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Consumer Preferences for Animal Welfare Attributes: The Case of Gestation Crates

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Animal welfare concerns are having dramatic impacts on food and livestock markets. Here we examine consumer preferences for pork products with a focus on use of gestation crates. We examine underlying consumer valuations of pork attributes while considering preference heterogeneity as well as voluntary and legislative alternatives in producing gestation crate-free pork. Our results suggest that prohibiting swine producers from using gestation crates fails to improve consumer welfare in the presence of a labeling scheme documenting voluntary disadoption of gestation crates. Consumers are found to implicitly associate animal welfare attributes with smaller farms. Preference heterogeneity drives notably diverse consumer welfare impacts when pork produced with use of gestation crates is no longer available for consumption.

Key Words: animal welfare, consumer welfare, economics of legislation, gestation crates, pork, swine, voluntary labeling, willingness to pay

JEL Classifications: Q11, Q13, Q18

There is increasing consumer interest in the production practices used in modern food production. Examples currently circulating throughout the meat industry include consumer interest to know whether and how antibiotics or growth hormones were used, whether the product was produced "locally" or "on family farms," and whether animals were handled in an "animal friendly manner." Although we are unaware of current standardized definitions of "animal friendly," "proper animal welfare," or related terms, throughout this article such phrases are used consistent with ongoing public discussions on the subject of how production practices impact the livelihood of farm animals. Given this lack of concrete definitions and the inherent range of public perceptions and knowledge on farm animal livelihoods, it is hardly surprising that opinions vary regarding acceptability of current production practices.

A particular issue facing the U.S. swine industry is the possible elimination of production practices deemed by some consumers to be animal unfriendly. In particular, consumer pressure is mounting for the industry to no longer use gestation crates (also known as gestation stalls). Gestation crates are metal crates that house female breeding stock in individually confined areas during an animal's four-month pregnancy. Pork producer organizations suggest that use of these crates may facilitate more efficient pork production resulting in lower prices for consumers. The use of these crates is deemed as cruel to the animal by some consumer groups as the crates limit animal mobility. This consumer group perception has resulted in ballot initiatives having been passed by residents of

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Florida and Arizona that will ban the use of gestation crates in their state (Videras, 2006). In November 2008, California residents passed a similar ballot initiative. Oregon was the first state to ban gestation crates using legislature. In addition to these state-specific changes, food retailers (i.e., McDonald's and Burger King) have responded by sourcing an expanding share of their food from animal wel fare friendly—meaning crate free—sources (Martin, 2007).

Not surprisingly, this growing consumer interest in more knowledge of production practices has led to an increase in research on the underlying perceptions and preferences of consumers, as well as the economic impact and viability of making corresponding adjustments (Darby et al., 2008; Lusk, Norwood, and Pruitt, 2006; Nilsson, Foster, and Lusk, 2006). However, as noted by Norwood, Lusk, and Prickett (2007), the views of consumers in 'the animal welfare debate' are basically absent. In particular, a question yet to be addressed is whether these legislative changes are welfare enhancing for the representative consumer. Moreover, the distribution of consumer welfare effects is relevant. Economic welfare evaluation is particularly warranted as the desires of a population subset (e.g., ban supporters) may restrict the food choice set of an entire population. For instance, the November 2002 ballot initiative banning gestation crates in Florida passed by a margin of 55 to 45% (Videras, 2006). Similarly, Proposition 2 passed (63–37%) in California in November 2008 banning confinement not allowing animals to turn around freely, lie down, stand up, and fully extend their limbs (Humane Society of the United States, 2008). These ballot initiatives have implications for all consumers in Florida and California and these implications likely are not equal across consumers differing in pork and animal welfare preferences.

Another unresolved issue relates to the question of underlying perceptions that consumers have in mind when stating a preference for a change in animal welfare practices. In particular, when consumers reveal a preference for "more animal friendly practices," do they implicitly associate these products with smaller and/or domestic U.S. farms? This is an important question to address because if consumers are truly more interested in the size or country of origin of the operation producing their food, then an evaluation of preferences for "animal friendly" products must take this into account. Furthermore, the optimal response of both policy makers and the meat industry should reflect this implicit association if it exists.

The objectives of this study are to: (1) estimate consumer willingness-to-pay for alternative pork production practice attributes including use of gestation crates; (2) examine whether these preferences are related to preferences for farm size and country-of-origin attributes; (3) evaluate whether or under what conditions banning use of gestation crates may be justified on grounds of economic welfare enhancement; and (4) identify the distribution of welfare impacts of gestation crate bans across consumers. Our approach allows us to directly examine whether the public good benefits of a ban on the use of gestation crates outweigh the private loss stemming from a reduction in selection of products. Specifically, we examine whether a gestation crate ban enhances consumer welfare given a labeling scheme was in place documenting the use or absence of gestation crates in production.

Mixed logit and latent class models are employed to investigate the extent of consumer preference heterogeneity influencing conclusions to these individual objectives. To the best of our knowledge, no previous research has examined consumer preferences for alternative pork production techniques, while controlling for farm size and country of origin preferences, in assessing valuations of gestation crate use as well as voluntary and mandatory omission of use. This study was designed to provide a better understanding of these issues, to improve future assessments and appropriateness of possible adjustments in swine production practices, and to identify consumer welfare impacts of banning gestation crates.

Prior Research

Several studies have investigated what consumers are willing to pay to avoid or obtain various food attributes (Alfnes, 2004; Burton et al., 2001; Grannis and Thilmany, 2002; Lusk, Roosen, and Fox, 2003; McCluskey et al., 2003; Roosen, 2003; Roosen, Lusk, and Fox, 2003; Tonsor et al., 2005). A few studies have focused on consumer valuations of "animal friendly" products (Carlsson, Frykblom, and Lagerkvist, 2007a, 2007b; Lijenstolpe, 2008; Lusk, Nilsson, and Foster, 2007; Nilsson, Foster, and Lusk, 2006). Moreover, some have focused on how consumers value use of antibiotics in pork production (Lusk, Norwood, and Pruitt, 2006), factors impacting brand premiums earned by meat products (Parcell and Schroeder, 2007), determinants of poultry prices (Parcell and Pierce, 2000), and the impacts of generic advertising on pork demand (Capps and Park, 2002). However, we are not aware of any studies evaluating U.S. consumer preferences regarding the use of gestation crates.

Grethe (2007) notes that future costs of complying with animal welfare standards in the European Union may be substantial enough to spur a relocation of production to other countries. In the context of our analysis, this raises important questions for U.S. pork producers and consumers alike. If the costs of complying with gestation crate legislation (coupled with other associated regulatory pressures) lead to an increasing proportion of U.S. pork consumption from imports, how would that impact consumer perceptions and preferences for use of gestation crates by U.S. pork producers?

Carlsson, Frykblom, and Lagerkvist (2007c) present an appealing method for examining externality effects of food production practices that may supersede effects internalized by voluntary market adjustments and hence justify legislative bans. Product labeling enables consumers to internalize the private costs of production adjustment expenditures. A legislative ban however may be justified if public costs or other externalities exceed the loss in option values associated with restricting consumer choice sets. In their application to use GM fodder in Swedish meat production, Carlsson, Frykblom, and Lagerkvist (2007c) do not find support for the hypothesis that a ban on GM fodder would be welfare enhancing in the presence of adequate labeling of meat produced voluntarily without using GM fodder. Our study uses a choice experiment designed to directly examine whether a ban on gestation crate use in the U.S. swine industry can be justified on grounds of consumer welfare enhancement.

Research Design: Data Collection and Choice Experiment

This study uses a choice experiment to estimate willingness-to-pay (WTP) for pork attributes. As in previous experimental research (i.e., Lusk, Norwood, and Pruitt, 2006), we collected information about consumer perceptions and preferences via a survey of consumers from only one state, Michigan. The surveys were reviewed by pork industry representatives and animal science faculty, updated to reflect suggestions, and then mailed to Michigan households identified by SSI, a global market research company. In November 2007, 1,000 surveys were mailed and followed by a postcard reminder 2 weeks later. The final response rate was 26%, and after eliminating incomplete surveys, there were 205 surveys available for this analysis.

