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Hedonic Retail Beef and Pork Product Prices

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Consumer-level hedonic models are estimated to determine factors affecting retail pork and beef meat cuts. Results indicate that brand premium and discount varies across private, national, and store brands and that brand premium varies across meat cuts carrying the same brand name. Product size discounts are linear for beef and nonlinear for pork, meat items on sale are significantly discounted to nonsale items, specialty stores typically will not garner higher prices than supermarket/grocery stores, and warehouse stores typically have premium prices relative to supermarket/grocery stores.

Key Words. beef, brand premium, hedonic modeling, pork

JEL Classifications: Q13, D12, M31, M32

Over the past decade, consumers have become more discriminating in their purchase decisions (Barkema), prompting growing interest in developing and branding new meat products. For example, 472 new beef products were developed in 2001 compared with only 70 in 1997 (National Cattlemen's Beef Association). A study commissioned by the National Pork Producers Association reported 77% of fresh pork is now branded. Producer efforts to add value to livestock often is hindered because of a lack of retailer/consumer knowledge of what and how to sell meat products. In considering new meat marketing initiatives, more information is needed about consumer value placed on retail meat primal characteristics. This is especially true given increased producer interests and efforts to launch local or national product brands. The purpose of this study is to determine how retail beef and pork product characteristics affect their prices.

Many livestock producers and producer groups are working to direct market meat products to consumers. Branded meat products and new product development are heralded as important for developing customer loyalty (Motameni and Shahrokhi) and increasing consumer demand (Purcell). In addition, as more livestock producers become involved in vertical alliances (Schroeder and Kovanda), interest in farmer-owned brands increases (e.g., Hayes and Lence). For producer-owners, processors, and meat retailers to manage meat production and marketing programs effectively and to differentiate their products, they need additional information on how to market packaged meat products in response to consumer preferences.

Strategies for developing brand identity in beef and pork have varied. For instance, Farmland (a producer-owned cooperative whose beef division was recently bought by U.S. Premium Beef and pork division by Smithfield) developed a supply chain to deliver branded beef and pork products to consumers. Excel Corporation converted their Marshall, MO, pork processing plant to a further processing plant in 2002. Excel also recently developed an alliance with Hormel to market beef products under the Hormel brand name.

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Smithfield Foods has acquired a number of regional "mom-and-pop" labels. Even on the individual or small group producer level, branded meat products have emerged from small farming operations. Do such branding efforts have realized or potential value for producers? Brand loyalty is identifiable through purchase loyalty (i.e., price) and attitudinal loyalty (i.e., market share) (Chaudhuri and Holbrook). In this research, we examine brand loyalty through purchase prices.

In this study, we used retail purchase data to analyze beef and pork product–differentiated pricing among products, geographic location, store type, sale items, composition (fresh, frozen, or cooked), and package size for beef steak, roast, ground beef, pork chops, ribs, roast, ham, and steak. A consumer-level hedonic pricing model is specified to assess characteristic marginal implicit values and marketing characteristic values across the different pork and beef primal cuts. Given the growth in new meat marketing initiatives, understanding factors affecting retail meat product prices is important for all participants in the livestock and meat marketing chain. In particular, understanding the value of branding efforts is important because this information is useful for producers, processors, or retailers seeking to segment markets and differentiate products (Aaker; Dickson and Ginter; Hauser and Simmie; Meredith and Maki; Rosen).

Previous Research

Consumer product choice is based on an observation of intrinsic and extrinsic product attributes (Loureiro and McCluskey). Intrinsic attributes relate to the actual product. Examples of intrinsic attributes in the food category include product portion size, color, smell, flavor, and composition. Extrinsic attributes relate to promotional and informational characteristics of the product and the shopping experience. Examples of extrinsic attributes in the food category include store environment, brand, or advertising. Hedonic modeling, focusing on consumer purchases, is the common method used by economists to estimate the value of individual product attributes. The retail and marketing literature interprets "hedonics" more narrowly than does the economics literature. Hirschman and Holbrook and Wakefield and Barnes describe hedonics as a desired consumer emotional experience that brings the consumer satisfaction or enjoyment. Empirical estimation of hedonic models in the marketing and retailing literature is relatively thin.

Although the economics hedonic literature has numerous studies that have analyzed attribute marginal implicit values, the agricultural economics hedonic literature has focused primarily on intermediary buyer preferences for input attributes (e.g., Ahmadi-Esfahnai and Stanmore; Dhuvetter et al.; Parcell and Stiegert; Wahl, Shi, and Mittelhammer). The economics hedonic literature has focused primarily on consumer durable goods or assets such as automobiles (e.g., Atkinson and Halvorsen; Grilliches; Lancaster), housing (e.g., Dubin; Palmquist; Zabel and Kiel), and property valuation (e.g., Cheshire and Sheppard; Palmquist, Roka, and Vukina). Also, economists often use hedonic models for constructing price indexes that are exogenous to technological change (e.g., Brown; Can and Megbolugbe). Much of the economic hedonic pricing literature is focused at deriving Rosen's second-stage structural characteristic demand modeling, which is not relevant for this study. Thus, the discussion here is an overview of the handful of studies that focused on hedonic estimation of consumer-level attribute values for perishable products.

Stanley and Tschirhart examined the relationship between intrinsic attributes and price of breakfast cereals. They applied a hedonic breakfast cereal pricing model to sales at three different stores. Their model specified price paid for a box of cereal as a function of servings per container (linear and squared), available vitamins, sweetener content, fiber content, whether the cereal was natural or contained fruit, sodium content, dummy variables for preservatives, composition, and primary ingredient. The marginal implicit value from increasing serving size decreased at an increasing rate, natural

products garnered no price premium, and puffed cereal received a premium.

