category: j = 1–5, where 1 = special, 2 = program/breed, 3 = store, 4 = other, and 5 = none/generic; base = none/generic
$Quality_j$	Zero-one dummy variable for quality: ‣ Ground Beef Model: j = 1–6, where 1 = 96% or more lean, 2 = 90–95% lean, 3 = 85–89% lean, 4 = 80–84% lean, 5 = less than 80% lean, and 6 = none indicated; base = none indicated ‣ Roast and Steak Model: j = 1–5, where 1 = USDA Standard, 2 = USDA Select, 3 = USDA Choice, 4 = USDA Prime, and 5 = none indicated; base = none indicated
$PkgType_j$	Zero-one dummy variable for type of packaging: j = 1–5, where 1 = chub (Ground Beef Model only), 2 = foam tray, 3 = case-ready, 4 = custom-cut, and 5 = vacuum-sealed; base = foam tray
$SpecLabel_j$	Zero-one dummy variable for special label: j = 1–6, where 1 = no antibiotics added, 2 = no hormones added, 3 = all natural, 4 = source verified, 5 = guaranteed quality, and 6 = none; base = none
$ExpirDate_j$	Zero-one dummy variable for expiration date: j = 1–4, where 1 = today or past expiration date, 2 = 1–7 days, 3 = 8 days or more, and 4 = none indicated; base = none indicated
$PkgWeight_i$	Weight of the ith package (lbs.)
$Discount_i$	Price discount (when shown) for the ith package ($/lb.)

one dummy variables indicating the specific cut or product of beef; *Brand* is a series of zero-one dummy variables designating the brand category; *Quality* is a series of zero-one dummy variables designating the fat/lean content for ground products and USDA quality grade for roast and steak products; *PkgType* is a series of zero-one dummy variables designating package type; *SpecLabel* is a series of zero-one dummy variables designating the presence of a special label; *ExpirDate* is a series of zero-one dummy variables indicating the freshness (i.e., the length of time until expiration date); *PkgWeight* is a continuous variable indicating the size (in pounds) of the package; and *Discount* is a continuous variable indicating the package discount, if found. Complete variable descriptions can be found in table 3.

All models were estimated using Proc Mixed in SAS (SAS Institute, Inc., 2002–2003). The Mixed procedure was used to account for random store effects and for nonconstant error variance. A likelihood-ratio test confirmed the presence of heteroskedasticity and a nonzero store variance for each model considered, indicating that equation (2) is the appropriate specification.

Results

Regression results are presented in table 4. Theory provides little guidance on the correct functional form for the hedonic equation. Therefore, two models are presented for each beef type (ground products and roast/steak products), one estimated with nominal prices (referred to as the linear model) and one with the log transformation of dependent variable prices (referred to as the log model). Overall, both models fit the data well and presentation of both models provides readers an indication of robustness across functional forms.[1] Most variables are dummy variables; thus linear model coefficients show price differences in each dummy variable category relative to the base or left-out variable, while log model coefficients show the percentage price differences. Within each model, coefficient size implies larger price (or price difference) marginal effects. The squared correlation between predicted and actual values ranged from 84–90% for the two ground products and two roast/steak products models in table 4.

Ground Products Results

Results were relatively insensitive to the specification of the dependent variable in levels or logs. Specific results related to each product attribute are discussed in turn. Larger and significant coefficients are noted for each attribute group as larger coefficients represent larger marginal effects, i.e., price differences in the linear model, and percentage price differences in the log model.

Store Type. Ground beef prices were $1.36/lb. lower, on average, for supermarkets than specialty stores and $1.96/lb. lower for discount and warehouse club stores compared with specialty stores. This is consistent with the nature of specialty stores which most often satisfy the needs of smaller, niche markets—i.e., specialty stores may be able to extract premium prices in return for satisfying specific consumer needs.

Metropolitan Area. Prices for ground products were lower on average in Tulsa ($0.39/lb.) and Oklahoma City ($0.37/lb.) compared with Denver. These findings are consistent with the higher cost of living in general between Denver and Oklahoma. One cost-of-living calculator reports that the cost of living in Denver is 14.2% higher than in Oklahoma City (Bankrate, 2007). The natural log specification indicates Oklahoma City prices are about 13% lower than Denver prices, remarkably similar to the cost-of-living figure cited above.

