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Role of credence and health information in determining US consumers' willingness-to-pay for grass-finished beef

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Consumer demand for forage- or grass-finished beef is rapidly emerging in the US. This research uses data elicited from consumer surveys and experimental auctions to provide insight on product attributes (taste/flavour, credence and nutritional characteristics) and socio-demographic factors that are most important in determining US consumers' preferences and willingness to pay premiums for grass-finished versus grain-finished beef. Information related to beef production processes increased the probability consumers would be willing to pay a premium for grass-fed beef. However, it appears that health-related messages are more important drivers of willingness-to-pay, on average, than the absence of antibiotics and supplemental hormones and traceability. Labelling information regarding grass-fed beef's nutritional content and related production processes is vital for maintaining and growing premium niche markets for grass-fed beef in the US. The relative size of the willingness to pay estimates compared to previous cost estimates suggest that the Australian beef industry may have a comparative advantage for finishing beef on forage and marketing premium grass-fed differentiated beef products in the US market.

Key words: Beef, consumer, credence, experimental auctions, health, willingness-to-pay.

1. Introduction

Consumer interest in forage- or grass-finished beef is rapidly emerging in the US (Martin 2004; Gerrish 2006). Much of the growth can be attributed to consumers' increasing concerns about the effects of meat production and processing methods on the safety and nutritional content of their food and on the environment (Umberger *et al.* 2009). Approximately 85 per cent of the beef raised and sold through retail outlets in the US is grain-finished in a feedlot on a high-concentrate (e.g. corn/maize) diet, often including growth hormones and/or antibiotics (Feuz *et al.* 2004). Domestic US supplies of high-quality grass-fed beef are relatively small, and beef products marketed as 'pasture-fed' or 'grass-fed' typically receive premiums in the retail market (Martin 2004).

The lack of continually available forage supplies combined with relatively higher processing costs (related to size and scale issues), longer production

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cycles and more complex marketing decisions prevents many US producers from taking advantage of this growing market (Martin 2004). The Australian beef industry may have a comparative advantage for finishing beef on forage and marketing 'grass-fed' beef in the US market. The US is currently Australia's second largest beef export market both in terms of volume and value. Most Australian beef currently imported into the US is grass-finished beef that is blended with US beef to create leaner beef. It is primarily sold to consumers as relatively low-value commodity beef products through non-retail outlets (Feuz *et al*. 2004; Thomason 2007).

Considering the success of other Australian-branded products in the US (e.g. wine, lamb), opportunities to increase the export value of Australian beef through marketing higher valued, branded grass-fed beef products may exist. Interestingly, some Australian companies have begun to sell premium grain-fed Australian beef products; however, no known Australian-branded grass-fed beef products are currently being marketed at US retail outlets.

Various types of information are important to consumers when marketing premium meat products. Marketers must understand the interrelationship and relative importance to consumers of the attributes inherent in grass-fed beef. Experimental auctions are used to provide insight on product attributes that are most important when marketing grass-finished beef to US consumers. Specifically, we examine intrinsic and extrinsic product attributes (taste/flavour, credence and nutritional attributes) and consumer characteristics that may be useful in predicting consumers' preferences and premiums for grass-finished versus grain-finished beef. Insight is provided on the relative premiums for grass-finished beef when consumers are presented with different types of information.

2. Relevant consumer research

Consumers generally use two broad categories of visual *cues* to form perceptions about the related quality of a retail meat product. *Intrinsic* cues such as fat content (marbling or leanness), colour and meat cut are quality characteristics that cannot be altered without changing the physical properties of the product. *Extrinsic* cues such as brands, nutrition panels and certifications (e.g. certified organic) can be changed without altering the physical properties of the meat product. These intrinsic and extrinsic cues are used by consumers to ascertain the presence of important meat quality attributes (Caswell and Mojduszda 1996; Grunert 1997; Caswell 1998; Umberger 2007).

In the case of retail beef purchasing decisions, without extrinsic cues consumers use cues such as colour and fat content to make beef purchasing decisions. Consumers do not always understand how visual intrinsic search attributes such as marbling and colour affect eating quality (Melton *et al*. 1996a). Likewise, consumers may not understand the relationship between production (credence) attributes such as grass-fed and eating quality. Previous studies have shown that in visual evaluations, US consumers are more

likely to prefer grain-fed beef to grass-finished beef because of the relatively darker lean and fat colour of grass-fed beef (Sitz 2003; Sitz *et al*. 2005). Berry *et al*. (1988), Umberger *et al*. (2002) and Sitz *et al*. (2005) reported significantly higher average palatability ratings for grain-fed beef versus grass-fed beef. Conversely, after segmenting the data, Umberger *et al*. (2002) and Sitz *et al*. (2005) found that approximately 20 per cent of consumers were willing to pay large premiums for grass-finished steaks.

None of these previous consumer preference studies provided participants with visual or labelling information regarding the credence attributes of the meat. Therefore, it is not known if consumers who preferred the taste of the grass-finished meat were the same consumers who would purchase the meat when presented with extrinsic cues explaining the production practices used to produce the steaks.

Additional product information related to credence attributes may increase consumers' likelihood of purchasing and paying a premium for grass-finished beef. Some consumers may be more concerned about the health attributes and process or production attributes of beef rather than the flavour. Grass-finished beef often contains higher levels of 'good fats' such as omega-3 fatty acid (Duckett *et al*. 1993). Research by McCluskey *et al*. (2005) found that labelling information indicating higher levels of omega-3 fatty acid in grass-finished beef increased the probability of consumers choosing grass-finished products. A recent conjoint study by Lusk *et al*. (2008) found consumers' marginal value for pasture-grazed beef significantly increased when consumers were presented with information regarding potentially higher levels of omega-3 fatty acid, linoleic acid and vitamin E in pasture-grazed beef. It is likely that this various information will be relatively more or less important to different segments of consumers.

3. Methods

3.1 Participant Recruitment

In 2005 and 2006, a representative sample of US consumers from Clemson, South Carolina and Athens, Georgia were recruited by a market research firm to participate in a beef study. Ten qualifying consumers, those over the age of 18 and willing to consume beef, were scheduled to participate in one of 12 sessions in each location. Fifteen participants cancelled or failed to turn-up at their scheduled time, so panels ranged between 7 and 10 consumers for a total of 225 participants.