Brester et al. analyzed how ground beef leanness content affected ground beef price. They used a linear hedonic model with ground beef lean percentage and U.S. total personal consumption expenditures as right-hand side variables. For each percentage point increase in leanness, ground beef price increased by $0.0206/lb. Unnevehr and Bard used a hedonic model to analyze whether consumers would pay for reduced fat in beef table cuts. They used survey data on consumer purchases and intrinsic attributes of different meat cuts. A linear model was specified with price per pound as a function of external fat, marbling percent, seam fat, a dummy variable for whether the product was sold bone-in, and binary variables for time and location. Their R^2 measures ranged from 0.22 to 0.62 for the eight beef table cut models. They concluded that for all beef table cuts, except round, bone-in and increased external fat thickness generally discounted price, whereas, an increase in marbling percent generally resulted in no premium or discount, and an increase in seam fat percent caused meat price discounts.

Unnevehr and Gouzou used hedonic modeling to investigate retail premiums for branded honey products. They examined both intrinsic and extrinsic attributes. With the use of scanner data, they expressed honey price as a function of bottle size (linear and squared), type of container, composition, flavor, and brand. An increase in container size was linearly associated with a price increase, the magnitude of brand premium discounts varied with generic or store brand products discounted, and comb honey garnered premiums.

Loureiro and McCluskey specified a hedonic model to analyze factors affecting beef prices, with emphasis given to how protected geographic indications affected price. Their explanatory variables were explicit and implicit attributes. Results indicated that consumers paid premiums for labeled products, fat content and color were not important price determinants, and supermarket sales were discounted relative to nonsupermarket sales.

Conceptual Model

Economic hedonic models are used to decompose a product price into values for individual product attributes. Product attributes can be either intrinsic or extrinsic. Furthermore, hedonic model theory differs between consumer and intermediary buyer. Intermediary buyers purchase an input for use in production of a product (see Ladd and Martin). Intermediary buyers derive their marginal implicit value for an attribute on the basis of the profit gained from adding a unit of the attribute into the production of a product. Consumers purchase a product for use in their own consumption (see Ladd and Suvannunt). Consumers derive their marginal implicit value for an attribute on the basis of maximizing their utility function subject to a budget constraint. Consumer purchases are the focus of this study.

Theoretical foundations for analyzing imputed values of consumer-level product characteristics emanate from Dhrymes; Grilliches; Ladd and Suvannunt; Lancaster; and Rosen. Following from these contributions to hedonic pricing theory, a model of consumer utility was used to arrive at a consumer-level hedonic pricing equation. Consumer food purchasing decisions are based on expected utility derived from the consumption of all retail food products ($\mathbf{Q}|q_i$; $i = 1, 2, 3, \ldots, t$) for which each ith retail food product contains a vector ($\mathbf{X}|x_j$; $j = 1, 2, \ldots, k$) of j different characteristics. Consumers face a set of retail food prices ($\mathbf{P}$), so that $\mathbf{PQ}$ is consumer expenditures on retail food products. Consumers also allocate their wealth to other activities besides retail food purchases, referred to as $\mathbf{Y}$. Consumer purchasing preferences are specified in utility form as

$$(1) \quad U = U[\mathbf{X}(\mathbf{Q}), \mathbf{Y}, \mathbf{w}],$$

where $\mathbf{w}$ is a vector of exogenous observed and unobserved factors that describe consumer preferences.

Consumers face a budget constraint (M), and for each ith retail food product, observe product price $p_i(\mathbf{X})$, and consume quantity q_i.

The retail food product price $p_i(x_1, x_2, \ldots, x_j)$ is the price paid for the ith food product purchased with a vector $(\mathbf{X})$ of j unique product characteristics. Also, x_j is the total amount of characteristic j from consumption of the ith good. Assume that the consumer's willingness to pay for the ith retail food product can be expressed as $\Gamma_i(\mathbf{X(Q)}, \mathbf{M}, U, \mathbf{w})$, so that consumer willingness to pay is a function of the total quantity of product characteristics x_j available in the ith product, income $(\mathbf{M})$, utility (U), and exogenous preferences. Note, $(\partial\Gamma_i/\partial x_j)(\partial x_j/\partial q_i)$ is the change in a consumer's willingness to pay for retail food product i as the level of characteristic x_j changes in response to a change in the quantity (q_i) consumed of product i. Equation (1) can be specified as

$$(2) \quad U = U\left[\mathbf{X(Q)}, M - \sum_i \Gamma_i q_i, \mathbf{w}\right].$$

Given that retail food prices and food product attributes are observable, the consumer chooses the basket of retail food products to consume by

$$(3) \quad \max_{X,Y} U[\mathbf{X(Q)}, Y, \mathbf{w}]$$

subject to

$$M \geq \mathbf{P(X)Q} + Y.$$

Solving for the first-order conditions for the ith product yields

$$(4) \quad \frac{(\partial U/\partial x_j)(\partial x_j/\partial q_i)}{\partial U/\partial Y} = \frac{\partial P}{\partial x_j/\partial q_i} = p_i \forall i,$$

and recalling that the consumer's willingness to pay for characteristic j lies tangent to the consumer's indifference curve (hedonic price) between characteristic x_j and $\mathbf{Y}$ yields

$$(5) \quad \frac{\partial\Gamma_i}{\partial x_j}\frac{\partial x_j}{\partial q_i} = \frac{(\partial U/\partial x_j)(\partial x_j/\partial q_i)}{\partial U/\partial Y} = p_i \forall i.$$

Equation (5) states that price paid for the ith good is determined by the availability of product characteristics embodied in the good and consumer willingness to pay for additional units of the characteristic. A conceptual model for Equation (5) is

$$(6) \quad p_i = \sum_j S_j\left(\frac{\partial x_j}{\partial q_i}\right) + \tau_i,$$

where S_j is the rate of substitution between expenditures and the jth product characteristic (i.e., marginal implicit value) in purchasing decisions, and τ_i is an identically and independently distributed error term. For example, x_j is the total pounds of steak consumed in beef consumption. Thus, $(\partial x_j/\partial q_i)$ is the marginal yield of characteristic j for one additional unit of the ith product. This term represents, for example, the marginal change in pounds of steak consumed given an additional steak purchase.