Product. Ground chuck was priced $0.14/lb. higher than other ground beef products. Ground beef consists of trimmings from several cuts, whereas ground chuck is from a specific primal cut. Consumers may perceive ground chuck to be of higher quality or higher value than simply ground product from unknown sources, i.e., trimmings from several primal cuts, older products, etc. A higher price for ground chuck is consistent with this logic.

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[1] Box-Cox regressions suggest a linear functional form is more appropriate for the ground beef model, but the log-linear functional form is more appropriate for the roast and steak model. However, the difference in "fit" is slight. Both models are presented given the small advantage in a statistical sense for picking one model over the other. Some readers may prefer interpreting results in terms of price differences and some in terms of percentage price differences.

Table 4. Hedonic Model Estimation Results ($/lb.)

	Ground Products		Roast/Steak Products	
Independent Variable	Linear	Natural Log	Linear	Natural Log
Intercept	3.47***	1.06***	5.55***	2.16***
	(7.35)	(7.73)	(8.11)	(20.63)
$StoreType_j$:				
Specialty	Base	Base	Base	Base
Supermarket	–1.36***	–0.33***	3.62***	0.16
	(3.00)	(2.77)	(5.15)	(1.55)
Discount	–1.96***	–0.59***	3.67***	0.08
	(4.22)	(4.74)	(5.18)	(0.70)
Warehouse Club	–1.96***	–0.61***	3.27***	0.10
	(4.01)	(4.45)	(4.30)	(0.80)
$Metro_j$:				
Tulsa	–0.39***	–0.14***	–1.42***	–0.21***
	(2.97)	(2.78)	(5.69)	(5.03)
Oklahoma City	–0.37***	–0.13***	–1.21***	–0.22***
	(2.93)	(2.78)	(4.84)	(5.05)
Denver	Base	Base	Base	Base
$Product_j$:				
Ground Beef	Base	Base	NA	NA
Ground Chuck	0.14***	0.09***	NA	NA
	(3.56)	(4.94)		
Chuck Roast	NA	NA	–4.97***	–0.94***
			(54.03)	(54.59)
Round Roast	NA	NA	–4.36***	–0.77***
			(45.25)	(46.05)
Ribeye Steak	NA	NA	Base	Base
Sirloin Steak	NA	NA	–3.77***	–0.56***
			(39.72)	(37.00)
Round Steak	NA	NA	–4.33***	–0.75***
			(53.89)	(68.79)
T-bone Steak	NA	NA	–0.22**	–0.00
			(2.08)	(0.53)
$Brand_j$:				
Special	0.94***	0.17***	6.20***	0.64***
	(5.05)	(2.98)	(24.20)	(7.16)
Program/Breed	0.39***	0.09	1.04***	0.01
	(2.60)	(1.41)	(4.47)	(0.25)
Store	0.22**	0.03	–0.00	–0.00
	(2.47)	(1.02)	(0.02)	(0.12)
Other	1.26***	0.36***	1.09***	0.15***
	(12.14)	(9.56)	(4.26)	(3.32)
None/Generic	Base	Base	Base	Base
$Quality_j$ (lean content):				
96% or more lean	1.12***	0.48***	NA	NA
	(12.40)	(13.32)		
90–95% lean	0.94***	0.43***	NA	NA
	(11.18)	(11.98)		

(continued . . .)

