DEPARTMENT OF AGRICULTURAL, ENVIRONMENTAL, AND DEVELOPMENT ECONOMICS

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Preserving America's Heritage Livestock Breeds

Using Marketing to Maintain Genetically Viable Production Livestock Populations

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Abstract

Populations of Heritage breeds of livestock are declining across the U.S., reducing valuable genetic diversity. These breeds are typically less efficient to produce, so maintaining viable populations in a commercial market may not be economically feasible. This project first determined the size of populations that needed to be maintained to ensure genetic diversity. An experiment was conducted to determine if consumers would be willing to pay premiums to preserve a Heritage breed, and what other product characteristics influenced their pork purchases. Probit modeling found consumers willing to pay for preserving these breeds, but most interested in paying premiums for meat that was grown locally.

Introduction

The preservation of America's heritage breeds is a serious issue facing animal production today. Heritage breeds are those original "pure" breeds that were introduced into the United States as it was settled. The production livestock that is being raised in the country today is very different from that raised as it was settled. Much of the change has been positive, with superior genetic lines being combined to produce animals that finish into higher quality carcasses in less time, using less feed. However, in this push for a more efficient animal, some of the foundational breeds are being lost. These breeds represent the basis for current livestock genetics, and if the original breeds are lost, then the original genetic information and variability is lost with them.

Heritage breeds also have a strong link to America's agricultural past. Agriculture is one of the rare industries in the United States where deeply rooted traditions work along side modern innovation to improve products and production efficiency. These were the breeds raised by our forefathers, and they represent an important piece of our history. Preserving this population is a significant facet of preserving the agricultural tradition.

Preservation of these breeds is a difficult matter. The USDA is working to preserve the germplasm from some of these breeds in the National Animal Germplasm Program (Agricultural Research Service, 2006). To be completed in 2007, the program aims to gather information about populations, collect and store genetic material, and provide information about the genetics (ARS, 2006). The catch in this is that the genetic material is just stored and will not be used to actively maintain a population. That effort must be put forth by breeders and producers. To make this effort economically viable, Heritage producers must have a market large enough to ensure the economic incentive to produce at the level necessary to maintain a genetically viable population. These research questions involve both population genetics and marketing, and no work like this is being done in either discipline.

The challenge of providing a significant pool of genetic material is in generating a large enough market, with sustainable premiums, for animals that are essentially outside the mainstream commodity product channels.. Here producers may be faced with the aspects of market market access not unlike those of a new innovative product: market access for a product that does not comply with the uniformity of the existing supply chain; inability to generate enough initial production volume to break this access barrier or develop new channels. Premiums that can be garnered for unique, consumer-preferred attributes, may provide the producer with an economic incentive to balance the costs of less efficient production. Heritage breeds do have a demonstrated opportunity to occupy niche markets of consumers who will search outside standard market channels for unique taste and texture attributes. This, however, also presents challenges for producers in that they must adjust their logistical, and even psychological, approaches to marketing in directions certainly foreign to commodity producers. Yet, it appears the ability to make such adjustments is the opportunity to capture premium markets that may save Heritage livestock. There is no small irony in that one of the best ways to preserve a breed's genetic diversity is to eat more of the breed.

Although there are Heritage breeds in virtually all livestock species, this project focused on swine. The researchers are familiar with this species and have a background in their production and marketing; however, swine also possess other characteristics that are important to this study. The pork market is consumer-oriented and produces a product that standard production practices have honed to a highly consistent consumption item. Data on swine breed populations, characteristics, and market status already exists and is available in various forms. Further, Heritage labeling has shown some promise of success in the swine industry with the emerging use of the Berkshire breed as a premium meat producer by some high profile “celebrity” chefs and white tablecloth restaurants.

Problem Identification and Justification

Genetic variability is the key to maintaining any population. Without a continuous mixing of genes, serious genetics consequences can result. The overuse of line breeding to improve a strain of animal will eventually lead to the inclusion of inferior genetic traits on a large scale, and the fitness of the entire population will suffer. Only maintaining the line by mixing diverse populations of varied heritage within the breed will keep the overall population stable.