Equation (6) specifies that the price paid for product i equals the sum of the marginal implicit values of the j characteristics of the product. Following Ladd and Suvannunt, $(\partial x_j/\partial q_i)$ is assumed constant and equal to x_{ji}. That is, for the steak example, the portion size of steak purchased increases total steak consumed in a constant proportion. Therefore, Equation (6) can be respecified as

$$(7) \quad p_i = \sum_j S_j x_{ji} + \tau_i.$$

The marginal implicit values for product characteristics (S_j) need not be linear. Ladd and Suvannunt indicated that these could be specified with a nonlinear functional form in which the marginal implicit price for an individual product is dependent on the level of the characteristic. For example, the marginal implicit price of steak could vary as the portion size of the product changes (i.e., one might pay more in dollars per pound for an 18-oz. compared with a 32-oz. steak package).

Data

Table 1 provides summary statistics for the beef and pork data used to estimate the hedonic models in this study. Data were collected from the Meat Panel Diary (MPD) database, obtained through the Retail Meat Purchase Diary research conducted by the

Table 1. Description of Variables and Summary Statistics

Variable	Description	Expected Effect on Price	Avg.	SD
d	Retail cut d, where d = beef (steak, roast, or ground) and pork (chop, rib, roast, ham, or steak)			
Z	Individual consumer purchase z for cut d, where z is			
	Beef (number of observations)			
	Steak			
	Low quality		429	
	Medium quality		664	
	High quality		168	
	Roast		353	
	Ground		729	
	Pork			
	Chop		10,775	
	Rib		4,206	
	Roast		3,701	
	Ham		9,944	
	Steak		1,124	
p_{zd} (dependent variable)	Retail price of cut d for purchase z. ($/lb.)			
	Beef			
	Steak			
	Low quality		2.87	1.53
	Medium quality		3.65	1.96
	High quality		4.17	1.96
	Roast		2.02	0.88
	Ground		1.70	0.57
	Pork			
	Chop		2.67	0.98
	Rib		1.88	0.80
	Roast		2.08	1.06
	Ham		1.61	0.63
	Steak		2.00	1.00
$RetailPriceIndex_z$	Composite retail pork price for the month purchase z was made ($/lb.)			
	Beef	(+)	2.91	0.11
	Pork		2.38	0.18
$Weight_{zd}$	Average weight (lbs.) of beef or pork cut d for purchase z			
	Beef			
	Steak		1.9	1.6
	Roast		3.7	5.0
	Ground	(?, vary by cut)	2.8	3.2
	Pork			
	Chop		2.3	2.8
	Rib		3.3	3.0
	Roast		4.2	3.4
	Ham		5.2	5.6

Table 1. (Continued)

Variable	Description	Expected Effect on Price	Avg.	SD
$Composition_{zdk}$	Composition (k) of cut d for purchase (z, where k is			
	Fresh	(+)	89	
	Frozen	*default*	5	
	Cooked	(+)	6	
$Sale_{zd}$	Whether cut d for purchase z was on sale (*default* = nonsale)			
	Beef (% on sale)	(−)	26	
	Pork (% on sale)		37	
$StoreType_{zdl}$	Store type (l) binary variables for store type where purchase z was made for beef or pork cut d, where l is			
	Beef (% of purchases)			
	Supermarket/grocery and other (*default*)	*default*		
	Warehouse	(−)	96.5	
	Supercenter	(−)	0.8	
	Butcher/meat market	(+)	0.5	
	Pork (% of purchases)		2.0	
	Supermarket/grocery (*default*)	*default*		
	Warehouse	(−)	93	
	Supercenter	(−)	3.4	
	Butcher/meat market	(+)	1.6	
	Neighborhood/local deli	(+)	1.3	
	Convenience store	(+)	0.4	
	Co-op	(?)	0.1	
$Leanness_{z,hamburger}$	Average lean content (%) of ground beef for purchase z	(+)	82.8	6.5
$Grade_{z,steak,e}$	Steak grade of for purchase z (% of observations)			
	Nongraded	*default*	62.0	
	Select	(?)	13.3	
	Choice	(+)	21.4	
	Prime	(+)	3.3	
$Month_{zdp}$	Separate 0 or 1 binary variables for month p when purchase z was made for pork cut d (p = 1, . . . , 12; *default* = December)	(?)	n/a	
$Location_{zdn}$	Geographic location (n) purchase z was made for beef or pork cut d, where n is			
	Beef (% of observations)			
	East	(+)	22	
	Central	*default*	27	
	South	(+)	31	
	West	(+)	20	
	Pork			
	East	(+)	22	
	Central	*default*	24	
	South	(+)	34	
	West	(+)	20	

Table 1. (Continued)

Variable	Description	Expected Effect on Price	Avg.	SD
$Brand_{zdq}$	Brand (q) of beef or pork cut d for purchase z (q = angus, *default* = store brand for beef and q = 1, 2, . . . , 20, *default* =store brand for pork)			
	Beef (% of observations with a brand)			
	Steak		35	
	Roast		35	
	Ground	(?)	15	
	Pork			
	Chop		24	
	Rib		31	
	Roast		27	
	Ham		53	
	Steak		19	

[a] Chuck, blade, arm, shoulder, flank, London broil, cube, and other steak.
[b] T-bone, sirloin, New York strip, top loin, top sirloin, tip, porterhouse, and round.
[c] Rib, ribeye, tenderloin, and filet mignon

NPD Group on behalf of the Beef Board. MPD data were collected at the household level. Data were collected for all meat purchases. Approximately 2,000 households were surveyed twice per month. Specific information collected included type of meat purchased, package weight, dollars spent, whether purchased was on sale, brand, store type, product composition, grade, lean content, and demographic factors of the household. For this study, beef cuts were aggregated to ground, roasts, and steaks (the only beef products with sufficient brands contained in the dataset). Pork cuts used included hams, chops, roasts, ribs, and steaks. Information on further processed meats and frozen prepared dinner/entrees were not collected in the MPD.