3.2 Experimental auction procedures

Upon arrival at the research facilities, participants were paid the $50 promised for their participation and were reminded that they would receive a one pound package of strip loin beef steaks after they finished participating in the

research. They completed surveys describing their socio-demographic characteristics, meat-purchasing behaviour, knowledge and preferences regarding various labelling claims and beef characteristics. The evaluation and experimental auction procedures were explained and practice auctions were held. Six rounds of 'binding' auctions were conducted. In each round, participants simultaneously bid (in $/pound) for one grass-finished steak and one grain-finished steak after evaluating and receiving different amounts of information about the steaks.

In the first two rounds of auctions, participants tasted the products before bidding, but they did not visually evaluate the products. In round 3, participants visually evaluated the steaks before bidding, but they were not provided with any labelling information and they did not taste the steaks. In rounds 4 and 5, participants were given different kinds of information about the steaks, including information on production methods (round 4) and health information (round 5). In round 6, participants were provided with production and health information, and they also tasted the steaks.

The willingness-to-pay values in this study were elicited using a random *n*th-price auction (Shogren *et al.* 2001) and a modified version of the procedures used by Feuz *et al.* (2004). Similar auctions have been used in other food attribute valuation studies as they are incentive compatible and avoid hypothetical bias. Lusk and Shogren (2007) provide a comprehensive review of experimental auction theory and discuss the features and tradeoffs of different experimental auction methods and previous studies. Some important features of the current study's auction procedures are outlined in the following paragraphs.

In this study, we were interested in determining differences in participants' preferences and willingness-to-pay for grass-finished versus grain-finished steaks when they were presented with different types of information. As Alfnes and Rickertsen (2003) discuss, when consumers' preferences for differentiated products are expected to be heterogeneous, it is important to be able to obtain a complete distribution of differences in willingness-to-pay. Therefore, rather than choosing a base product (e.g. the grain-finished steak) and asking participants to bid a premium to upgrade to another differentiated steak (e.g. the grass-finished steak), participants *simultaneously* provided bids for both steaks in each round. This feature allowed us to elicit actual differences (positive and negative) in participants' willingness-to-pay for grass-finished steaks.

Simultaneous bidding and multiple auction rounds create the potential for demand reduction, strategic bidding and disengagement of bidders with relatively lower values for the products (Shogren *et al.* 1994; Lusk and Shogren 2007). To avoid strategic bidding and to keep bidders engaged, a random *n*th price auction was used with no market feedback (no posting of prices) between rounds. Further, to eliminate the potential for demand reduction, we followed the advice of Lusk *et al.* (2004) and randomly selected only one treatment in one auction round to be binding – participants could only 'win' one auction.

Additionally, because we wanted consumers to specifically consider the amount or premium they would be willing to pay to upgrade to a preferred

steak, the *difference* in participants' bids determined whether they would have the opportunity to pay a premium to obtain their preferred steak. This is a unique characteristic of the auction procedures used in this study compared with those used by Feuz *et al*. (2004). Participants knew that although they were bidding for each steak, their bid differences determined if they were 'winners'. If they 'won' an auction, they would be asked to pay a 'market premium' and they would take home their preferred steak. The 'market premium' would be set by drawing one of the steak identification numbers out of a hat to determine the binding steak, steak *a*. Premiums for steak *a* were calculated by subtracting each participant's bid for the non-binding steak in the round, steak *b*, from their bid for steak *a*. Participants' premiums for steak *a* were arranged from highest to lowest, and a second number (from one to five) was drawn out of a hat to determine the *n*th price, which was the 'market premium'. Participants $(n - 1)$ who bid above the 'market premium' for steak *a*, were asked to pay the 'market premium' and receive their preferred steak. All other participants were endowed with their non-preferred steak.

A moderator explained the evaluation process and auction procedures using a script and examples.[1] Practice auctions were then conducted using candy bars and cans of soft drink. Consumers were moved into taste panel booths and practice taste tests and auctions were conducted using steaks. Panellists were told that unbranded strip loin steaks were selling for an average price of $5.99/pound in the local supermarket. They were reminded that it was in their best interest to place truthful bids and that the next six rounds of evaluations and auctions were potentially binding. The auction procedures are explained in detail in the following paragraphs.

3.2.1 Step 1: taste tests

In step 1, consumers were provided with pairs of cooked samples from strip loin steaks to taste and evaluate. Unbeknownst to the consumers, the steak samples differed primarily in the feeding practices used to produce the beef: one sample was grain-finished (grain) and the other was grass-finished (grass). Steaks had similar degrees of marbling (intramuscular fat) as determined by their US Department of Agriculture (USDA) quality grades. Tenderness and degree of doneness were also held constant within a pair.[2] Participants wrote the steak sample identification number on a taste rating sheet, tasted and rated

[1] The moderator script is available from the authors upon request.

[2] The USDA quality grading system is based primarily on the amount of intramuscular fat in the lean muscle tissue (marbling). Steaks with higher levels of marbling receive a higher USDA quality grade (e.g. USDA Prime and USDA Choice have more marbling than USDA Select). Most of the meat currently sold in US supermarkets is USDA Choice and USDA Select, or no grade information is shown on the product (Sitz 2003; Killinger *et al*. 2004). Warner-Bratzler shear force values, a quantitative measure of the force necessary to shear through a cooked meat sample, were used to measure tenderness. The cooking method used to control for degree of doneness is commonly used in meat science research (Shackelford *et al*. 2001).

each sample's tenderness, juiciness and overall acceptability. After tasting both samples (grass and grain), consumers then participated in auction 1 (A1) by simultaneously providing their bids in $/pound for both samples in the pair. Participants tasted and evaluated a second pair of grass versus grain steaks and again simultaneously bid on both in auction 2 (A2).

3.2.2 Step 2: visual evaluation of fresh steaks with no taste information

After completing A1 and A2, consumers visually evaluated and bid on three pairs of fresh loin steaks. Steaks were presented using clear plastic over-wrapped Styrofoam containers, similar to how steaks are typically presented in the supermarket. Steaks in each pair consisted of a grass and grain steak of similar USDA Quality grades. In the first visual evaluation and simultaneous auction (A3) no information was provided.

In the second visual evaluation and auction round (A4) participants were informed using a white label placed on the lower left corner of each steak that the grain steak was 'Corn-fed beef, USDA inspected' while the grass steak was 'Natural, grass-fed beef, raised without supplemental hormones or antibiotics; traceable to the farm where it was produced and USDA inspected'. The information was printed on the label using black, 12-point Times New Roman font. Consumers were told that all of the information provided on each steak was true and could be verified through auditable records. The information was not read to participants.

