Journal of Agricultural and Applied Economics, 44,4(November 2012):447–459

Willingness-to-Pay for Beef Quality Attributes: A Latent Segmentation Analysis of Korean Grocery Shoppers

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A latent segmentation modeling is used in this study to identify the heterogeneity of willingness-to-pay estimates for quality attributes and country-of-origin in the Korean beef market. Three distinctive groups of grocery shoppers are identified based on their level of concern (very, moderately, and not too concerned) about the use of antibiotics and genetically modified organism feed ingredients in beef production. Results indicate that the very concerned group values such attributes as antibiotics-free, genetically modified organism-free, and domestic production the most among the three groups. Results also suggest that the most important factor in determining grocery shoppers' willingness-to-pay is country-of-origin for all three groups.

Key Words: latent segmentation, willingness-to-pay for beef attributes, conjoint analysis, choice experiment, heterogeneity of preference

JEL Classifications: Q110, Q130, Q180

Limited agricultural profit opportunities are often rectified by identifying and meeting international demand for products (Briggeman and Henderson, 2009). U.S. beef is no exception. In fact, the U.S. Meat Export Federation (USMEF) has worked on developing international markets in which to sell U.S. meat. One market that has received a lot of attention from the USMEF is South Korea. Since the liberalization of the beef market in 2001, Korea has continuously increased beef imports to the point where more than 50% of the total beef consumed in Korea is from foreign markets. According to the USMEF, the biggest benefactors from this increase in Korean beef imports are major beef exporting markets such as the United States (68% of beef imports), Australia (22% of beef imports), and New Zealand (10% of beef imports).

However, after the discovery of BSE (bovine spongiform encephalopathy) in the United States, the market share of imported beef drastically decreased. Despite the repeal of the Korean ban on U.S. beef in early 2007, the market share of imported beef has not returned to previous levels due to various political and food safety regulation issues. For U.S. beef producers to recover their Korean beef market share, Korean beef consumers' shopping behavior must be understood. So, what are important product attributes that affect Korean grocery shoppers' valuation of beef? Also, are there any differences in valuation (such as willingness-to-pay (WTP))

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This research was supported by the Oklahoma State University Agricultural Experiment Station, and partial funding was provided by Konkuk University, Seoul, Korea.

of these attributes among different groups of Korean grocery shoppers? Answers to these questions should provide important information for U.S. beef exporters in developing their marketing strategies in the Korean beef market.

Researchers have widely used the conditional (or multinomial) logit model as well as the mixed logit model for estimating consumers' WTP in the choice experiment literature. Conditional logit (or multinomial) models assume that all individuals share the same parameters for all attributes, which indicates that individuals have the same preferences for attributes of the product in question (Lusk and Parker, 2009; Peterson and Yoshida, 2004). To account for respondent heterogeneity, some studies have used the mixed logit approach and found that mixed logit models yield better estimates compared with the traditional logit models (Abidoye et al., 2011; Chung, Han, and Boyer, 2009; Train, 2003). To address the respondents' heterogeneity in marginal utilities, researchers specify a distribution for coefficients and estimate the underlying parameters of that distribution. However, the mixed logit model cannot identify the sources of unobserved heterogeneity from respondents. Another limitation of the mixed logit model is that the model assumes continuous distribution of preference, while peoples' preferences might cluster in some cases (Boxall and Adamowicz, 2002; Patunru, Braden, and Chattopadhyay, 2007).

To identify the heterogeneity of WTP estimates, one might consider incorporating a number of socio-demographic and other respondent characteristic variables in the logit models. However, in the choice experiments, while attributes of the product under evaluation vary across alternatives, those of individual specific characteristics remain the same across alternatives. Therefore, these attributes cannot directly enter into the model on their own as the conditional effects of individual characteristics on the probability of choosing specific alternatives are not identifiable.

The objective of this paper is to estimate WTP for quality and country-of-origin attributes in the Korean beef market while considering consumer heterogeneity. To accomplish this objective, first a latent segmentation model was used to identify groups of grocery shoppers that share common preferences for beef. The segmentation assigns each survey respondent to a group based on the probability of how they would respond to the preference and attitude questions posed in the interview. After determining group membership, the study describes each group's typical demographic and perception profile on quality attributes using the surveyed demographic and perception data. Then, the WTP is estimated for quality attributes such as marbling, freshness, chilled versus frozen, food safety (such as genetically modified organisms (GMO) and antibiotics), and country-of-origin for the overall sample and the preference groups.

Results suggest that three distinctive groups of Korean grocery shoppers exist, and they are differentiated by their concerns about the use of antibiotics and GMO feed ingredients in beef production: "very concerned (VC)," "moderately concerned (MC)," and "not too concerned (NC)." WTP estimates for each group indicate that the VC group values not only antibiotics-free and GMO-free beef production the most but also values other attributes such as marbling, freshness, chilled versus frozen, and domestic production the most among the three groups. The WTP estimates from all three groups also suggest that the most important factor is country-of-origin, while the least important factor is chilled versus frozen.

