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European Preferences for Beef Steak Attributes

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A choice experiment is used to evaluate how consumers in London, Frankfurt, and Paris value beef steaks with attributes such as: "hormone-free," "GM-free," farm-specific source verification, and domestic origin. The effect of various consumer characteristics on steak selection is also evaluated. Results suggest that European consumers are significantly heterogeneous in their preferences for beef steak attributes. French and German consumers have a higher willingness to pay to avoid genetically modified feed use than British consumers, while German and British consumers would pay more for growth hormone-free beef. French and German consumers are willing to pay for farm-specific source verification.

Key words: beef, choice experiment, country of origin, genetically modified, hormones, preference heterogeneity, random parameters, source verification

Introduction

On January 1, 1989, the European Union (EU) banned imports of meat derived from animals treated with growth-promoting hormones. While the ban is based on the premise that hormone use poses a health risk for consumers, numerous scientific studies have concluded hormones pose no public health risk. Most slaughtered cattle in the United States are administered growth-promoting hormones, and are therefore excluded from the European market. With its recent expansion to 25 member countries, the European Union has a population of over 454 million and gross domestic product of over $10 trillion (European Union website). Estimates of the cost to the U.S. beef industry of being shut out of this market range from $100 million to over $200 million per year (Ahearn, 2002).

Bureau, Marette, and Schiavina (1998) argue that, as a result of the ban on hormone-treated products, "consumers suffer from the absence of choice between hormone-free goods and cheaper goods" (p. 445). The magnitude and existence of loss to EU consumers and U.S. producers is difficult to determine without information on European preferences for beef produced with or without the use of growth hormones. Normally, such preferences are revealed by market prices, but that is not feasible while the ban is in effect. Researchers have therefore resorted to other means of determining those preferences, including laboratory experiments (Alfnes and Rickertsen, 2003) and contingent valuation surveys (Alfnes, 2004; Lusk, Roosen, and Fox, 2003; Roosen, Lusk, and Fox, 2003).

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A better evaluation of EU consumer preferences for beef production methods would benefit policy makers negotiating trade relations, associations developing global markets for beef, and producers affected by the EU ban or investigating potential niche markets or investing in traceability systems targeting EU consumers. In this study a choice experiment is used to estimate how much consumers in three European countries are willing to pay (WTP) to avoid or obtain certain beef attributes. Specifically, we evaluate how EU consumers value beef steaks from animals administered growth hormones, from animals fed genetically modified feeds, with farm-specific source verification, and of U.S. origin relative to their typical, domestically produced steak products.

Previous Research

Several studies have investigated what consumers are willing to pay to avoid/obtain various food attributes (McCluskey et al., 2003; Grannis and Thilmany, 2002; Misra, Grotegut, and Clem, 1997; Misra, Huang, and Ott, 1991; Roosen, Lusk, and Fox, 2003; Burton et al., 2001; Lusk, Roosen, and Fox, 2003; Roosen, 2003; Alfnes, 2004). Most of these studies evaluate preferences using data from surveys that include hypothetical valuation scenarios. In general, hypothetical values are less appealing than those generated in situations involving real monetary commitments. Evidence suggests that experiments featuring actual products and monetary exchanges more accurately reveal true valuations for products (Lusk and Schroeder, 2004; Cummings, Harrison, and Rutström, 1995; List and Shogren, 1998).

Recent work by Alfnes (2004), Alfnes and Rickertsen (2003), and Lusk, Roosen, and Fox (2003) investigates European consumer preferences for beef product attributes. Alfnes (2004), using data from over 1,000 household interviews, found that the average Norwegian consumer prefers domestic to imported beef, beef from Sweden over beef from Ireland, Botswana, or the United States, and beef produced without the use of growth hormones.

In a non-hypothetical experimental auction, Alfnes and Rickertsen (2003) evaluated Norwegian consumer WTP for Irish, Norwegian, U.S. hormone-free, and U.S. hormone-treated beef. Participants were provided with one beef product and allowed to bid for the right to exchange it for an alternative product. Over one-half of the 106 participants were willing to pay at least as much for U.S. hormone-free beef as for Irish beef, and nearly one-third were willing to pay at least as much for U.S. hormone-free beef as for domestic (Norwegian) beef. About one-quarter of participants bid zero for U.S. hormone-treated beef; however, 28% preferred U.S. hormone-treated product to U.S. hormone-free. These findings suggest that preferences are highly heterogeneous and that both U.S. hormone-free and hormone-treated beef may have market potential within Norway.[1]

Lusk, Roosen, and Fox (2003) used data from a mail survey of consumers in the U.S., U.K., France, and Germany to estimate willingness to pay for beef produced without the use of growth hormones or genetically modified organisms. Consumers in all four countries were willing to pay premiums for hormone-free as well as GM-free beef. French consumers were most concerned with growth hormone use, while French, German, and

[1] The population of Norway is approximately 4.5 million, while the populations of the United Kingdom, Germany, and France are about 60, 83, and 59 million each, respectively. This is important to note because interest by the U.S. beef industry in European markets is likely to focus on the more populated nations than on smaller countries such as Norway.