Given the controversial nature of animal welfare issues and the use of gestation crates, we provided three different information statements in the survey discussing gestation crates to examine if and how provision of information impacts consumer pork valuations (Fox, Hayes, and Shogren, 2002). Consumers randomly received one of three types of information: (1) *Industry Information*, (2) *Consumer Group Information*, or (3) *Base Information*. Appendix A contains copies of these three information treatments.

In addition to socio-demographic information about each respondent, meat consumption habits and a multitude of other factors were collected. Each respondent also completed a choice experiment designed to determine the amount consumers were willing to pay for various pork attributes. Choice experiments simulate real-life purchasing situations and permit multiple attributes to be evaluated, thus allowing researchers to estimate tradeoffs among different alternatives (Lusk, Roosen, and Fox, 2003). In this choice experiment, consumers were presented with a set of eight simulated shopping scenarios, each of which involved choosing a preferred alternative from two pork chops and a no purchase option.

Boneless pork chops were offered at three different price levels ($3.49/lb, $4.99/lb, $6.49/lb) selected to be consistent with local retail prices. The base price ($3.49/lb) reflected the average price ($3.53/lb) for boneless pork chops over the 1998–2007 period (United States Department of Labor, Bureau of Labor Statistics, 2008). Two price increases of $1.50/lb were incorporated in the experimental design to reflect possible price premiums associated with the evaluated hypothetical products.[1] In addition to price, the pork chop attributes varied by farm size, production practice, and country of origin (see Table 1). An orthogonal fractional design (Kuhfeld, Tobias, and Garratt, 1994) was used to select scenarios in which pork chop prices are uncorrelated, and which allowed for identification of own-price, cross-price, and alternative specific effects. This process also allowed the choice experiment to be of reasonable size for survey participants. An example choice scenario is:

Pork Chop Attribute	Option A	Option B	Option C
Price ($/lb)	$3.49	$6.49	
Average farm size	Large	Small	
Production practice	Labeled gestation crate-free	Gestation crate ban	Neither A nor B is preferred
Country of origin	United States	Canada	
I choose . . .			

As in Lusk, Roosen, and Fox (2003), the choice experiments were hypothetical in that they did not include exchange of actual money or pork products. However, our instructions specifically stated *"The experience from previous similar surveys is that people often state a higher willingness to pay than what one actually is willing to pay for the good. It is important that you make your selections like you would if you were actually facing these choices in your retail purchase decisions."* This statement was included as part of a "cheap-talk" strategy at reducing hypothetical bias by informing survey participants of the concept prior to conducting the choice experiment (Cummings and Taylor, 1999; Lusk, 2003). Furthermore, given that our principal interest is differences in marginal willingness-to-pay amounts, we are less concerned with the hypothetical nature of our survey. This reassurance is based upon Lusk and Schroeder's (2004) research, which suggests that hypothetical willingness-to-pay for marginal changes in desirable attributes are not significantly different from nonhypothetical valuations. Descriptions included in the choice experiments of the specific product attributes are included in Appendix A.

We consider that pork products produced with and without gestation crates, by voluntary and mandatory initiatives, is timely and appropriate. In particular, U.S. consumers currently live in an environment characterized by partial banning of gestation crates (e.g., Florida, Arizona, Oregon, California) and significant use of typical

Table 1. Pork Attributes and Attribute Levels Evaluated in Choice Experiments

Product Attribute	Attribute Label
Country of Origin	United States
	Canada
	Brazil
Production Practice	Typical
	Labeled Gestation Crate-Free
	Gestation Crate Ban
Size	Small
	Median
	Large
Price ($/lb)	$3.49
	$4.99
	$6.49

Note: See Appendix A for a description of the attributes provided to consumers.

[1] The selection of prices can be challenging in designing choice experiments that often include hypothetical products without existing market prices (Lusk, Roosen, and Fox, 2003; Tonsor et al., 2005; Lusk, Nilsson, and Foster, 2007). Although worthy of additional research, Hanley, Adamowicz, and Wright (2005) and Ohler et al. (2000) found results from models based upon choice experiments not to be sensitive to the selection of prices in the experimental design.

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

Variable	Definition	Mean
Gender	1 = Female; 0 = Male	0.35
	Total Participants	205
Age	Average age in years	55.6
Education (highest level completed)	1 = Did not attend college	24.51%
	2 = Attended College, No Bachelor's (B.S. or B.A.) Degree	32.81%
	3 = Bachelor's (B.S. or B.A.) College Degree	18.18%
	4 = Graduate or Advanced Degree (M.S., Ph.D., Law School)	14.62%
	5 = Other	9.98%
Household income	1 = Less than $25,000	13.42%
	2 = $25,000 to $49,999	34.63%
	3 = $50,000 to $74,999	22.08%
	4 = $75,000 to $99,999	13.85%
	5 = $100,000 to $124,999	8.23%
	6 = $125,000 or more	7.79%
Pork consumption frequency	1 = 4 or more times per week	4.76%
	2 = 2–3 times per week	21.03%
	3 = Once per week	24.60%
	4 = 2–3 times per month	29.76%
	5 = Once per month or less	15.87%
	6 = Never	3.97%

production practices that may include gestation crate use. Moreover, recent research suggests U.S. consumers understand that animal welfare is impacted by their shopping decisions (Norwood, 2007). As such, the selections required in this choice experiment are applicable and timely as the debate of whether to ban use of crates is yet to be settled nationally.

Summary statistics of selected demographic attributes of survey respondents are provided in Table 2. Male respondents outnumbered female respondents and the average consumer was 56 years of age.[2] The education and income distribution is roughly consistent with U.S. Census data (United States Census Bureau, 2006). Nearly all respondents are at least occasional pork consumers, with more than 50% consuming pork at least once per week.

[2] While we expected a larger proportion of female respondents, our conclusions are not sensitive to estimating models with responses weighted by gender or by incorporating a gender dummy variable.

Research Methods: Random Parameters Logit, Latent Class Models, and Willingness-To-Pay Analysis

Choice experiments are based upon the assumption that individual i receives utility (U) from selecting option j in choice situation t. Utility is represented by a deterministic [$V(x_{ijt})$] and a stochastic component (ε_{ijt}) and is specified here as:

$$(1) \qquad U_{ijt} = V(x_{ijt}) + \varepsilon_{ijt},$$

where x_{ijt} is a vector of pork chop attributes and ε_{ijt} is the stochastic error component iid over all individuals, alternatives, and choice situations (Revelt and Train, 1998). Alfnes (2004) points out that this describes a panel data model where the cross-sectional element is individual i and the time-series component is the t choice situations.[3]

[3] Consequently, our model estimation procedures are carried out in LIMDEP (Greene, 2002) utilizing the program's panel data specification.

Our estimated models specify the systematic portion of the utility function as:

(2) $V_{ijt} = \alpha' P_{ijt} + \boldsymbol{\beta}_i x_{jt} \quad \forall j = Option\,A, Option\,B,$

(3) $V_{ijt} = \delta \quad \forall j = Option\,C,$

where P_{ijt} is price and $\mathbf{x}_{jt}$ is a 6×1 vector of pork attributes (x_{jt} = [$Small_{jt}$, $Large_{jt}$, $Crate\ Ban_{jt}$, $Labeled\ Crate\ Free_{jt}$, $Canada_{jt}$, $Brazil_{jt}$]. These pork attribute variables were effects coded relative to the omitted, base pork chop originating from a *Median* sized, *U.S.* based operation using *Typical* production practices.[4] The remaining terms in Equations (2) and (3) are α, β_i, and δ which are parameters to be estimated.