In round five (A5), additional health information was provided (via a new label) for the grass steak only: '62 per cent lower in fat content than corn-fed beef, 65 per cent lower in saturated fat than corn-fed beef, greater concentrations of omega-3 fatty acids and conjugated linoleic acid (CLAs)'. The omega-3 fatty acids and CLA's had been previously measured by food chemists so the statement of higher levels of these nutrients in the grass steaks could be verified.

3.2.3 Step 3: taste test with complete visual information

In the final round (A6), consumers were provided with a pair of steaks to taste using methods similar to those in A1 and A2. However, in addition to tasting, consumers were also shown the fresh steaks with labelling similar to A5, explaining the production practices, traceability and health information relevant to each steak. After all panellists completed A6, the binding steak auction and *n*th price were drawn and announced, participants were presented with their steaks, and premiums from 'winning' participants were collected.

4. Econometric analysis

The primary goal of this research was to reveal factors influencing consumers' willingness to pay a premium for grass-finished versus grain-finished beef. Each consumer's premium (*GrassPremium*) for the grass steak can be represented by Equation (1):

$$GrassPremium_{ij} = BidGrass_{ij} - BidGrain_{ij}. \quad (1)$$

$BidGrass_{ij}$ is the ith consumer's bid in \$/pound for the grass steak in the jth round; and $BidGrain_{ij}$ is the ith consumer's bid in \$/pound for the grain steak in the jth round. *GrassPremium* is positive when consumers preferred and were willing to pay more for the grass steak than the grain steak and is negative when consumers preferred the grain steak.

To empirically measure the impact of information on participants' premiums for grass, Equation (2) was developed:

$$GrassPremium_{ij} = \mathrm{f}(PRODUCTION\_INFO, HEALTH\_INFO, TASTE\_INFO). \quad (2)$$

PRODUCTION_INFO, *HEALTH_INFO* and *TASTE_INFO* are dummy variables used to indicate that production, health and/or taste information was provided in the paired comparison. *PRODUCTION_INFO* is equal to one when the premium was elicited in A4, A5 or A6. *HEALTH_INFO* is equal to one when the premium was elicited in A5 or A6. *TASTE_INFO* is equal to one when the premium was elicited in A1, A2 and A6. The *PRODUCTION_INFO* and *HEALTH_INFO* coefficients are both expected to be positive as the additional information regarding production methods and related health information is expected to increase the premium for grass beef. The majority of US consumers in previous studies preferred the taste of grain beef to grass beef; therefore, the *TASTE_INFO* coefficient is expected to be negative. Each participant is represented in the data six times, therefore, LIMDEP's panel data random effects linear regression procedure was used to estimate Equation (2) (Greene 2005).

In an actual shopping setting, payment of negative premiums (where $BidGrain_{ij} \geq BidGrass_{ij}$) would *not* reflect a consumer's decision at the meat counter, whereas avoidance of purchase would. In other words, consumers faced with two beef products, which are identical in every way except that one is labelled as grass-fed and is priced higher than the other labelled grain-fed, must decide to pay a positive premium to purchase the grass-fed product or to buy the cheaper grain-fed product. To be consistent with this interpretation, the *GrassPremium* variable was recoded as follows: if $GrassPremium \leq 0$, *GrassPremium* was set equal to 0. Further, premiums from those auction rounds where participants had no visual information about steaks (A1 and A2) do not reflect situations faced by prospective meat purchasers in actual retail settings. Thus, these premiums should not be included in analyses where researchers attempt to explain factors that influence purchase behaviour in retail settings. Thus, additional econometric analysis was required to provide a shopping context for the two beef purchase decisions where the first step involves the

decision to pay a premium for the grass beef and the second step concerns ascertaining the size of their premium.

A number of factors were involved in the model selection. The distribution of recoded *GrassPremium* data exhibited a large mass of observations with values of \$0. Thus, assessment of the determinants of the size of an individual's premium requires regression models in which the dependent variable is censored or truncated. We believe that there are differences between the variables explaining of the existence of premiums (first stage) and those explaining of the size of the premium (second stage). We also wished to include variables to proxy the types of information provided to consumers in the auction design when modelling both the existence and size of premiums. Including these design variables creates potential for collinearity among regressors in the two models. These features of our study suggest that the two-stage Cragg model (Cragg 1971) is an appropriate choice in this empirical case.[3]

To illustrate the econometric approach, the observed *GrassPremium*, p, can be represented as follows: $p = d \cdot p^{**}$. Consumers first make a decision to purchase grass-finished beef; and the first stage, participation, w, in the grass-finished beef market can be represented by: $w = \alpha' Z + v$, $d = 1$ if $w > 0$, otherwise $d = 0$. Second, consumers decide the premium they are willing to pay for grass-feed beef. Therefore, in the second stage, consumers' willingness to pay a premium is denoted: $p^{**} = \max[0, p^*]$, $p^* = \beta' X + \varepsilon$. Z and X represent vectors of regressors influencing the participation and willingness-to-pay decisions, α and β are parameter vectors, and v and ε are randomly distributed disturbance terms with a bivariate normal distribution. When $Z = X$ and thus $\alpha = \beta$, a Tobit model results. However, when $Z \neq X$ and v and ε are assumed to be independent, the Cragg model can be employed. This involves using a probit model to estimate the α parameters and a truncated normal regression model to estimate the β parameters. Greene (2005) shows that as the tobit log likelihood is simply the sum of the probit and truncated regression log likelihoods, a simple test of the tobit model as a restriction on Cragg's model can be performed using a likelihood ratio test.

In addition to the different types of information (taste tests, production practices and health information), previous studies suggest that consumer characteristics that explain consumers' preferences are somewhat different than characteristics that help explain consumers' willingness-to-pay for differentiated food products(Melton *et al.* 1996a; Umberger *et al.* 2002; Feuz *et al.* 2004). We expect that $Z \neq X$, and that some of the variables used to explain preferences for grass beef (*GrassPremium* > 0) were different than those used to explain *GrassPremium*.

The following Equation (3) was used to estimate the probit regression (the first step) of the Cragg model:

[3] Lusk and Shogren (2007) provide an overview of the Cragg double hurdle model versus the tobit and their use in analyzing bid data elicited through experimental auctions.

$$PREF\_GRASS_{ij} = \text{f}(PRODUCTION\_INFO, HEALTH\_INFO, TASTE\_INFO, NOHORM\_ANTI, SAFETYGRASS, FEMALE, AGE, AGINVOLVE, CHILDREN, EDUCATION, NONCAUCASIAN). \quad (3)$$

$PREF\_GRASS_{ij}$ equals 1 if $GrassPremium_{ij}$ is greater than 0 and equals 0 otherwise. *PRODUCTION_INFO*, *HEALTH_INFO,* and *TASTE_INFO* are as explained previously. However, because data from A1 and A2 were not included in this analysis, *TASTE_INFO* is equal to 1 only when the premium was elicited in A6.