Data

Data were collected through an in-person choice experiment targeted toward Korean grocery shoppers. For choice experiments (often referred to as conjoint analysis), respondents were asked what type of beef they would buy among choice sets in each individual's survey. Each choice set included alternative types of beef with various levels of price, quality, and country-of-origin attributes. Table 1 summarizes attributes and levels of each attribute included in the choice experiment design. The attribute price has 11 levels ranging from $10 to $35 per pound. Five levels of marbling grade are considered following the current grading scale in Korea, and three levels are considered for freshness. The survey

Table 1. Attributes and Levels in Choice Experiment Design

Attributes	Levels
Price ($/lb)	$10, $12.50, $15, $17.50, $20, $22.50, $25, $27.50, $30, $32.50, $35
Marbling	Extra premium, premium, A, B, C
Freshness	High, medium, low
Chilled versus frozen	Yes, No
Free of antibiotics	Yes, No
Free of GMO feed ingredients	Yes, No
Country-of-origin	Korea, United States, other exporting countries

also includes three quality attributes: chilled or frozen beef, free of antibiotics or not, and free of GMO feed ingredients or not in beef production. Finally, three different country-of-origins are considered: Korea, United States, and other (Australia, New Zealand, and Canada). Therefore, with the number of attributes and attribute levels in Table 1, a full factorial design results in 3,960 scenarios.

To reduce the number of scenarios, a set of choice sets were identified for each respondent. Each choice set was constructed by randomly drawing scenarios from the full factorial with replacement. No identical scenario was presented in each choice set, and each respondent answered 10 unique choice sets. Random assignment of profiles from a full factorial design has been shown to work efficiently in estimating parameters of individuals' choice behavior (Lusk and Norwood, 2005).[1]

The survey was conducted in January and February of 2007. Eleven agricultural economics students (undergraduate and graduate students) conducted surveys with 1,000 grocery shoppers using randomized attribute values for each respondent. The interviewers were sent to small and large grocery stores in Seoul, Korea, and intercept surveys were conducted at store gates. Before the survey, interviewers were trained in survey administration and the beef attributes described in the survey so that they could sufficiently explain differences in the levels of each attribute to the survey participants. Pictures and descriptions of each attribute were also provided to interviewers so that they could present them to survey participants. An example of a choice set is illustrated in Figure 1.[2]

Table 2 compares summary statistics of demographic characteristics of survey participants to previous surveys and Korean census data. All three surveys, this study's survey, Park, Jung, and Kim (2007), and Rho, Han, and Chung (2007), show that more than 70% of grocery shoppers are female while male and female were almost evenly distributed in the national population census. Food Marketing Institute (2004) and Katsaras et al. (2001) also

[1] Random designs have been commonly used in the literature of choice experiments and have been shown to produce unbiased and efficient parameter estimates (Lusk and Norwood, 2005) However, recently, Carson, Louviere, and Wasi (2009) point out some limitations of random designs.

[2] Descriptions of attributes and other survey instructions were written in Korean for Korean participants, and key parts of the descriptions were translated in English and listed below:

Marbling: marbling grade represents the amount of intramuscular fat inside beef (rib). Five levels of marbling grade we use in the survey are consistent with marbling grades used by processors and retail grocers in Korea. For example, the grade "Extra Premium" contains the highest amount of intramuscular fat while the grade "C" contains the lowest amount of intramuscular fat among the five grade levels. Pictures of each of these grades are provided for your reference.

Free of antibiotics: cattle in Korea, United States, Canada, Australia, and New Zealand are routinely administered antibiotics during feeding to reduce the chance of illness and to achieve higher growth and feed conversion rates. The beef (rib) with the label "Free of antibiotics" is guaranteed to not have been administered any antibiotics during production.

Free of GMO feed ingredients: cattle are fed corn and soybean meal during production. Some of the corn and soybeans (which produced soybean meal) may have been genetically modified because a significant amount of grains and oilseed meals available for livestock production is genetically modified. The beef (rib) with the label "Free of GMO feed ingredients" is guaranteed to not have been fed any genetically modified grains and oilseed meals during production.

Country-of-origin: three different origins are considered for this survey. They are Korea, United States, and other. The country-of-origin "other" includes Australia, New Zealand, and Canada.

	Option 1	Option 2	Option 3	
Price (won/lb)[a]	12,500	15,000	17,500	
Marbling Grade	A	A	Premium	I would not choose either of these options
Freshness	Low	High	Moderate	
Chilled versus frozen	Yes	No	Yes	
Free of antibiotics	No	Yes	Yes	
Free of GMO	No	Yes	Yes	
County of Origin	Other	US	Korea	
I would choose…	☐	☐	☐	☐

[a]Exchange rate between US dollar and Korean won: $1 = 1,000 won.