The model described by Equations (1) to (3) may be estimated assuming homogeneous preferences for the evaluated sample of consumers or by allowing preference heterogeneity. A growing amount of research suggests consumers possess heterogeneous preferences, so employing a model that allows for and evaluates preference heterogeneity is appropriate (Alfnes, 2004; Alfnes and Rickertsen, 2003; Lusk, Roosen, and Fox, 2003; Tonsor et al., 2005). Our analysis examines preference heterogeneity by applying two alternative models, random parameters logit (also known as mixed logit) and latent class logit models. Random parameters logit (RPL) and latent class models (LCM) are both increasingly being used as they encompass logit models assuming homogeneous preferences, in turn providing valuable insight into differential welfare effects on a sample of potentially differentiated consumers.

We apply both models to examine sensitivity of conclusions regarding consumer pork preferences and impacts of gestation crate bans to alterative model assumptions. The RPL model allows for random taste variation within the surveyed population, is free of the independence of irrelevant alternatives assumption, and allows correlation in unobserved factors over time, thus eliminating three limitations of standard logit models (Train, 2003; Revelt and Train, 1998). In the context of our study, the RPL is appealing as some of the pork chop alternatives presented in our choice experiment are similar, possibly making the independence of irrelevant alternatives assumption overly restrictive. The RPL model also facilitates correlation in random parameters and hence a thorough evaluation of relationships in preferences across attributes. This facet is particularly valuable given our interest in the relationships between preferences for production practice attributes with other controlled attributes (i.e., farm size and country-of-origin).

Application of the general random utility of Equation (1) in a random parameters logit model can be presented as:

(4) $U_{ijt} = \lambda_i' x_{ijt} + \varepsilon_{ijt},$

where x_{ijt} is a vector of observed variables, λ_i is unobserved for each individual and varies within the population with density $f(\lambda_i|\theta^*)$ where θ^* are the true parameters of this distribution, and ε_{ijt} is the stochastic error component iid over all individuals, alternatives, and choice situations (Revelt and Train, 1998). For maximum likelihood estimation of the RPL model we need to specify the probability of each individual's sequence of selections. Let $j(i,t)$ denote the alternative that individual i chose in period t. The unconditional probability of subject i's sequence of selections is given by (Revelt and Train, 1998):

(5) $$P_i(\theta^*) = \int \prod_t \frac{e^{\lambda_i' x_{ij(i,t)t}}}{\sum_j e^{\lambda_i' x_{ijt}}} f(\lambda_i|\theta^*)d\lambda_i.$$

In the RPL model we specify the price coefficient to be fixed and focus on heterogeneity in preferences for each of the six pork chop attributes. We do this by allowing β_i in Equation (2) to vary within our consumer population. Prior to proceeding, it is important to note that these random coefficients could be correlated (Scarpa and DelGiudice, 2004; Train, 1998). For instance, consumers who are concerned

[4] That is, the six attributes in Equation (2) take on a value of 1 when applicable, a value of −1 when the base pork chop attribute applies, and zero otherwise. Effects coding is used to avoid confoundment with the *Opt Out* coefficient (δ) (Ouma, Abdulai, and Drucker, 2007).

with the use of gestation crates might also value pork from smaller operations. To investigate these possibilities, we let β represent the vector of attribute coefficients and specify $\beta \sim N(\bar{\beta},\Omega)$. The resulting coefficient vector is expressed as $\beta = \bar{\beta} + LM$ where L is a lower-triangular Cholesky factor of Ω such that $LL' = \Omega$, and M is a vector of independent standard normal deviates (Revelt and Train, 1998). Upon estimation, evaluation of the individual elements in L allows for a better understanding of correlations in preferences across attributes evaluated.[5]

While continuous heterogeneity is assumed in RPL models, latent class models specify preference heterogeneity to occur discretely (Train, 2003). More specifically, LCM models assume that individuals can be intrinsically sorted into a number of latent classes where each class is characterized by homogeneous preferences, but preferences are heterogeneous across classes (Boxall and Adamowicz, 2002). LCM models simultaneously assign each individual into latent classes probabilistically while also identifying utility parameters of each latent class. Within a given class, individual choices from one choice situation to another are assumed to be independent and choice probabilities are assumed to be generated by the logit model (Greene, 2006). The probability that individual i selects option j in choice situation t, given that he belongs to latent class s, is:

$$(6) \qquad P_i(ijt|s) = \prod_{t=1}^{T} \frac{\exp(B_s x_{ijt})}{\sum_{j=1}^{J} \exp(B_s x_{ijt})},$$

where x_{ijt} is a vector of observed attributes associated with alternative j and B_s is a class-specific utility parameter vector (Ouma, Abdulai, and Drucker, 2007).

Estimated coefficients from random utility models themselves have little interpretive value. However, relative combinations of select coefficients provide economically meaningful insights on consumer preferences. For example, traditional calculations of WTP from RPL model coefficients are based on the mean of the normal distribution (e.g.,$\overline{\beta_{Small}}$) and implicitly ignore the distribution of preferences around the mean (e.g., relevant elements of L). To relax this strong assumption, as well as consider statistical variability in parameter estimates, we utilize simulation techniques consistent with those described by Rigby and Burton (2005) and Hensher and Greene (2003).

To consider the entire preference distribution of WTP (rather than just the mean and standard deviation) and consider statistical variability in parameter estimates, we use a two-step simulation approach. First, we let η be the vector of model point estimates (e.g., individual elements of α, δ, $\bar{\beta}$, and L), $\sigma = \text{var}(\eta)$, and T be the lower-triangular matrix of σ such that $TT' = \sigma$. We then take 1,000 draws from a standard normal distribution for each element of η and place them in a vector μ. For each of these 1,000 draws, we identify estimates of the model parameters as $\eta + T\mu$. Secondly, for each of the simulated 1,000 parameter values, 1,000 preference drawings from a standard normal distribution are made to generate a distribution of WTP estimates. This provides a series of 1,000 estimates for any desired statistic, facilitating identification of confidence intervals for each statistic (e.g., 95% confidence intervals for mean WTP). This simulation process makes more complete use of valuable information provided by estimated random parameters logit models, and results in a much more complete mapping of consumer preferences.

Willingness-to-pay estimates from the LCM model were derived specific to each class, accounting for different preference structures. While simulated WTP estimates stemming from the RPL model require examination of both statistical variation and variation in preferences, corresponding examinations from the LCM model incorporate variation in class membership probability as well as statistical

[5] Furthermore, in our situation of multiple, correlated random parameters, standard deviations of β are not independent (Hensher and Greene, 2003). For proper assessment we utilize Cholesky decomposition to identify attribute-specific standard deviations (e.g., *Crate Ban*) and attribute-interaction standard deviations (e.g., *Crate Ban* × *Small*).

variation in class-specific utility parameters. A distribution of 1,000 values of each WTP estimate was generated using a bootstrapping procedure proposed by Krinsky and Robb (1986). More specifically, 1,000 observations were drawn from a multivariate normal distribution parameterized by using the coefficients and variance terms estimated by the LCM model.

The simulated WTP statistics from each model were utilized to empirically test for differences in WTP preferences. First, mean WTP estimates and 95% confidence intervals were identified incorporating both statistical and preference (class membership) variability in the RPL (LCM) model. Second, a combinational technique suggested by Poe, Giraud, and Loomis (2005) was used to provide a simple nonparametric evaluation of differences in WTP distributions. The difference between two simulated WTP series was evaluated with this difference being calculated for all possible combinations of the two series. In other words, 1,000,000 differences (e.g., $WTP_a - WTP_b\ \forall a,b$; where $a = 1,\ldots,1000$ and $b = 1,\ldots,1000$) were calculated for each test.