All other independent variables in Equation (3) are included to test whether specific psychographic and socio-demographic variables are helpful in explaining preferences for grass beef. A description of each variable is included in Table 1. The coefficients on *NOHORM_ANTI* and *SAFETY-GRASS* are both expected to be positive as previous evidence suggests many US consumers interested in non-conventionally produced beef are more concerned about hormone and antibiotic use and food safety (Thilmany *et al*. 2006). The *FEMALE, CHILDREN* and *NONCAUCASIAN* coefficients are expected to be positive based on previous consumer studies (Jekanowski *et al*. 2000; Umberger *et al*. 2002; Ziehl *et al*. 2005). The *AGINVOLVE* coefficient is expected to be negative as consumers who are more experienced and knowledgeable about production agriculture may feel more confident in conventional beef, or may associate grain beef with higher eating quality. The relationship between consumers' age and education and their preferences for credence-differentiated products is not consistent across previous studies, therefore, there were no prior expectations for *AGE* and *EDUCATION* (Loureiro and Umberger 2003; Umberger *et al*. 2003).

The second step of the Cragg model utilized a truncated regression procedure to determine some factors that increased consumers' premium for grass beef. Only consumers who were willing to pay a positive premium for grass steaks were included in the estimation of Equation (4):

$$GRASS\_WTP_{ij} = \text{f}(PRODUCTION\_INFO, HEALTH\_INFO, TASTE\_INFO, MEAT\_EXPEND, PRICE\_DRIVE, HI\_INCOME, FEMALE, AGE, CHILDREN). \quad (4)$$

If *GrassPremium* was greater than 0 and positive, then $GRASS\_WTP_{ij}$ was equal to the *GrassPremium* submitted by the *i*th consumer in the *j*th paired comparison. However, if *GrassPremium* was equal to 0 or was negative, then the consumer was not included in this stage of the estimation.

Only three socio-demographic variables are included in both Equations (3) and (4): *FEMALE*, *AGE*, *AGINVOLVE*, *CHILDREN*. Additional independent

Table 1 Select summary statistics of consumers' socio-demographic characteristics

Variable	Description	Mean	SD	Minimum	Maximum	*N*
SUPPORT LOCAL	Desirability of attribute: 1 = not at all desirable, … 5 = extremely desirable	2.560	1.130	1	5	198
TRACEABILITY	Desirability of attribute	3.090	1.270	1	5	203
EATING QUALITY	1 if eating quality of grass believed better than conventional	0.480	0.500	0	1	205
NUTRITIONAL VALUE	1 if nutritional value of GRASS beef believed better than conventional	0.550	0.500	0	1	196
AFRICAN AMERCIAN	1 if African American	0.160	0.370	0	1	207
HISPANIC	1 if Hispanic	0.010	0.120	0	1	207
STUDENT	1 if current student	0.130	0.340	0	1	207
INCOME	Annual household income (before tax in US$): 1 = < $20 000, 2 = $20 000–$24 999…7 = 50 000–59 999…11 = 90 000–99 999, 12 = 100 000 or more	7.080	3.740	1	12	190
VRYSAFEUSA	Perceived safety of meat products from the US: 5 = extremely safe, …, 1 = not at all safe	4.320	0.720	2	5	210
VRYSAFECANADA	Perceived safety of meat from Canada	3.700	0.890	1	5	205
VRYSAFEMEXICO	Perceived safety of meat from Mexico	2.420	0.770	1	5	203
VRYSAFEAUSTRALIA	Perceived safety of meat from Australia	3.340	0.920	1	5	206
VRYSAFENZ	Perceived safety of meat from New Zealand	3.270	0.910	1	5	206
VRYSAFBRAZIL	Perceived safety of meat from Brazil	2.790	0.860	1	5	206
VRYSAFEARGENTINA	Perceived safety of meat from Argentina	2.780	0.900	1	5	206
VRYSAFEJAPAN	Perceived safety of meat from Japan	3.040	1.070	1	5	205
PREF_GRASS	1 if $GrassPremium_{ij} > 0$, 0 otherwise	0.496	0.500	0	1	213
GRASS_WTP	$= GrassPremium$	0.717	1.067	0	8	213
PRODUCTION_INFO	1 if production information provided	0.750	0.433	0	1	213
HEALTH_INFO	1 if health information provided	0.500	0.500	0	1	213
TASTE_INFO	1 if consumers tasted steak	0.250	0.433	0	1	213

Table 1 (*Continued*)

Variable	Description	Mean	SD	Minimum	Maximum	*N*
NOHORM_ANTI	Desirability of attribute	2.752	1.279	1	5	206
SAFETYGRASS	1 = Grass believed safer than conventional	0.400	0.490	0	1	195
FEMALE	1 = Female, 0 = male	0.569	0.495	0	1	209
AGE	Years of age	41.587	13.801	18	81	206
AGINVOLVE	1 = Currently or previously involved in production agriculture	0.264	0.441	0	1	208
CHILDREN	1 = Dependent children <18 living in the household	0.390	0.488	0	1	205
EDUCATION	1 = Primary school or some high school, 2 = completed high school, … 5 = some post-graduate school or a post-graduate degree	3.976	0.534	2	5	207
NONCAUCASIAN	1 = Non-Caucasian	0.174	0.379	0	1	213
MEAT_EXPEND	Estimated family/household expenditures on meat (US$/week)	34.526	25.156	0	200	213
PRICE_DRIVE	1 = Price is the primary driver of meat shop ping decisions	0.333	0.528	0	4	213
HI_INCOME	1 = Annual household income before taxes was ≥$70 000	0.371	0.483	0	1	213

variables (explained in Table 1) are included in Equation (4). The *MEAT_EXPEND* coefficient is expected to be negative as it is hypothesized that consumers purchasing relatively more meat are more knowledgeable of and comfortable with conventional production practices and safety standards. The *PRICE_DRIVE* coefficient is expected to be negative as price driven consumers may be less likely to pay premiums for differentiated beef. The *HI_INCOME* variable's coefficient is expected to be positive as consumers with more disposable income may be more able and willing to pay a premium for quality-differentiated beef products. All other variables and their expected signs were previously explained.