Figure 1. An Example of Choice Set Used in Choice Experiment

report that about 75% of U.S. grocery shoppers are female in their surveys. The age distribution of our sample is close to the two previously mentioned surveys of Korean grocery shoppers. The household income distribution of our sample is similar to the census data although our sample contains somewhat fewer people in the less than $24,000 group, but more people in the $24,001 to $60,000 group. Overall, our sample appears representative of the Korean grocery shoppers.

In addition to choice questions (illustrated in Table 1 and Figure 1), perception and attitude questions were also included for latent segmentation in each survey. The questions focused on shopper perceptions of beef attributes such as price, marbling, freshness, the use of GMO-free feed ingredients, the use of antibiotics, and Korean beef, and shopper attitudes on packaged beef over butcher-shop beef and cooking at home. The 3-point scale responses were recorded for each question, and the percent of respondents for each scale is reported in Table 3. For example, 66% of respondents strongly agreed when they were asked if price was an important decision factor when purchasing beef. When similar questions were asked about antibiotics-free and domestic (Korean) beef, approximately 62% and 85% of respondents, respectively, strongly suggested that those attributes were important factors for their purchasing decision. Only 27% of respondents

Table 2. Comparisons of Demographic Characteristics of Current Survey with Previous Surveys and Korean Census Data (%)

		Previous Surveys		
Demographics	Current Survey	Park, Jung, and Kim (2007)	Rho, Han, and Chung (2007)	Korean Census Bureau 2007 Data[a]
Age				
20s	5.4	5.0	9.4	13.6 (18.0)
30s	13.3	28.0	13.2	16.6 (22.0)
40s	28.5	38.0	25.2	17.5 (23.2)
50s	34.9	22.0	35.0	14.0 (18.6)
60 and older	17.9	7.0	17.0	13.7 (18.2)
Gender				
Male	15.6	20.7	27.1	50.1
Female	84.4	79.3	72.9	49.9
Income				
Less than $24,000	33.3		13.5	47.2
$24,001 to $60,000	54.1		54.5	39.2
$60,001 to $96,000	7.3		21.1	8.0
More than $96,000	5.3		10.9	5.6

[a] Korean Census Bureau (2010); for the purpose of comparison, an age distribution was estimated without under 20 years of age and reported in parentheses.

Table 3. Perception/Attitude Questions and Percent of Respondents for Each Level

How Strongly Do you Agree or Disagree with the Following Statements on Each of Product Attributes and your Attitudes when you Purchase Beef? Please Circle the Number you Would Like to Choose for Each Question.						
	Strongly Agree	%	Moderately Agree	%	Strongly Disagree	%
Questions A–F: . . . . . is an important decision factor when purchasing beef.	1	66.0	2	28.5	3	5.5
A. Price						
B. Marbling	1	75.3	2	19.7	3	5.0
C. Freshness	1	94.5	2	3.0	3	2.5
D. GMO - Free	1	63.2	2	26.4	3	10.4
E. Antibiotics - Free	1	61.6	2	28.3	3	10.1
F. Domestic (Korean) Beef	1	84.8	2	13.1	3	2.1
Question G: I prefer packaged beef over beef from butcher-shop.	1	48.4	2	17.5	3	34.1
Question H: I enjoy cooking at home.	1	27.1	2	43.9	3	29.0

strongly agreed that they enjoyed cooking at home

Identifying a Group's Willingness-to-Pay for Beef Attributes

Identifying a group of individuals that share common traits or attitudes is the primary objective of latent segmentation modeling. This type of modeling has been used quite extensively in the literature of marketing (Kamakura, Wedel, and Agrawal, 1994; Ramaswamy and Cohen, 2007; Wedel and Kamakura, 2000), environmental economics (Hynes, Hanley, and Scarpa, 2008; Morey, Thacher, and Breffle, 2006; Patunru, Braden, and Chattopadhyay, 2007; Scarpa and Thiene, 2005), and agricultural and food economics (Pouta et al., 2010; Rigby and Burton, 2005; Ruto, Garrod, and Scarpa, 2008). Identifying common traits of mutually exclusive groups of consumers has been the focus of many marketing studies (see Wedel and Kamakura, 2000 for a review). In general, these studies state that identifying groups of consumers or grocery shoppers assists firms in making better decisions regarding advertising, marketing, pricing, product development, and other factors.

Latent segmentation modeling is used in this study to identify groups because it does not require *a priori* knowledge of the elements of heterogeneity within the data (Boxall and Adamowicz, 2002). Moreover, these models can be estimated jointly with the results from a conjoint analysis in a utility framework (Boxall and Adamowicz, 2002; Kamakura, Wedel, and Agrawal, 1994; Ramaswamy and Cohen, 2007). However, as argued by Patunru, Braden, and Chattopadhyay (2007), estimating segment membership jointly with utility introduces potential endogeneity. Therefore, Patunru, Braden, and Chattopadhyay (2007) identify segments first, and then estimate the utility for each segment. As stated by Patunru, Braden, and Chattopadhyay (2007), this two step approach is consistent with most surveys, where survey participant first answers attitudinal and perception questions, then makes choices for conjoint experiments.