Our methodological approach allows us to directly examine if a state-wide ban prohibiting the use of gestation crates can be economically justified. In particular, our choice experiment contains three different attribute levels for gestation housing: *Typical*, *Labeled Gestation Crate-Free*, and *Gestation Crate Ban*. Instructions preceding the choice experiment inform survey participants that the *Labeled Gestation Crate-Free* attribute guarantees pork to have been raised by a producer who voluntarily chose not to use gestation crates while the *Gestation Crate Ban* attribute guarantees the pork to have originated from an animal raised in a region (state or country) where the use of gestation crates is legally banned for all swine producers. This is consistent with the approach of Carlsson, Frykblom, and Lagerkvist (2007c) and allows us to directly test if the public good benefits of a ban outweigh the private loss of option values (reduction in selection of products if pork raised using gestation crates is completely banned). Specifically, we examine whether a gestation crate ban enhances consumer welfare given a labeling scheme was in place documenting the use or absence of gestation crates in production.

Results

An array of alternative model specifications were considered prior to selecting the random utility model described above with log likelihood tests rejecting the hypothesis that preferences are jointly homogeneous (e.g.,$\beta = \overline{\beta}$ in the RPL and $\beta_s = \beta_t,\ \forall s \neq t$ in the LCM) and the hypothesis that the random parameters of the RPL model were uncorrelated (e.g., the off-diagonal elements of Ω are jointly zero). We estimated separate models for each of the three information treatments (see Appendix A) and compared the sum of the log-likelihood functional values to values from a pooled model constraining coefficient equality across information treatments (but allowing relative scale variation). Consumer choice experiment responses were found to be insensitive to the information treatment they received as we failed to reject the hypothesis that we can pool observations across consumers receiving the three alternative information statements.[6] The finding that information differences had no effect on pork chop selections may stem from the similarity in the underlying point of all three, intentionally brief information treatments, or in strong prior beliefs held by consumers. Our finding of pork preferences to be insensitive to differences in information presentations is similar to that of Lusk, Norwood, and Pruitt (2006). As an outcome of these findings, the remainder of this analysis reports results from pooled models with identical parameters and scales across the three information treatments.

Estimates to RPL and LCM models are provided in Table 3. In the RPL model, the majority of the estimated means for the random pork chop attribute parameters were

[6] These tests were conducted allowing the scale parameter to vary across the pooled data sets when estimating the pooled model. See Louviere, Hensher, and Swait (2000) for additional tests details.

Table 3. Parameters (standard errors) for Two Choice Models

Variable	Random Parameters Model	LCM - 4 Class Model			
	Mean[a]	Class 1 "*Pork Enjoyers*"	Class 2 "*Attribute Conscious*"	Class 3 "*Price Conscious*"	Class 4 "*Ban Preferring*"
Membership Probability		0.3221** (0.0268)	0.3326** (0.0261)	0.1412** (0.0343)	0.2040** (0.0331)
Small	0.2033 (0.1234)	0.2956 (0.1836)	0.1705 (0.1157)	−0.1199 (0.3769)	−0.1351 (0.1257)
Large	−0.4666** (0.1227)	−0.4429* (0.1817)	−0.1572 (0.1121)	0.4426 (0.3034)	0.0396 (0.1246)
Ban	0.1264 (0.2131)	−0.6630** (0.1956)	−0.6001** (0.1092)	0.3756 (0.3566)	1.4453** (0.1276)
Label	0.7695** (0.2319)	0.5499** (0.1886)	0.3286** (0.1178)	−0.0881 (0.3507)	0.8110** (0.1245)
Canada	0.5115* (0.2037)	0.1954 (0.1937)	−0.4105** (0.1293)	−0.7734 (0.4506)	0.1663 (0.1170)
Brazil	−3.4415** (0.3786)	−1.9029** (0.2690)	−2.3232** (0.2208)	−0.3335 (0.4276)	−1.3740** (0.1446)
Opt Out	−1.9123** (0.3079)	−9.0966** (0.8546)	−0.3138 (0.3357)	−0.5281 (0.9929)	−1.8749** (0.3392)
Price	−0.7317** (0.0622)	−1.3306** (0.1495)	−0.3662** (0.0632)	−0.9408** (0.2548)	−0.5173** (0.0656)

Notes: Presented models (log likelihoods of −1,215 and −1,052, respectively) were estimated using NLOGIT 4.0, with Halton draws, and 500 replications for simulated probability. Standard errors are presented in parentheses.[a] Elements of the random parameter model's Cholesky matrix, along with corresponding correlation statistics, are presented in Appendix B.
*, ** Indicates statistical significance at the 0.05 and 0.01 level, respectively.

statistically significant. To further evaluate preference heterogeneity we examine estimated Cholesky matrices (Appendix B). The diagonal values of each Cholesky matrix represent the true level of variance for each random parameter once the cross-correlated parameters terms have been unconfounded (Hensher, Rose, and Greene, 2006). This formulation is an important distinction in our RPL model application. For instance, five of the six random parameters were estimated to have statistically significant standard deviation parameter estimates.[7] However, only the diagonal Cholesky elements for *Small* and *Gestation Crate Ban* in our final model were statistically significant. This implies that the statistically significant standard deviation parameters for the *Labeled Gestation Crate-Free*, *Canada*, and *Brazil* variables were attributable to cross-correlations with other random parameters and not heterogeneity around the mean of each random parameter (Hensher, Rose, and Greene, 2006).

The statistical significance of diagonal Cholesky elements for *Small* and *Gestation Crate Ban* is evidence of preference heterogeneity persisting, even after allowing cross-correlations to exist across attribute parameters. Examination of the off-diagonal elements of the Cholesky matrix reveals several statistically significant estimates, primarily stemming from the *Small* coefficient. This suggests significant cross-correlations among the random parameter estimates would have been inappropriately confused within standard deviation estimates of each random parameter without Cholesky matrix decomposition and evaluation. Evaluation of the correlation terms reveals the *Small* variable to be positively correlated with the *Gestation Crate Ban* and *Labeled Gestation Crate-Free* variables. This suggests that farm size attributes are closer substitutes for production practices than suggested by the

[7] These standard deviations, while provided by NLOGIT, are not presented. In the context of correlated random parameters, these standard deviation parameters are not independent and Cholesky decomposition should be used to identify proper standard deviation terms (Hensher, Rose, Greene, 2006).

nonstochastic portion of our RPL model (Alfnes, 2004).

The latent class model estimates are also presented in Table 3. To identify the number of latent classes to be used in the analysis, we employed the Bayesian Information Criterion as discussed by Boxall and Adamowicz (2002). This criterion is minimized in a four-class model, leading to the estimates presented in Table 4.[8] Incorporating class membership covariates (i.e., demographics, attitudinal information, and information treatment dummies) failed to improve the model's statistical performance. This result is not necessarily surprising and is consistent with several other applications of latent class models to consumer food preferences that have found observable consumer characteristics to be poor indicators of food preferences (Nilsson, Foster, and Lusk, 2006).

The LCM results reveal significant heterogeneity in consumer preferences across latent classes with associated class membership probabilities of 32%, 33%, 14%, and 20%, respectively. That is, there is a 32%, 33%, 14%, and 20% probability that a randomly chosen respondent belongs to the first, second, third, and fourth class, respectively (Nilsson, Foster, and Lusk, 2006). The first and fourth classes have significant, negative coefficients on the "opt out" parameter indicating a preference to retain pork in their choice set. Utility coefficients for the first class (32% of population) indicate a preference for pork *Labeled Gestation Crate-Free* and dislike of *Large*, *Gestation Crate Ban,* and *Brazil* attributes. These preferences, however, appear to be dominated by a significantly negative "opt out" parameter. As such, we refer to this class as the *"Pork Enjoyers"* group. The second class (33% of population) is characterized by a preference for pork *Labeled Gestation Crate-Free* and dislike of nonU.S. pork and pork produced under a ban on gestation crate use (*Gestation Crate Ban*).