The MPD beef data represented more than 350,000 and the pork data 120,000 point of purchase observations over the 1992–2000 period (an observation is an individual product purchase by a particular household). Observations in which either dependent or independent variables were missing or not reported were dropped. For instance, numerous observations for beef and pork brand were reported as "other brand" or "not reported." Because there is no way of knowing what brands, if any, these products represented, these observations were deleted (this situation represented the vast majority of the deleted observations). Only a very small portion of beef products are branded, and we had no way to determine which beef products were not branded or simply the brand not reported in the data when recorded as "not reported," so a large number of beef purchases were not useable in this study. Approximately 2,300 usable beef transactions and 30,000 usable pork transactions with complete data were contained in the dataset. Over this time period, numerous national pork product brands existed. In contrast, the only beef brand of substance contained in the dataset was Angus beef. This "brand" is likely primarily Certified Angus Beef®, but because other Angus beef brands also were present in the market, the Angus brand analyzed probably included some of these other Angus brands.

Empirical Model

To ascertain price premiums for branded beef and pork products, this study used hedonic modeling to measure the effect of characteristics associated with the particular beef or pork product. Separate models were estimated

for beef and pork primal cuts. Price per pound (p_{zd}) of beef or pork of cut d (for beef, d refers to high-, medium-, or low-quality steak,[1] roast, or ground; for pork, d refers to pork chops, ribs, roast, ham, or steak) for purchase z was specified as a hedonic pricing model,

$$(8)\quad p_{zd} = f[RetailPriceIndex_z, Weight_{zd}, \log(Weight_{zd}), Composition_{zdk}, Sale_{zd}, Leanness_{z,groundbeef}, Grade_{z,steak,e}, StoreType_{zdl}, Location_{zdn}, Month_{zdp}, Brand_{zdq}],$$

in which $RetailPriceIndex_z$ is the composite retail beef or pork price (U.S. Department of Agriculture) during the month when purchase z was made; $Weight_{zd}$ is the weight of cut d for purchase z; $Composition_{zdk}$ is a set of binary variables (0 or 1; k refers to fresh, frozen, or cooked, *default* = frozen) relevant for pork only; $Sale_{zd}$ refers to whether purchase z of cut d was on sale (0 or 1; *default* = nonsale); $Leanness_{z,groundbeef}$ refers to the leanness content of purchase z relevant for ground beef only; $Grade_{z,steak,e}$ is set of binary variables (0 or 1) referring to USDA quality grade (e = Select, Prime, Choice, or nongraded; *default* = nongraded) relevant for beef steak only; $StoreTtype_{zdl}$ refers to seven (0 or 1) store type dummy variables for store type l (l = supermarket/grocery, warehouse, supercenter, butcher/meat market, neighborhood/local deli, convenience store, or co-op; *default* = supermarket/grocery); $Location_{zdn}$ refers to four (0 or 1) geographic locations in the United States (n = East, Central, South, and West; *default* = Central); $Month_{zdp}$ is a series of monthly dummy variables to capture potential seasonal pricing patterns; $Brand_{zdq}$ refers to brand q of product z (q = supermarket/grocery store brand or angus for beef, and q = Hillshire Farms, Hormel, Oldham's [Farm], Thomas E. Wilson, Jimmy Dean, Johnsonville, John Morell, Cook's [Ham], Corn King, Farmland, Hamilton, Oscar Mayer, Ossian, Rose's, Taylor, Farmer John, Warehouse, Supercenter, Butcher/meat market, Neighborhood/local deli, Co-op, and supermarket/grocery store brand for pork; *default* = supermarket/grocery store brand).

Retail prices fluctuate over time because of factors outside of the scope of this analysis (e.g., aggregate supply and demand). To adjust for aggregate market changes, a composite retail beef or pork price was included as an explanatory variable.[2] A positive relationship was expected between individual meat cut prices and retail composite price. Weight and the logarithm of weight were included in the empirical model to enable price to vary nonlinearly with portion size.[3] Pork cut composition was included because fresh products are often sold at a premium to frozen products, and cooked products (e.g., deli) typically garner a premium to frozen and fresh products. Further prepared products will garner premiums, reflecting their higher manufacturing costs that displace consumer effort in preparing foods. All beef in the sample were fresh products.

The sale variable was included as a dummy variable to assess the effect on per unit product price from a sale item. Products on sale should sell for a lower price because sale items often represent products that are either being featured to draw customers into the store or nearing the end of their shelf life. Because the dataset does not allow for discerning why a product might have been placed on sale or by whom (i.e., the store or the manufacturer), assessing discounting strat-

[1] Steak quality categories represent aggregated primal cuts. For high-quality cuts, steak, rib, ribeye, tenderloin, and filet mignon were aggregated. For medium-quality cuts, steak, T-bone, sirloin, NY strip, top loin, top sirloin, tip, porterhouse, and round were aggregated. For low-quality cuts, steak, chuck, blade, arm, shoulder, flank, London broil, cube, and other steak were aggregated.

[2] A Hausman simultaneity test was performed on the retail price variable. All explanatory variables, in addition to year, were used as instruments for the retail price variable. For each of the beef and pork models, the null hypothesis that retail price is exogenous could not be rejected.

[3] A Box-Cox transformation test of functional form on the *Weight* variable indicated a linear and logarithmic transformation of pork weight and only a linear transformation for beef weight.

egies by brand or across store type was not possible.

Ground beef leanness was included to assess premiums associated with an increase in lean percent as found by Brester et al. Meat obviously has more value than fat, and consumers have demonstrated substantial concerns about fat in meat products (McLean-Meyinsse). Prime and Choice grade steaks were expected to garner premiums relative to nongraded steaks. Because different stores cater to different consumer profiles, store type was included to determine how product pricing differs between store types. The limited sample size for branded beef products reduced the store type to supermarket/grocery, warehouse, supercenter, and butcher/meat market. A geographic location variable was included to determine whether regional pricing differences were present.