Following the approach taken by Patunru, Braden, and Chattopadhyay (2007), which is similar to the approach of Morey, Thacher, and Breffle (2006), the procedure followed in this study involves three steps. First, latent segments or groups are identified based on their perceptions and attitudes toward beef. After the groups are identified, the second step identifies each individual's preference for beef via a random utility model that is conditional on the individual belonging to a particular latent group. Finally, utility model estimates are used to derive each group's WTP for a particular beef attribute.

Latent Segmentation Model

The primary objective of our latent segmentation model is to identify groups of Korean grocery shoppers that are similar across a set of responses to the beef attitudinal questions detailed in Table 3. It is assumed that in the Korean population there are X number of latent grocery shopper groups, and each group shares similar beef attitudes, as measured by y_i a vector of responses from i individuals, and observable characteristics known as covariates such as age and gender, measured by a vector z_i. Because these two vectors are observable, they are the first probability to be estimated in the latent segmentation model, $\Pr(y_i{:}z_i)$. That is, what is the unconditional probability that an individual with covariates z_i shares a response pattern y_i.

$\Pr(y_i{:}z_i)$ is a function of the probability that individual i in group x answers level m to attitudinal question q. This probability, denoted $\pi_{qm|x}$, is the foundation to the latent segmentation model because it represents the probability that response patterns to the attitudinal questions are similar in a given grocery shopper group, which is the primary objective of our study. To identify this similarity, an indicator variable is introduced. Let δ_{iqm} equal one if individual i's answer to question q is level m and zero otherwise.

This model, as any latent segmentation model, assumes that attitudinal responses are independent because group membership is controlled. To control for group membership, the $\Pr(y_i{:}z_i)$ is estimated via a set of weighted multinomial logit models. Weights are determined by the probability of belonging to a particular X latent group, $\Pr(x{:}z_i)$. More formally, the latent segmentation model is presented as,

$$\Pr(y_i{:}z_i) = \sum_{x=1}^{X} \Pr(x{:}z_i) \prod_{q=1}^{Q} \prod_{m=1}^{M} (\pi_{qm|x})^{\delta_{iqm}}. \tag{1}$$

The objective of our latent segmentation model is to identify Korean grocery shoppers that share similar beef attitudinal responses. This is accomplished by searching for the $(\pi_{qm|x})$ and $\Pr(x{:}z_i)$ that maximize the log likelihood function,

$$\ln L = \sum_{i=1}^{N} \ln[\Pr(y_i{:}z_i)] = \sum_{i=1}^{N} \ln\left[\sum_{x=1}^{X} \Pr(x{:}z_i) \prod_{q=1}^{Q} \prod_{m=1}^{M} (\pi_{qm|x.})^{\delta_{iqm}}\right], \text{ subject to} \tag{2}$$
$$\sum_{m=1}^{M} \pi_{qm|x} = 1 \text{ and } \sum_{x=1}^{X} \Pr(x{:}z_i) = 1.$$

Maximizing Equation (2) relative to $\pi_{qm|x}$ yields:

$$\pi_{qm|x} = \frac{\sum_{i=1}^{N} \Pr(x{:}z_i|y_i)\delta_{iqm}}{\sum_{i=1}^{N} \Pr(x{:}z_i|y_i)}. \tag{3}$$

Equation (3) represents the probability that an individual in latent group x answers level m to question q.

Next, maximizing Equation (2) relative to $\Pr(x{:}z_i)$ yields:

$$\Pr(x{:}z_i) = \frac{1}{N_{z_i}} \sum_{i=1}^{N_{z_i}} \Pr(x{:}z_i|y_i). \tag{4}$$

In Equation (4), N_{z_i} represents the number of individuals in the population that have the same characteristics as individual i. Therefore, Equation (4) is the average conditional membership probability for group x that shares similar characteristics and attitudes toward beef as individual i. Note that if no covariates are used, then Equation (4) merely becomes, $\Pr(x) = \frac{1}{N} \sum_{i=1}^{N} \Pr(x|y_i)$.

Finally, following the Bayes' Theorem, the $\Pr(x{:}z_i|y_i)$ are defined as:

$$\Pr(x{:}z_i|y_i) = \frac{\Pr(x{:}z_i) \prod_{q=1}^{Q} \prod_{m=1}^{M} (\pi_{qm|x})^{\delta_{iqm}}}{\Pr(y_i{:}z_i)}. \tag{5}$$

The log likelihood function is maximized by exploiting the advantages of two widely used algorithms, the expectation-maximization (EM) and the Newton-Raphson algorithm

(NR) (see Wedel and Kamakura, 2000 for detailed discussion on EM and NR). Initial parameter estimates begin with the EM algorithm and switch to the NR algorithm when either the maximum number of EM iterations (1,000) or further EM iterations result in minimal changes (smaller than 10^{-12}) in the log posterior. The NR algorithm further refines the parameter estimates until the maximum number of NR iterations (1,000) is reached or the overall convergence criterion is met.