Table 4. Consumer Willingness-to-Pay [95% confidence intervals] for Pork Attributes

	Random Parameters Model	LCM - 4 Class Model			
		Class 1 *"Pork Enjoyers"*	Class 2 *"Attribute Conscious"*	Class 3 *"Price Conscious"*	Class 4 *"Ban Preferring"*
Small (vs. median)	$0.56 [−0.15, 1.26]	$0.48 [−0.07, 1.09]	$0.99 [−0.23, 2.60]	($0.21) [−1.70, 1.69]	($0.52) [−1.42, 0.46]
Large (vs. median)	($1.27) [−1.97, −0.64]	($0.70) [−1.36, −0.15]	($0.89) [−2.32, 0.40]	$0.98 [−0.50, 2.73]	$0.17 [−0.81, 1.11]
Ban (vs. typical)	$0.34 [−0.79, 1.58]	($1.00) [−1.58, −0.45]	($3.39) [−5.44, −1.99]	$0.73 [−0.97, 2.30]	$5.62 [4.18, 7.41]
Label (vs. typical)	$2.11 [0.71, 3.54]	$0.84 [0.30, 1.39]	$1.86 [0.50, 3.49]	($0.08) [−1.68, 1.75]	$3.13 [2.08, 4.39]
Canada (vs. United States)	$1.44 [0.27, 2.64]	$0.33 [−0.28, 0.99]	($2.29) [−4.05, −0.83]	($1.68) [−4.03, 0.20]	$0.64 [−0.30, 1.57]
Brazil (vs. United States)	($9.49) [−12.55, −7.00]	($2.90) [−3.72, −2.19]	($13.13) [−20.00, −9.00]	($0.89) [−3.51, 1.11]	($5.35) [−7.19, −3.93]
Opt Out	($2.60) [−3.01, −2.10]	($6.88) [−7.54, −6.35]	($0.72) [−2.06, 1.49]	($0.23) [−1.73, 3.43]	($3.62) [−4.14, −3.06]

Notes: Simulated confidence 95% confidence intervals are presented in brackets and were derived by the complete combinational approach of Poe, Giraud, and Loomis (2005). All presented values are in $/lb units.

[8] Furthermore, marginal reductions in the AIC (Akaike Information Criterion) reduce significantly as additional latent classes are added and inclusion of more than four latent classes results in classes less than 10% in size.

Collectively, this leads us to refer to this group as the "*Attribute Conscious"* class.

The third class is the smallest group (14% of population) and appears to be most concerned with the price of pork. The insignificance of individual pork attribute coefficients, as well being rather indifferent on maintaining pork in their choice set, compels us to refer to this class as the *"Price Conscious*" group. The fourth class (20% of population) is the only class with utility estimates suggesting a preference for pork produced without use of gestation crates originating under a ban over that originating from voluntary choices of farmers. Collectively, this leads us to refer to this group as the "*Ban Preferring*" group.

Willingness-to-Pay

Consumer willingness-to-pay estimates are of particular interest. Results (point estimates and indication of statistical significance) of our simulations are presented in Table 4. By examining both point estimates and overlapping of confidence intervals, the RPL model indicates a significant preference for pork from Canada over the United States (mean WTP of $1.44/lb) and a larger discount for Brazilian pork (mean WTP of −$9.49/lb). The RPL model indicates indifference between small and median sized farms of origin, indifference between pork from operations using typical production practices or operating under a gestation crate ban, and positive preference for pork voluntarily produced without use of gestation crates (mean WTP of $2.11/lb). Significance of the *Opt Out* coefficient reveals our sample population has a preference for having pork chops in their food choice set.

Table 4 also reveals notable diversity in consumer WTP values across the four latent classes suggested by the LCM model. Class 1 ("*Pork Enjoyers*") is the only class (32% of the population) willing to pay a significant amount for farm size preferences, with a mean WTP of $0.70/lb for pork from median, rather than large farms. Similarly, class 2 ("*Attribute Conscious*") is the only class significantly differentiating between Canadian and U.S. pork, with consumers indicating a mean WTP of $2.29/lb for pork from the US over pork from Canada. Class 3 ("*Price Conscious*") is the only class indifferent between pork from the United States and from Brazil. Discounts for Brazilian pork range from $2.90/lb for class 1 ("*Pork Enjoyers*") to $13.13/lb for class 2 ("*Attribute Conscious*").

The four classes are also very diverse in their valuations of gestation crate use. More specifically, classes 1 and 2 (a combined approximately two-thirds of the population) place a significant premium on pork from producers voluntarily selecting not to use gestation crates (mean WTP of $0.84/lb and $1.86/lb, respectively). However, these same consumers place a significant discount on pork known to have originated from regions operating under a gestation crate ban (mean WTP of −$1.00/lb and −$3.39/lb, respectively).

This is in contrast to class 3 (14% of population) that is unwilling to pay a premium for either gestation crate use attribute relative to *Typical* production practices. Class 4 (20% of population) is the only class possessing a significant preference for pork produced without use of gestation crates regardless of the voluntary or mandatory nature of this production practice (mean WTP of $5.62/lb and $3.13/lb for ban and voluntary label, respectively).[9]

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[9] It is prudent to note the conclusions that can, and cannot, be drawn from these results in the context of current discussions regarding mandatory country of origin labeling (MCOOL) (Meyer, 2008). The RPL model suggests the representative consumer prefers pork from Canada rather than the United States while the LCM model suggests only one-third of consumers (class 2, "*Attribute Conscious*") significantly differentiate between pork from Canada and the United States. Differences in valuation estimates reflect alternative assumptions about preference heterogeneity and the functional form of these underlying models. However, these valuation estimates are not sufficient to draw final conclusions regarding MCOOL. In particular, this analysis intentionally (primarily as our focus was on gestation crates and we limit experimental complexity) did not include products carrying *Product of the U.S., Canada* or *Product of Canada, U.S.* labels that in reality exist under MCOOL. Moreover, no evaluation of cost increases imposed by MCOOL is evaluated in this analysis.

Table 5. Comparison of Crate Ban and Labeled Crate-Free Willingness-to-Pay

Model/Segment	*Gestation Crate Ban* vs. Typical[a]	*Labeled Gestation Crate-Free* vs. Typical[a]	*p*-Value[b]
Random Parameters Model	\$0.34	\$2.11	0.972
LCM-Class 1 "*Pork Enjoyers*"	−\$1.00	\$0.84	0.999
LCM-Class 2 "*Attribute Conscious*"	−\$3.39	\$1.86	0.999
LCM-Class 3 "*Price Conscious*"	\$0.73	−\$0.08	0.228
LCM-Class 4 "*Ban Preferring*"	\$5.62	\$3.13	0.005

[a] WTP values are derived from models presented in Table 4 and are in \$/lb increments.
[b] *p*-Values report results of the one-sided test that the *Gestation Crate Ban* distribution exceeds the *Labeled Gestation Crate-Free* distribution. These values were determined by applying the nonparametric combinational method of Poe, Giraud, and Loomis (2005).

Consumer Welfare Evaluation

Table 5 presents results of nonparametric tests comparing WTP series to evaluate consumer welfare impacts of banning gestation crates. A ban is welfare enhancing, in the presence of transparent labeling, if and only if consumer willingness-to-pay for *Gestation Crate Ban* pork exceeds that of *Labeled Gestation Crate-Free* (Carlsson, Frykblom, and Lagerkvist, 2007c). As shown in Table 5, consumers (20% of the population) possessing the utility function represented by class 4 ("*Ban Preferring*") of the LCM model are the only consumers identified as having a significantly higher WTP for *Gestation Crate Ban* pork than *Labeled Gestation Crate-Free* pork. Estimated utility functions for the other three consumer classes in the LCM model, and for representative consumers modeled by the RPL model, indicate either indifference between a gestation crate ban and voluntary disadoption (class 3 of LCM model) or actually discount pork produced under a gestation crate ban relative to pork labeled to have been voluntarily produced without use of gestation crates. Combined, these findings suggest that only a subset (20% belonging to class 4 of the LCM model) of the evaluated consumer population have pork preferences consistent with justifying a ban on gestation crates. Stated differently, using estimates from an RPL model we reject the hypothesis that a ban on gestation crates would improve consumer welfare. We also reject this hypothesis using LCM estimates for consumers in latent classes 1 and 2 (approximately 65%).