Consumers perceive branded products to be more reliable and of higher quality and to reduce the possibility for purchasing faulty products (Gedenk and Neslin). Thus, a series of brand variables was specified into three categories of national, private, and store. Brands with broader national prominence, greater advertising, and having a longer presence in the industry were expected to receive premiums over more localized store brands.

Results and Discussion

Parameter estimates from Equation (8) are reported in Tables 2–4. Models were initially estimated by ordinary least squares. The hedonic pricing model was specified linearly with the exception of portion size. Cropper, Deck, and McConnell found that the linear specification hedonic model performed as well as alternative functional forms when attributes were omitted or proxies used. Because several implicit attributes were not available for the meat products, the linear hedonic model was specified. Residual nonnormality is a common concern with hedonic models. Therefore, Jarque-Bera tests of the null hypothesis of residual normality were performed (Jarque and Bera). For each of the five beef and each of the five pork hedonic models, the null hypothesis of residual normality was rejected. Models were re-estimated with the multivariate-t errors robust estimation in SHAZAM 9.0 with three degrees of freedom and assuming independent residuals (Judge et al.; Zellner). In interpretation of results, care is taken to differentiate between statistical and economic significance. With the large data samples used, the number of observations can make a coefficient statistically significant, but the coefficient might not be economically important (McCloskey; McCloskey and Ziliak). The multivariate-t hedonic models explained between 19% and 54% of the variation in retail beef prices and between 29% and 48% of the variation in retail pork prices. The range in explanatory power across meat cuts is not surprising given differences in the level of heterogeneity across products. For example, "ground beef" has the highest R^2 of the beef products (.54), in part because lean percentage is an explicit product attribute that is an important price determinant. In contrast, "roast," a product that has numerous different forms that we do not have information about and is not considered a staple like ground beef, not unexpectedly has the lowest R^2 at .19. To summarize the statistical significance of groups of intrinsic and extrinsic meat attributes, F-statistics are also reported in Tables 2–4.

Beef

Beef model estimates are reported in Table 2. In general, statistically significant coefficients had the expected signs. The composite retail beef price was statistically significant and of the expected sign, positive, for ground beef and low- and medium-quality steaks. Roast and high-quality steak prices did not change systematically with overall retail beef prices. The weight parameters for each of the beef cuts were negative and statistically significant, indicating that price per pound decreased as package size increased. Ground beef and roast prices declined by roughly \$0.25/lb. for each 1-lb. increase in package weight. Steak prices declined by about \$0.65/lb. to \$0.90/lb. (higher quality steaks declining by more) as package

Table 2. Results of Hedonic Model for Retail Beef Cuts

	Dependent Variable: Retail Price of Beef Cut ($/lb.)				
			Steak		
	Ground Beef	Roast	Low Quality	Medium Quality	High Quality
$RetailPriceIndex_z$	0.463**	0.125	1.881**	1.884**	0.976
	(0.181)a	(0.605)	(0 774)	(0.827)	(1.489)
$Weight_{zd}$	−0.229**	−0.277**	−0.643**	−0.695**	−0.891**
	(0.032)	(0.129)	(0.139)	(0.136)	(0.251)
$Sale_z$ (*default* = nonsale)	−0.343**	−0.363**	−0.890**	−1.373**	−0.402
	(0.045)	(0.132)	(0.197)	(0.198)	(0.462)
$Leanness_{z,hamburger}$	0.0388**	n/a	n/a	n/a	n/a
	(0.003)				
Beef Grade$_{ze}$ (*default* = nongraded)					
Prime	n/a	n/a	1.405*	0.268*	2.459**
			(0.587)	(0.273)	(0.705)
Choice			0.048	0.067	−0.823
			(0.222)	(0.282)	(0.529)
Select			−0.572*	−0.038*	0.253
			(0.351)	(0.438)	(0.588)
F-statistic for beef grade			3.06**	96.49**	5.17**
StoreType$_{zl}$ (*default* = supermarket/grocery)					
Warehouse	0.025	0.129	1.369	2.525**	4.096*
	(0.187)	(0.830)	(1.036)	(1.253)	(2.215)
Supercenter	−0.260	0.053	−0.616	−0.319	n/a
	(0.391)	(1.164)	(0.929)	(1.226)	
Butcher/meat market	−0.371**	0.329	1.024	−0.007	0.890
	(0.160)	(0.421)	(1.054)	(0.907)	(1.602)
F-statistic for store type	1.93	0.21	1.05	1.38	1.86
Location$_{zn}$ (*default* = Central)					
East	0.297**	0.121	−0.511*	0.835**	−0.121
	(0.063)	(0.185)	(0.247)	(0.262)	(0.534)
South	0.202**	−0.097	−0.039	0.215	−0.306
	(0.063)	(0.164)	(0.257)	(0.273)	(0.495)
West	0.266**	0.029	0.003	0.003	−1.117**
	(0.063)	(0.191)	(0.273)	(0.285)	(0.511)
F-statistic for location	7.99**	0.51	1.93	4.53**	1.86
Month$_{zp}$ (*default* = December)					
January	0.378**	−0.327	−0.284	0.338	−1.354
	(0.137)	(0.288)	(0.508)	(0.431)	(1.106)
February	0.214	−0.382	0.279	0.055	−0.117
	(0.132)	(0.323)	(0.518)	(0.420)	(1.026)
March	0.094	−0 636**	0.163	0.216	−0.631
	(0.134)	(0.311)	(0.517)	(0.425)	(0.927)
April	0.173	−0.647**	−0.321	−0.113	−1.548
	(0.128)	(0.300)	(0.479)	(0.410)	(0.983)
May	0.098	−0.453	−0.471	0.497	−1.663
	(0.125)	(0.293)	(0.499)	(0.420)	(1.097)
June	0.004	−0.473	−0.182	0.239	−0.502
	(0.126)	(0.308)	(0.462)	(0.405)	(0.889)

Table 2. (Continued)