Willingness-to-pay Within Latent Groups

After identifying the latent groups, a utility function is estimated for each Korean grocery shopper i choosing option j, conditional on membership in latent group x. More formally, the conditional logit model to be estimated is:

$$
\begin{aligned}
U_{ijx} = {} & \alpha_{1x} + \alpha_{2x}Price_{ijx} + \alpha_{3x}Marb1_{ijx} + \alpha_{4x}Marb2_{ijx} + \alpha_{5x}Marb3_{ijx} + \alpha_{6x}Marb4_{ijx} \\
& + \alpha_{7x}Fres1_{ijx} + \alpha_{8x}Fres2_{ijx} + \alpha_{9x}Chilled_{ijx} + \alpha_{10x}Antibiotics_{ijx} + \alpha_{11x}GMO_{ijx} \\
& + \alpha_{12x}Orig\_US_{ijx} + \alpha_{13x}Orig\_Other_{ijx} + \varepsilon_{ijx},
\end{aligned} \tag{6}
$$

where *Price* refers to the retail price of beef rib ($/lb). *Marb*1 to *Marb*4 are dummy variables that represent the grade of marbling: *Marb*1 = one if beef is extra premium grade, zero otherwise; *Marb*2 = one if beef is premium grade, zero otherwise; *Marb*3 = one if beef is grade A, zero otherwise; *Marb*4 = one if beef is grade B, zero otherwise. *Fres*1 and *Fres*2 are dummy variables that represent the extent of beef freshness with three different levels: *Fres*1 = one if beef is highly fresh, zero otherwise; *Fres*2 = one if beef is moderately fresh, zero otherwise. The dummy variable for the lowest freshness is used as a base. *Chilled*, *Antibiotics*, and *GMO* are dummy variables that represent the following: *Chilled* = one if beef is freshly chilled (instead of frozen), zero otherwise; *Antibiotics* = one if beef is produced without feeding antibiotics to cattle, zero otherwise; *GMO* = one if beef is produced without feeding GMO feed ingredients to cattle. Finally, three country-of-origin variables for beef are considered in this study: Korea, the United States, and other. *Orig_US* and *Orig_Other* are dummy variables that represent beef from the United States and other countries such as Australia, New Zealand, and Canada with Korean beef as a base: *Orig_US* = one if beef is imported from the United States, zero otherwise; *Orig_Other* = one if beef is imported from other countries (stated above), zero otherwise. The error term ε_{ijx} represents the stochastic portion of the utility.

Estimates from Equation (6) are used to derive the WTP_x or marginal value of a beef attribute conditional on membership in latent group x. The estimated coefficient for a given attribute is divided by the coefficient of the payment vehicle. For example, when α_{2x} is the estimated coefficient for the *Price* attribute, WTP_x for kth attribute is computed as:

$$WTP_x = -\alpha kx/\alpha 2x. \tag{7}$$

Testing for statistical significance for each WTP is done through bootstrapped WTP_x confidence intervals (Krinsky and Robb, 1986). Finally, WTP estimates are calculated for the entire population using probability of each group membership.

The first step in the latent segmentation analysis is to determine the appropriate number of groups. Estimates used for this purpose include Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC), Consistent Akaike Information Criterion (CAIC), and Entropy R^2 (ER^2). The information criteria are calculated as:

$$
\begin{aligned}
BIC &= -\ln L + \left(\frac{M \ln N}{2}\right), \\
AIC &= -2(\ln L - M), \\
CAIC &= -2\left[\ln L - \frac{M \ln(N+1)}{2}\right], \\
ER^2 &= 1 - \frac{\sum_{i=1}^{N}\sum_{x=1}^{K} -P\,(x{:}z_i)\ln[P(x{:}z_i)]}{N \ln K},
\end{aligned} \tag{8}
$$

where $\ln L$ is the log-likelihood value at convergence, M is the number of parameters, and

N is the sample size. Equation (8) indicates that *BIC, AIC*, and *CAIC* estimates are penalized as M and N increase while the best fitting model minimizes the information criteria. The best fitting model maximizes ER^2, close to 1, while ER^2 increases as N increases.

Empirical Results

Estimates used to determine the appropriate number of groups are presented in Table 4. The first step is to consider estimates for one to six groups without covariates. Inspecting estimates of information criteria, the conclusion was made that the model with three groups has the optimal fit because it shows the lowest estimates from *BIC* and *CAIC* and has the highest ER^2. The *AIC* statistic does not seem reliable here because it decreases continuously with the number of groups.