Collectively these results suggest that if a consumer is provided with adequate labeling of pork produced on farms certified to voluntarily not use gestation crates, we find no economic support justifying a ban on the use of gestation crates on the grounds of improving general consumer welfare. Using the RPL model we firmly reject the notion of gestation crate bans improving consumer welfare in the presence of voluntary labeling. This implies that the private loss of option values (reduction in selection of products if pork raised using gestation crates are completely banned) is offsetting any public good benefits of a ban that would be necessary for a ban to enhance overall consumer welfare (Carlsson, Frykblom, and Lagerkvist, 2007c; Hamilton, Sunding, and Zilberman, 2003). However, use of LCM model estimates reveals that conclusions are segment specific. For approximately 65% of the population we can reject the notion of gestation crate bans improving consumer welfare, but for the remaining 35% we cannot. Identification of markedly different consumer welfare effects is consistent with other applications of LCM models, most notably that of Boxall and Adamowicz (2002).

The remaining issue addressed in this paper is identification of actual consumer welfare effects our estimated models imply would occur in the event of a gestation crate ban. As explained by Lusk, Norwood, and Pruitt (2006), the WTP valuations of Table 5 are only one welfare measure of relevance to our study. These typical WTP estimates are not appropriate welfare measures in situations where consumers may not make a purchase (i.e., "Opt Out") or in situations involving choice uncertainty. Following Morey (1999) and Lusk, Norwood, and Pruitt (2006) we note that expected maximum utility (*EMU*) from each consumer's choice set selection is given by:

$$(7) \qquad EMU = \ln\left(\sum e^{V_j}\right) + C,$$

where C is Euler's constant and V_j is defined as in Equations (2) and (3). As such, the general welfare change of moving from situation Y to situation Z is given by:

$$(8) \qquad \frac{1}{MUI}\left(EMU^Z - EMU^Y\right),$$

where MUI is the marginal utility of income.[10] Note that consumers currently have choice sets containing pork produced under three conditions: (1) under gestation crate bans, (2) using typical production, and (3) with voluntary disadoption of gestation crates. However, when a ban is imposed, the consumer choice set is reduced and the latter two options are no longer available for purchase. The welfare change that would result from choosing between three pork products and none to a situation of choosing between one pork product and none can hence be identified by using Equations (7) and (8). Evaluation of Equation (8) provides a value that may be interpreted as the amount consumers would pay to maintain pork originating from typical production and voluntary disadoption of gestation crates in their choice sets.

Table 6 presents estimates of the welfare impacts our utility models imply consumers would experience following a gestation crate ban. Two sets of estimates are provided. The first corresponds with the assumption that consumers currently have access to pork produced by farmers voluntarily not using gestation crates. Given the possibility that some consumers may not currently have access to these products, we also present the welfare impacts of consumers losing the ability to purchase *Typical* pork (but not pork labeled to have been produced by producers voluntarily choosing not to use gestation crates). Welfare estimates in \$/choice occasion and aggregated values for the population are presented assuming 26,975 million choice occasions per year (Lusk, Norwood, and Pruitt, 2006).

Table 6 reveals that each model implies statistically significant welfare losses. As anticipated, the welfare losses are larger for consumers who lose the ability to purchase two pork products (typical production and voluntary gestation crate-free production) than for consumers who only lose the ability to purchase one product (typical production). Estimates for the four classes identified by the LCM model reveal differential welfare impacts. Consumers belonging to class 2 ("*Attribute Conscious*") are found to experience significantly larger welfare declines than consumers in the other three segments. Consumers of class 4 ("*Ban Preferring*"), the only class with statistically significant preferences for pork produced under a gestation crate ban (Table 4), also experience a welfare decline from a gestation crate ban. This potentially counter-intuitive finding corresponds with consumers in this segment also possessing positive valuations of pork produced by farmers voluntarily not using gestation crates. Furthermore, the general overall finding of negative welfare impacts corresponds to the loss of purchasing options experienced by consumers following a ban, including the "*Ban Preferring*" class implied by the LCM model. This important distinction underlies the necessity of not only evaluating traditional WTP measures in assessing welfare impacts (Lusk, Norwood, and Pruitt, 2006).

It is critical to note that these consumer welfare measures are based upon the assumption of no production cost adjustment and hence no overall pork price adjustment. In reality there would be some nonzero production cost adjustment, resulting in an increase in pork prices, further exacerbating the consumer welfare estimates presented here (Lusk, Norwood, and Pruitt, 2006). That is, the presented consumer welfare estimates reflect only changes in available pork choice sets and marginal valuations of alternative uses and regulation of gestation crates. For instance, Lusk, Norwood, and Pruitt (2006) incorporated

[10] We use −1 times our estimated price coefficients as marginal utility of income estimates.

Table 6. Welfare Measures [95% confidence intervals] for Banning Gestation Crates

	Labeled Gestation Crate-Free Pork Available		Labeled Gestation Crate-Free Pork NOT Available	
	Welfare Change from Ban with Loss of Option to Buy Typical and Labeled Gestation Crate-Free Pork		*Welfare Change from Ban with Loss of Option to Buy Typical Pork*	
	$/Choice Occasion	Millions of Dollars/Year	$/Choice Occasion	Millions of Dollars/Year
Random parameters model	−$0.17	−$4,626.21	−$0.07	−$1,971.87
	[−$0.26, −$0.11]	[−$7,062.06, −$2,872.84]	[−$0.12, −$0.04]	[−$3,183.05, −$1,173.41]
LCM-Class 1 "*Pork Enjoyers*"	−$0.02	−$147.71	−$0.01	−$97.31
	[−$0.04, −$0.01]	[−$369.27, −$44.31]	[−$0.03, −$0.00]	[−$255.45, −$26.07]
LCM-Class 2 "*Attribute Conscious*"	−$0.80	−$7,194.63	−$0.43	−$3,853.95
	[−$1.40, −$0.44]	[−$12,605.41, −$3,951.75]	[−$0.77, −$0.23]	[−$6,872.50, −$2,072.79]
LCM-Class 3 "*Price Conscious*"	−$0.08	−$308.62	−$0.04	−$154.31
	[−$0.40, −$0.01]	[−$1,527.88, −$31.62]	[−$0.19, −$0.00]	[−$706.40, −$13.72]
LCM-Class 4 "*Ban Preferring*"	−$0.36	−$1,996.50	−$0.13	−$731.90
	[−$0.58, −$0.21]	[−$3,218.73, −$1,180.95]	[−$0.23, −$0.08]	[−$1,285.51, −$427.04]

Notes: Values in brackets are simulated confidence 95% confidence intervals derived via the Krinsky-Robb bootstrapping method. These estimates are based upon the assumption of 26,975 million choice occasions per year (Lusk, Norwood, and Pruitt, 2006).

an expected retail price increase of 0.81% in their evaluation of banning antibiotic use, reflective of farm-level production cost increases of 2.02% suggested by Brorsen et al. (2002). Although certainly needed for a broader welfare analysis of the issue (i.e., improved consumer, producer, and society impacts), we are unaware of similar published estimates of production cost impacts stemming from banning gestation crates. Moreover, such estimates are dependent upon the production practices used in lieu of gestation crates, an issue notably less certain than in discussions such as use of antibiotics, growth hormones, or genetically modified feeds that likely do not require substantial capital investments (Tonsor, Wolf, and Olynk, 2008).