	Dependent Variable: Retail Price of Beef Cut ($/lb.)				
			Steak		
	Ground Beef	Roast	Low Quality	Medium Quality	High Quality
July	0.204	−0.396	−0.598	−0.113	−1.994**
	(0.125)	(0.324)	(0.473)	(0.422)	(0.939)
August	0.310**	−0.814**	−0.459	0.480	−1.585
	(0.136)	(0.308)	(0.487)	(0.401)	(0.951)
September	0.258**	−0.543*	−0.300	0.316	−1.034
	(0.125)	(0.312)	(0.487)	(0.445)	(0.915)
October	0.238	−0.219	−0.035	0.554	−1.640
	(0.154)	(0.346)	(0.534)	(0.457)	(1.018)
November	0.137	−0.545	0.242	0.461	−1.053
	(0.137)	(0.354)	(0.691)	(0.499)	(1.285)
F-statistic for month	2.36**	0.96	0.81	0.69	1.83
$Brand_2$ (*default* = supermarket/ grocery store brand)	−0.019	0.338**	0.758**	1.260**	1.224**
	(0.065)	(0.148)	(0.209)	(0.205)	(0.426)
Constant	−2.898**	2.395	−2.039	−2.224	2.705**
	(0.610)	(1.781)	(2.331)	(0.917)	(4.323)
R^2	.543	.190	.385	.441	.496

[a] Standard errors are in parentheses under parameter estimates.
*Statistically significant at the 10% level.
**Statistically significant at the 5% level.

weight increased. As expected, the sale parameter was negative and statistically significant with coefficient estimates ranging in magnitude from −$0.34/lb. for ground beef to −$1.37/lb. for medium-quality steak. Interestingly, high-quality steak prices were not discounted (and the coefficient was not statistically different from zero) when labeled as being on sale as much as low- and medium-quality steaks. This makes sense because higher quality steaks are purchased mostly by higher income consumers who are less sensitive to price.

In the ground beef equation, *Leanness* had the expected positive and statistically significant effect on price, with each percentage point increase in leanness increasing price $0.039/lb. Thus, ground beef with a 5% higher lean percentage would garner a $0.20/lb. premium. This estimate is similar to, although a bit larger than, that of Brester et al., who estimated a premium of $0.021/lb. on the basis of aggregate wholesale price data for each percentage point increase in ground beef leanness. For the *Beef Grade* variable in the steak equations, Prime steak received a statistically significant premium ranging from $0.27/lb. to $2.46/lb. relative to steak that did not have a quality grade indicated on the label. For low- and medium-quality steak cuts, Select grade price was discounted relative to steak without a quality grade indicated on the label. However, Choice steak price was not statistically different from nongraded steak.[4]

Medium- and high-quality steak cuts sold through warehouse markets garner premiums of more than $2/lb. relative to supermarket/grocery store beef. Supercenter store prices were similar to supermarket/grocery stores. Ground beef received a $0.20–$0.30/lb. higher price in the East, South, and West regions relative to the Central part of the country, and

[4] A separate model was estimated only for observations graded Select, Choice, and Prime. Results indicated no significant change in premiums associated with Choice or Prime, relative to Select, compared with the model results presented here.

Table 3. Results of Hedonic Model for Retail Pork Cuts

	Dependent Variable: Retail Price of Pork Cut ($/lb)				
	Chop	Rib	Roast	Ham	Steak
$RetailPriceIndex_z$	0.081	0.432**	0.331**	0.084	0.431**
	(0.064)[a]	(0.084)	(0.110)	(0.065)	(0.127)
$Weight_{zd}$	0.0411**	0.029**	0.0458**	0.032**	0.166**
	(0.005)	(0.008)	(0.009)	(0.004)	(0.038)
$\text{Log}(Weight_{zd})$	−0.828**	−0.503**	−0.849**	−0.787**	−0.808**
	(0.023)	(0.039)	(0.054)	(0.018)	(0.087)
$Composition_{zdk}$ (*default* = Frozen)					
Fresh	0.309**	0.106*	0.182*	0.162**	−0.200
	(0.047)	(0.062)	(0.102)	(0.059)	(0.128)
Cooked	−0.395**	1.350**	−0.123	0.194**	−0.088
	(0.158)	(0.118)	(0.213)	(0.064)	(0.692)
F-statistic for composition	31.93**	75.04**	2.86**	4.63**	1.23
$Sale_{zd}$ (*default* = nonsale)	−0.581**	−0.393**	−0.251**	−0.335**	−0.305**
	(0.025)	(0.118)	(0.040)	(0.024)	(0.043)
$StoreType_{zdl}$ (*default* = supermarket/grocery)					
Warehouse	0.521**	0.522**	1.001**	0.047	0.115
	(0.083)	(0.094)	(0.111)	(0.078)	(0.258)
Supercenter	−0.246	−0.007	0.004	−0.076	−2.749**
	(0.244)	(0.302)	(0.294)	(0.116)	(0.735)
Butcher/meat market	0.489**	−0.086	0.102	−0.333**	0.056
	(0.139)	(0.161)	(0.299)	(0.150)	(0.305)
Neighborhood/local deli	0.006	0.135	−0.158	−0.039	−0.113
	(0.359)	(0.424)	(0.528)	(0.329)	(0.483)
Convenience store	0.357	n/a	n/a	0.287	n/a
	(0.506)			(0.544)	
Co-op	−0.054	−0.113	−0.475	−0.687*	n/a
	(0.381)	(0.239)	(1.175)	(0.386)	(0.258)
F-statistic for store type	9.11**	6.26**	16.06**	1.76	3.55**
$Location_{zdn}$ (*default* = Central)					
East	0.142**	0.372**	0.298**	0.115**	0.218**
	(0.034)	(0.048)	(0.061)	(0.032)	(0.086)
South	0.201**	0.189**	0.003	−0.059*	0.057
	(0.031)	(0.043)	(0.054)	(0.031)	(0.052)
West	0.201**	0.240**	−0.055	0.082**	0.235**
	(0.038)	(0.046)	(0.062)	(0.037)	(0.056)
F-statistic for location	15.81**	21.21**	14.15**	12.67**	6.78**
$Month_{zdp}$ (*default* = December)					
January	0.011	−0.002	−0.089	−0.139**	0.014
	(0.055)	(0.081)	(0.087)	(0.051)	(0.116)
February	0.036	−0.016	−0.164*	−0.148**	−0.082
	(0.055)	(0.081)	(0.088)	(0.052)	(0.111)
March	0.038	−0.004	−0.118	−0.092**	0.012
	(0.055)	(0.080)	(0.090)	(0.046)	(0.112)
April	0.082	0.073	−0.087	−0.086**	−0.038
	(0.055)	(0.079)	(0.091)	(0.041)	(0.118)
May	0.070	0.105	−0.097	−0.080	0.002
	(0.055)	(0.074)	(0.093)	(0.052)	(0.112)