This same problem applies to the Heritage swine breeds being examined in this study. Just as these breeds may be needed to maintain genetic variability within the overall production livestock pool, they also need large enough populations within their own breeds to sustain themselves. Self sustainability requires large populations, which is central to the research problem, as Heritage breed numbers have dwindled. A general hypothesis might be that once a breed has become essentially self-sustaining through market development, they will be in the position to provide the genetics necessary to support the overall population. The problem that presents itself is determining the characteristics and size of the niche markets. Niche markets are generally much smaller and have distinctive traits that define them separately from other markets. The potential niche market for Heritage meats and its definitive characteristics are not yet known. Producers need to understand the market that they will be operating in to be able to produce the meat products with the attributes that niche consumers demand.

Objectives

1. The first objective is to determine the minimum population that is necessary to maintain the genetic variability of the population. This portion of the study is one of population genetics, essentially using statistical formulas to calculate the minimum efficient population; that is, the minimum population of breeding animals that is required to maintain the normal genetic variation, drift, and permutations that are seen in wild, unaltered populations. Once this minimum population of breeding animals is determined, a total population can be calculated. This total population would include the non-breeding members, in essence, the animals that will be marketed to provide the income and incentive to raise the breed.

2. The second objective for this project is to use the numbers of marketable animals required by the first objective to determine to the marketing goals of the breeders. There needs to be an incentive to grow these breeds specifically, since these animals are not as efficient as the more commercial lines that are being raised. If these animals can be marketed to provide a healthy profit, then the preservation of the species will be taken care of by the breeders without the help of outside preservation groups. The project will investigate the attributes that consumers desire and are willing to pay a premium for. These attributes can be related back to production goals for producers. This investigational research will lay a foundation for a more inclusive study being planned using a much wider population sample.

Literature Review

Genetics

Preserving a species' genetic diversity is a question of population genetics. Most of the foundational work in this area comes from wildlife biologists. These individuals are often focused on preserving wild species of animals, for which a dwindling genetic base and extinction may be a very real threat. Deriving the number of necessary population members is as much a statistical question as it is a genetic one. One of the most important pieces that support the idea of a statistical model for determining the minimum viable population comes from Frankel and Soulé, in their 1981 work Conservation and Evolution (Frankel and Soulé, 1981). The input model that they use is supported by Hill and Reed, Doerr, and Walter and involves the use of input factors such as size and age structure of the adult population, as well as the offspring (Hill, 1972; Reed, Doerr, & Walter, 1986).

The model that most wildlife biologists employed specifically involves four input factors that are applied to both males and females, rendering a total of eight inputs (Reed et al., 1986). The output of the model yields the minimum viable population, N_e, the population at which the genetic variability, drift, and mutation rates would be the same in the wild population if left to its natural devices (Reed, et al.). This model requires accounting for a number of factors, including overlapping generations, random mating, and yearly variation in males and females (Holtsford, 1998).

Computer modeling of minimum viable populations has also been studied, employing many of the same input factors. D.H. Reed et al. used a computer simulation model, called the Vortex program, that input a number of factors to estimate the minimum viable populations for a number of different species (Reed, O'Grady, Brook, Ballon, & Franklin, 2003). In addition to the demographic variables employed, the computer model was also able to factor in potential impacts such as catastrophes and inbreeding depression (Reed et al., 2003). The wild pig, *sus scrofa*, was one of the species included in the population calculations; a minimum population of 144 animals was determined using the computer model (Reed et al.).

Conjoint Analysis

Determining and understanding what consumers value has long been a pursuit of both academic and commercial researchers. Each consumer's unique utility of a consumable determines not only whether they purchase the item, but how much they will buy and the price at which they will buy it. Valuation studies, in their inception, attempted to determine the value of individual attributes, and then sum them to estimate the total value; a method based on a compositional approach. Conjoint analysis, on the other hand, is a decompositional approach; it takes consumers' apparent values for a specific product and attempts to break it down into individual choices (Green & Srinivasan, 1978; Louviere, 1988).

