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

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Abstract:

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. Preference heterogeneity is found to drive notably diverse 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

There is increasing consumer interest in the production practices used in modern food production. Examples circulating throughout the meat industry currently include growing desire of consumers to know if and how antibiotics were used, if the product was produced "locally," and if animals were handled in an "animal friendly manner."

A particular issue facing the U.S. swine industry is the possible disadoption 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. While, 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 Florida and Arizona that will ban the use of gestation crates in their state (Videras, 2006). In November 2008, California residents will vote on a similar ballot initiative. Oregon was the first state to ban gestation crates using state 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 welfare friendly—meaning crate free—sources.

Not surprisingly, this growing consumer interest 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 (Lusk, Norwood, and Pruitt, 2006; Darby et al., 2008; Nilsson, Foster, and Lusk, 2006). A question yet to be addressed is if these legislative changes are welfare enhancing for the representative consumer. Moreover, additional evaluation of how consumer welfare impacts differ across consumers is needed. This 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). This has implications for all consumers in Florida 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 U.S. farms? This is an important question to address because if consumers are truly more interested in the size or country of residence 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 if these preferences are related to preferences for farm size and country-of-origin attributes; 3) evaluate if 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. Mixed logit and latent class models are employed to investigate the extent of consumer preference heterogeneity influencing conclusions to theses individual objectives. To the best of our knowledge, no previous research has examined U.S. 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 enable an improved assessment of possible adjustments in swine production practices, and to identifying consumer welfare impacts of banning gestation crates.

The manuscript proceeds with a short overview of related literature followed by a discussion of the methods and data utilized a comparison of the empirical models estimated. The article then concludes with results discussion and summary comments and implications.

Prior Research

Several studies have investigated what consumers are willing to pay to avoid or obtain various food attributes (McCluskey et al., 2003; Grannis and Thilmany, 2002; Roosen, Lusk, and Fox, 2003; Burton et al., 2001; Lusk, Roosen, and Fox, 2003; Roosen, 2003; Alfnes, 2004; Tonsor et al., 2005). A few studies have focused on consumer valuations of "animal friendly" products (Lusk, Nilsson, and Foster, 2007; Carlsson, Frykblom, and Lagerkvist, 2007b and 2007c; Lijenstolpe, 2008; Nilsson, Foster, and Lusk, 2006). However, none of these studies have evaluated 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) leads to an increasing proportion 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 (2007a) 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 of GM fodder in Swedish meat production, Carlsson, Frykblom, and Lagerkvist (2007a) 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 similarly designed (following Carlsson, Frykblom, and Lagerkvist (2007a)) to directly examine if 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 WTP for pork attributes. To collect information about consumer perceptions and preferences we conducted a survey of Michigan consumers. The surveys were mailed to households identified by SSI, a global market research company. In November 2007, 1,000 surveys were mailed and followed by a postcard reminder two 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. Consumers randomly received one of three types of information: a) *Industry Information*, b) *Consumer Group Information*, or c) *Base Information*. The appendix 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.

Pork chops were offered at three different price levels selected to be consistent with local retail prices. 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 allows for identification of own-price, cross-price, and alternative specific effects. This process also allows 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	
Avg. Farm Size	Large	Small	
Production Practice	Labeled Gestation Crate-Free	Gestation Crate Ban	Neither A nor B is preferred
Country of Origin	US	Canada	
I choose …			

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 (Lusk, 2003; Cummings and Taylor, 1999). 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 non-hypothetical valuations. Descriptions included in the choice experiments of the specific product attributes are included in the appendix.

Considering 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), potentially more regional banning of gestation crates (e.g., California), and significant use of typical production practices that may include gestation crate use. As such, the selections required in this choice experiment are applicable 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 outweighed female respondents and the average consumer was 56 years of age. 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.

