

**A Calibrated Auction-Conjoint Valuation Method:
Valuing Pork and Eggs Produced under Differing Animal Welfare Conditions**

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Abstract: This paper introduces a valuation method which has the potential to generate consistent and systematic estimates of people's preferences for multi-attribute products by inextricably linking auction bids with conjoint ratings. The method is used to determine people's preferences for eggs and pork produced from different production systems. Data from three diverse U.S. locations (Chicago, IL, Dallas, TX, and Wilmington, NC) indicates that people are, on average, willing to pay \$0.93 for a dozen eggs raised in an aviary, pasture system vs. a cage system, and are willing to pay \$2.02 for two-pounds of pork chops raised in a pasture system as opposed to a crate system. The advantage of the valuation approach is that it permits the estimation of people's values for these and many other potential production systems, and allows one to decompose people's values for a production system into its sub-components.

Key words: animal welfare, auction, conjoint, discovered preference hypothesis, willingness-to-pay

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Although survey and experimental valuation methods have become standard tools in economic and marketing research, there remains significant debate on the malleability, contextuality, and even irrationality of elicited values. When a behavioral anomaly is observed in a survey or experiment that violates a normative model of consumer behavior, two options exist: (i) add parameters to the utility function to create a behavioral theory that is consistent with the observed choices, and/or (ii) utilize an institutional or elicitation setting that promotes more systematic and rational behavior. The explosive growth in the field of behavioral economics has tended to follow the first approach in that the typical paper identifies a “bias” in decision making and then outlines a new model that can account for the bias (e.g., Kahneman and Tversky, 1979; O’Donoghue and Rabin, 1999). In this article, we pursue the second path by combining the strengths of the conjoint and auction value elicitation mechanisms in a hybrid approach we refer to as a calibrated auction-conjoint method (CACM).

Despite the appeal of the typical behavioral economics approach, elicited values are most useful in cost-benefit analysis and in making marketing decisions if they arise from some systematic and stable process consistent with normative principles. Relying on rational theory to inform public policy and marketing is most useful if people make, or act as if they make, consistent and systematic choices. Unfortunately, people do not always act in such a systematic manner. For example, there is now an extensive literature on the so-called preference reversal phenomenon, which began with the early studies of Lichtenstein and Slovic (1971) and Grether and Plott (1979). Preference reversals refer to a situation when a person chooses good A over good B in task involving a straightforward choice, but places a higher monetary value on B than A in a pricing or auction-type task. In one of their experiments, Grether and Plott (1979) showed the effect to be quite pervasive with 70% of participants preferring one lottery in a choice task,

but assigned a higher value to another lottery in a pricing task. The identification of preference reversals has led to the development of a variety of competing behavioral theories, virtually all of which abandon classical preference theory (e.g., Goldstein and Einhorn, 1987; Tversky, Slovic, and Kahneman, 1990). An alternative approach to developing new theories of behavior is to ask whether there might be environments in which people will act in a more systematic and consistent manner, and indeed and Chu and Chu (1990), Cherry, Crocker, and Shogren (2003), and Cherry and Shogren (2007) have found that certain elicitation environments can significantly reduce if not eliminate preference reversals and other behavioral anomalies.

If we accept the premise that analysts need to elicit people's values to inform cost-benefit and marketing analyses, a natural question that arises is whether environments or elicitation mechanisms can be created that generate rational and systematic willingness-to-pay values. The purpose of this paper is to introduce just such a mechanism, the CACM, which forces a kind of rationality or internal consistency on people's behavior. The CACM can be described generally as follows. Like typical experimental auction methods (e.g. see Lusk and Shogren, 2007), people place bids on several products. Like typical conjoint methods (e.g., see Louviere, Hensher, and Swait, 2000), the products are defined by a bundle of attributes. But unlike typical auction and conjoint methods, the CACM involves an iterative and interactive decision making task where people's auction bids are inextricably linked to an underlying attribute-based utility function. The method is "self-calibrating" because the only way for people to alter their bids for a product is by changing their utility coefficients via responses to rating scales. In essence, people must calibrate their attribute-based utility function to produce the auction bids they desire. For example, individuals cannot simply increase their bid for a product; to bid higher they must change their answers to questions about the relative importance of a product attribute. The

CACM was design specifically for the application studied in this paper, animal welfare, and is particularly useful in other such applications where there are there are a large number of complex attributes related to product outcomes.

The CACM possesses several advantages over existing valuation approaches. First, as previously indicated, the CACM generates consistent and systematic responses by linking auction bids with conjoint ratings. This consistency or rationality works in three ways. The first is simply that the method, by definition, imposes a mechanical or algebraic relationship between valuations and utility. Secondly, and more importantly, people are able to directly see the consequences of their conjoint-rating decisions and the trade-offs implied in their auction bids. That is, the CACM puts the conjoint-ratings in an economic context where choices have consequences that might otherwise be less transparent. Likewise, the CACM puts the auction bids in a context where it is clear that the valuations correspond in a systematic way to underlying product attributes. Finally, despite what is typically assumed, people may not have well formed preferences for the goods being valued in an experiment, which could lead to a number of behavioral anomalies. Plott (1996), however, argued, via the so-called discovered preference hypothesis, that although people may not have well formed preferences, rational choice arises from a series of stages in which people gain experience with and receive feedback from a particular market environment. Empirical support for the theory can be found in studies on preference reversals as just discussed, the willingness-to-pay/willingness-to-accept gap (Shogren et al., 1994), and violations of expected utility theory (Keren and Wagennar, 1987). See Braga and Starmer (2005) for a more complete discussion. An advantage of the CACM is that it entails a lengthy and iterative valuation process that promotes learning and provides

feedback, which according to the discovered preference hypothesis, promotes the formation of rational preferences.

A second key advantage of the CACM is that it allows for a distribution-free characterization of heterogeneity in preferences.¹ For example, in typical contingent valuation or conjoint methods, people simply choose (or rank) which product or outcome they most prefer. Assumptions must be made about the form of a representative utility function and the distribution of errors in the random utility model for such responses to be meaningfully used. Although preference heterogeneity can be incorporated in discrete choice models by using advances in econometric techniques, such as mixed logit models or hierarchical Bayes models (e.g., Train, 2003), such approaches require assumptions about a functional form for the utility function and assumptions about the joint distribution of preferences.

Although an assumption must be made about the functional form for the utility function, the CACM allows one to obtain utility coefficients for each individual without using econometric methods or assuming anything about the distribution of preferences in the population. It is curious that the recent interest in preference heterogeneity has only altered the statistical techniques practitioners use, but has not affected the survey or experimental elicitation methods employed. The elicitation method used in this study is specifically designed to uncover preference heterogeneity.