British consumers were all willing to pay significantly more than American consumers for beef from cattle that had not been fed genetically modified corn.

This study uses a non-hypothetical choice experiment to estimate WTP for GM-free and growth hormone-free beef. Our sample, drawn from shoppers in London, Paris, and Frankfurt, represents a broader sample of EU consumers (approximately 202 million people) than that of Alfnes and Rickertsen (2003), and our choice experiment is designed to be less prone to hypothetical bias than, for example, the mail survey used by Lusk, Roosen, and Fox (2003). In addition, estimates are provided of consumer WTP for farm/ranch-specific source verification and country-of-origin attributes not offered by these prior studies.[2]

The Choice Experiment

Choice experiments simulate real-life purchasing situations, and thus are expected to provide more reliable willingness-to-pay estimates than hypothetical valuation questions. Furthermore, choice experiments permit multiple attributes to be evaluated, thereby allowing researchers to estimate tradeoffs between different alternatives (Lusk, Roosen, and Fox, 2003). In this choice experiment, consumers were presented with a set of 16 scenarios, each of which involved choosing a preferred alternative from five different beef steaks. The five steaks were labeled: (*a*) *USDA Choice*, (*b*) *USDA Choice No Hormones*, (*c*) *USDA Choice No Hormones or GMs*, (*d*) *Domestic Typical*, and (*e*) *Domestic Source Verified* (see table 1 for descriptions). More detailed information was provided to participants for the novel U.S. products relative to the domestic steaks.

A sizeable body of literature indicates EU consumers are acutely aware of domestic food production practices (e.g., Frewer et al., 2005; Gaskell et al., 1999; House et al., 2004; Frewer, Risvik, and Schifferstein, 2001). In addition, consumer knowledge and awareness of new product attributes may not have significant impacts on actual purchasing behavior or acceptance (Harrison, Boccaletti, and House, 2004; Hamstra, 1995). This underlying awareness of food production practices, and evidence questioning the effect of new product attribute knowledge on subsequent consumer behavior, suggests the approach taken in this study is reasonable. Given this approach, our study focuses on consumer perceptions of these novel products relative to beef they are very familiar with and accustomed to purchasing.

Steaks were offered at four different price levels selected to be consistent with local retail prices. The combination of five steaks and four price levels results in (4^5) 1,024 different choice sets. An orthogonal fractional design (Kuhfeld, Tobias, and Garratt, 1994) was used to select 15 scenarios in which steak prices are uncorrelated, and which allows for identification of own-price, cross-price, and alternative specific effects. To this design we added a 16th scenario in which the prices of all five steaks were equal.

Participants were informed they would purchase the steak they chose in one, randomly selected, scenario.[3] Maintaining the perception that the subjects were going

[2] See Dickinson and Bailey (2002) for a review of prior research on source verification.

[3] When the experiment was completed, however, it was explained to participants that we would be unable to actually sell them a steak because of the EU ban on hormone-treated beef. While misleading subjects in this instance is harmless, it is not ideal. Alfnes and Rickertsen (2003) dealt with a similar problem by labeling Irish beef as U.S. hormone-free beef. They noted, "... nobody questioned that we actually used U.S. hormone-free beef" (p. 398). None of our participants expressed discontent when informed they would not actually be purchasing a steak.

Table 1. Description of Ribeye Beef Steaks Used in Choice Experiment

Steak Name	Steak Description
USDA Choice	This steak was produced in the U.S. under typical U.S. production practices. This includes the probable use of growth hormones, antibiotics, and genetically modified feed. The label *USDA Choice* denotes that the U.S. Department of Agriculture (USDA) has inspected this steak and given its second highest quality grade. Typical U.S. production practices include approximately 95% of all fed cattle being administered added growth hormones during production. Animals that are administered growth hormones generally grow at faster rates and reach higher weights compared to animals which have not been administered growth hormones. Second, cattle are routinely administered antibiotics during feeding to reduce the chance of illness. Most cattle raised in the U.S. are fed genetically modified corn, as it is the most prevalent grain available to livestock feeders.
USDA Choice No Hormones	This steak was produced in the U.S. under typical U.S. production practices, but is guaranteed to not have been administered any synthetic growth hormones or antibiotics during production.
USDA Choice No Hormones or GMs	This steak is from an animal that was raised in the U.S. with NO added hormones, was NOT fed antibiotics, and was NOT fed genetically modified crops.
Domestic Typical[a]	This steak was produced under typical production conditions and regulations within this country. Beyond the fact that the steak has been inspected, no other guarantees about meat quality are provided.
Domestic Source Verified[a]	This steak is a typical steak that is produced in this country. The label identifies the production practices utilized in producing the product and names the actual farmer/feeder who raised the animal. Beyond the fact that the steak has passed government inspections, no other guarantees are given regarding the quality of the meat.