5. Results

5.1 Consumer characteristics and survey results

Although 225 individuals participated in the experiments, not all provided complete information, thus, information from 213 participants was included in the final analysis. The majority of participants were Caucasian (82.6 per cent), married (59.6 per cent) and female (56.9 per cent), with about 39.0 per cent having dependent children living at home. The average age was about 42 years and the mean annual household income was $50 890. Most respondents had received some collegiate training. The sample included fewer minorities, more females, and the average income and age were slightly higher than the mean reported in the US census (US Census Bureau, 2000; 2006).

Considering the mean ratings of 11 different attributes, humane treatment of animals, traceability and no growth hormones were the most important attributes. On an average, 54.6 per cent, 48.3 per cent and 40.0 per cent of consumers indicated a belief that the nutritional value, eating quality and food safety, respectively, of grass-finished beef was higher than conventional beef. The mean perceived safety rating for Australian meat was significantly lower than those ratings for US and Canadian beef, the two main competitors in the US beef market. However, the mean rating was significantly larger than the mean ratings for meat from Mexico, New Zealand, Brazil, Argentina and Japan (Table 1).

5.2 Auction bids and premiums

The average auction bids for the grass beef steaks over all auction rounds were lower ($0.04/pound), but not significantly less than for the grain beef (Table 2). Mean values do not tell the whole story. A primary objective of this research was to examine the intrinsic and extrinsic product attributes that might influence consumers' premiums for grass-finished beef. *GrassPremium*s were calculated using Equation (1), and the complete distributions of *GrassPremium*s for each auction round are displayed in Figure 1. It is obvious from these distributions that, in each round, a proportion of consumers were will-

ing to pay a premium for grass beef. The proportion of consumers willing to pay for grass beef increases as additional production and health information is provided (A4 and A5), but then decreases again as consumers taste the steaks in the final round (A6). Both the size of the grass preferring segments and the average premiums for grass can be compared by examining the four rows of results provided for each auction round in Table 2.

Table 2 Average bids for grass steaks, grain steaks and *GrassPremium*s by auction round and grass-preferring segment

	Mean†	SD	Minimum	Maximum	*N*
All Observations					
BidGrass	4.816	2.188	0	13	1278
BidGrain	4.852	2.090	0	15	1278
GrassPremium	−0.036	1.858	−10	10	1278
GrassPremium PREF_GRASS*‡ (45.2%)	0.650*	1.077	0	10	1278
A1: taste tests					
BidGrass	4.141	2.060	0	10	213
BidGrain	4.336	2.154	0	10	213
GrassPremium	−0.194	1.818	−6	10	213
GrassPremium PREF_GRASS* (35.7%)	0.543*	1.161	0	10	213
A2: taste tests					
BidGrass	4.089	2.200	0	12	213
BidGrain	4.446	2.301	0	15	213
GrassPremium	−0.357*	2.006	−10	7	213
GrassPremium PREF_GRASS* (36.6%)	0.491*	1.006	0	7	213
A3: visual evaluations with no information					
BidGrass	4.615	2.086	0	10	213
BidGrain	5.021	2.080	0	12	213
GrassPremium	−0.409*	1.656	−9	5	213
GrassPremium PREF_GRASS* (37.1%)	0.421*	0.762	0	5	213
BidGrass	5.132	1.993	0	11	213
BidGrain	5.092	1.978	0	12	213
GrassPremium	0.041	1.719	−6	5	213
GrassPremium PREF_GRASS* (53.1%)	0.678*	0.932	0	5	213
A4: visual evaluations with production information					
BidGrass	5.132	1.993	0	11	213
BidGrain	5.092	1.978	0	12	213
GrassPremium	0.041	1.719	-6	5	213
GrassPremium PREF_GRASS* (53.1%)	0.678*	0.932	0	5	213
A5: visual evaluations with production and health information					
BidGrass	5.724	2.169	0	13	213
BidGrain	5.055	1.909	0	10	213
GrassPremium	0.669*	1.873	−6	7	213
GrassPremium PREF_GRASS* (62.9%)	1.101*	1.297	0	7	213
A6: visual evaluation, production, health information and taste test					
BidGrass	5.196	2.153	0	11	213
BidGrain	5.162	1.960	0	11	213
AVERAGE GrassPremium	0.034	1.866	−10	8	213
GrassPremium PREF_GRASS* (46.0%)	0.668*	1.094	0	8	213

*GrassPremiums are statistically different than zero ($\alpha = 0.05$).
†Values are in $/pound, ‡*GrassPremium* PREF_GRASS* is equal to the grass premium for the segment of participants who preferred grass; the market share preferring grass is in parenthesis.

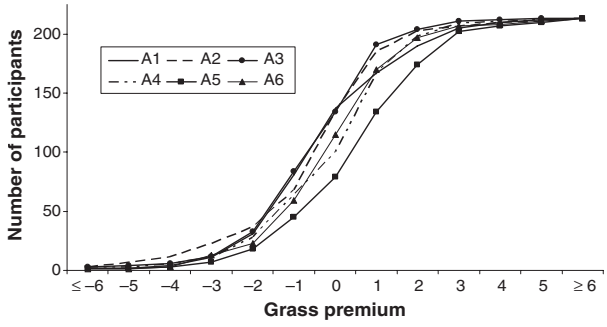

Figure 1 Cumulative distributions of the *GrassPremiums* for all auction rounds.

In A1 and A2, where panellists performed sensory/taste evaluations only, consumers discounted the grass steaks by \$0.19/pound and \$0.36/pound, respectively. In A1, the difference in average bids between grass and grain was not statistically significant ($\alpha = 0.05$), however, it was statistically significant in A2. The negative average premium for grass can likely be attributed to the fact that, on an average, consumers perceived and rated the palatability of the grass steaks significantly lower on flavour and juiciness than the grain steaks. It is interesting to note that a substantial segment of consumers, approximately 36 per cent in both A1 and A2, preferred and were willing to pay a premium for the grass steak. The size of this grass-preferring segment is larger than those found in similar taste studies by Umberger *et al.* (2002) and Sitz *et al.* (2005).