A final key advantage of the CACM is that it allows for the evaluation of a large number of attributes and attribute-levels and permits the estimation of people's values for a very large number of products – much larger than the number of products people bid on in an

¹ Identifying heterogeneity is important to: (i) develop market segmentation strategies which rely on grouping individuals with similar preferences, (ii) implement and test various models of market power and price discrimination, (iii) determine the aggregate and distributional effects of public policy, and (iv) test economic theory which is formulated to hold, with the fewest assumptions, at the individual level.

experiment. For example, in the application we consider there are numerous attributes or characteristics that can be used to describe the well-being of farm animals. In one of our applications, for example, we consider 10 non-price attributes, most of which were varied at 4 levels or more. This means there are at least $4^{10} = 1,048,576$ possible products that could be created based on the variation in attributes.

A typical conjoint-type approach would attempt to select from this full factorial of 1,048,576 possible options a much smaller number to present to respondents, but assuming one utilized a design where only main effects were orthogonal would still require that each person evaluate 64 options. Asking people to rank or choose between 64 options in a consistent and systematic manner is likely beyond the capabilities and patience of most respondents. To circumvent this problem, the CACM relies instead on the so-called self-explicated approach to preference measurement, where people simply rate the relative desirability of attribute-levels and the relative importance of attributes. The self-explicated approach has been shown to perform as well or better than traditional conjoint analysis (e.g., see Srinivasan and Park, 1997; Srinivasan and deMaCarty, 1999).

The ability to value multiple attributes is of paramount importance for farm animal welfare, where a change in one farm practice may result in unintended consequences for animal welfare. For example, animal advocacy groups have been particularly interested in banning gestation stalls in hog operations. If stalls are banned, producers will likely transition to group pens, where multiple sows may be housed in cramped conditions creating an environment conducive to injury from inter-sow fighting. Thus, determining whether consumers value the elimination of gestation stalls also requires estimating the value consumers place on reducing sow injury.

The next section of the paper provides more background on animal welfare. We then discuss our experimental methods, including a more detailed discussion of the CACM. The following section presents the results, and the final section concludes.

Background on Farm Animal Welfare

Animal welfare is rapidly becoming one of the most contentious issues in animal agriculture (Farm Foundation, 2006). For example, it is estimated that about 50 to 60 pieces of legislation regarding animal welfare are introduced in the U.S. Congress each year (Rollin, 2004). Citizens in Arizona and Florida have recently voted to pass constitutional amendments to ban the use of gestation crates in hog production, and similar measures are on the horizon in several other states including California. Recent events have served to further highlight the growing concern about animal welfare issues. In February 2008, the largest beef recall in U.S. history took place. The U.S. Department of Agriculture ordered the Hallmark/Westland Meat Packing Co. to recall 143 million pounds of beef in response to undercover video made public by the Humane Society of the United States (HSUS), which showed a variety of cruel and inhumane practices at the packing plant. Such events have helped the Humane Society of the United States (HSUS) in their efforts to further push a host of ballot and legislative initiatives related to animal welfare (e.g., the U.S. congress passed a ban on horse slaughter).

Although it is clear that there are many important public policy issues at play in the animal welfare debate, in this paper we focus more specifically on aspects related to the marketing of products produced under alternative conditions of animal care, which is becoming increasingly important to food retailers. For example, food retailers such as McDonald's and Burger King have adopted improved animal welfare standards as a result of pressures from

activist groups and a perception that such changes were demanded by their customers. Further, there are many specialty grocers such as Wild Oats that are proactively appealing to growing concern about animal welfare by selling “animal compassionate” meat. Indeed, there are even certification agencies and labels such as “certified humane,” available to producers interested in exploiting such market opportunities. These developments suggest the need for a better understanding of people’s preferences for food produced under different conditions of animal well-being.

One of the key challenges in studying people’s preferences for the well-being of farm animals is that animal well-being is a complex and multi-dimensional issue. Most previous studies have tended to focus on eliciting consumer preferences for a limited number of production practices, such as the use of cages, gestation crates, or mobile abattoirs (e.g., Bennett, 1987; Carlsson, Frykblom, and Lagerkvist, 2007; Tonsor, Olynk, and Wolf, 2008). However, such results are necessarily limited to the specific production practice studied and do not generalize well when attempting to forecast what consumers think about entire production systems.

For example, consider the recent bans on gestation stalls in the U.S. These stalls confine sows to a metal crate slightly larger than the sow herself, and the sows are kept in the stalls for two-thirds of their lives. Many contend this practice is inhumane, but what are the consequences of a ban on stalls? If stalls were banned, many producers would likely replace gestation stalls with gestation pens. These pens hold several sows, but the space per sow is roughly the same as the stall. Unfortunately, multiple sows in a cramped space frequently inflict injury one another. In fact, scientific studies have concluded animal well-being is roughly equivalent in gestation stalls and gestation pens (McGlone et al., 2004; Task Force Report, 2005). Surely, consumers

require such information to properly value a gestation stall ban. Nevertheless, previous studies on consumer willingness-to-pay for pork produced without gestation crates have tended to utilize choice experiments, and the need for parsimony prohibited the studies from considering the full consequences of crate-free pork, which includes the positive value of increased sow space and the negative value of increased sow injuries.

Consider another example: banning minor surgeries such as beak trimming in poultry production. A ban would reduce the pain from the surgery but could lead to more injuries from inter-bird pecking and fighting. If consumers are not informed of the secondary effect and are unable to modify their choices appropriately, a simple choice experiment measuring the value of a beak trimming ban could provide misleading estimates. Understanding how a change in production practices alters animal well-being requires a holistic consideration of many attributes, and a valuation instrument that has the ability to take such a holistic point of view is needed.

It would be a significant challenge to determine consumer preferences for the large number of attributes that characterized the well-being of farm animals using conventional approaches like experimental auctions or conjoint analysis. For example, in trying to devise a system to characterize the well-being of sows housed in seven different production systems, Bracke et al. (2002) utilized 37 different attributes (such as space per sow, space per pen, etc.) related to 12 different well-being outcomes (such as pain, illness, aggression, etc.). This difficulty with traditional valuation approaches is reflected in recent study by Liljenstolpe (2008), who measures the consumer value of animal welfare improvements in hog production. Liljenstolpe (2008) utilized a choice experiment, which requires a manageable number of attributes and attribute levels. To achieve this manageable number, Liljenstolpe (2008) focused only on the welfare of growing pigs, ignoring the welfare of breeding sows. However, most of

the debate regarding hog production has centered on the welfare of the breeding sows. By ignoring the welfare of sows, consumers may fall under the false impression that the attributes present in the choice experiment completely determine the well-being of pigs.

This study measures consumer preferences for the most important attributes in determining farm animal welfare, as determined by animal science research, at the production facility. Our approach does not consider activities away from the farm, such as transportation or harvesting methods. The particular attributes utilized in this study were also selected for their relevance to current animal welfare debates. Details on the attribute and attribute levels selected are provided in the next section. Interested readers are referred to the appendices to see how this information as it was presented to the subjects.

It should be clear from the preceding discussion that there is a need for a method that is able to consider a numerous and complex set of attributes, and is capable of eliciting preferences for these numerous attributes without producing subject fatigue or irrational responses. Such an instrument is described in detail in the next section.