Conjoint analysis was developed in the early 1900's, refined and applied to market analysis by Luce and Tukey (1964), and has seen increasing use since then. There are essentially three types of conjoint analysis: traditional, choice-based, and adaptive-choice. Adaptive choice is fairly new, and requires sophisticated computer programs that adjust the questions posed to the respondent based on previous answers. Adaptive choice molds the computer pairings to the respondent's answers, so that as the experiment progresses, the respondents are asked only about those attributes that they respond to (Orme, 2003). Adaptive choice is an excellent tool, especially if there are many attributes being used (Orme, 2003). However, the software necessary to perform this work requires more resources than were available for this study.

Both traditional and choice-based conjoint analyses have been proven to possess external validity, and it has been established that the two methods perform equally well (Levin, Louviere, Schepanski, & Norman, 1983; Elrod, Louviere, & Krishnakumar, 1992). However, there are some significant differences between them. Traditional conjoint analysis was developed first, and possesses the ability to draw conclusions from each individual's utility measurements (Louviere, 1988). With this method, respondents are asked to rank or provide a relative rating for each product in a presented group (Louviere). Because each individual is asked to evaluate a product in relation to all the other products, it is possible to develop individual utilities (Louviere). In contrast to traditional conjoint analysis, choice-based conjoint asks each respondent to choose between two detailed products, acting as they would under their normal budget constraints (Louviere). Because each individual consumer is asked only to evaluate each product in relation to another product, individual utilities cannot be captured. Rather, utilities are determined for the aggregate group (Green & Wind, 1975). However, choice-based conjoint analysis has a few very important attributes. Most importantly, it most closely resembles real-life decision making. Consumers do not rate or rank products as they shop; instead they assimilate many factors, including their budget, to reach a single purchasing decision. Thus, choice-based conjoint analysis asks the consumer to act as they would normally, which produces a much more accurate picture of consumer behavior. Also, using ratings or rankings requires researcher assumptions about the respondents' individual utility basis and reference points to analyze, whereas choice-based conjoint removes this potential error point (Louviere). Once data has been collected using either conjoint method, it can be analyzed using analysis of variance, multi-attribute utility estimation, or multivariate regression techniques (Green & Srinivasan, 1978).

Specialty Marketing and Organic and Local Labeling Relevance

Specialty meat marketing using niche markets or product-specific attributes is not a new idea in American agriculture. One example of the push toward a separate, high quality product can be seen in the rise of Certified Angus Beef (CAB). This program enrolls producers who are raising a high quality product, and has created a brand that consumers now equate with quality (Fuduric, Barkley, & Henry, 2005). Smaller producers and packers have found that marketing in the niche areas provides them with an important differentiation from their competitors. These firms use strategies such as direct to consumer sales and specialty and seasonal products to meet consumer demand (Buhr, 2004).

Consumer demand for specific product attributes such as organic or antibiotic-free production has been on the rise (Dimitri & Greene, 2000). Consumers want a product that is safer, more natural, better tasting, and healthier, and they perceive that foods that have labels such as “natural,” or “certified organic,” or “locally grown” will provide these attributes. Consequently, consumers are willing to pay more for these product characteristics. Batte, Beaverson, and Hooker (2003) surveyed customers in six Ohio groceries about organic purchases and found that 42% of consumers purchased organic products. They also found indications that consumers that preferred organic products were generally less price sensitive (Batte et al., 2003). Hooker, Batte, and Beaverson (2004) determined that consumers who were familiar with the USDA’s National Organic Program were more willing to pay a premium for produce that was labeled as such. Govidasamy and Italia (1999) surveyed consumers in New Jersey grocery stores, and established that females, younger consumers, and consumers with higher incomes were more willing to pay a premium for organic products.