In A3, participants visually compared the grass and grain steaks with no taste or labelling information. The average bid for the grass steaks was statistically lower, \$0.41/pound less, than the grain steak. Comments from consumers indicated that some consumers perceived the grass steak to be darker in colour. Yet, when the data was segmented, 37 per cent of participants preferred and were willing to pay a premium of \$0.42/pound for the grass steak. After participants were provided with the relevant production information for each steak in A4, the number of consumers preferring the grass steaks increased to 53 per cent. The average bid for grass steaks also increased, and was slightly, but not significantly more (\$0.04/pound) than the average grain steak bid.

Additional information regarding the nutritional content of the grass steak was provided in A5, but the information provided for the grain steak remained the same as in A4. In A5, more consumers shifted their preferences away from grain beef – 63 per cent of consumers indicated a preference for grass beef. The average premium for grass beef increased substantially to a significant difference of \$0.67/pound. The nutritional information obviously had a positive impact on the experimental market for grass beef.

In A6, allowing the subjects to taste the steaks appears to have caused some consumers to shift preference away from grass and towards grain steaks, although it was combined with the production and nutritional information.

The market share for grass declined from A5 with only 46 per cent preferring grass steaks. The average premium for grass also decreased from A5 by \$0.64/pound to \$0.03/pound (not significantly different than 0).

After further exploring the data, it was discovered that 29 per cent of consumers who preferred the grass product in A5 changed their preference to the grain steak after having the opportunity to taste both steaks. Furthermore, 13 per cent of consumers switched their preference from the grain steak in A5 to the grass steak in A6. Only 59 per cent of consumers' remained consistent in their preferences from A5 to A6. This inconsistency in visual and taste preferences for meat is similar to that found by Melton *et al*. (1996b) and has important marketing implications. The shift in preferences from A5 to A6 implies that although positive information on health and production attributes encourages some consumers to purchase a grass product; if they take the product home, cook it, and it does not meet their taste expectations, then repeat sales are likely to be low or infrequent (Melton *et al*. 1996a; b). Conversely, as evidenced by the shift in some panellists' preferences from preferring grain in A5 to preferring grass in A6, taste information can positively impact demand for grass beef. Yet, as Melton *et al*. (1996a,b) point out, if consumers are unwilling to make the initial purchase and try the product, repeat sales will not occur.

5.3 Econometric results

The results of the econometric analyses are provided in Table 3. Parameter estimates for the estimation of Equation (2) are provided in the first column of Table 3. The coefficient for *HEALTH_INFO* was positive and statistically significant in explaining the premium for grass beef. Not surprisingly, when presented with potentially positive health information, the premium for grass steak was \$0.41/pound higher than when no information is given. The coefficient for *TASTE_INFO* was also statistically significant, but it was negative. When participants were allowed to taste the steaks, the premium for grass steak was \$0.20/pound lower than when no information was provided. Interestingly, production information was not statistically significant in explaining the participants' premiums for grass beef.

Although, interesting, these results do not shed light on the questions of who might be more likely to prefer grass beef and which consumers are willing to pay a higher premium for grass beef. The results of the first hurdle of the Cragg model provide information to address the former question; and the results of the second hurdle, provide insight on the latter question. Maximum likelihood estimates and marginal effects from the random effects probit model (first hurdle) are provided in the second column of Table 3. The variables *PRODUCTION_INFO, NOHORM_ANTI, SAFETYGRASS,* were all positive (as expected) and statistically significant. When presented with information indicating the steak was from grass-fed animals without the use of hormones or antibiotics, consumers were 16.9 per cent more likely to

Table 3 Coefficient estimates from regression models for three different treatments of the premium for grass-fed beef

Variable	Random effects (Y = *Grass Premium*)	Random effects probit (*Y* = 1 *GrassPremium* > 0; *Y* = 0 if *GrassPremium* ≤0)		Truncated normal (Y = *GrassPremium*)	
	Coefficient (SE)	Coefficient (SE)	Marginal effect	Coefficient (SE)	Marginal effect
Constant	−0.190*	−1.228		0.747	—
	(0.109)	(0.994)		(0.621)	
PRODUCTION_INFO	0.230	0.567**	0.169	0.475	0.181
	(0.153)	(0.182)		(0.447)	
HEALTH_INFO	0.409**	0.305	0.091	1.092**	0.416
	(0.153)	(0.215)		(0.364)	
TASTE_INFO	−0.195*	−0.585**	−0.174	−0.622*	−0.237
	(0.108)	(0.162)		(0.347)	
MEAT_EXPEND	—	—	—	0.011*	0.004
				(0.006)	
PRICE_DRIVE	—	—	—	0.238	0.091
				(0.234)	
NOHORM_ANTI	—	0.151**	0.038	—	—
		(0.076)			
SAFETYGRASS	—	0.406**	0.121	—	—
		(0.203)			
FEMALE	—	0.265	0.079	−0.324	−0.124
		(0.191)		(0.271)	
AGE	—	−0.002	−0.001	−0.024**	−0.009
		(0.007)		(0.010)	
HI_INCOME	—	—	—	−0.680**	−0.259
				(0.315)	
AGINVOLVE	—	−0.476**	−0.142	—	—
		(0.211)			
CHILDREN	—	0.164	0.049	−1.074**	−0.409
		(0.198)		(0.315)	
EDUCATION	—	−0.067	−0.020	—	
		(0.201)			
NONCAUCASIAN	—	−0.013	−0.004	—	
		(0.298)			
ρ	—	0.442**		—	
		(0.061)			
σ	—	—	—	1.659**	—
				(0.147)	
N	213	740		404	
Log likelihood	—	−441.925		−509.330	

(*), (**) correspond to significance at the α = 10 per cent and 5 per cent levels, respectively.

purchase grass beef than grain beef. Consumers with high preference ratings for production methods using no hormones and antibiotics and those who believed grass beef was safer than conventional beef were 3.8 per cent and 12.1 per cent more likely to prefer grass steak. Thus, marketers should include this type of credence information when marketing their beef if they are able

to verify the use of these alternative production practices. Although the coefficient on *HEALTH_INFO* was positive, it was not statistically significant.

TASTE_INFO and *AGINVOLVE* were the only statistically significant variables with negative coefficients. Consumers currently or previously involved in production agriculture were 14.2 per cent less likely to prefer grass beef. The marginal effect of *TASTE_INFO* was the largest of any coefficient. As discussed earlier, some consumers who purchase grass beef because of their perceptions of it being a 'healthier' or a more 'altruistic' alternative may not become repeat purchasers after they experience/taste grass beef. This result provides further support for Melton *et al.*'s (1996b) notion that trying to predict demand for fresh meat without using taste information is inefficient.