Methods and Data

To study people's preferences for animal well-being, three marketing research companies were hired to recruit 100 people from the general population of each of the following U.S. cities: Chicago, IL, Dallas, TX, and Wilmington, NC. The companies were asked to recruit participants to reflect the demographic make-up of the respective locals, and to avoid "professional respondents," by only recruiting people who had not participated in a research project within the past 6 months. Participants were recruited by phone to participate in a "food preference study" and were paid between \$60 and \$85 (depending on the location) to participate in a 90 minute

session. These three locations were chosen because they are geographically disparate, and thus provide diversity in several demographic variables. Furthermore, the locations were selected because much of our analysis focuses on pork. Data suggests that per-capita pork consumption is highest in the Midwest and the South (Davis and Lin, 2005), the location of our experiments. Furthermore, data suggests per-capita pork consumption is particularly high among African Americans (Davis and Lin, 2005), and the relative share of the population that is black is significantly higher in Wilmington (25.8%), Dallas (25.9%), and Chicago (36.8) than in the U.S. as a whole (12.8%) according to the U.S. Census Bureau.

Collecting data in person, rather than through phone, mail, or Internet survey was extremely important in this application given the complex issues involved the need to convey a substantial amount of information to people about animal production practices and answer questions for subjects know little about livestock and poultry production. Within each location, one half of the subjects (50) were randomly assigned to the egg layer treatment and the other 50 subjects were assigned to the pork treatment. In each location, four sessions were held with approximately 25 people each, and we rotated which treatment was assigned to a session (i.e., the first session held in Dallas was with 25 people evaluating eggs, the second session in Dallas was with 25 people evaluating pork, the third session in Dallas was with 25 people evaluating eggs, and the last session in Dallas was with 25 people evaluating pork).

Once people arrived at a session they were seated in front of a lap-top while the monitor made several introductory comments. The introductory comments stressed the points that: (i) the researchers were not affiliated with either animal production or animal rights organizations, (ii) all responses were completely confidential, (iii) there would be several real money, real product

decision tasks, and (iv) the respondents should not try to answer in a “socially acceptable” way or in a way to “please” the researchers, but rather to honestly provide their own preferences.

After the introduction, people were presented a lengthy presentation describing the attributes characterizing hog or egg laying production systems. The key attributes and attribute-levels were chosen by selecting the key factors affecting hog and layer welfare identified in previous animal science research (Bracke et al, 2002; De Mol et al., 2006). The attributes included issues like space, optional surgeries, flooring materials, etc. The authors of these animal science studies were personally contacted, and they provided information on the range over which each of the attributes was varied and described how each production system related to each of the underlying attributes. Table 1 lists each of the attributes and attribute levels studied in the egg and pork treatments. A copy of the introductory presentations is included in Appendix A.

Collection of data proceeded in three steps as shown in figure 1. The two steps were designed to loosely follow the methods used by Srinivasan and Park (1997). In step 1, people were shown numerous tables corresponding to each of the attributes studied, and in each table, people were asked to rate the desirability of each attribute-level on a scale of 1 to 7, where 1 was very undesirable and 7 was very desirable. Thus, unlike typical conjoint approaches where people rate, rank, or choose between different product options that differ by attributes (typically an experimental design is used to create different options defined by different levels of each attribute), this self-explicated approach simply asks people to evaluate the desirability of each attribute-level directly. In addition to the information presented by the moderators in the preliminary instructions, on the computer screen additional information was provided about each attribute to aid the subjects’ understanding of each attribute’s role in animal well-being.

After rating the relative desirability of each level within an attribute, in step 2 people were asked to indicate the relative importance of each attribute. We accomplished this task in two stages to ease respondent burden. First, subjects were simply asked to rate the relative importance of each of the attributes to them when purchasing eggs or pork chops on a scale of 1 to 7, where 1 was very unimportant and 7 was very important (step 2). Respondents were encouraged not to rate everything as very important, but rather to think about the *relative* importance. In step 3, these ratings were used to provide a starting point for “importance weights” assigned to each of the attributes, where the weights summed to 100 across each of the attributes. In step 3, respondents were allowed to adjust the weights upward or downward to match their own desires.

Once step 2 had been completed, sufficient data were available to calculate each person’s attribute-based utility for a pork chop or carton of eggs. In particular, a person’s utility for a product can be calculated by multiplying the relative importance of each attribute, normalized to sum to one over all attributes, by attribute’s rating. Let I_k represent the stated importance of the k^{th} attribute, where $\sum I_k = 1$. Further, let R_{kl} represent the rating of the l^{th} level of the k^{th} attribute, which is normalized so that the lowest rated level of each attribute has a scaled rating of 0 and the highest rated level of each attribute has a scaled rating of 1. We write individual i ’s utility for pork chop or egg carton option j as:

$$(1) \quad Z_{ij} = W_{kl} \sum_{k=1}^K \sum_{l=1}^{L_k} (I_k R_{kl})$$

where L_k is the number of levels over which the k^{th} attribute is varied, K is the number of attributes, and W_{kl} is a dummy variable that equals 1 if the product possesses the l^{th} level of the k^{th} attribute, and 0 otherwise. The term $I_k R_{kl}$ can be interpreted as a utility “part-worth,” which is the utility provided from the l^{th} level of the k^{th} attribute. This part-worth is analogous to the

coefficients in a random utility model estimated from a conjoint analysis, with W_{kl} being the explanatory variable for the presence of absence of an attribute in the conjoint analysis.

Equation (1) is the basis from which a typical conjoint study would estimate consumer preferences and willingness-to-pay for product attributes (e.g., see Srinivasan and Park, 1997). That is, a typical conjoint-type study would have stopped at this point. The problem with stopping at this point and utilizing the utility function calculated in (1) is that people are unable to directly see the consequences of their rating decisions and the trade-offs implied. To put the ratings in an economic context which have real consequences, we take the analysis a step further. In particular, equation (1) was used to calculate, for each person, their willingness-to-pay for five different pork or egg products that differed according to the underlying attributes. Willingness-to-pay to have one product versus another is calculated, quite simply, by calculating the utility differences between the products (by using equation 1) and dividing by the “part-worth” on price, which represents the marginal utility of income.

Prior to revealing this willingness-to-pay calculation to people, however, two additional training/information phases were necessary. First, people were introduced to the five products that systematically differed by the underlying attributes. People were given another power point presentation describing each of the products which detailed exactly how they differed from one another on the underlying spectrum of attributes. A copy of the presentation is included in Appendix B. Table 2 lists each of the five products/production systems and shows how they differ along the continuum of attributes studied in the hog and egg treatments. The products were completely described by the underlying attributes.

Following this presentation, people were told that they would have the opportunity to participate in auction to purchase the five packages of pork chops (each were two-pound

packages of fresh pork chops that were identical except for the attributes in question) or five egg products (each were one dozen brown eggs that were identical except for the attributes in question). Then, people were trained on the bidding procedures used. In particular, people first bid to buy a Snickers bar using a Becker-DeGroot-Marshack (BDM) type mechanism. Each person submitted a bid, one bid was chosen at random, and the bid was compared against a randomly drawn “secret price.” If the bid was higher than the secret price, the person bought the candy bar for a price equal to the secret price; if the bid was less than the secret price, no candy bar was purchased and no payment was made.