Note: All steaks were described as being equal in weight (0.35 kg or 12 oz.), packaging, and freshness. These descriptions and instruction sheets outlining the experiment were provided to participants prior to conducting the choice experiment.

[a]Additional details on the *Domestic Typical* and *Domestic Source Verified* steaks were not provided to participants because the experiments sought to evaluate how consumers would react based on presented information on the three U.S. steaks and existing perceptions of domestically produced steaks.

to actually purchase a steak was important because total willingness-to-pay estimates may be inflated if the consumer does not perceive that an actual exchange of money for goods will occur (Cummings, Harrison, and Rutström, 1995; Fox et al., 1998; List and Gallet, 2001; List and Shogren, 1998; Lusk and Schroeder, 2004). To familiarize subjects with the procedure, and to reinforce the perception that one scenario would be binding, subjects first participated in a choice experiment using candy bars. One of three scenarios was selected as binding, with the participant receiving the selected candy bar and paying the indicated price.

Data were collected in August 2002 from subjects at supermarkets in London, England; Frankfurt, Germany; and Paris, France. Potential participants were randomly selected as they walked by the research station and asked if they would participate in our study. Experiments were conducted by the lead author, with the aid of a translator, in a one-on-one research setting with individual participants. This format facilitated better understanding of the exercise (especially as compared to a mail survey in which interaction is nonexistent). Special care was taken to use the same procedures with each

Table 2. Demographic Variables and Summary Statistics of Choice Experiment Participants

Variable	London	Frankfurt	Paris	Overall
Number of Participants:				
1 = Male	53	41	33	127
2 = Female	68	24	29	121
Total Participants	121	65	62	248
Average Age (years)	38.4	33.4	33.4	35.9
Average No. of Individuals in Household	2.9	2.9	2.8	2.9
Educational Background (%):				
High School Diploma	36.4	36.9	19.0	32.2
Some College	38.0	13.9	23.8	28.1
Bachelor's or Master's Degree	23.1	24.6	46.1	29.3
Professional Degree	2.5	24.6	11.1	10.4
Household Income Level (%):				
Less than $30,000	44.2	42.1	50.8	45.1
$30,000 to $69,999	36.7	36.4	39.7	37.5
Over $70,000	19.1	21.5	9.5	17.4

Note: As pointed out by a reviewer, information on participant ethnicity/nationality was not collected. The three cities used in this analysis (especially London and Paris) could include consumers not native to that country, which could contribute to consumer heterogeneity observed.

participant, and the fact that the same person conducted all experiments limits the issue of interviewer and novelty effects.[4]

Experiments were conducted at several locations in each city to avoid having results dominated by localized biases. A total of 248 subjects (121 in London, 65 in Frankfurt, and 62 in Paris) participated (see table 2 for participant summary statistics). London subjects were paid 10 pounds (at the time, approximately $16 US), while Frankfurt and Paris participants were paid 20 euros (about $20 US) for the approximately 20 minutes it took to complete the experiment. Other than a relatively high level of education in the French sample, participants were representative of their respective national demographics (Eurostat, 2004).

Results and Analysis

Table 3 reports the percentage of participants choosing different steaks for six of the 16 scenarios, including the scenario (VI) in which all steaks had the same price. These six scenarios were selected to exemplify the types of responses across varying relative steak prices.[5] In scenarios I and II, 15% or fewer in each country chose the most expensive *USDA Choice* or *USDA Choice No Hormones* steaks. This suggests there is a relatively

[4] As with all experimental designs (e.g., mail surveys, interviews, etc.) potential for selectivity bias by both researchers and participants exists in this study. This research was conducted in a way so as to attempt to minimize biases as much as possible.

[5] In Scenarios I through V, each of the five steaks is, by turn, the most expensive in the scenario. Results from the other 10 scenarios are available from the authors upon request.

Table 3. Percentage of Participants Choosing Each Steak, in Six of Sixteen Scenarios