The second hurdle of the estimated Cragg model determines the impact of information on consumers' willingness to pay a premium for grass beef, and to examine whether psychographic and socio-demographic characteristics help to explain these premiums. The results of this estimation are displayed in the third column of Table 3. Not surprisingly, different variables were significant in this second hurdle than in the first hurdle. The *HEALTH_INFO* variable had the largest, significant and positive marginal effect on the premium for grass beef. This is not surprising considering the relative size of the *GrassPremiums* elicited in A5. This is information that marketers of Australian grass beef could potentially include in their marketing campaigns as research by Mann *et al.* (2002) found Australian grass beef to have higher levels of omega-3 fatty acids and CLA's.

The demographic variables *AGE* and *CHILDREN* were significant in predicting consumers' premiums for grass beef. Older consumers and consumers with children living at home were willing to pay less for grass beef. The opposite signs of the *CHILDREN* coefficients in the probit and truncated regression models and the relatively large, negative marginal coefficient found after estimating the second hurdle was an unexpected outcome. This result suggests that households with dependent children may be income-constrained and while they would like to purchase grass beef, the premiums charged for grass beef may not be affordable. Although *PRODUCTION_INFO* had the largest significant marginal effect when predicting preferences for grass beef, it was not a significant explanatory variable in explaining the premium.

The negative sign and size of the *TASTE_INFO* coefficient again was not surprising considering the change in the *GrassPremiums* between A5 and A6. The negative sign on *HI_INCOME* was unexpected; however, the sign is similar to the result found by Loureiro and Umberger (2003) and Ziehl *et al.* (2005). As Loureiro and Umberger (2003) suggest, high-income consumers may already be confident in the quality and safety of their meat. The positive sign on the *MEAT_EXPEND* coefficient was also not expected, however, consumers may be spending relatively more to purchase better quality meat rather than larger quantities of meat.

Alternative model specifications were estimated using other psychographic and socio-demographic information as independent variables. However, these other variables were not statistically significant or were highly correlated with other independent variables. A Tobit model was also estimated on the full set of bid data and the log likelihood ratio test on parameter restrictions imposed by this model was conducted. The results ($\chi^2 = 495$, df = 15, $P < 0.01$) suggest the Cragg model was the preferred analytical approach for these data.

6. Conclusions

The growth of an economically viable grass market in the US will likely depend on the palatability (e.g. tenderness) and quality of grass beef being similar to grain beef, as well as having consistently available and affordable supplies of grass-finished beef. Previous beef production research ascertained that at least a 10 per cent premium was needed for production of grass-finished beef to be an economically viable alternative to grain-finishing for US producers (Lacy 2007). A considerable number of panellists were willing to pay much larger premiums when provided with production and nutritional information that could be associated with grass beef. Consumers with relatively higher preference ratings for production methods using no additional hormones or antibiotics and those who believe grass-fed beef was safer than conventional beef were more likely to pay a premium of any level for grass beef. Consumers who spent a relatively higher amount of their household expenditures on meat were more likely to pay a premium for the grass-fed beef. Conversely, older consumers and those with children living at home were less likely to pay a premium. Marketers of grass beef should focus on targeting consumers who are both willing and able to pay at least a 10 per cent premium.

It is important to point out that most of the production information included with the grass-fed attribute (natural, no added hormones, antibiotic-free and traceable to the farm) could also be incorporated into the production and marketing strategies of grain beef. Therefore, premiums for grass beef with these additional credence attributes included are likely influenced by more than just the attribute of 'grass fed'.[4] It would be interesting to conduct further research comparing consumers' preferences for steak labelled as 'grass-finished' relative to steak labelled only as 'grain-finished', as well as comparing 'hormone and antibiotic free' grass steak to grain steak with the same credence attributes.

Furthermore, when considering whether differentiated Australian food products can be successfully marketed as high-quality products abroad,

[4] In a hypothetical conjoint analysis, Lusk *et al.* (2008) found U.S. consumers valued the hormone and antibiotic free attribute more than pasture-raised and traceable attributes in beef.

consumers' perceptions of country-of-origin relative to food quality is obviously an important aspect to consider. Country-of-origin was not a specific attribute examined in this research. However, this research found that US consumers perceived Australian meat products as relatively less safe than meat from the US and Canada – the two main competitors on the US market. This country-of-origin issue is of greater concern considering compliance with the country-of-origin labelling of meat became mandatory in the US in September 2008. Future research could also examine consumers' perceptions and preferences for Australian versus US grass beef with similar credence attributes to determine the relative importance of country-of-origin. Additional information regarding Australia's low risk rating classification regarding bovine spongiform encephalopathy (or mad cow disease) and the industry's quality assurance, traceability and food safety certification systems may be utilized in marketing strategies (Thomason 2007).

Finally, although experimental auctions are less hypothetical than other preference elicitation methods (e.g. contingent valuation), the premiums elicited in this study are not necessarily representative of the premiums that grass beef would garner in the market. Nevertheless, the information on relative premiums and market size for grass beef across paired auctions does provide insight on the *relative* importance of different intrinsic and extrinsic attributes when marketing grass beef. Information provided related to the beef production process had a positive impact on premiums for the grass beef. However, it appears that health aspects are a more important driver of premiums, on an average, than the combined information of absence of antibiotics or supplemental hormones and traceability.

As more discoveries are made regarding the benefits and sources of CLA's, it is possible that other products such as dairy or fish may prove to be the toughest competition for grass beef. Regardless, labelling information regarding grass beef's potentially beneficial nutritional attributes and related production processes is vital for maintaining and growing niche markets for grass-fed beef in the US. This information will help international agribusinesses who are interested in producing and marketing grass-fed beef to develop targeted marketing strategies for higher end beef distribution channels in countries such as the US.

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References

Alfnes, F. and Rickertsen, K. (2003). European consumers' willingness to pay for U.S. beef in experimental auction markets, *American Journal of Agricultural Economics* 2003, 396–405.

Berry, B.W., Leddy, K.F., Bond, J., Rumsey, T.S. and Hammond, A.C. (1988). Effect of silage diets and electrical stimulation on the palatability, cooling and pH characteristics of beef loin steaks, *Journal of Animal Science* 66, 584–589.

Caswell, J.A. (1998). How labeling of safety and process attributes affects markets for food, *Agricultural and Resource Economics Review* 27, 151–158.

Caswell, J.A. and Mojduszda, E.M. (1996). Using informational labeling to influence the market for quality in food products, *American Journal of Agricultural Economics* 78(5), 1248–1253.