The participants were shown numerous examples and were provided several justifications illustrating why it was in their best interest to bid truthfully – i.e., submit bids exactly equal to their maximum willingness-to-pay. Once participants were trained using the single candy bar auction, then another auction was held for five different types of candy bars to train people for subsequent bidding for five pork/egg products. The procedures used were as follows: people submitted bids for each of the five candy bars, one of the candy bars was randomly selected as “binding,” one of the bids was randomly selected as “binding,” and if the bid was higher than the secret price, the person bought the candy bar for a price equal to the secret price; if the bid was less than the secret price, no candy bar was purchased and no payment was made.

At the completion of the training phase, people were then shown a screen on their laptop that looked like what is shown in figure 1, step 3. Because the conjoint ratings only provide an indication of the *relative* desirability of products, equation (1) cannot identify an “overall” or “total” willingness-to-pay amount – only willingness-to-pay differences. Thus, people were first asked to use the drop-down box to place a bid for, depending on the treatment, eggs from cage system or pork from the crate system. Then, using each person’s previous responses and

equation (1), a bid was forecasted for each of the other four products. People were told that these computed bids were “intelligent guesses” of how they would value each of the products based on their previous answers, but that many people would likely want to alter their bids. To change the bids, people had to change the “importance weights” shown on the left-hand side of the screen assigned to each attribute (see step 3, figure 1) and they could also go back and change any of their previous ratings if they so desired. For example, if people wanted to bid a higher amount for eggs from a free-range system relative to the cage system, then they would need to increase the relative weight given to the attribute of free range. If people wanted to increase (or decrease) all bids proportionally, then they simply had to decrease (or increase) the “importance weight” assigned to the attribute of price.

Respondents were given numerous examples of how to change the importance weights to generate bids that matched their preferences and were given ample time to complete the task. Three experimental monitors assisted any participants that had difficulty making the bids fit their true preference, and subjects were given ample time to achieve their desired bids. Once a participant was comfortable with their bids for the products from the five production systems, they hit a “submit bids” button and waited for other participants. By requesting that people change the importance weights to alter their bids, each person was effectively calibrating equation (1) to match what they were willing to bid on each of the products; this results in a utility function that is systematically matched with people’s values in a context that has real economic consequences.

Once all bids were submitted, then one of the five pork/egg products was randomly selected as binding, and one of the bids for the product was randomly selected as binding. Importantly, no one’s bid was made public information, and people were repeatedly reminded

that all bids were private information and would not be revealed. At the conclusion of the experiment, the binding bidder was taken to a different room, and their bid was compared with the randomly drawn “secret price.” If the bid was greater than the secret price, the purchase ensued; otherwise, the participant paid nothing and received nothing.

Results

In total, 291 people participated in the study. Across all treatments, about 54% of subjects were male, while 46% were female. People of all age groups were well represented with 11%, 19%, 23%, 22%, 19%, and 7% of the sample falling in the following in the respective age categories, 18-24, 25-34, 35-44, 45-54, 55-64, and 65 or older. Almost half the sample had a bachelor’s degree or higher. About 36% had an annual household income less than \$40,000, about 37% had annual household income between \$40,000 and \$80,000, and the remaining 27% had household income greater than \$80,000. In terms of race, about 55% of the sample was white, 24% was black or African American, 12% was Hispanic, and 6% of the respondents were of Asian descent.

Table 3 reports people’s bids for a dozen eggs from each of five production systems. Across all locations, the mean bid for a dozen eggs from the cage system was \$0.90, and this value increased by \$0.60 to \$1.50 for eggs from the barn system. Interestingly, bids for eggs from the aviary system were only \$1.38, which is less than that for eggs from the barn system. An aviary system is like a barn system except that it has vertical layers or floors such that more birds can be housed on a unit of land (see the pictures in appendix B). Looking back at table 2, we can see that the aviary system differs from a barn system in that it has more barn space per hen, but less barn floor space per hen. Apparently, the gain in total barn space was not sufficient

to off-set the disutility of the decrease in barn floor space, resulting in eggs from the aviary system being valued less, on average, than that from a barn system. One might question whether such a preference ranking is “rational.” The answer is yes; the objective scientific rankings of animal well-being provided by De Mol (2006) indicate that animal well being is indeed slightly lower in an aviary system as compared to a barn system. The results in table 3 indicate that the aviary with free range and organic systems are most valued by consumers at \$1.84 and \$2.18 per dozen, respectively.

Table 4 reports people’s bids for a two pound package of pork chops from five different pork production systems. Across all locations, the mean bid for pork from the crate system was \$1.50. Bids for pork from a pen system were about \$0.13 higher or \$1.63. It is instructive to note that while bids for pork from the pen system are higher on average (a difference which is statistically significant), the magnitude is not particularly large. Bans on gestation crates have been proposed in several states (and have already happened in Arizona, Colorado, and Florida), and it is likely that many producers, if they stay in business, would transition from a crate-type system to one like a pen system were a ban on gestation crates enforced. Our results suggest that while such a change is positively valued, it is not markedly so.

It is instructive to compare the average premium for gestation-crate free pork in our study of about \$0.13 (for two pounds of pork) to the \$2.11 (per choice between one pound pork chops) estimate for “labeled gestation crate-free” pork provided by the random parameter logit model in Tonsor, Olynk, and Wolf (2008).² Why the stark difference? There are many differences in the two studies, and as such there is unlikely to be a definitive answer to this question; however, it is important to note that the choice experiment used by Tonsor, Olynk, and Wolf (2008) only

² Tonsor, Olynk, and Wolf (2008) find a much lower estimate from the simpler multinomial logit model (\$1.13), but one that remains substantially higher than our estimate of \$0.13. They also report that willingness-to-pay for legislation to ban gestation crates is effectively zero.

included a single attribute related to animal welfare: the use or non-use of gestation crates. We hypothesize that the subjects in our experiments significantly discounted space per sow, when they recognized that space per sow is only one of many factors affecting animal welfare. Although our study only found a relatively small value associated moving from a crate to pen system, by contrast, people's bids were almost twice as high for the open barn, pasture, and organic systems as compared to the crate system at \$3.33, \$3.51, and \$3.80, respectively. As can be seen by looking at the attributes in table 2, much of this increase is likely a result of a move to a free range system.

This paper was motivated, in part, by arguing that the CACM generates rational and systematic bids even in the presence of numerous, complex product attributes. Support for this line of argument can be found by comparing people's bids with expert opinion on animal welfare. Bracke et al. (2002) and De Mol et al. (2006) constructed models based on surveys of the animal science literature to generate predictions of animal well being in differing pork and egg production systems, respectively.³ Figure 2 plots the median bid (for the entire sample) for eggs/pork from the four non-organic production systems (we exclude organic because providing organic feed does not change animal well being) against the animal welfare scores from the models developed by Bracke et al. (2002) and De Mol et al. (2006). Results suggest a strong positive relationship between median bids and objective scientific ratings of animal well being.