Conclusions

Increasing consumer interest in the production practices employed in modern food production have led to growing analysis of consumer preferences for production methods. This analysis focused on the growing consumer pressure for the U.S. swine industry to no longer use gestation crates. In employing both random parameters logit and latent class models, we find strong consumer preference heterogeneity for pork chop attributes. RPL model estimates revealed preferences for pork from *Small* farms to be positively correlated with preferences for pork produced under a gestation crate ban or produced by farmers voluntarily not using gestation crates. This suggests our evaluated sample of consumers hold farm size attributes as partial substitutes for use of gestation crates. Inferences from the LCM model further document preference heterogeneity and provide insights on differential consumer welfare impacts of restrictions on gestation crate use.

In our analysis, if a consumer is provided with adequate labeling of pork produced on farms certified to voluntarily not use gestation crates, we find no economic support justifying a ban on the use of gestation crates that impacts all consumers. Using estimates from the RPL model we reject the hypothesis that a ban on gestation crates would improve consumer welfare. Considering preference heterogeneity differently, estimates from the LCM model suggest that only a subset (approximately 20%) of the evaluated consumer population have pork preferences consistent with those that could justify a ban on gestation crates.

Given the close voting margin of some related ballot initiatives (e.g., November 2002 initiative in Florida), this work highlights the implications of "ban preferring" consumers disproportionally showing up to vote. Furthermore, this work supports many of the "politics by other means" conclusions made by Schweikhardt and Browne (2001) as alternative methods, including consumer purchasing behavior, voting on ballot initiatives, and exerting indirect pressure on food producers and distributors increasingly being used by select consumer groups to initiate changes in food production practices. The results of this analysis imply that the desires (and corresponding voting behavior) of these consumers have substantial impacts on the consumer welfare of all consumers whose food product choice set is impacted.

These findings imply that the swine industry may benefit by encouraging additional labeling of products originating from producers voluntarily choosing not to utilize gestation crates. If these products are currently not widely available to consumers, results of this study suggest that additional labeling may, in addition to seizing market opportunities, potentially help alleviate some of the increasing pressure for production practice changes associated with gestation crates.

Given these findings, future work should further examine consumer perceptions and valuation of alternative methods of certifying voluntary disadoption of gestation crates. Future research could compare the findings based here on a sample of Michigan consumers with consumers from other U.S. states or regions. Additional work could also examine if operation size is truly coupled with other credence attributes of current interest including "locally grown," "natural," "organic," "food safety," and "free-range." Finally, this analysis highlights the need for additional research estimating the cost differentials of gestation crate use (i.e., cost of production with and without gestation crates) and alternative replacement practices (incorporating implicit changes in pig mortality, animal health, capital investments, etc.) including indoor group housing and pasture based systems. This future analysis should examine impacts on producers varying in specialization (e.g., farrow-finish versus farrow-weanling) and current operation characteristics (e.g., facility age, availability for physical expansion of facilities). Combined, these estimates would lead to an improved understanding of the net consumer, producer, and societal impacts of alternative forms of gestation crate use and regulation.

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References

Alfnes, F. "Stated Preferences for Imported and Hormone-Treated Beef: Application of a Mixed Logit Model." *European Review of Agriculture Economics* 31(2004):19–37.

Alfnes, F., and K. Rickertsen. "European Consumers' Willingness to Pay for U.S. Beef in Experimental Auction Markets." *American Journal of Agricultural Economics* 85(2003): 396–405.

Boxall, P.C., and W.L. Adamowicz. "Understanding Heterogeneous Preferences in Random Utility Models: A Latent Class Approach." *Environmental and Resource Economics* 23(2002): 421–46.

Brorsen, B.W., T. Lehenbauer, D. Ji, and J. Connor. "Economic Impacts of Banning Subtherapeutic Use of Antibiotics in Swine Production." *Journal of Agricultural and Applied Economics* 34(2002):489–500.

Burton, M., D. Rigby, T. Young, and S. James. "Consumer Attitudes to Genetically Modified Organisms in Food in the U.K." *European Review of Agriculture Economics* 28(2001):479–98.

Capps, O., and J. Park. "Impacts of Advertising, Attitudes, Lifestyles, and Health on Demand for U.S. Pork: A Micro-level Analysis." *Journal of Agricultural and Applied Economics* 34(2002):1–15.

Carlsson, F., P. Frykblom, and C.J. Lagerkvist. "Consumer Willingness to Pay for Farm Animal Welfare: Mobile Abattoirs versus Transportation to Slaughter." *European Review of Agriculture Economics* 34(2007a):321–44.

———. "Farm Animal Welfare – Testing for Market Failure." *Journal of Agricultural and Applied Economics* 39(2007b):61–73.

———. "Consumer Benefits of Labels and Bans on GM Foods – Choice Experiments with Swedish Consumers." *American Journal of Agricultural Economics* 89(2007c):152–61.

Cummings, R.G., and L.O. Taylor. "Unbiased Value Estimates for Environmental Goods: A Cheap Talk Design for the Contingent Valuation Method." *The American Economic Review* 89(1999):649–65.

Darby, K., M.T. Batte, S. Ernst, and B. Roe. "Decomposing Local: A Conjoint Analysis of Locally Produced Foods." *American Journal of Agricultural Economics* 90(2008):476–86.

Fox, J.A., D.J. Hayes, and J.F. Shogren. "Consumer Preferences for Food Irradiation: How Favorable and Unfavorable Descriptions Affect Preferences for Irradiated Pork in Experimental Auctions." *Journal of Risk and Uncertainty* 24(2002):75–95.

Grannis, J., and D. Thilmany. "Marketing Natural Pork: An Empirical Analysis of Consumers in the Mountain Region." *Agribusiness International Journal (Toronto, Ont.)* 18(2002):475–89.

Greene, W. *NLOGIT Version 3.0 Reference Guide*. Econometric Software, Inc., 2002.

Greene, W.H. *Econometric Analysis*, 5th Ed. Upper Saddle River, NJ: Prentice Hall, 2006.

Grethe, H. "High Animal Welfare Standards in the EU and International Trade – How to Prevent Potential 'Low Animal Welfare Havens'?" *Food Policy* 32(2007):315–33.

Hamilton, S.F., D.L. Sunding, and D. Zilberman. "Public Goods and the Value of Product Quality Regulations: The Case of Food Safety." *Journal of Public Economics* 87(2003):799–817.

Hanley, N., W. Adamowicz, and R.E. Wright. "Price Vector Effects in Choice Experiments: An Empirical Test." *Resource and Energy Economics* 27(2005):227–34.

Hensher, D.A., and W.H. Greene. "The Mixed Logit Model: The State of Practice." *Transportation* 30(2003):133–76.

Hensher, D.A., J.M. Rose, and W.H. Greene. *Applied Choice Analysis*. Cambridge, UK: Cambridge University Press, 2006.

Humane Society of the United States. "Think Outside the Crate Campaign." Internet site: http://www.hsus.org/ (Accessed October 27, 2008).

Krinsky, I., and A. Robb. "On Approximating the Statistical Properties of Elasticities." *The Review of Economics and Statistics* 64(1986):715–9.

Kuhfeld, W.F., R.D. Tobias, and M. Garratt. "Efficient Experimental Design with Marketing Research Applications." *JMR, Journal of Marketing Research* 31(1994):545–57.

Lijenstolpe, C. "Evaluating Animal Welfare with Choice Experiments: An Application to Swedish Pig Production." *Agribusiness* 21(2008):67–84.

Louviere, J.J., D.A. Hensher, and J.D. Swait. *Stated Choice Methods: Analysis and Application*. Cambridge: Cambridge University Press, 2000.

Lusk, J.L. "Effects of Cheap Talk on Consumer Willingness-to-Pay for Golden Rice." *American Journal of Agricultural Economics* 85(2003): 840–56.

Lusk, J.L., T. Nilsson, and K. Foster. "Public Preferences and Private Choices: Effect of Altruism and Free Riding on Demand for Environmentally Certified Pork." *Environmental and Resource Economics* 36,4(2007):499–521.

Lusk, J.L., F.B. Norwood, and J.R. Pruitt. "Consumer Demand for a Ban on Antibiotic Drug Use in Pork Production." *American Journal of Agricultural Economics* 88(2006):1015–33.