Research Methods: RPL, LCM, and WTP 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) $$U_{ijt} = V(x_{ijt}) + \varepsilon_{ijt} \quad ,$$

where x_{ijt} is a vector of pork chop attributes and ε_{ijt} is the stochastic error component i.i.d. 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.[1]

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

(2) $$V_{ijt} = \alpha' P_{ijt} + \beta_i \mathbf{x}_{jt} \quad \forall\, j = A, B ,$$

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

where P_{ijt} is price and $\mathbf{x}_{jt}$ is a 6 x 1 vector of pork attributes ($\mathbf{x}_{jt} = [Small_{jt}, Large_{jt}, Crate\ \ Ban_{jt}, Labeled\ \ Crate\ \ Free_{jt}, Canada_{jt}, Brazil_{jt}]$). 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.[2] The remaining terms in equations (2) and (3) are α , β_i, and δ which are parameter vectors to be estimated.

The model laid out by equations (1) – (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 (Lusk, Roosen, and Fox, 2003; Alfnes and Rickertsen, 2003; Alfnes, 2004; 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 (IIA) 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 IIA 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) $$U_{ijt} = \lambda_i' x_{ijt} + \varepsilon_{ijt} \quad ,$$

where x_{ijt} is a vector of observed variables, λ_i is unobserved for each individual and varies within the population with density $f(\lambda_i \mid \theta^*)$ where θ^* are the true parameters of this distribution, and ε_{ijt} is the stochastic error component i.i.d. 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) $$P_i(\theta^*) = \int \prod_t \frac{e^{\lambda_i' x_{ij(i,t)t}}}{\sum_j e^{\lambda_i' x_{ijt}}} f(\lambda_i \mid \theta^*) d\lambda_i \, .$$

In the RPL model we specify the price variable 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 (Train, 1998; Scarpa and DelGiudice, 2004). For instance, consumers who are concerned 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 $\beta \sim N(\overline{\beta}, \Omega)$. The resulting coefficient vector is expressed as $\beta = \overline{\beta} + LM$ 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.[3]

While continuous heterogeneity is assumed in RPL models, latent class models (LCM) 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) $$P_i(ijt \mid s) = \prod_{t=1}^{T} \frac{\exp(B_s x_{ijt})}{\sum_{j=1}^{J} \exp(B_s x_{ijt})},$$

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. 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 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 $\hat{\delta}$ be the vector of model point estimates (e.g., individual elements of α , $\boldsymbol{\gamma}$, $\overline{\beta}$, and L), $\sigma = \text{var}(\hat{\delta})$, and T be the lower-triangular matrix of σ such that $TT' = \sigma$. We then take A draws from a standard normal distribution for each element of $\hat{\delta}$ and place them in a vector μ . For each of these A draws, we identify estimates of the model parameters as $\hat{\delta} + T\mu$. Secondly, for each of the simulated A parameter values, C drawings from a standard normal distribution are made for the heterogeneous preferences to generate a distribution of WTP estimates. Desired statistics (e.g., mean, standard deviation, proportion greater than a particular $/lb) for the C WTPs within each A drawing are identified. This provides a series (size A) of each 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.[4]

Willingness-to-pay estimates from the LCM model were derived specific to each segment, 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 segment membership probability as well as statistical 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. 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 (segment 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 (*A* x *A*) differences (e.g., $WTP_a - WTP_b \; \forall a, b$; where $a = 1,..., A$ and $b = 1,..., A$) 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 <u>voluntarily chose</u> 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 (2007a) 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. Consistent with Carlsson, Frykblom, and Lagerkvist (2007a), a ban can only be 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* pork.

Results

An array of alternative model specifications were considered prior to selecting the random utility model described above. While the multitude of model specification tests is not presented here for brevity, log likelihood tests consistently rejected 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) 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.[5] 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 three alternative models (1-segment multinomial logit, random parameters logit, and latent class logit) are provided in table 3. The 1-segment model is rejected in favor of the RPL and LCM models, but is presented as a benchmark comparison of results when assuming homogeneous preferences. When assuming homogeneity, the representative consumer was found to dislike pork from *Large* farms or from *Brazil* and to prefer pork labeled to have been voluntarily produced without use of gestation crates (*Labeled Gestation Crate-Free*).