Indeed, the correlation coefficients between bids and animal welfare scores are in excess of 0.90 for both eggs and pork. Furthermore, figure 2 shows that when professional assessment of animal well-being is similar, people's bids are generally similar as well. Overall, these results

³ The Bracke et al. (2002) study only provides estimates of sow well being, while we also included some attributes related to the well-being of farrows. Thus, there is not a perfect one-to-one comparison of the Bracke et al. (2002) welfare measures and our willingness-to-pay values. Nevertheless, we believe comparing the estimated well being of sows from a particular production system with our bids for systems which include such sows is instructive.

suggest that people assimilated the information presented to them, and that their auction bids are indeed reflective of underlying differences in animal well-being across the differing production systems. Of course, consumer values need not coincide with scientific animal welfare assessments. Consumers may place a higher value on certain attributes than would scientists, or even the animal themselves. What figure 2 demonstrates is that consumers gave careful, thoughtful responses to the questions, the valuation instrument aggregated these responses in a rational fashion, and that consumers have reasonably accurate perceptions about what factors contribute towards animal well-being.

Although one could have simply utilized traditional experimental auction procedures to generate the bids shown in tables 3 and 4, the CACM method yields more information than could be extracted from a conventional auction. Indeed, bids for each of the systems can be “decomposed” into people’s values for each of the underlying attributes comprising the production system. Given people’s bids and the calibrated attribute-based utility function, we can calculate the utility of and willingness-to-pay for eggs or pork from *any* production system comprised of any combination of attributes shown in table 1. To illustrate, table 5 reports mean and median willingness-to-pay (for the entire sample) for selected marginal changes in attribute levels for pork.⁴ Table 5 shows that people are willing to pay \$0.35, on average, for a gestating sow to have 60 rather than 14 square inches of space. Interestingly, the value for the same space change is half as much for nursing sows. This finding is completely logical because sows spend a much longer period of their life in gestation as compared to nursing, and this result suggests a strong systematic component to people’s behavior.

⁴ The willingness-to-pay values shown in table 5 and figure 3 exclude the responses of any individual that gave the attribute of price an importance weight of 90 or higher. Such a high importance weight, in this context, implies that people did not want to buy any of the products at all, and thus, the values in table 5 should be interpreted as willingness-to-pay conditional on “being in the market” or bidding at least some positive amount for one of the five products.

Table 5 shows that while people value an increase in group size from 1 to 5 sows, they actually dislike increasing group size from 1 to 10 sows. Again, this finding is a completely logical reaction to animal well being, with people valuing socialization as hogs are moved from isolation to some level of companionship, but with people recognizing the decline in welfare that can result when group size becomes large and inter-fighting arises. Table 5 also shows that people value survival rate of farrows, with a change from 60% to 90% being valued at $\$0.18 + \$0.15 + \$0.13 = \0.46 , on average. The findings in table 5 illustrate how complicated an issue like a gestation and farrowing crate ban can be, and that the overall value people might derive from such a ban is comprised of many factors – all of which may not be apparent to a person unless they have participated in an experiment like the one discussed in this article. For example, banning gestation and farrowing crates would might space per sow – something people value; however, it could results in group sizes larger than 10 and could also result in lower survival rates. It is easy to see how adding up all these “partial effects” could result in a negative value for a gestation crate ban.

Again, we emphasize that table 5 only provides a partial picture of the many values that the CACM provides. Interested readers can directly contact the authors to obtain a copy of spreadsheets that one to calculate relative willingness-to-pay values for eggs and pork from any combination of the underlying attributes shown in table 1.

Another purported advantage of the CACM is that it permits a parametric-free characterization of heterogeneity in preferences. Table 5 showed that, on average, people prefer that baby pigs be administered the optional surgeries of tail docking and teeth trimming before seven days of age rather than no surgeries at all. Although such a finding might seems counterintuitive, one should consider the consequences of *not* performing such surgeries – injury and fighting later in life. Although the “average” person would prefer to see such surgeries

performed, as long as they occur prior to seven days of life, when the pain is temporary, one might expect a great deal of diversity in opinion on the issue. Figure 3 plots the distribution of willingness-to-pay for no surgeries vs. surgeries performed prior to seven days. As can be seen in figure 3, there is wide disagreement on the merits of surgeries, with the largest fraction of consumers either having slightly positive or slightly negative willingness-to-pay.

The recent interest in preference heterogeneity has generated refinements in statistical methods but relatively little improvement in the construction of valuation instruments. Latent class and mixed logit models rely on statistical modeling to infer preference heterogeneity, but require heterogeneity to be viewed through the lens of the assumed model. The heterogeneity in figure 3 is not an inferred distribution; it is a direct observation of individual differences in values. As such, we can be more confident that the heterogeneity observed represents true differences in preferences.

Conclusions

A conflict exists when attempting to project the market impacts of food policies or the success of new products. Decision makers are often in need of data on people's preferences to make such projections; however, research suggests that data from consumer preference studies often suffer from a number of biases that raise questions about the reliability of such information. In this paper, we introduced a hybrid valuation method that has the potential to assist people in providing more consistent and systematic responses than is the case with many other existing methodologies. With the so-called calibrated, auction-conjoint method (CACM), we link people's bids for products, obtained in an incentive compatible auction, to their preference ratings of product attributes. Because the approach forces people to changing their preference

ratings of product attributes to alter bids, the method creates internal consistency in respondent behavior.

Our results show that people's values for egg and pork products are affected by animal living conditions, and that the expressed willingness-to-pay values are highly correlated with scientific models of animal well-being. Auction bids indicate that people are, on average, willing to pay \$0.93 for a dozen eggs raised in an aviary, pasture system vs. a cage system, and are willing to pay \$2.02 for two-pounds of pork chops raised in a pasture system as opposed to a crate system. The advantage of the CACM is the auction bids can be de-composed to identify exactly what it is that makes people willing to pay more for pork from a pasture system, for example, as compared to a crate system. Results indicate that moving to a free-range system is highly valued by people, but only when accompanied with shelter and pasture. Although pasture systems can result in lower survival rates for baby pigs, our results indicate that the dis-utility of a decline in survival rate is more than offset by the extra utility of a move to pasture.

The advantage of our approach is that it provides a holistic consideration of animal well-being, and as such, we believe the measured preferences are likely to be much more useful in evaluating the consumer welfare effect of policy and marketing efforts that involve multiple changes to farm production systems.

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Step 1: Rate the desirability of attribute levels

Below are different amounts of space per hen that can be utilized at the egg laying facility. Space per hen refers to both the floor space and space provided on perches, walkways, and nests that are suspended from the ceiling. To help you understand the space requirements for laying hens, consider the following information.

- The body of a hen is approximately 40 square inches when its wings are folded and 180 square inches when its wings are spread open.
- Hens need approximately 67 square inches to stand and lie down comfortably, about 252 square inches to turn around freely (without bumping into other hens), and 300 square inches or more to flap its wings.