Cragg, J. (1971). Some statistical models for limited dependent variables with application to the demand for durable goods, *Econometrica* 39, 829–844.

Duckett, S.K., Wagner, D.G., Yates, L.D., Dolezal, H.G. and May, S.G. (1993). Effects of time on feed on beef nutrient composition, *Journal of Animal Science* 71, 2079–2088.

Feuz, D.M., Umberger, W.J., Calkins, C.R. and Sitz, B. (2004). U.S. consumers' willingness to pay for flavor and tenderness in steaks as determined with an experimental auction, *Journal of Agricultural and Resource Economics* 29, 501–516.

Gerrish, J. (2006). *Is pasture-finishing for you?* Beef Magazine 2 Oct, Available from URL: http://beefmagazine.com/Pasture_Finishing/ [accessed 10 Oct 2007].

Greene, W. (2005). Censored data and truncated distributions, in Mills, T. and Patterson, K. (eds), *The Handbook of Econometrics: Theoretical Econometrics*, Vol. 1. Palgrave, London, pp. 695–736.

Grunert, K.G. (1997). What's in a steak? A cross cultural study on the quality perception of beef, *Food Quality and Preference* 8, 157–174.

Jekanowski, M.D., Williams, D.R. II and Schiek, W.A. (2000). Consumers' willingness to purchase locally produced agricultural products: an analysis of an Indiana survey, *Agricultural and Resource Economics Review* 29, 43–53.

Killinger, K.M., Calkins, C.R., Umberger, W.J., Feuz, D.M. and Eskridge, K.M. (2004). Consumer visual preference and value for beef steaks differing in marbling level and color, *Journal of Animal Science* 82, 3288–3293.

Lacy, R.C. (2007). *Market analysis of forage-finished beef in the Southeast*, Final Report to the Federal State Market Improvement Program (FSMIP). U.S. Department of Agriculture, Washington, DC.

Loureiro, M.L. and Umberger, W.J. (2003). Estimating consumer willingness-to-pay for country-of-origin labeling, *Journal of Agricultural and Resource Economics* 28, 287–301.

Lusk, J.L. and Shogren, J.F. (2007). *Experimental Auctions: Methods and Applications in Economic and Marketing Research*. Cambridge University Press, New York.

Lusk, J.L., Feldkamp, T. and Schroeder, T.C. (2004). Experimental auction procedure: impact on valuation of quality differentiated goods, *American Journal of Agricultural Economics* 86, 389–405.

Lusk, J.L., Fields, D. and Prevatt, W. (2008). An incentive compatible conjoint ranking mechanism, *American Journal of Agricultural Economics* 90(2), 487–498.

Mann, N.J., Sinclair, A.J. and Yep, Y. (2002). Do differences in the food supply explain discrepancies in epidemiology? *Proceedings of the Nutrition Society of Australia* 26, S303.

Martin, J.M. (2004). Review: forage-produced beef: challenges and potential, *The Professional Animal Scientist* 20, 205–210.

McCluskey, J.J., Wahl, T.I., Li, Q. and Wandschneider, P.R. (2005). U.S. grass-fed beef: marketing health benefits, *Journal of Food Distribution Research* 36, 1–8.

Melton, B.E., Huffman, W.E. and Shogren, J.F. (1996a). Economic values of pork attributes: hedonic price analysis of experimental auction data, *Review of Agricultural Economics* 18, 613–627.

Melton, B.E., Huffman, W.E., Shogren, J.F. and Fox, J.A. (1996b). Consumer preferences for fresh food items with multiple quality attributes: evidence from an experimental auction of pork chops, *American Journal of Agricultural Economics* 78, 916–923.

Shackelford, S.D., Wheeler, T.L., Meade, M.K., Reagan, J.O., Byrnes, B.L. and Koohmaraie, M. (2001). Consumer impressions of tender select beef, *Journal of Animal Science* 79, 2605–2614.

Shogren, J.F., Fox, J.A., Hayes, D.J. and Kliebenstein, J.B. (1994). Bid sensitivity and the structure of the Vickrey auction, *American Journal of Agricultural Economics* 76, 1089–1095.

Shogren, J.F., Margolis, M., Koo, C. and List, J. (2001). A random *n*th price auction, *Journal of Economic Behavior and Organization* 46, 409–421.

Sitz, B.M. (2003). Consumer sensory acceptance and value of beef from various aging techniques and countries of origin. Unpublished Masters Thesis, Department of Animal Science, University of Nebraska-Lincoln, Lincoln. May.

Sitz, B.M., Calkins, C.R., Feuz, D.M., Umberger, W.J. and Eskridge, K.M. (2005). Consumer sensory acceptance and value of domestic, Canadian, and Australian grass-fed beef steaks, *Journal of Animal Science* 83, 2863–2868.

Thilmany, D.D., Umberger, W.J. and Ziehl, A.R. (2006). Strategic market planning for value-added natural beef products: a cluster analysis of Colorado consumers, *Renewable Agriculture and Food Systems* 21, 192–203.

Thomason, D. (2007). Production practices for red meat in Australia. *Nutrition and Dietetics: the Journal of the Dietitians Association of Australia* (1 Sep). Available from URL: http://www.thefreelibrary.com/Production practices for red meat in Australia.-a0169311707 [accessed 10 Jan 2008].

Umberger, W.J. (2007). Beef quality, beef demand and consumer preferences, in VanOverbeke, D.L. (ed.), *The Handbook of Beef Quality and Safety*. The Haworth Press Inc., Binghamton, NY, pp. 187–213.

Umberger, W.J., Feuz, D.M., Calkins, C.R. and Killinger, K. (2002). U.S. consumer preference and willingness-to-pay for domestic corn-fed beef versus international grass-fed beef measured through an experimental auction, *Agribusiness* 18, 491–504.

Umberger, W.J., Feuz, D.M., Calkins, C.R. and Sitz, B.M. (2003). Country-of-origin labeling of beef products: U.S. consumers perceptions, *Journal of Food Distribution Research* 34, 103–116.

Umberger, W.J., Thilmany McFadden, D. and Smith, A.R. (2009). Does altruism play a role in determining U.S. consumer preferences and willingness to pay for natural and regionally produced beef? *Agribusiness* 25 (2), 268–285.

Ziehl, A., Thilmany, D.D. and Umberger, W.J. (2005). A cluster analysis of natural beef product consumers by shopping behavior, importance of production attributes, and demographics, *Journal of Food Distribution Research* 36, 210–217.