Table 4. Continued

	Ground Products		Roast/Steak Products	
Independent Variable	Linear	Natural Log	Linear	Natural Log
$Quality_j$ (fat content), cont'd.:				
85–89% lean	0.23**	0.20***	NA	NA
	(2.03)	(4.27)		
80–84% lean	0.12	0.08**	NA	NA
	(1.23)	(2.19)		
Less than 80% lean	–0.27***	–0.10***	NA	NA
	(3.19)	(2.66)		
None indicated	Base	Base	NA	NA
$Quality_j$ (USDA grades):				
USDA Standard	NA	NA	–0.53***	–0.02
			(4.28)	(0.22)
USDA Select	NA	NA	–0.23	–0.07
			(0.93)	(1.26)
USDA Choice	NA	NA	0.70***	0.12**
			(3.15)	(2.58)
USDA Prime	NA	NA	1.37***	0.42***
			(3.76)	(6.93)
None indicated	NA	NA	Base	Base
$PkgType_j$:				
Chub	–0.00	–0.02	NA	NA
	(0.00)	(1.08)		
Foam Tray	Base	Base	Base	Base
Case-Ready	0.20***	0.08***	0.17**	0.02
	(2.81)	(2.92)	(2.27)	(1.30)
Custom-Cut	0.26	0.06	0.39**	0.01
	(1.23)	(0.66)	(2.56)	(0.38)
Vacuum-Sealed	0.46***	0.03	0.07	–0.07**
	(2.81)	(0.67)	(0.47)	(2.02)
$SpecLabel_j$:				
No antibiotics added	0.71***	0.27***	0.00	0.03
	(4.19)	(4.00)	(0.11)	(0.47)
No hormones added	0.03	–0.01	–0.28**	–0.04***
	(0.35)	(0.34)	(2.34)	(2.58)
All natural	–0.13***	–0.05***	–0.01	–0.03
	(3.27)	(3.67)	(0.06)	(1.00)
Source verified	–0.10**	–0.02	0.29	–0.01
	(2.01)	(1.45)	(0.63)	(0.23)
Guaranteed quality	0.06	0.01	–0.06	0.00
	(1.24)	(0.62)	(0.42)	(0.29)
None	Base	Base	Base	Base
$ExpirDate_j$:				
Today or past expiration	0.82***	0.29***	0.22	–0.03
	(5.02)	(4.62)	(1.23)	(0.45)
1–7 days	0.78***	0.28***	–0.02	0.00
	(5.49)	(4.84)	(0.17)	(0.07)
8 days or more	0.71***	0.26***	0.06	0.03
	(4.89)	(4.46)	(0.48)	(1.10)
None indicated	Base	Base	Base	Base

(continued . . .)

Table 4. Continued

	Ground Products		Roast/Steak Products	
Independent Variable	Linear	Natural Log	Linear	Natural Log
PkgWeight	–0.06***	–0.03***	–0.21***	–0.05***
	(16.52)	(13.54)	(10.09)	(9.56)
Discount	–0.06	–0.02	–0.04	–0.00
	(1.57)	(1.29)	(0.98)	(1.03)
–2 LLF	279.9	544.4	2,212.8	796.0
R^2	0.844	0.855	0.874	0.902

Notes: Single, double, and triple asterisks (*) denote statistical significance at the 0.10, 0.05, and 0.01 levels, respectively. Numbers in parentheses are absolute values of calculated *t*-statistics.

Brand. Coefficients on brand categories differed slightly between the linear model and log model. In the linear model, all branded beef was priced significantly higher than generic or unbranded beef. Other and special brands of ground beef were $1.26/lb. and $0.94/lb. higher, respectively, than generic products and were significant in both models. Program/breed and store brands were significant in the linear model but not the log model. Premium prices for branded products were consistent with a priori expectations, but it should be noted that our results differ from those of Parcell and Schroeder (2007) who found no premium for branded ground beef products.

Fat Content. Percentage fat or lean is an objective indicator of quality for ground beef, and this variable was a significant explanatory variable for fresh ground product prices. Products with the highest percentage lean earned the highest premium and the premium declined as percentage lean declined. Ground products with the lowest percentage lean (alternatively, most fat) were significantly discounted. The premium for leanest products (96% or more) was $1.12/lb., while the discount for fattest ground products (less than 80% lean) was $0.27/lb., both compared to packages that did not specify a fat/lean content. Parcell and Schroeder (2007) found a $0.04/lb. price premium associated with each percentage point decrease (increase) in fat (lean) content. We find the price premiums for ground beef packages between 5% and 10% fat to be about $0.82/lb. greater than price premiums for ground beef packages between 16% and 20% fat—implying a marginal value of about $0.055/lb., i.e., $(0.94 - 0.12)/(20 - 5)$, which compares reasonably well with the Parcell and Schroeder finding.

Package Type. Case-ready and vacuum-sealed packages were priced $0.20/lb. and $0.46/lb. higher, respectively, compared to foam tray packaging which was the most common type of fresh meat packaging. Ground beef packaged in chubs or custom-cut packaging were not priced significantly differently than ground products packaged in foam trays. Case-ready packaging was the only package type statistically significant in the log model. The higher price for case-ready packages may reflect higher costs or consumer preferences for cleaner, leak-proof packaging that ensures longer shelf life, and enhances visual appeal of the product.