Please indicate the desirability of each space per hen to you personally below.

Barn Space Per Hen (Attribute Level)	1= highly undesirable	10= highly desirable
48 square inches	<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input checked="" type="radio"/> 5 <input type="radio"/> 6 <input type="radio"/> 7 <input type="radio"/> 8 <input type="radio"/> 9 <input type="radio"/> 10	
69 square inches	<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input checked="" type="radio"/> 5 <input type="radio"/> 6 <input type="radio"/> 7 <input type="radio"/> 8 <input type="radio"/> 9 <input type="radio"/> 10	
110 square inches	<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input checked="" type="radio"/> 5 <input type="radio"/> 6 <input type="radio"/> 7 <input type="radio"/> 8 <input type="radio"/> 9 <input type="radio"/> 10	
171 square inches	<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input checked="" type="radio"/> 5 <input type="radio"/> 6 <input type="radio"/> 7 <input type="radio"/> 8 <input type="radio"/> 9 <input type="radio"/> 10	
252 square inches	<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input checked="" type="radio"/> 5 <input type="radio"/> 6 <input type="radio"/> 7 <input type="radio"/> 8 <input type="radio"/> 9 <input type="radio"/> 10	
353 square inches or more	<input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4 <input checked="" type="radio"/> 5 <input type="radio"/> 6 <input type="radio"/> 7 <input type="radio"/> 8 <input type="radio"/> 9 <input type="radio"/> 10	

Step 2: Indicate the relative importance of each attribute (used to provide starting weights in Step 3)

Page 4

Below is a list of attributes regarding how laying hens are raised. For each attribute, indicate how important the attribute is to you personally on a scale of one to seven (1 = very unimportant and 7 = very important).

the egg price	4
barn space per hen	4
barn floor space per hen	4
how and whether beaks are trimmed	4
scratching / foraging / dustbathing space for hens	4
nests provided to hens	4
free-range access	4
protection from bully birds	4
type of feed given to hens	4

Next Page

Step 3: Indicate bid for cage system eggs, and then alter the importance weight on each attribute to change bids for other egg products (user may also go back and change answers to previous questions)

Attribute	Importance of Attribute as Percentage	Your Bids
egg price	<input type="radio"/> Increase 1% <input type="radio"/> Decrease 1% <input type="radio"/> Increase 5% <input type="radio"/> Decrease 5%	11.11%
space per hen	<input type="radio"/> Increase 1% <input type="radio"/> Decrease 1% <input type="radio"/> Increase 5% <input type="radio"/> Decrease 5%	11.11%
barn floor space per hen	<input type="radio"/> Increase 1% <input type="radio"/> Decrease 1% <input type="radio"/> Increase 5% <input type="radio"/> Decrease 5%	11.11%
how and whether beaks are trimmed	<input type="radio"/> Increase 1% <input type="radio"/> Decrease 1% <input type="radio"/> Increase 5% <input type="radio"/> Decrease 5%	11.11%
scratching / foraging / dustbathing space	<input type="radio"/> Increase 1% <input type="radio"/> Decrease 1% <input type="radio"/> Increase 5% <input type="radio"/> Decrease 5%	11.11%
nests provided to hens	<input type="radio"/> Increase 1% <input type="radio"/> Decrease 1% <input type="radio"/> Increase 5% <input type="radio"/> Decrease 5%	11.11%
free-range access	<input type="radio"/> Increase 1% <input type="radio"/> Decrease 1% <input type="radio"/> Increase 5% <input type="radio"/> Decrease 5%	11.11%
protection from bully birds	<input type="radio"/> Increase 1% <input type="radio"/> Decrease 1% <input type="radio"/> Increase 5% <input type="radio"/> Decrease 5%	11.11%
type of feed given to hens	<input type="radio"/> Increase 1% <input type="radio"/> Decrease 1% <input type="radio"/> Increase 5% <input type="radio"/> Decrease 5%	11.11%
SUM = 100%		Cage System: \$0.00 Barn System: \$0.00 Aviary System: \$0.00 Aviary System w/ Free-Range: \$0.00 Organic System (includes free-range): \$0.00
		Once you are satisfied with your bids, click the button below. <input type="button" value="Submit Bids"/>

Figure 1. Steps in the Calibrated Auction-Conjoint (CAC) Valuation Method

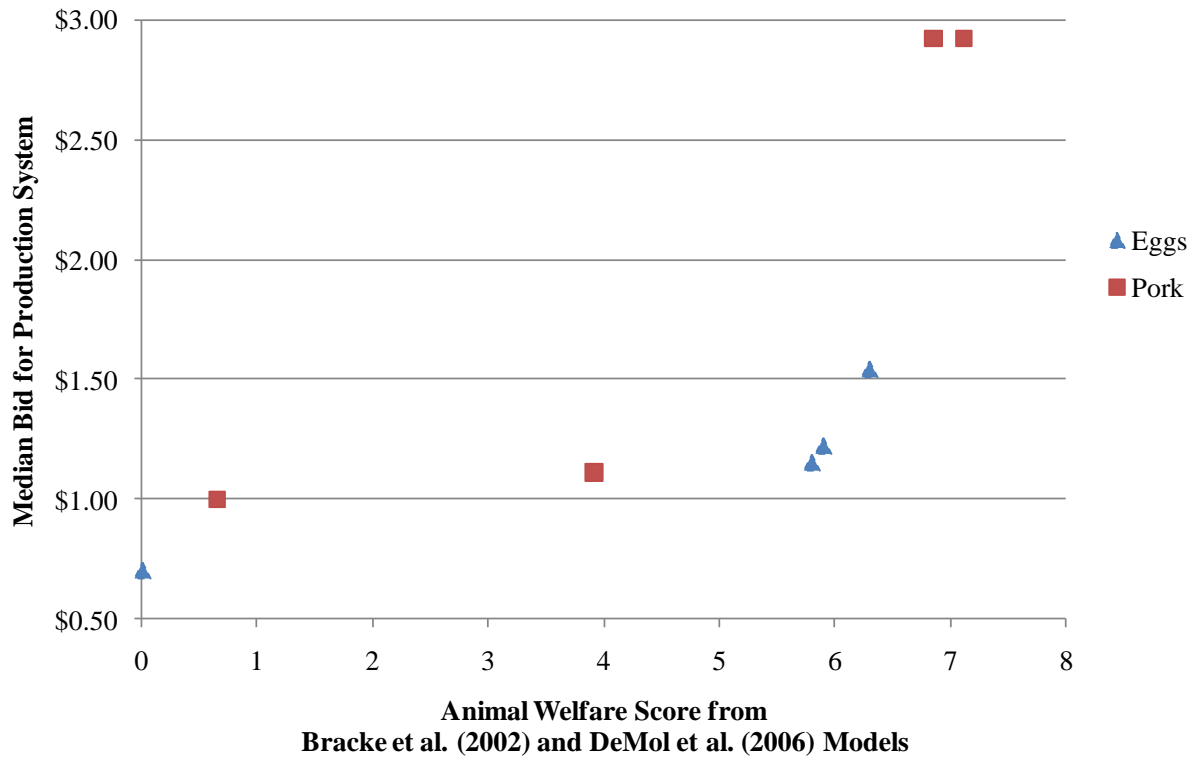


Figure 2. Relationship between Participant's Bids and Animal Welfare for Eggs and Pork from Different Production Systems