In the RPL model, the majority of the estimated means for the random pork chop attribute parameters were statistically significant. Interpretation of individual coefficients must be done with caution and is generally discouraged in random utility models (Scarpa and Del Giudice, 2004). To further evaluate preference heterogeneity in the RPL model that allows for correlation in random pork chop attribute parameters we examine estimated Cholesky matrices. The diagonal values of each Cholesky matrix (table 3) 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 in each of the four models.[6] 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.[7] 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 non-stochastic portion of our RPL model (Alfnes, 2004).

The maximum likelihood estimates for the latent class model 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 (BIC) as discussed by Boxall and Adamowicz (2002). This criterion is minimized in a four-segment model, leading to the estimates presented in table 4.[8] Incorporating segment membership covariates (i.e., demographic and attitudinal information) 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 probabilities of 32%, 33%, 14%, and 20%. Only the first and fourth classes have significant, negative coefficients on the "opt out" parameter. This indicates that the second and third class are statistically indifferent to maintaining 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 segment 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 non-US pork and pork produced under a ban on gestation crate use (*Gestation Crate Ban*). Collectively, this leads us to refer to this group as the "*Attribute Conscious"* segment.

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 segment 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 (WTP) estimates are of particular interest. Results (point estimates and indication of statistical significance) of our simulations are presented in table 4 for the 1-Segment, RPL, and LCM models, respectively. The homogeneous, 1-Segment model indicates the representative consumer possesses a significant preference for pork from operations that have voluntarily chose to not use gestation crates (mean WTP of $1.13/lb) and a significant discount for pork from large farms (mean WTP of -$0.75/lb) or from Brazil (mean WTP of -$5.00/lb). Furthermore, the representative consumer is indifferent to pork from small and median farms, from operations using typical production practices or operating under a gestation crate ban, and to pork from Canada and the U.S.

Consideration of preference heterogeneity by using a random parameters logit model leads to slightly different conclusions. In particular, by examining both point estimates and overlapping of confidence intervals, the RPL model indicates a significant preference for pork from Canada over the U.S. (mean WTP of $1.44/lb) and a larger discount for Brazilian pork (mean WTP of -$9.49/lb). Both the RPL and 1-Segment model indicate 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 (RPL model mean WTP of $2.11/lb). Significance of the *Opt Out* coefficient in both models 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. Segment 3 ("*Price Conscious*") is the only group indifferent between pork form the U.S. 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 segment 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).

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, 2007a). As shown in Table 5, consumers (20% of the population) possessing the utility function represented by segment 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 segments in the LCM model, and for representative consumers modeled by the 1-Segment and RPL models, indicate either indifference between a gestation crate ban and voluntary disadoption (segment 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 segment 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 a 1-Segment or 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 1-Segement and RPL models 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, 2007a; 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 can not. 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 Small and Rosen (1978), Morey (1999) and Lusk, Norwood, and Pruitt (2006) we note that expected maximum utility from each consumers' choice set selection is given by:

(7) $$CV = \ln(\sum e^{V_j}) + C,$$

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 *A* to situation *B* is given by:

(8) $$\frac{1}{MUI}\left(CV^B - CV^A\right),$$

where *MUI* is the marginal utility of income.[9] 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 paper's discussion to this point assuming 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 all three models imply statistically significant welfare losses. As anticipated, the welfare losses are notably 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). It is important to note that the 1-Segment model implies welfare losses that are double those implied by the RPL model. Estimates for the four segments identified by the LCM model reveal differential welfare impacts. Consumers belonging to segment 2 ("*Attribute Conscious*") are found to experience significantly larger welfare declines than consumers in the other three segments. It is noteworthy that consumers of segment 4 ("*Ban Preferring*"), the only segment 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 surprising 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. Finally, it is critical to clearly note that these consumer welfare measures are based upon the assumption of no production cost adjustments and hence no overall pork price adjustments. In reality there would be some non-zero production cost adjustment, resulting in an increase in pork prices, further exacerbating the welfare estimates presented here.