Next, the effect of including demographic covariates in determining the number of groups was examined. Dummy variables for age, income, gender, and education were generated following categories presented in Table 2 and used as covariates. Since the model fits best with the three groups when no covariate is considered, the three groups with covariates were considered. The *BIC*, *CAIC*, and ER^2 statistics indicate that the model without covariates fits better than the one with covariates. Therefore, the appropriate number of latent groups is three based on the model without covariates.

Table 5 presents response probabilities, $\pi_{qm|x}$ from Equation (3), of each group to perception and attitude questions for the three group case without covariates. While little variation across most of the attributes is found, two attributes/questions really describe the differences across the three groups. Respondents in the first group have a very high probability (99%) of strongly agreeing with the statement that "GMO-free" (question D) and "antibiotics-free" (question E) are important factors in their beef purchase decision. The second group shows probabilities of 83% and 87% of moderately agreeing with the same statements, and the last group shows probabilities of 99% and 96% of strongly disagreeing with the statement. Furthermore, the vast majority of individuals have a very high probability, greater than 90%, of belonging to the group that they are assigned to. Also, the lowest probability for an individual belonging to a particular group is well above 50%. The lowest probability in group one was 89%, group two was 72%, and group three was 65%.

Therefore, the groups are labeled based on their relative concern for the use of GMOs and antibiotics in beef production. Given the first group's strong agreement with "GMO-free" and "antibiotics-free" beef, the first group is labeled "very concerned" to reference their strong concern for the use of GMOs and antibiotics in beef production. The next group is labeled "moderately concerned", and the final group is labeled "not too concerned". Approximately 59%, 32%, and 9% of respondents belong to the VC, MC, and NC groups, respectively. With regards to other attributes, all three groups tend to strongly agree that marbling, freshness, and country-of-origin (domestic beef) are important decision factors when purchasing beef.

Random utility model estimates of parameters for each group are reported in Table 6. Estimates from all three models are statistically

Table 4. Information on Latent Segmentation Statistics

Number of Segments	Log Likelihood	BIC	AIC	CAIC	Entropy R^2	Number of Parameters
1	−5304.15	10716.64	10640.29	10811.83	N/A	16
2	−4870.92	9911.14	9791.84	10017.85	0.93	25
3	−4721.08	9672.42	9510.17	9793.04	0.95	34
4	−4705.83	9702.85	9497.66	9836.65	0.80	43
5	−4672.45	9697.04	9448.90	9852.99	0.87	52
6	−4662.75	9738.58	9447.49	9922.59	0.72	61
3 (with covariates)	−4701.33	9700.63	9490.67	9832.25	0.93	44

Table 5. Response Probabilities of Each Group to Perception/Attitude Questions, $\pi_{qm|x}$

Questions	Very Concerned	Moderately Concerned	Not Too Concerned
Question A. Price is an important decision factor when purchasing beef.			
Strongly agree	0.68	0.65	0.57
Moderately agree	0.26	0.32	0.34
Strongly disagree	0.06	0.03	0.09
Question B. Marbling is an important decision factor when purchasing beef.			
Strongly agree	0.82	0.70	0.47
Moderately agree	0.15	0.25	0.33
Strongly disagree	0.03	0.05	0.20
Question C. Freshness is an important decision factor when purchasing beef.			
Strongly agree	0.98	0.93	0.72
Moderately agree	0.01	0.05	0.06
Strongly disagree	0.01	0.02	0.22
Question D. "GMO-free" is an important decision factor when purchasing beef.			
Strongly agree	0.99	0.04	0.00
Moderately agree	0.01	0.83	0.01
Strongly disagree	0.00	0.13	0.99
Question E. "Antibiotics-free" is an important decision factor when purchasing beef.			
Strongly agree	0.99	0.09	0.00
Moderately agree	0.01	0.87	0.04
Strongly disagree	0.00	0.04	0.96
Question F. "Domestic (Korean) beef" is an important decision factor when purchasing beef.			
Strongly agree	0.91	0.77	0.72
Moderately agree	0.08	0.21	0.18
Strongly disagree	0.01	0.02	0.10
Question G. I prefer packaged beef over beef from butcher-shop.			
Strongly agree	0.52	0.40	0.56
Moderately agree	0.16	0.20	0.19
Strongly disagree	0.32	0.40	0.25
Question H. I enjoy cooking at home.			
Strongly agree	0.26	0.25	0.37
Moderately agree	0.42	0.50	0.40
Strongly disagree	0.32	0.25	0.23
Overall	0.59	0.32	0.09

The three groups, VC, MC, and NC, are labeled based on respondents' relative concern for the use of GMOs and antibiotics in beef production.

significant at the 5% level or better and have expected sign except *Marb*4 of the NC group. The coefficient of *Marb*4 of the NC group is statistically insignificant. ASC represents alternative specific constant. The negative signs of price coefficients indicate that the level of shoppers' utility decreases as the price of beef increases. The positive signs of marbling coefficients imply that Korean grocery shoppers have greater preferences for well-marbled beef. The regression results also indicate that Korean grocery shoppers prefer fresh, chilled (rather than frozen), antibiotic-free, and GMO-free beef. The negative signs of the parameter estimates for the country-of-origin suggest that Korean grocery shoppers value Korean beef more than imported beef, even if all controlled quality attributes are the same.