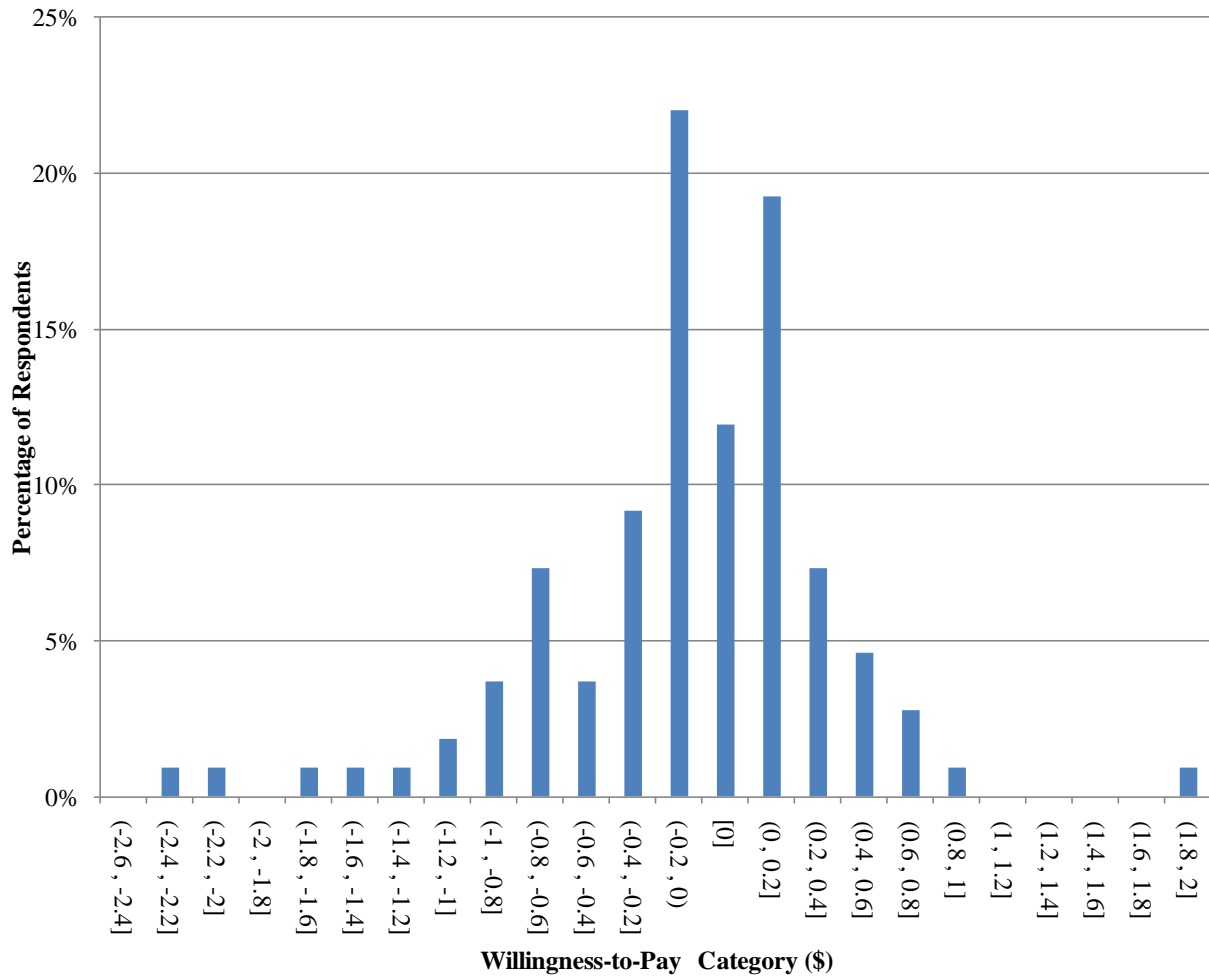


Figure 3. Distribution of Willingness-to-pay for No Surgeries vs. Surgeries Performed within Seven Days in Pork Production

Table 1. Attributes and Attribute Levels used in Preference Elicitation Experiment

Attribute	Levels
<i>Eggs</i>	
1. Price (dozen eggs)	\$0.50, \$1.50, \$2.50, \$3.50, \$4.50
2. Barn Space Per Hen (sq inches)	48, 69, 100, 171, 252, ≥ 353
3. Barn Floor Space Per Hen (sq inches)	≤ 97 , 111, 129, 155, ≥ 194
4. Beak Trimming	beaks are not trimmed, beaks are trimmed < 10 days old, beaks are trimmed when older than 10 days
5. Room for scratching, foraging, and dust bathing (sq feet per hen)	0, 1, 2
6. Nest Availability	no nests, group nests - no bedding, group nests - with bedding, individual nests - no bedding, individual nests - with bedding
7. Free Range	no free range, free range without predator protection or shelter, free range with predator protection, free range with shelter, free range with predator protection and shelter
8. Group Size	> 3,000 hens, > 3,000 hens with perches, 2,000 hens, 2,000 hens with perches, < 7 hens, < 7 hens with perches
9. Type of Feed	non-organic, non-organic with flaxseed to add omega 3 fatty acids, organic
<i>Pork</i>	
1. Price (2 lb package)	\$2, \$4, \$6, \$8, \$10
2. Space Per Gestating Sow (square feet)	14, 30, 60, 90, 120, ≥ 150
3. Space Per Nursing Sow (square feet)	14, 30, 60, 90, 120, ≥ 150
4. Space Per Growing Pig (square feet)	8, 16, 24, 32, 40, ≥ 48
5. Nesting Provisions	no straw/no privacy, with straw/no privacy, no straw/with privacy, with straw/with privacy
6. Survival Rate of Farrows	50%, 70%, 80%, 90%, 99%
7. Minor Surgeries	none, performed when < 7 days old, performed when older than 7 days
8. Free Range	no free range, free range without shelter or pasture, free range with no shelter and with pasture, free range with shelter and no pasture, free range with shelter and pasture
9. Group Size (number of sows)	1, 5, 10, 20, 30
10. Provision of Dry Straw (inches)	0, 3, 6, 12
11. Type of Feed	non-organic, non-organic without hormones or antibiotics, organic