Special Labels. More special-label variables were significant in the linear model than the log model. Results differed in some cases from expectations. Special-label products have higher production costs than products without special handling or production methods (Yanik et al., 1999), yet ground products labeled "all natural" were discounted

in both models ($0.13/lb. in the linear model). As expected, products carrying a "no antibiotics" label were priced higher in both models ($0.71/lb. in the linear model). Reasons for the seeming disparity in results for special labels are not known and deserve further attention.

Expiration Date. Results reveal products which had no expiration date were significantly discounted relative to those products that carried an expiration date. Putting an expiration date on the package increased price by about $0.70/lb. to $0.80/lb. Somewhat unexpectedly, large price differences were not found across different expiration dates. Logic suggests retail stores price products lower with a short time to expiration to encourage quick sale. Yet, this behavior was not evident from our results. It is important to note, however, that these models also control for price discounting by retailers, and if retailers routinely price discount packages about to expire, this effect would be captured by the price discount variable rather than by the expiration date variable.

Package Weight. Package size (weight) was statistically significant for ground products in both models. For each one pound increase in package size, price declined $0.06/lb. In contrast, Parcell and Schroeder (2007) found as package size increased by one pound, price decreased by $0.23/lb. for ground beef. However, recall their study used meat purchase data over a several-year period while data for this study were collected at a single point in time.

Price Discount. A price discount shown on the package, converted to or labeled in cents/pound, may have resulted from a price reduction to stimulate a quick sale or may have been referred to as a special sale or manager's sale. The price discount variable did not include an advertised feature price unless each package was individually marked. This variable was not statistically significant in either model for ground products.

Roast and Steak Products Results

The last two columns of results in table 4 report hedonic models for roasts and steaks in linear and log form, and are discussed in detail below.

Store Type. The effect of store type on roast and steak prices differed from the effects found for ground products and differed between functional forms. Prices on average for roasts and steaks were higher for all three store types (supermarket, discount, and warehouse club) compared with specialty stores in the linear model, but none were significant in the log model, indicating no significance in percentage price differences.

Metropolitan Area. As with ground products, both Tulsa and Oklahoma City prices for roasts and steaks were lower than Denver. However, the magnitude was greater ($1.42/lb. for Tulsa and $1.21/lb. for Oklahoma City) both in nominal and percentage terms than the ground products models. In percentage terms, prices were about 20% higher in Denver than in Oklahoma.

Product. All roast and steak cuts were priced significantly lower than ribeye steak in the linear model, and all but T-bone steak in the log model. Roast prices were lowest on average, $4.97/lb. lower for chuck roasts and $4.36/lb. lower for round roasts compared with ribeye steak. Consistent with expectations, round roasts are likely perceived to be higher quality than chuck roasts. Among steaks, ribeye steak was priced $3.77/lb. higher than sirloin steak and $4.33/lb. higher than round steak.

Brand. Special and other brands were priced at a significant premium to generic or unbranded roasts and steaks in both models. Special and other brands were $6.20/lb. and $1.09/lb. higher, respectively, in the linear model. Program/breed brands were priced higher in the linear model but were not significantly different than generic roasts and steaks in the log model. Parcell and Schroeder (2007) found branded roast and steak premiums ranged from $0.34/lb. to $1.26/lb.

Quality Grade. Quality grade results were as expected. Linear and log models were consistent in finding significant price premiums for USDA Choice and Prime roasts and steaks compared with products with no quality grade designation. In the linear model, USDA Standard roasts and steaks were significantly discounted, but not in the log model. Prices for USDA Choice roasts and steaks were $0.70/lb. higher and USDA Prime roasts and steaks were $1.37/lb. higher than products with no quality designation. Consumers would expect to pay more for higher quality grade roasts and steaks and less for lower graded products. Our results are consistent with those reported by Parcell and Schroeder (2007) in direction though not in magnitude. They found consumers paid a $0.27/lb. premium for USDA Prime steaks compared with steaks of medium quality and a $0.04/lb. lower price for USDA Select steaks compared with steaks that did not designate a USDA grade. Killinger et al. (2004) found willingness to pay price premiums for highly marbled steaks (Prime) ranging from $0.24/lb. to $1.13/lb. for Chicago participants in their study, while San Francisco participants revealed willingness to pay premiums for highly marbled steaks of $1.47/lb.