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 (RPL) and latent class models (LCM), 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 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 typical 1-Segment multinomial logit and RPL models 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, are 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. 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." Furthermore, future work may consider applying multiple random utility models as this analysis in an example demonstration of the richer evaluation that can be conducted collectively by multiple models than is available by utilization of only one model.

Footnotes

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

[2] That is, the 6 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].

[3] 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* x *Small*).

[4] In our application we use 1,000 simulations for both steps (e.g., 1,000=*A*=*C*).

[5] 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.

[6] 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, 2003).

[7] The entire Cholesky matrix and corresponding correlation statistics are not presented, but are available upon request.

[8] Furthermore, marginal reductions in the AIC (Akaike Information Criterion) reduce significantly as additional latent classes are added and inclusion of more than 4 latent classes results in segments less than 10% in size.

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

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

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

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%

Table 3. Parameters (standard errors) for three choice models

Variable	*1 Segment Model*	*Random Parameters Model*		*LCM - 4 Segment Model*			
		Mean	Cholesky Diagonal Elements [b]	Segment 1 "*Pork Enjoyers*"	Segment 2 "*Attribute Conscious*"	Segment 3 "*Price Conscious*"	Segment 4 "*Ban Preferring*"
Membership Probability				0.3221**	0.3326**	0.1412**	0.2040**
				(0.0268)	(0.0261)	(0.0343)	(0.0331)
Small	0.0758	0.2033	0.3600*	0.2956	0.1705	-0.1199	-0.1351
	(0.0680)	(0.1234)	(0.1864)	(0.1836)	(0.1157)	(0.3769)	(0.1257)
Large	-0.1981**	-0.4666**	0.1365	-0.4429*	-0.1572	0.4426	0.0396
	(0.0665)	(0.1227)	(0.2100)	(0.1817)	(0.1121)	(0.3034)	(0.1246)
Gestation Crate Ban	-0.0854	0.1264	1.5109**	-0.6630**	-0.6001**	0.3756	1.4453**
	(0.0619)	(0.2131)	(0.2908)	(0.1956)	(0.1092)	(0.3566)	(0.1276)
Labeled Gestation Crate-Free	0.2990**	0.7695**	0.8550	0.5499**	0.3286**	-0.0881	0.8110**
	(0.0676)	(0.2319)	(0.5477)	(0.1886)	(0.1178)	(0.3507)	(0.1245)
Canada	-0.0344	0.5115*	0.9450	0.1954	-0.4105**	-0.7734	0.1663
	(0.0670)	(0.2037)	(0.5392)	(0.1937)	(0.1293)	(0.4506)	(0.1170)
Brazil	-1.3211**	-3.4415**	0.8823	-1.9029**	-2.3232**	-0.3335	-1.3740**
	(0.0882)	(0.3786)	(1.1321)	(0.2690)	(0.2208)	(0.4276)	(0.1446)
Opt Out	-2.0796**	-1.9123**		-9.0966**	-0.3138	-0.5281	-1.8749**
	(0.1878)	(0.3079)		(0.8546)	(0.3357)	(0.9929)	(0.3392)
Price	-0.5319**	-0.7317**		-1.3306**	-0.3662**	-0.9408**	-0.5173**
	(0.0388)	(0.0622)		(0.1495)	(0.0632)	(0.2548)	(0.0656)

Notes: Presented models (log likelihoods of -1,417, -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] One (two) asterisk(s) indicates statistical significance at the 0.05 (0.01) level.

b These values are the diagonal elements of the random parameter model's Cholesky matrix. The entire Cholesky matrix and corresponding correlation statistics are available upon request.