Table 3. (Continued)

	Dependent Variable: Retail Price of Pork Cut ($/lb)				
	Chop	Rib	Roast	Ham	Steak
June	0.119**	0.063	−0.119	−0.110**	0.224**
	(0.056)	(0.074)	(0.098)	(0.053)	(0.107)
July	0.126**	0.050	−0.088	−0.061	0.102
	(0.055)	(0.074)	(0.094)	(0.054)	(0.119)
August	0.117**	0.134*	−0.167*	−0.079	0.030
	(0.055)	(0.076)	(0.095)	(0.052)	(0.109)
September	0.089	0.093	−0.112	−0.103**	0.064
	(0.055)	(0.079)	(0.091)	(0.049)	(0.112)
October	0.024	0.005	−0.072	−0.101**	−0.038
	(0.055)	(0.078)	(0.088)	(0.051)	(0.120)
November	0.036	0.115	−0.196**	0.037	0.336**
	(0.058)	(0.085)	(0.089)	(0.046)	(0.104)
F-statistic for month	1.31	1.04	0.64	2.10**	1.49
$Brand_{zdq}$ (See Table 4)					
Constant	2.510**	0.934**	1.880**	2.621**	0.891**
	(0.163)	(0 214)	(0.282)	(0.168)	(0.318)
R^2	.335	.296	.332	.478	.426

[a] Standard errors are in parentheses under parameter estimates.
*Statistically significant at the 10% level.
**Statistically significant at the 5% level.

high-quality steak sold at a discount of $1.12/lb. in the West relative to the Central region.

The *Brand* parameter in the steak and roast equations was positive and statistically significant. Branded roasts received a $0.34/lb. higher price than store brands, and branded steaks brought $0.76–$1.26/lb. premiums, with medium- and high-quality steak garnering the larger brand premiums. Angus brand ground beef was not statistically significantly different from zero at standard significance levels. This is not surprising given that the primary factor that differentiates ground beef is percent lean, which is not uniquely associated with any particular brand. Although the beef branding results are narrow in scope, there is strong evidence that Angus beef brands garnered considerable brand premiums. This provides support for increased branding of Angus beef, which is consistent with the trend in Certified Angus Beef.

Certified Angus Beef (CAB) accounted for 5.7% of 2001 fed cattle slaughtered (Ishmael). CAB began as a brand in 1978. Since 1978, the time it takes to market one million pounds of CAB meat has dropped from 22 months to 22 hours. In addition, a higher proportion of the carcass is now marketed under the CAB brand (about 20% of carcass in 1978 to over 50% today; Ward and Hildebrand) as evidenced by brand line extensions (e.g., Certified Angus Steak). Growth in CAB marketing can be partially attributed to the American Angus Association's supply development branch, which provided third-party verification for quality and consistency (Schroeder and Kovanda). This verification allowed for vertical linkages in the supply chain to help develop the brand.

Pork

Results of the pork model estimates are reported in Tables 3 and 4. The composite retail pork price was statistically significant and of the expected sign, positive, for all retail-level pork cuts except chops and hams (for which the coefficients were not statistically different from zero). For each of the pork cuts, weight had a positive and statistically signif-

Table 4. Results of Hedonic Model for Retail Pork Cuts—Selected Brands (*default* = Supermarket/Grocery Store Brand)

	Dependent Variable: Retail Price of Pork Cut ($/lb)				
	Chop	Rib	Roast	Ham	Steak
National brand					
Hillshire Farms	n/a	0.747*	−0.820*	0.604**	n/a
Hormel	−0.007	0.194**	0.585**	0.689**	0.335**
Oldham's (Farm)	n/a	n/a	n/a	0.847	n/a
Thomas E. Wilson	−0.228	0.310	0.359	0.497**	−0.123
Jimmy Dean	−0.661	0.432	n/a	−1.217	n/a
Johnsonville	−0.142	0.195	1.676	n/a	0.470
John Morell	−0.189**	−0.028	0.578**	−0.027	0.144
Cook's (Ham)	−0.219	0.056	−0.043	−0.111**	0.958**
Corn King	n/a	n/a	n/a	−0.207**	n/a
Farmland	−0.055	0.043	0.082	−0.093*	0.136*
Hamilton	n/a	0.1112	0.288	0.038	n/a
Oscar Mayer	−0.092	−0.124	1.087*	−1.001**	n/a
F-statistic for national brands	1.10	1.00	11.35**	40.48**	4.88**
Private brand					
Ossian	n/a	n/a	0.078	0.527	n/a
Rose's	n/a	2.409**	0.447**	−0.001	n/a
Taylor	0.190**	n/a	n/a	−2.084*	n/a
Farmer John	n/a	0.177*	0.191	0.031	0.109
F-statistic for private brands	n/a	4.54**	2.08*	0.84	n/a
Store brand					
Warehouse	−0.094	−0.079	−0.462**	0.064	0.037
Supercenter	0.294	0.014	0.117	0.701**	2.932**
Butcher/meat market	−0.197	0.059	0.306	0.670**	n/a
Neighborhood/local deli	n/a	0.073	0.171	0.381	n/a
Co-op	−0.485	n/a	1.329	2.324**	n/a
F-statistic for store brands	1.07	0.13	1.77	8.32	6.79**

* Statistically significant at the 10% level.
** Statistically significant at the 5% level.

icant effect, and the logarithm of weight had a negative and statistically significant effect on price. Marginal implicit pricing schedules reveal that for chop, rib, and roast, discounts occurred for package size over 1 lb. For hams, no weight discount was present for any of the ham sizes contained in the dataset.