Package Type. Case-ready and custom-cut packaging were valued significantly higher than foam tray packaging for roasts and steak in the linear model but were not significantly different in the log model. Vacuum-sealed packaging was lower in price than foam tray packaging in the log model but was not significantly different in the linear model. In general, type of packaging for roasts and steaks may be less important to consumers than for ground products. Traditionally, packaged ground products may be perceived as being messier and potentially adversely related to food safety than roast or steak packages, thus meriting a price discount relative to case-ready and vacuum-sealed packages.

Special Labels. Although consistency was found between the linear and log models for special labels, the sign on the sole significant variable was unexpected. Roasts and steaks labeled as "no hormones added" were priced lower ($0.28/lb.) than products with no special labels. However, results here conflict with expectations and what previous research has indicated. Lusk, Roosen, and Fox (2003) found consumers were willing to pay significant premiums for steaks produced without growth hormones. Our result may be attributable to the fact that the model already controls for brand name, and thus the extra value of "no hormones added" over the existing brand names, some of which advertise no growth hormones, is nonexistent.

Expiration Date. Expiration dates for roasts and steaks were not as important as for ground products. This result was expected since shelf life for ground products is typically less than for roasts and steaks.

Package Weight. Package size was significant in both roast and steak models. Increasing package size by one pound reduced the price by $0.21/lb., less than the $0.28/lb. for roasts and $0.74/lb. for steaks found by Parcell and Schroeder (2007).

Price Discount. As with ground products, specified discounts were not significant in either model for roasts and steaks. The model may be controlling for factors associated with specified discounts or for the reasons a retailer may have discounted the product.

Summary and Conclusions

Primary data were collected from 66 grocery stores located in three metropolitan areas—Oklahoma City and Tulsa, Oklahoma, and Denver, Colorado. The sample population of stores was randomly generated and attempted to represent several suburban areas in each metropolitan area, as well as various store types (specialty, supermarket, discount, and warehouse club). Data were collected on 462 ground products, 175 roast products, and 749 steak products.

Hedonic pricing models were used to estimate the value consumers place on observable characteristics of fresh beef products. Models were estimated for ground products and for roasts and steaks. Models were estimated for two functional forms with Proc Mixed in SAS, a linear model with nominal retail beef prices and a log transformation model. A summary of our findings includes the following:

- Across all products sampled, metropolitan area explained a significant amount of the variation in product prices.
- Prices of ground products were highest in specialty stores, but steak/roast prices were lowest in specialty stores.
- Product name or cut significantly influenced retail beef prices.
- Special and other brands were priced higher than generic or unbranded beef.
- Objective quality measures significantly influenced product prices. Increases in leanness were associated with increased ground beef prices, and USDA Choice steaks/roasts were priced at premiums over USDA Select and generic steaks.
- Packaging was important and more consistent for ground products than for roasts and steaks.
- Label results were not consistent across product groups and functional forms. In addition, the sign on certain significant variables was counterintuitive.
- Ground beef products without an expiration date were significantly discounted relative to products with a date. Steak/roast prices were not affected by expiration date.
- Larger package sizes were priced lower per unit than smaller ones.
- Price discounts were not significant in any models after controlling for the aforementioned factors.

This research used the same detailed data/information from each package in the meat case that is available to consumers when shopping, and more detailed package data than previous studies to estimate the value of retail beef attributes. Two recognized

limitations of this study are the one-time data snapshot and limited scope of data collection. Broadening this type of research both temporally and spatially would provide considerable additional information. Data could be collected over a span of time rather than the one-time data collection from each retail store sampled. This extension would allow for comparison of implicit prices over time, possibly considering seasonal supply-demand factors. Similarly, expanding the study to include additional metropolitan areas would permit the investigation of differences in implicit prices over geographic regions. Broader data collection may provide insight into the occasional unexpected results found here.

Finally, data in this study were pre-purchased observations of product offerings rather than actual transactions. Therefore, actual purchase data complete with demographic information regarding consumer purchases would allow comparison of implicit prices among socioeconomic groups.

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