Steak Scenario	London	Frankfurt	Paris	Overall
	<---------- (%) ---------->			
Scenario I:				
▸ *USDA Choice* ($10.50)[a]	9.2	6.7	1.7	6.7
▸ *USDA Choice No Hormones* ($9.25)	9.2	10.0	6.7	8.8
▸ *USDA Choice No Hormones or GMs* ($9.25)	35.3	16.7	11.7	24.5
▸ *Domestic Typical* ($8.00)	15.1	18.3	13.3	15.5
▸ *Domestic Source Verified* ($6.75)	31.1	48.3	66.7	44.5
Scenario II:				
▸ *USDA Choice* ($6.75)	10.3	5.0	0.0	6.3
▸ *USDA Choice No Hormones* ($8.00)	11.1	15.0	3.3	10.2
▸ *USDA Choice No Hormones or GMs* ($6.75)	40.2	43.3	21.7	36.4
▸ *Domestic Typical* ($6.75)	11.1	6.7	8.3	9.3
▸ *Domestic Source Verified* ($6.75)	27.4	30.0	66.7	37.9
Scenario III:				
▸ *USDA Choice* ($9.25)	11.9	5.0	3.3	7.9
▸ *USDA Choice No Hormones* ($9.25)	14.4	21.7	5.0	14.0
▸ *USDA Choice No Hormones or GMs* ($10.50)	31.4	16.7	10.0	22.2
▸ *Domestic Typical* ($6.75)	19.5	26.7	23.3	22.3
▸ *Domestic Source Verified* ($8.00)	22.9	30.0	58.3	33.6
Scenario IV:				
▸ *USDA Choice* ($6.75)	14.4	14.8	6.7	12.6
▸ *USDA Choice No Hormones* ($9.25)	8.5	11.5	5.0	8.4
▸ *USDA Choice No Hormones or GMs* ($8.00)	43.2	45.9	28.3	40.2
▸ *Domestic Typical* ($10.50)	10.2	6.6	5.0	7.9
▸ *Domestic Source Verified* ($9.25)	23.7	21.3	55.0	30.9
Scenario V:				
▸ *USDA Choice* ($8.00)	10.1	8.3	5.0	8.4
▸ *USDA Choice No Hormones* ($9.25)	10.9	11.7	3.3	9.2
▸ *USDA Choice No Hormones or GMs* ($6.75)	52.1	50.0	31.7	46.4
▸ *Domestic Typical* ($9.25)	14.3	13.3	20.0	15.5
▸ *Domestic Source Verified* ($10.50)	12.6	16.7	40.0	20.5
Scenario VI:				
▸ *USDA Choice* ($8.00)	8.5	1.7	1.7	5.0
▸ *USDA Choice No Hormones* ($8.00)	11.1	15.0	3.3	10.2
▸ *USDA Choice No Hormones or GMs* ($8.00)	41.0	46.7	21.7	37.7
▸ *Domestic Typical* ($8.00)	13.7	11.7	5.0	11.0
▸ *Domestic Source Verified* ($8.00)	25.6	25.0	68.3	36.1

[a] Amounts in parentheses are U.S. dollar equivalent prices per pound for each of the described 12-ounce steaks.

price-inelastic niche market for the *USDA Choice* (hormone-treated) product among a small number of London and Frankfurt respondents. Almost 10% of London respondents preferred *USDA Choice* when it was priced at a premium to the other steaks, with that share rising to just below 15% when it was priced at a relative discount in scenario IV. Alfnes and Rickertsen (2003) also found that some respondents chose hormone-treated over hormone-free beef. These results suggest some consumers have some familiarity with either the U.S. product or potential benefits (e.g., tenderness) associated with hormone treatment, and thus preference heterogeneity exists.

Comparing market shares of the three U.S. products reveals the strength of preference for hormone-free and GM-free attributes. For example, at equal prices (scenario VI), only 1.7% of German and French respondents chose *USDA Choice*, whereas the hormone-free and GM-free *USDA Choice* product was chosen by 46.7% of German and 41% of British participants. In scenario III, in which its price was the highest, *USDA Choice No Hormones or GMs* steak was preferred by over 30% of English consumers and over 20% of participants across all three countries combined.

Scenario V demonstrates one of our more striking results—the popularity of the *Domestic Source Verified* steak among French participants. Domestic source verified beef was preferred by 40% of French consumers even though it was at least $1.25 per pound more expensive than any of the other steaks; the corresponding shares among English and German consumers were only 13% and 17%, respectively. At equal prices (scenario VI), almost 70% of French respondents chose *Domestic Source Verified*, and in only two of the 16 scenarios was this steak chosen by fewer than 50% of French participants. Comparing responses across the three markets also reveals that the combined demand for typical and source-verified domestic product was always highest among French respondents, with U.S. products faring relatively better among U.K. and German respondents.

A somewhat surprising result is that at equal prices, fewer than 14% of participants in each country chose the *Domestic Typical* steak, with a similar percentage of respondents choosing the *USDA Choice No Hormones* product. Perhaps some of these consumers are not aware that their domestic product is produced without use of hormones (i.e., they reacted to the "no hormones" character of the U.S. product), or they have a preference for U.S. Choice product, all else equal. Our description of the *Domestic Typical* steak did not explicitly mention the hormone issue, and we did not question respondents about it because we wanted them to make choices based on their own perceptions of beef they typically consume relative to alternative steaks not currently available to them. Packaged beef products in Europe typically do not mention that the product is produced without hormones and, compared to the United States, a greater share of beef products are not prepackaged. We expect most European beef consumers are aware of the hormone ban, but the extent to which they believe this ban is adhered to could be one explanation for discounting the *Domestic Typical* product.[6] It is also possible that concerns about BSE in European beef play a role in these choices, because, at the time this study was conducted, BSE had not been discovered in the U.S.[7]