Table 6. Estimates of Beef Attribute Parameters from Random Utility Models

	Groups		
	Very Concerned	Moderately Concerned	Not too Concerned
ASC	−0.4012** (0.1080)	−0.8709** (0.1482)	−1.9193** (0.3103)
Price	−0.2628** (0.0422)	−0.5752** (0.0577)	−0.7112** (0.1239)
Marb1	0.7907** (0.0665)	0.9089** (0.0828)	0.6264** (0.1590)
Marb2	0.5596** (0.0679)	0.6021** (0.0855)	0.6641** (0.1580)
Marb3	0.5352** (0.0685)	0.5254** (0.0865)	0.4398** (0.1657)
Marb4	0.2418** (0.0703)	0.2243* (0.0895)	−0.0423 (0.1787)
Fres1	0.7727** (0.0511)	0.9735** (0.0652)	0.8093** (0.1255)
Fres2	0.2854** (0.0536)	0.4369** (0.0680)	0.3999** (0.1337)
Chilled	0.1654** (0.0408)	0.3062** (0.0517)	0.1696* (0.0999)
Antibiotics	1.1550** (0.0439)	0.6110** (0.0522)	0.5795** (0.1000)
GMO	1.14438** (0.0436)	0.5458** (0.0519)	0.4198** (0.1013)
Orig_US	−2.2027** (0.0589)	−2.1536** (0.0728)	−2.0263** (0.1393)
Orig_Other	−1.9041** (0.0534)	−1.9977** (0.0698)	−1.5576** (0.1223)
Likelihood ratio	5595.40	2528.80	495.72
Number of observations	512	280	81

Notes: Numbers in parentheses are standard errors. ASC, alternative specific constant.
* and ** denote statistical significance at the 5% and 1% level, respectively.

Based on estimates of coefficients reported in Table 6, the WTPs (the marginal values of attributes) are estimated by dividing the estimated coefficient for each attribute by the coefficient of *Price*. The corresponding confidence intervals are estimated using the Krinsky-Robb parametric bootstrapping procedure (Krinsky and Robb, 1986). Following this procedure, 1,000 observations were randomly drawn from multivariate normal distributions using estimates and variance-covariance matrices.

Table 7 presents WTP for each attribute and corresponding confidence interval. For all attributes, group VC tends to show the highest WTP while group NC shows the lowest WTP compared to the base levels. For example, group VC is willing to pay for *Marb*1 (extra premium) $3.01/lb more than Grade C, while group NC is willing to pay only $0.88/lb more for *Marb*1. WTPs for antibiotics-free and GMO-free beef are $4.39/lb and $4.35/lb respectively for group VC, while they are only $0.81/lb and $0.59/lb for group NC. Group VC also values Korean domestic beef the most, $8.38/lb and $7.25/lb more than U.S. and other imported beef, respectively, while group NC shows the lowest value for Korean beef: only $2.85/lb and $2.19/lb more than U.S. and other imported beef, respectively. Simple z-tests show that WTPs for each attribute are statistically different across groups.[3]

The estimates from the three models and the probability-weighted-mean estimates indicate that the most important factor determining grocery shoppers' WTP in the Korean beef market is country-of-origin, and the least important factor is chilled versus frozen. For example, based on estimates of probability-weighted-mean WTP, Korean grocery shoppers are willing to pay $6.39 and $5.57 more for Korean-origin domestic beef compared with the U.S. and other imported beef, respectively while the WTP for chilled versus frozen beef is only $0.56. The 95% confidence intervals show that all WTP estimates are statistically significant at the 5% level except *Marb*4 and *Chilled* for group NC.

Conclusions and Implications

A latent segmentation modeling approach is used in this study to identify groups of grocery shoppers with similar WTP estimates for beef

[3] The z-tests were conducted because the normal distribution was assumed for the Krinsky-Robb parametric bootstrapping procedure.