Lusk, J.L., J. Roosen, and J. Fox. "Demand for Beef from Cattle Administered Growth Hormones or Fed Genetically Modified Corn: A Comparison of Consumers in France, Germany, the United Kingdom, and the United States." *American Journal of Agricultural Economics* 85(2003):16–29.

Lusk, J.L., and T.C. Schroeder. "Are Choice Experiments Incentive Compatible? A Test with Quality Differentiated Beef Steaks." *American Journal of Agricultural Economics* 86(2004):467–82.

Martin, A. "Burger King Shifts Policy on Animals." *New York Times*. March 28, 2007.

McCluskey, J.J., K.M. Grimsrud, H. Ouchi, and T.I. Wahl. "Consumer Response to Genetically Modified Food Products in Japan." *Agricultural and Resource Economics Review* 32(2003): 222–31.

Meyer, S.R. "Implementation of Mandatory Country of Origin Labeling (MCOOL) in the Pork Industry." *Choices (New York, N.Y. 1994)* 23(2008):39–42.

Morey, E.R. "TWO RUMS unCLOAKED: Nested-logit Models of Site Choice and Nested-logit Models of Participation and Site Choice." *Valuing Recreation and the Environment*. J.A. Herriges and C.L. Kling, eds. Northampton, MA: Edward Elgar, 1999.

Nilsson, T., K. Foster, and J.L. Lusk. "Marketing Opportunities for Certified Pork Chops." *Canadian Journal of Agricultural Economics* 54(2006):567–83.

Norwood, F.B. (2007). "Lessons Abound on Animal Welfare Issue." *The Voice of Agriculture-American Farm Bureau*. November 26, 2007.

Norwood, F.B., J.L. Lusk, and R.W. Prickett. (2007). "Consumers Express Views on Farm Animal Welfare." *Feedstuffs*. October 8, 2007.

Ohler, T., A. Le, J. Louviere, and J. Swait. "Attribute Range Effects in Binary Response Task." *Marketing Letters* 11(2000):249–60.

Ouma, E., A. Abdulai, and A. Drucker. "Measuring Heterogeneous Preferences for Cattle Traits among Cattle-Keeping Households in East Africa." *American Journal of Agricultural Economics* 89(2007):1005–19.

Parcell, J.L., and V. Pierce. "Factors Affecting Wholesale Poultry Prices." *Journal of Agricultural and Applied Economics* 32(2000): 471–8.

Parcell, J.L., and T.C. Schroeder. "Hedonic Retail Beef and Pork Product Prices." *Journal of Agricultural and Applied Economics* 39(2007): 29–46.

Poe, G.L., K.L. Giraud, and J.B. Loomis. "Computational Methods for Measuring the Difference of Empirical Distributions." *American Journal of Agricultural Economics* 87(2005):353–65.

Revelt, D., and K. Train. "Mixed Logit with Repeated Choices: Households' Choices of Appliance Efficiency Level." *The Review of Economics and Statistics* 80(1998):647–57.

Rigby, D., and M. Burton. "Preference Heterogeneity and GM Food in the UK." *European Review of Agriculture Economics* 32(2005): 269–88.

Roosen, J. "Marketing of Safe Food through Labeling." *Journal of Food Distribution Research* 34(2003):77–82.

Roosen, J., J.L. Lusk, and J.A. Fox. "Consumer Demand for and Attitudes Toward Alternative Beef Labeling Strategies in France, Germany, and the UK." *Agribusiness International Journal (Toronto, Ont.)* 19(2003):77–90.

Scarpa, R., and T. DelGiudice. "Market Segmentation via Mixed Logit: Extra-Virgin Olive Oil in Urban Italy." *Journal of Agricultural and Food Industrial Organization* 2(2004):1–18.

Schweikhardt, D.B., and W.P. Browne. "Politics by Other Means: The Emergence of a New Politics of Food in the United States." *Review of Agricultural Economics* 23(2001):302–18.

Tonsor, G.T., T.C. Schroeder, J.A. Fox, and A. Biere. "European Preferences for Beef Steak Attributes." *Journal of Agricultural and Resource Economics* 30(2005):367–80.

Tonsor, G.T., C. Wolf, and N. Olynk. "Consumer Voting and Demand Behavior Regarding Swine Gestation Crates." Working paper, 2008.

Train, K.E. "Recreation Demand Models with Taste Differences over People." *Land Economics* 74(1998):230–39.

———. *Discrete Choice Methods with Simulation*. Cambridge: Cambridge University Press, 2003.

United States Census Bureau (2006). *International Database Summary Demographic Data*. Internet site: http://www.census.gov/ipc/www/idb/ (Accessed October 27, 2008).

United States Department of Labor, Bureau of Labor Statistics (2008). Databases, Tables & Calculators by Subject. Series Id: APU0000704212.

Videras, J. "Religion and Animal Welfare: Evidence from Voting Data." *Journal of Socio-Economics* 35,4(2006):652–59.

Appendix A. Information Treatments and Choice Experiment Definitions

Respondents randomly received one of the following three information treatments:

1. Industry Information Treatment:

Use of Gestation Crates in Pork Production

Gestation crates refer to metal crates that house female breeding stock in individually confined areas during an animal's four-month pregnancy. Some pork producer organizations (such as National Pork Producers) suggest that using gestation crates may facilitate more efficient pork production, leading to lower pork prices for consumers.

2. Consumer Group Information Treatment:

Use of Gestation Crates in Pork Production

Gestation crates refer to metal crates that house female breeding stock in individually confined areas during an animal's four-month pregnancy. Some consumer groups (including the Humane Society of the United States and Sierra Club) suggest gestation crates are inhumane devices.

3. Base Information Treatment:

Use of Gestation Crates in Pork Production

Gestation crates refer to metal crates that house female breeding stock in individually confined areas during an animal's four-month pregnancy.

Attribute descriptions included in the choice experiments were:

Farm Size refers to the size of operation the animal was raised on where:

- *Small* means the animal was raised on a farm that is smaller than about 75% of the firms in the industry,
- *Median* means the animal was raised on a farm that is smaller than about 50% and larger than about 50% of the firms in the industry, and
- *Large* means the animal was raised on a farm that is larger than about 75% of the firms in the industry.

Production Practice is the method used in raising the animal where:

- *Typical* means the animal was raised using production practices typical for the industry,
- *Labeled Gestation Crate-Free* is the same as Typical except the animal is guaranteed to have been raised by a producer who voluntarily chose not to use gestation crates, and
- *Gestation Crate Ban* is the same as Typical except the animal is guaranteed to have been raised in a region (state or country) where the use of gestation crates is legally banned for all swine producers.
- *Country of Origin* refers to the country in which the animal was raised in and includes the United States, Canada, and Brazil.

Appendix B. Cholesky Matrix and Correlation Statistics from the Random Parameters Logit Model

Cholesky Matrix						
	Small	*Large*	*Ban*	*Label*	*Canada*	*Brazil*
Small	0.36*					
Large	−0.08	0.14				
Ban	0.99*	−0.07	1.51**			
Label	0.93*	0.57	0.91*	0.86		
Canada	−1.17*	−0.21	0.20	−0.20	0.95	
Brazil	2.98*	−0.68	−0.27	0.42	−0.78	0.88
Correlation Matrix						
	Small	*Large*	*Ban*	*Label*	*Canada*	*Brazil*
Small	1.00	−0.52	0.55	0.56	−0.76	0.90
Large	−0.52	1.00	−0.32	0.00	0.28	−0.64
Ban	0.55	−0.32	1.00	0.75	−0.30	0.43
Label	0.56	0.00	0.75	1.00	−0.47	0.45
Canada	−0.76	0.28	−0.30	−0.47	1.00	−0.82
Brazil	0.90	−0.64	0.43	0.45	−0.82	1.00

*, ** Indicates statistical significance at the 0.05, 0.01 level, respectively.