Logit and WTP Analysis

A random parameters logit (RPL) model (also referred to as a mixed logit) was used to determine consumer willingness to pay for the various steaks relative to one

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[6] Incorporating an explicit reminder about the "hormone-free" status of European beef would have made for an interesting additional treatment, but that was beyond the intended scope of this project. The assumption that consumers are reasonably knowledgeable of such bans and food production practices is validated by numerous studies (e.g., Frewer et al., 2005; Gaskell et al., 1999; House et al., 2004; Frewer, Risvik, and Schifferstein, 2001). Whether this assumption affects our conclusions is hard to assess, but the impact should be relatively small given documented consumer concern and awareness of domestic food product attributes.

[7] Because of uncertainty about respondents' perceptions regarding the hormone status of domestic beef, and other factors such as BSE that could impact the choice between beef steaks of different origins, our analysis primarily focuses on comparisons between products from the same origin (e.g., *Domestic Typical* vs. *Domestic Source Verified*), and between consumers in the different locations (i.e., Paris vs. Frankfurt vs. London).

another.[8] The RPL model allows for random taste variation within the surveyed population, is free of the independence of irrelevant alternatives (IIA) assumption, and allows correlation in unobserved factors over time, thus eliminating three limitations of standard logit models (Train, 2003; Revelt and Train, 1998). Use of an RPL model rather than a standard multinomial logit model is warranted by the nature of our data. First, some of the five steaks used in our choice experiment are similar, possibly making the IIA assumption overly restrictive. Second, Lusk, Roosen, and Fox (2003); Alfnes and Rickertsen (2003); and Alfnes (2004) found that steak preferences among European consumers are heterogeneous. Consequently, employing a model that allows for and evaluates preference heterogeneity is appropriate.

Underlying the random parameters logit model is the consumer's random utility (U), in which the utility of steak j for individual i in choice situation t is described by:

$$U_{ijt} = V_{ijt} + [\upsilon_{ij} + \varepsilon_{ijt}], \tag{1}$$

where V_{ijt} is the systematic portion of the utility function, υ_{ij} is an error term distributed normally over individuals and alternatives (but not choice situations), and ε_{ijt} is the stochastic error component independently and identically distributed extreme value over all individuals, alternatives, and choice situations. As noted by Alfnes (2004), this describes a panel data model where the cross-sectional element is individual i and the time-series component is the t choice situations. The probability of subject i choosing steak j in choice situation t is given by:

$$P(U_{ijt} \geq U_{ikt}) \tag{2}$$

for all possible k steak alternatives. Following Alfnes (2004) and assuming V_{ijt} is linear in parameters, the utility function can be expressed as:

$$U_{ijt} = B_j + \alpha * price_{jt} + \gamma_j' * \mathbf{demo}_i + [\upsilon_{ij} + \varepsilon_{ijt}], \tag{3}$$

where B_j is an alternative-specific constant for steak j, $price_{jt}$ is the price of steak j in choice situation t, and $\mathbf{demo}_i$ is a vector of demographic variables for subject i.[9] In this context, υ_{ij} is freely correlated between the steak alternatives and perfectly correlated across the selections made by a given individual i. Following Alfnes, this decomposed error structure is imposed by employing the panel data specification in LIMDEP (Greene, 2002). Furthermore, it is important to note this model differs from the standard multinomial logit in that the multinomial logit model would not contain the υ_{ij} term. In the context of our study, failing to properly decompose the error structure would yield a misspecified model because the perfect correlation of the demographic variables for a given i would cause the i.i.d. assumption of standard logit models to be violated.[10]

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[8] For a comprehensive review of the RPL model, see the recent article in this *Journal* by Nahuelhual, Loureiro, and Loomis (2004).

[9] Age, education, income, and gender are the variables included in $\mathbf{demo}_i$. *Age* is the participant's age, and *Education* and *Income* each increase by one for every increase in education level or $10,000 equivalent increase in annual income, respectively. *Gender* is equal to one for females and zero otherwise. The survey instrument and choice experiment are available from the authors upon request.

[10] Lusk, Roosen, and Fox (2003) and Alfnes and Rickertsen (2003) fail to make this distinction. As such, the conclusions proposed in these studies should be tempered, as the effect of misspecification in their underlying models is hard to evaluate.