Table 7. Willingness-to-Pay for Beef Attributes and Confidence Intervals ($/lb)

	Groups			
	Very Concerned	Moderately Concerned	Not too Concerned	Probability Weighted Mean
Marb1	3.01 [2.15, 4.52]	1.58 [1.21, 2.07]	0.88 [0.41, 1.55]	2.35 [1.68, 3.46]
Marb2	2.13 [1.45, 3.24]	1.05 [0.72, 1.43]	0.93 [0.47, 1.61]	1.67 [1.13, 2.52]
Marb3	2.04 [1.36, 3.09]	0.91 [0.60, 1.28]	0.62 [0.17, 1.19]	1.55 [1.01, 2.34]
Marb4	0.92 [0.36, 1.59]	0.39 [0.08, 0.70]	−0.06 [−0.06, 0.43]	0.66 [0.23, 1.20]
Fres1	2.94 [2.19, 4.30]	1.69 [1.36, 2.16]	1.14 [0.72, 1.84]	2.37 [1.79, 3.39]
Fres2	1.09 [0.65, 1.76]	0.76 [0.51, 1.05]	0.56 [0.21, 1.04]	0.93 [0.56, 1.47]
Chilled	0.63 [0.29, 1.07]	0.53 [0.34, 0.75]	0.24 [−0.03, 0.57]	0.56 [0.27, 0.92]
Antibiotics	4.39 [3.34, 6.40]	1.06 [0.82, 1.37]	0.81 [0.50, 1.33]	3.00 [2.27, 4.33]
GMO	4.35 [3.35, 6.24]	0.95 [0.74, 1.23]	0.59 [0.31, 1.02]	2.92 [2.24, 4.16]
Orig_US	−8.38 [−12.31, −6.38]	−3.74 [−4.70, −3.07]	−2.85 [−4.40, −2.05]	−6.39 [−9.16, −4.92]
Orig_Other	−7.25 [−10.53, −5.57]	−3.47 [−4.32, −2.90]	−2.19 [−3.37, −1.60]	−5.57 [−7.89, −4.35]

Bracketed terms contain the 95% confidence intervals estimated by the Krinsky-Robb bootstrap technique.

quality attributes in the Korean beef market. This approach first identifies a set of Korean grocery shoppers who are homogenous in their preferences for beef and then estimates each preference groups' WTPs for beef.

Latent segmentation statistics suggest that the major sources of heterogeneity among survey respondents are grocery shoppers' concern about the use of antibiotics and GMO feed ingredients in beef production, and the analysis of heterogeneity results in three groups: very concerned, moderately concerned, and not too concerned. The WTP estimates for each group indicate that the very concerned group not only values antibiotics-free and GMO-free beef production the most but also values other attributes such as marbling, freshness, chilled versus frozen, and domestic production the most among the three groups. The WTP estimates from all three groups also suggest that the most important factor in determining Korean grocery shoppers' WTP is country-of-origin, while the least important factor is chilled versus frozen.

U.S. beef producers face a significant challenge in regaining share of the Korean beef market. One of the biggest challenges is the Korean consumers' strong preference for Korean raised beef or ethnocentrism for Korean products. The Korean grocery shoppers in this study preferred and greatly valued Korean raised beef, which is consistent with many previous studies in the literature (Chung, Han, and Boyer, 2009; Mennecke et al., 2006; Umberger et al., 2002; Verlegh and Steenkamp, 1999). In fact, many Korean commodity groups are tailoring advertising and promotional campaigns to leverage Korean consumers' high ethnocentrism. For example in 2007, the Korean beef checkoff program spent approximately 80% of their $12.3 million budget on advertising and promotion programs (Rho, Han, and Chung, 2007), which were heavily based on ethnocentrism.[4] This

[4] One of the survey questions posed to Korean beef consumers in Rho, Han, and Chung (2007) was: "Why do you purchase Korean beef even if it is almost three times more expensive than imported beef?" Rho, Han, and Chung (2007) report that the most popular answer (35%) is that they purchase the Korean beef because it is "Made-in-Korea."

study's empirical finding suggests that if U.S. beef producers are to increase sales and recover their market share in the Korean market, they must counter Korean consumers' strong ethnocentrism by improving the value of their country-of-origin. That is, the U.S. beef producers must create consumer loyalty to "Made in U.S.A." through various promotion and advertising programs.

Another important finding in this study, which may help boost Korean consumer loyalty to U.S. raised beef, is that using antibiotics and GMO feed ingredients in beef production are two major factors that segment Korean grocery shoppers into definable groups. The very concerned group about the use of antibiotics and GMO feed ingredients in beef production values each one of the attributes the most while the not too concerned group values them the least. U.S. beef exporters could use this finding for a future promotion strategy in the Korean market.

For this promotional strategy to work, it is paramount to focus on the Korean grocery shoppers' current perception on domestic and imported beef. Rho, Han, and Chung (2007) show that many Koreans believe Korean beef is superior to U.S. beef particularly in food safety, which includes the use of antibiotics and GMO feed ingredients. In fact, survey respondents in Rho, Han, and Chung's study believed that Korean beef producers use less antibiotics and GMO feed ingredients than U.S. producers. To increase U.S. market share in the Korean beef market, future work and promotional strategies should focus on whether or not these concerns are indeed true, and ways to alleviate these concerns.

[Received April 2011; Accepted March 2012.]

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