As expected, fresh chop, rib, roast, and ham products garnered statistically significant price premiums relative to frozen products. Fresh chops garnered a $0.31/lb. premium over frozen pork chops, and fresh hams and roasts received $0.16–$0.18/lb. premiums over frozen products. Cooked ribs had a $1.35/lb. premium and cooked hams a $0.19/lb. premium relative to frozen. These price premiums reflect the value of creating, handling, and storing either fresh or cooked products. For instance, precooked ribs would include preparation and ingredient costs, so the $1.35/lb. premium reflects opportunity costs and ingredient costs from creating cooked ribs from frozen ribs.

In general, when the store type variable was statistically significant, the coefficient signs tended to be different from that expected. The default category was supermarket/grocery store. For ribs, roasts, and chops,

warehouse stores had positive and statistically significant coefficients ranging from \$0.52 to \$1.00/lb. Supercenter stores appeared to price similar to supermarkets/grocery stores (with perhaps the exception of pork steak, which they sold cheaper). These results suggest that consumers shopping at warehouse stores pay a premium for some pork products relative to purchases at supermarkets/grocery stores. This result is unexpected because warehouse stores are promoted as selling products at discounts. Huang et al. found that during the first few months following the opening of a Wal-Mart Supercenter in Athens, GA, Wal-Mart sold red meat for roughly 18% lower than six supermarkets. Whether this trend would persist in the long run once the new store matured is unknown. Current results suggest that on a national basis, supercenter-type stores did not sell pork products more cheaply than grocery stores, and warehouse stores sold certain products at a premium. Local deli, butcher shops, and cooperative stores generally did not have pork prices that were significantly different from supermarket/grocery stores.

Stores located in the South, East, and West sold ribs and pork chops at premiums of \$0.14–\$0.37/lb. relative to pork products sold in the Central region. Stores in the East and West priced ham and steak at premiums relative to pork products sold in the Central region. This finding was expected because transportation costs of moving meat outside of the primary production region are greater. For pork roasts and hams, higher prices were only observed in the East.

Only pork chops and hams had statistically significant seasonality for more than a couple of months. December was the default month, so coefficient values are relative to December prices. During the summer months, chops were around \$0.12/lb. higher relative to December (after adjusting for aggregate retail pork price changes). This result is consistent with when pork chops are in greatest demand, during the summer grilling season. For hams, statistically significant negative coefficients tended to be present during the first quarter of the year. This is consistent with the purchasing pattern of hams around the Thanksgiving and Christmas holidays (during the default month).

Coefficient estimates for individual pork brands by cut are reported in Table 4. All brand premiums and discounts are relative to supermarket/grocery store brands. For instance, the value 0.747 for Hillshire Farms pork ribs indicates that Hillshire Farms pork ribs had a price \$0.747/lb. higher than supermarket/grocery store brand ribs, *ceteris paribus*.

In general, national brand pork products tended to have higher prices than products with a private label or other types of store brands (although ham is a notable exception). For instance, warehouse brand roasts were discounted \$0.46/lb. relative to similar products with a supermarket/grocery store brand.

For hams, brand premiums were observed for private label and specialized store type brands. Some national brand hams had premium prices relative to supermarket store brands and others are sold at a statistically significant discount. For example, Hillshire farms, Hormel, and Thomas E. Wilson brands had greater than \$0.49/lb. premiums relative to supermarket store brands. This indicates that for the highly branded ham market, there was brand premium value to having an established name or purchasing an existing brand name (e.g., Sara Lee Corp. owning the Hillshire Farms brand). However, other brands (Corn King, Farmland, and Oscar Meyer) had discounts of \$0.09/lb. or more relative to store brands. Apparently, these brands were targeting more price-conscious consumers. Several store brands for hams were statistically significant, suggesting that, relative to warehouses, other types of stores charged higher prices for hams.

Conclusions

Retail meat product prices vary substantially across product characteristics. Firm and industry efforts to develop new differentiated products are being made to attract new consumers and enhance prices. This study was undertaken to determine factors affecting

retail beef and pork price differentials and to particularly determine values of brands on meat products.

Several important observations developed from this research. First, meat items on sale are sold at significant discounts to nonsale items; with a few noted exceptions, sale prices are indeed typically lower than general meat prices, all else constant. Second, price per pound varies by product package weight. These two results provide additional motivation for why the USDA needs to collect retail scanner data to better approximate retail meat values. That is, if the volume of meat on special is greater than the volume of meat not on special and if meat prices vary by package size, then these factors need to be accounted for when estimating retail meat prices. Second, specialty stores typically do not garner higher prices than supermarket/grocery stores, whereas, warehouse and supercenter stores often sell meat at premium prices relative to supermarket/grocery stores.

The current analysis of branded beef and pork products and, to a greater degree, the difference between national, store, and private brands provide interesting implications for the meat industry and future research. The level of brand premiums differed across beef and pork cuts. Private-label brands only garner economically significant premiums for specific labels and cuts. A farmer-owned brand, Farmland, tended not to have a brand premium associated with it, except for pork steak. Some brands clearly command a considerable brand premium, whereas others appear to be targeting price-sensitive consumers by selling lower priced products.

The Angus beef brand premium value varies across beef cut, with steak having the largest premium. Ground beef does not have a brand premium. The brand premium for an Angus steak relative to store brand is from $0.76 to $1.26/lb. across steak product quality, which is roughly one half the premium consumers indicated they are willing to pay in nonhypothetical experiments for Certified Angus Beef relative to generic steak (Feldkamp, Schroeder, and Lusk). Thus, a brand name like Certified Angus Beef that can attain national prominence might garner even greater premiums than the broader Angus type brand category analyzed here.

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