Following Lusk, Roosen, and Fox (2003) and Revelt and Train (1998), models were estimated with the steak alternative-specific constant (B_j) allowed to vary randomly and with the price coefficient (α) fixed to prevent it from varying within each population.[11] Here, the "population" refers either to the sample of London, Frankfurt, or Paris participants. Not allowing the price coefficient to vary randomly ensures a negative price coefficient for all respondents. It also ensures that willingness-to-pay estimates for a particular steak are normally distributed. Furthermore, the steak alternative-specific constant for steak j is given by $B_j = \overline{B}_j + \sigma_j * \mathbf{u}_{ij}$, where $\overline{B}_j$ is the mean estimate across all i for a given country population, σ_j is a diagonal matrix containing the coefficient standard errors, and $\mathbf{u}_{ij}$ is a vector of independent normal deviations for each individual i within that country population.

The Gumbel distribution used in logit models is characterized by a "location" parameter and a "scale" factor. This scale factor is inversely related to the variance of the model, but is not identifiable and is often arbitrarily set to one. Scaling allows parameter estimates in logit models across countries (equations) to be compared. While the actual scale factor cannot be identified, relative scale parameters across groups can be found. Following Swait and Louviere (1993) and Lusk, Roosen, and Fox (2003), the data for each country were scaled prior to estimating the model to allow for heterogeneity of preferences by consumers in each country.[12]

The value subjects place on the various attributes differentiating the five steaks can be determined using model estimates.[13] Total willingness to pay for a given steak, relative to the steak omitted from the model, is given by the negative ratio of the steak alternative-specific constant to the price coefficient (i.e., $-B_j/\alpha$).[14] If the standard deviations ($\mathbf{u}_{ij}$) of the steak alternative constants are not statistically different from zero, the average WTP estimate is representative for the entire consumer group under question and the random parameters logit effectively reverts to the standard multinomial logit. However, if standard deviations of steak alternative constants are statistically significant, evidence persists that preference heterogeneity exists among the participants, and average WTP estimates cannot be interpreted as being representative of the population. Additionally, marginal WTP estimates for one steak (steak j) versus another steak (steak k) are calculated by: $-B_j/\alpha + B_k/\alpha$.[15]

To test if the estimated average WTP premiums are statistically different from zero, a Krinsky-Robb (1986) bootstrapping procedure was employed. More specifically, by utilizing the estimated parameter vector and covariance matrix, 1,000 WTP estimates were generated from 1,000 randomly drawn parameter vectors. Given these 1,000 WTP estimates, p-values associated with the one-tailed test that the WTP estimates are greater than zero are calculated.

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[11] Following Lusk, Roosen, and Fox (2003), random parameters are assumed to be drawn from a normal distribution, providing the model flexibility to allow both positive and negative WTP estimates.

[12] London was set as the reference group, so it was scaled by 1.0. The independent variables in the Frankfurt and Paris data were multiplied by candidate values of scale factors. A grid search was then conducted to find the relative scale factors that maximized an appropriate log-likelihood function. The resulting scale factors were 1.06 and 1.41, respectively, for Frankfurt and Paris.

[13] In the random parameters logit model, even with scaled data, the parameter estimates themselves cannot be compared, but ratios (such as WTP estimates) can, as the ratio offsets the effect of scaling the data (Revelt and Train, 1998).

[14] Note that one of the alternatives must be omitted to avoid perfect multicollinearity.

[15] Marginal willingness-to-pay estimates were calculated with the income effect being held at zero.

Random Parameters Logit Results

The random parameters logit model results are presented in table 4. Marginal willingness-to-pay estimates were also calculated for each of the three consumer groups for the various steaks (table 5). To identify steak preference, the steaks can be ranked using the parameter estimates, where the most preferred steak has the most positive estimate and the least preferred steak has the least positive estimate. As expected, a negative relationship exists between the price of each steak and the utility consumers obtain from consuming that steak.

Average consumer willingness to pay for *hormone-free* steak was estimated as described previously by utilizing the ratios of the coefficient on the steak labeled *USDA Choice No Hormones* and the price coefficient. This ratio is compared to zero, as the omitted steak was labeled *USDA Choice*. Therefore, the only difference between the two steaks was the labeled use of growth hormones in production. The estimated premiums for the steak having no hormones used in production were \$7.13/lb., \$8.27/lb., and \$1.01/lb., respectively, for London, Frankfurt, and Paris consumers (table 5). However, *p*-values from the Krinsky-Robb bootstrapping procedure indicate that the premium for French consumers is not statistically different from zero, and for German consumers estimated WTP is significant at the 90% confidence level.

The "*hormone-free*" premium can be interpreted as the amount of money that would make the representative consumer in each country indifferent between the two steaks. Our estimates are similar (with the exception of French consumers) to those of Lusk, Roosen, and Fox (2003) who surveyed consumers by mail and used a random parameters logit model to estimate premiums for *hormone-free* steak of \$7.39/lb., \$7.29/lb., and \$9.94/lb. for the United Kingdom, Germany, and France, respectively. Alfnes and Rickertsen (2003) used second-price auctions in a study of Norwegian consumers and found consumer willingness to pay for *hormone-free* steak of only \$1.39/lb. Both our study and Alfnes and Rickertsen (2003) use less hypothetical approaches in design in which consumers anticipated an actual exchange of money for goods. However, our study and Lusk, Roosen, and Fox (2003) differ from Alfnes and Rickertsen in that *hormone-free* premiums were estimated from random parameters logit models important in dealing with the heterogeneous preferences found for the *hormone-free* attribute.