Table 2. Egg and Pork Production Systems

Attribute	Production System				
	Cage	Barn	Aviary	Aviary with Free Range	Organic
<i>Eggs</i>					
2. Barn Space Per Hen (sq inches)	69	155	186	186	186
3. Barn Floor Space Per Hen (sq inches)	69	155	97	97	97
4. Beak Trimming	trimmed <10 days	trimmed <10 days	trimmed <10 days	trimmed <10 days	trimmed <10 days
5. Room for scratching, foraging, and dust bathing (sq feet per hen)	0	1.35	1.35	1.35	1.35
6. Nest Availability	no nests	individual nests with bedding	individual nests with bedding	individual nests with bedding	individual nests with bedding
7. Free Range	no free range	no free range	no free range	free range with shelter and predator protection	free range with shelter and predator protection
8. Group Size	< 7	> 3,000	> 3,000 with perches	> 3,000 with perches	> 3,000 with perches
9. Type of Feed	non-organic	non-organic	non-organic	non-organic	organic
<i>Pork</i>					
2. Space Per Gestating Sow (square feet)	14	24	90	90	90
3. Space Per Nursing Sow (square feet)	14	14	90	90	90
4. Space Per Growing Pig (square feet)	8	8	32	32	32
5. Nesting Provisions	with privacy/no straw	with privacy/no straw	with privacy/with straw	with privacy/with straw	with privacy/with straw
6. Survival Rate of Farrows	90%	90%	80%	70%	70%
7. Minor Surgeries	performed < 7 days	performed < 7 days	none	none	none
8. Free Range	no free range	no free range	free range with shelter and no pasture	free range with shelter and pasture	free range with shelter and pasture
9. Group Size (number of sows)	1	5	20	20	20
10. Provision of Dry Straw (inches)	0	0	12	12	12
11. Type of Feed	non-organic	non-organic	non-organic	non-organic	organic

Table 3. Distribution of Bids for One Dozen Eggs from Five Egg Production Systems

	Cage	Barn	Aviary	Aviary with Free Range	Organic
<i>Chicago, IL (N=50)</i>					
Minimum	\$0.00	-\$1.86	-\$0.35	\$0.00	\$0.00
Median	\$0.75	\$1.29	\$1.21	\$1.79	\$2.15
Mean	\$0.75	\$1.43	\$1.33	\$1.87	\$2.26
Max	\$3.00	\$6.52	\$4.65	\$5.64	\$8.23
Percent \$0.00	30.0%	16.0%	16.0%	16.0%	16.0%
Standard deviation	\$0.36	\$0.71	\$0.58	\$0.71	\$0.85
<i>Dallas, TX (N = 43)</i>					
Minimum	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Median	\$0.80	\$1.40	\$1.30	\$1.70	\$2.00
Mean	\$0.85	\$1.57	\$1.37	\$1.88	\$2.31
Max	\$2.00	\$7.72	\$5.53	\$8.81	\$9.17
Percent \$0.00	23.3%	18.6%	20.9%	18.6%	16.3%
Standard deviation	\$0.65	\$1.46	\$1.15	\$1.66	\$1.98
<i>Wilmington, NC (N=50)</i>					
Minimum	\$0.00	-\$0.09	\$0.00	\$0.00	\$0.00
Median	\$0.61	\$0.89	\$0.90	\$1.26	\$1.48
Mean	\$1.09	\$1.50	\$1.45	\$1.77	\$2.00
Max	\$8.47	\$10.15	\$9.85	\$10.14	\$14.14
Percent \$0.00	10.0%	4.0%	4.0%	2.0%	2.0%
Standard deviation	\$1.75	\$2.27	\$2.11	\$2.28	\$2.56
<i>Pooled (N=143)</i>					
Mean	\$0.90	\$1.50	\$1.38	\$1.84	\$2.18
Median	\$0.70	\$1.22	\$1.15	\$1.54	\$1.94
Standard Deviation	\$1.18	\$1.76	\$1.55	\$1.82	\$2.11

Table 4. Distribution of Bids for Two Pounds of Pork Chops from Five Pork Production Systems

	Crate	Pen	Open Barn	Pasture	Organic
<i>Chicago, IL (N=50)</i>					
Minimum	\$0.00	-\$0.32	-\$0.01	-\$0.03	-\$0.02
Median	\$1.20	\$1.89	\$3.29	\$3.44	\$3.60
Mean	\$1.80	\$2.01	\$3.86	\$3.99	\$4.26
Max	\$7.00	\$6.85	\$21.59	\$22.44	\$24.66
Percent \$0.00	38.8%	16.3%	12.2%	10.2%	10.2%
Standard deviation	\$1.97	\$2.06	\$3.86	\$4.01	\$4.31
 <i>Dallas, TX (N = 48)</i>					
Minimum	\$0.00	-\$5.78	-\$0.07	-\$0.07	-\$0.02
Median	\$0.00	\$0.00	\$1.12	\$1.36	\$1.70
Mean	\$0.74	\$0.66	\$2.58	\$2.85	\$3.37
Max	\$5.00	\$5.11	\$34.79	\$40.11	\$57.32
Percent \$0.00	56.3%	37.5%	31.3%	31.3%	33.3%
Standard deviation	\$1.12	\$1.52	\$5.16	\$5.93	\$8.32
 <i>Wilmington, NC (N=50)</i>					
Minimum	\$0.00	\$0.00	-\$0.68	-\$0.67	-\$0.19
Median	\$1.27	\$1.53	\$3.41	\$3.31	\$3.40
Mean	\$1.93	\$2.19	\$3.53	\$3.68	\$3.77
Max	\$8.80	\$9.97	\$16.53	\$17.56	\$17.56
Percent \$0.00	8.0%	8.0%	6.0%	6.0%	4.0%
Standard deviation	\$1.84	\$2.19	\$3.06	\$3.24	\$3.30
 <i>Pooled Data (N=148)</i>					
Mean	\$1.50	\$1.63	\$3.33	\$3.51	\$3.80
Median	\$1.00	\$1.11	\$2.92	\$2.92	\$3.11
Standard deviation	\$1.76	\$2.05	\$4.11	\$4.51	\$5.67

Table 5. Marginal Willingness-to-Pay Values for Selected Changes in Pork Production

Practices

Change	Mean	Median
<i>Space</i>		
60 vs. 14 in ² per gestating sow	\$0.35	\$0.24
60 vs. 14 in ² per nursing sow	\$0.17	\$0.27
32 vs. 8 in ² per growing pig	\$0.37	\$0.24
<i>Group Size</i>		
5 sows vs. 1 sow	\$0.06	\$0.00
10 sows vs. 1 sow	-\$0.19	-\$0.11
30 sows vs. 1 sow	-\$0.45	-\$0.25
<i>Surgeries</i>		
performed < 7 days vs. none	\$0.14	\$0.01
performed > 7 days vs. none	-\$0.15	-\$0.06
<i>Survival Rate of Farrows</i>		
90% vs. 80%	\$0.18	\$0.13
80% vs. 70%	\$0.15	\$0.11
70% vs. 60%	\$0.13	\$0.07
<i>Other</i>		
organic vs. non-organic feed	\$0.41	\$0.13
free range with shelter but no pasture vs. no free range	\$0.43	\$0.13
free range with pasture and shelter vs. no free range	\$0.82	\$0.42

Note: results are the average value across all three locations for people who placed less than 90% importance on price; N=109