Table 4. Consumer willingness-to-pay [95% confidence intervals] for pork attributes

	1 Segment Model	*Random Parameters Model*	*LCM - 4 Segment Model*			
			Segment 1 "*Pork Enjoyers*"	Segment 2 "*Attribute Conscious*"	Segment 3 "*Price Conscious*"	Segment 4 "*Ban Preferring*"
Small (vs. Median)	$0.30	$0.56	$0.48	$0.99	-$0.21	-$0.52
	[-$0.21, 0.84]	[-$0.15, 1.26]	[$-0.07, 1.09]	[-$0.23, 2.60]	[-$1.70, 1.69]	[-$1.42, 0.46]
Large (vs. Median)	-$0.75	-$1.27	-$0.70	-$0.89	$0.98	$0.17
	[-$1.27, -$0.26]	[-$1.97, -$0.64]	[-$1.36, -$0.15]	[-$2.32, 0.40]	[-$0.50, 2.73]	[-$0.81, 1.11]
Gestation Crate Ban (vs. Typical)	-$0.32	$0.34	-$1.00	-$3.39	$0.73	$5.62
	[-$0.77, 0.17]	[-$0.79, 1.58]	[-$1.58, -$0.45]	[-$5.44, -$1.99]	[-$0.97, 2.30]	[4.18, 7.41]
Labeled Gestation Crate-Free (vs. Typical)	$1.13	$2.11	$0.84	$1.86	-$0.08	$3.13
	[0.63, 1.67]	[0.71, 3.54]	[0.30, 1.39]	[0.50, 3.49]	[-$1.68, 1.75]	[2.08, 4.39]
Canada (vs. US)	-$0.13	$1.44	$0.33	-$2.29	-$1.68	$0.64
	[-$0.62, 0.36]	[0.27, 2.64]	[-$0.28, 0.99]	[-$4.05, -$0.83]	[-$4.03, 0.20]	[-$0.30, 1.57]
Brazil (vs. US)	-$5.00	-$9.49	-$2.90	-$13.13	-$0.89	-$5.35
	[-$5.93, -$4.14]	[-$12.55, -$7.00]	[-$3.72, -$2.19]	[-$20.00, -$9.00]	[-$3.51, 1.11]	[-$7.19, -$3.93]
Opt Out	-$3.91	-$2.60	-$6.88	-$0.72	-$0.23	-$3.62
	[-$4.15, -$3.65]	[-$3.01, -$2.10]	[-$7.54, -$6.35]	[-$2.06, 1.49]	[-$1.73, 3.43]	[-$4.14, -$3.06]

[a] Simulated confidence 95% confidence intervals are presented in brackets and were derived by the complete combinational approach of Poe, Giraud, and Loomis. All presented values are in $/lb units.

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]
1 Segment Model	-\$0.32	\$1.13	0.999
Random Parameters Model	\$0.34	\$2.11	0.972
LCM-Segment 1 "*Pork Enjoyers*"	-\$1.00	\$0.84	0.999
LCM-Segment 2 "*Attribute Conscious*"	-\$3.39	\$1.86	0.999
LCM-Segment 3 "*Price Conscious*"	\$0.73	-\$0.08	0.228
LCM-Segment 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.

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
1 Segment Model	-$0.38	-$10,326.03	-$0.19	-$5,127.95
	[-$0.53, -$0.28]	[-$14,205.04, -$7,509.84]	[-$0.26, -$0.14]	[-$6,919.09, -$3,692.88]
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-Segment 1	-$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-Segment 2	-$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-Segment 3	-$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-Segment 4	-$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]

[a] 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).

Appendix. 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 U.S. 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.

Appendix. Information Treatments and Choice Experiment Definitions (continued)

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 on and includes the US, Canada, and Brazil.