Participants' willingness to pay for *GM-free* steak was estimated by using revealed preferences for the *USDA Choice No Hormones or GMs* and *USDA Choice No Hormones* steaks. Average willingness-to-pay estimates were \$2.64/lb., \$4.25/lb., and \$2.27/lb. for Paris, Frankfurt, and London consumers, respectively (table 5). However, only the premium estimated for Paris consumers is statistically different from zero at the 0.05 level, with the Frankfurt premium marginally significant at the 0.11 level. These estimates contrast those of Lusk, Roosen, and Fox (2003) for *GM-free* steak where statistically significant WTP estimates of \$9.32/lb., \$7.67/lb., and \$6.31/lb. were present for consumers in France, Germany, and the United Kingdom, respectively. Participants in our study have heterogeneous preferences for the *GM-free* trait, which differs from Lusk, Roosen, and Fox who could not reject homogeneity for this attribute. This may offer one additional explanation as to why Lusk, Roosen, and Fox found statistically significant WTP premiums for each country whereas we observed only one statistically significant WTP premium.

Table 4. Parameter Estimates from Random Parameters Logit (RPL) Models

	London RPL		Frankfurt RPL		Paris RPL	
Variable	Coefficient	*p*-Value	Coefficient	*p*-Value	Coefficient	*p*-Value
STK2 Constant[a]	2.228	0.032	5.587	0.086	0.614	0.399
STK3 Constant	2.926	0.056	8.459	0.097	2.219	0.083
STK4 Constant	3.578	0.064	5.936	0.130	5.847	0.026
STK5 Constant	5.090	0.031	6.931	0.091	9.348	0.000
PRICE	-0.311	0.010	-0.675	0.000	-0.609	0.000
STK1×AGE[b]	-0.067	0.031	0.007	0.721	0.044	0.172
STK1×EDU	-0.385	0.039	0.761	0.084	-0.344	0.093
STK1×INCOME	-0.734	0.025	-0.042	0.908	0.098	0.368
STK1×GENDER	-1.101	0.137	1.716	0.456	-0.175	0.053
STK2×AGE	-0.024	0.175	-0.025	0.368	-0.038	0.378
STK2×EDU	-0.298	0.053	0.365	0.129	-0.268	0.143
STK2×INCOME	-0.423	0.050	-0.044	0.179	-0.914	0.041
STK2×GENDER	-0.268	0.626	2.169	0.054	0.537	0.182
STK3×AGE	-0.012	0.275	-0.081	0.537	-0.014	0.203
STK3×EDU	-0.163	0.090	0.242	0.082	-0.365	0.007
STK3×INCOME	-0.086	0.429	-0.356	0.319	0.133	0.155
STK3×GENDER	1.146	0.027	2.171	0.059	0.914	0.014
STK4×AGE	-0.016	0.227	-0.037	0.095	-0.028	0.345
STK4×EDU	-0.277	0.053	0.344	0.161	-0.230	0.028
STK4×INCOME	-0.254	0.163	-0.164	0.092	-0.009	0.601
STK4×GENDER	0.767	0.068	1.617	0.035	-0.098	0.047
StdDev_STK2[c]	1.784	0.191	1.093	0.048	3.456	0.000
StdDev_STK3	6.669	0.094	4.326	0.015	5.803	0.000
StdDev_STK4	4.543	0.163	4.052	0.012	5.740	0.000
StdDev_STK5	8.155	0.087	6.295	0.069	7.229	0.000
Log Likelihood	-2,338		-722		-543	
R^2	0.18		0.49		0.63	

Note: Models were estimated using NLOGIT 3.0 with 500 replications for simulated probability using Halton draws.

[a] *STK2*, *STK3*, *STK4*, and *STK5* denote alternative specific constants for the *USDA Choice No Hormones*, *USDA Choice No Hormones or GMs*, *Domestic Typical*, and *Domestic Source Verified* steaks relative to the omitted *USDA Choice* steak.

[b] *AGE*, *EDU*, *INCOME*, and *GENDER* are the $\mathbf{demo}_{ij}$ variables as described in text equation (3) and further explained in footnote 9.

[c] $StdDev\_STK_i$ is the estimated standard deviation of the alternative specific constant for steak i relative to the omitted *USDA Choice* steak.

The premium consumers were willing to pay for steak labeled as *Domestic Typical* steak relative to steak labeled *USDA Choice No Hormones or GMs* was \$2.07/lb., -\$3.74/lb., and \$5.96/lb. for London, Frankfurt, and Paris, respectively (table 5). However, none of these premium estimates are statistically different from zero at the 0.05 level (the Paris estimate is marginally significant at the 0.11 level), implying there was no significant preference for one of these steaks relative to the other. Consistent with preferences for *hormone-free* and *GM-free* steak attributes, preference heterogeneity was present for German and French consumers.

Table 5. Willingness-to-Pay Estimates for Various Beef Steak Attributes

Steak Attribute		Willingness-to-Pay Estimate		
		London	Frankfurt	Paris
Hormone-Free:				
USDA Choice No Hormones vs.	Point Estimate	$7.13	$8.27	$1.01
USDA Choice	*p*-Value	0.02	0.09	0.21
GM-Free:				
USDA Choice No Hormones or GMs vs.	Point Estimate	$2.27	$4.25	$2.64
USDA Choice No Hormones	*p*-Value	0.30	0.11	0.02
Domestic Origin:				
Domestic Typical vs.	Point Estimate	$2.07	-$3.74	$5.96
USDA Choice No Hormones or GMs	*p*-Value	0.32	0.19	0.11
Source Verification:				
Domestic Source Verified vs.	Point Estimate	$4.88	$1.47	$5.75
Domestic Typical	*p*-Value	0.10	0.08	0.00

Notes: Prices are U.S. dollar per pound equivalent for steaks with the same freshness and packaging. The *p*-values correspond to the one-tailed test that the estimated WTP premium for each attribute is > 0; *p*-values were calculated using 1,000 repetitions of the Krinsky-Robb bootstrapping method.

Comparing the *Domestic Source Verified* steak to the *Domestic Typical* steak, a willingness to pay for source verification specific to the farm from which that animal was raised can be estimated, as this attribute is the only difference in how the two steaks were labeled and described. This premium is estimated to be $4.88/lb., $1.47/lb., and $5.75/lb. for London, Frankfurt, and Paris, respectively (table 5). All three WTP estimates were statistically different from zero at least at the 90% level of confidence.

In addition to generating point estimates of willingness to pay for steak attributes, the estimated model allows for determining the effect of age, education, income, and gender on steak preference. Nine of the 16 demographic variables were statistically significant (at the 90% confidence level) in the London model, and seven were statistically significant in each of the Frankfurt and Paris models (table 4). Across all three consumer groups, income, gender, and education had statistically significant impacts on the selection of the *USDA Choice No Hormones or GMs*, *Domestic Typical*, and *Domestic Source Verified* steaks.

Conclusion

Little research has evaluated how European consumers feel about the ban on beef produced using growth hormones or how these consumers may react if given the opportunity to purchase potentially cheaper beef from the United States. This study evaluated EU consumer preferences and the willingness of consumers to pay for various beef steaks using data collected from choice experiments conducted in one-on-one settings. Other recent studies on the subject have mailed surveys to consumers (Lusk, Roosen, and Fox, 2003), used second-price auctions (Alfnes and Rickertsen, 2003), or used in-home interviews (Alfnes, 2004) to evaluate EU consumer beef preferences. This study is designed to address questions regarding U.S. beef in Europe, as it was conducted at supermarkets in large European cities, where U.S. beef would most likely be available

for sale if EU legislation permitted.[16] Furthermore, this research is unique in the sense that willingness-to-pay estimates for GM-free, hormone-free, farm-specific source verification, and country-of-origin attributes are developed from the same sample of consumers, facilitating more reliable comparison of relative WTP premiums across consumer groups.

EU consumers have demonstrated heterogeneous preferences for beef produced without use of growth hormones, without the use of GM feed grains, produced domestically, and/or for farm-specific source verification. Consumer preferences are heterogeneous not only across nationality, but also within each country. This finding suggests that future studies should explicitly consider the extent to which consumer preferences vary. To the extent the U.S. beef industry could provide products meeting these assorted preferences and properly target them, market share of U.S. products would likely be enhanced.

Typical Paris and Frankfurt consumers are concerned about genetically modified feed usage, and London and Frankfurt consumers tend to be apprehensive about consumption of beef produced with the use of growth hormones. Many Paris and London consumers are willing to pay sizeable premiums for farm-specific source verification. In addition, consumer characteristics including income, gender, and education influence steak selection, and suggest demographic targeting would increase the likelihood of U.S. beef consumption in Europe. Furthermore, this evidence suggests that the European beef industry could also use selective demographic targeting to maintain or build its own market share among competing beef products. Results should be tempered by noting that BSE had not yet been discovered in the United States at the time our choice experiments were conducted. Results here would be an important baseline for studying the effect of that news. Comparing results here with what might be obtained from a new experimental study could produce interesting and valuable information.

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[16] It should be noted that under the Hilton quota, European consumers do have the ability to purchase a small amount of hormone-free beef from the United States.

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