Consumers are also willing to pay more for local produce. Darby, Batte, Ernst, and Roe (2006) conducted intercept surveys in grocery stores and in direct markets, using a combination of traditional paper surveys and computer-based conjoint analysis. This work concluded that consumers were willing to pay substantive premiums for products identified as "fresh" or "local". In contrast, Brown (2003) found that although the majority of consumers (58%) would buy local food only if it was equal in price to other offerings, 28% of consumers would pay a premium for food labeled as local. One quarter of these respondents, or 7% of the surveyed sample, would pay a premium of 25% or more (Brown, 2003). Also of interest, respondents were asked about their definition of local. The survey found that the definition of local varied between respondents, but that most considered it to be a region, and did not consider the whole of the state to be local.

Procedures and Methods

Genetics

The first step in the project was to establish the formulas that account for the requisite genetic variability within a population. Investigational research indicated that the formula set utilized in J.M. Reed and associates' paper "*Determining minimum population sizes for birds and mammals*" is a well-used and reliable tool (Reed, Doerr, & Walters, 1986). This formula accounts for four variables each per gender. The four variables are number of breeding adults, the number of young born per year to each adult, the probability that a newborn makes it to breeding age and breeds, and the generational length, which is essentially the mean age of reproducing adults in a population with a stable age structure (Reed et al., 1986). The data for these inputs was gathered from a wide variety of sources, including academic research, extension service educational materials, and industry research. A data set was required to be large to provide the most accurate picture possible on a national scale.

After the input data for the models was gathered, individual models for each species were constructed. Ideally, there would have been individual descriptors by breed within a species, but there is little per breed data available given similarity of breeds in relation to these input factors. The minimum efficient populations can then be extended to a total population by determining the number of market animals that are required to produce the revenue necessary to sustain an operation.

Conjoint Experiment Design Issues

Putting together an effective conjoint analysis survey tool requires consideration of several important concepts. The first point of survey research is to consider potential errors. There are two types of errors: measurement error and sampling error (Orme, 2006). Sampling error results when the sample does not represent the population. In conjoint analysis, sampling error is reduced by drawing a larger sample. Measurement error is created within the question process, and can be reduced by asking each respondent to answer more questions (Orme, 2006).

Minimizing survey errors required careful analysis and determination of the number of respondents needed and the number of questions that could be posed to each respondent. In formulating a sample size in conjoint analysis, the researcher must consider the survey employed, specifically looking at the number of attributes per product and the number of levels per attribute. Larger numbers of attributes and levels require a larger sample to develop reliable answers. A guiding relationship that has been employed to estimate the number of respondents needed is:

$$\frac{nta}{c} \geq 500$$

where *n* is the number of respondents, *t* is the number of tasks or decisions, *a* is the number of attributes per decision, and *c* is the largest number of levels used in an attribute. For this project, the instrument is only being tested; for this kind of investigational research, it is suggested that 30 to 60 respondents can provide enough data to validate a survey tool (Orme, 2006).

Setting up the instrument itself requires some thought as well. The number of questions asked is very important. Deriving as much information as possible from each respondent makes the most of time and expense, both of which can be strong constraints in this type of work. However, respondents can begin to experience fatigue after too many questions, and the data collected from them begins to degrade. As a result, there is also an inclination to ask fewer questions of more people to ensure quality responses. Research has proven, however, that respondents' answers will actually improve slightly the longer they answer. In work done by Johnson and Orme (1996), the second 10 questions answered by respondents tended to be more statistically significant than the first 10. The authors further concluded that respondents could answer up to 20 questions before beginning to exhibit fatigue and answer degradation (Johnson et al., 1996).

Survey Methodology

In addition to the conjoint experiment, the marketing side of this project included an investigational survey to determine consumers' desire and willingness-to-pay for premium attributes in meat products. The survey was conducted to assess which attributes consumers value, and whether or not a Heritage production background is a characteristic that has the ability to capture a premium.

This survey was conducted in and around grocery stores. Respondents were required to be both pork purchasers and 18 years of age or older. The survey universe was then legal adults who purchase pork in the Central Ohio area. From this universe, a random sample was drawn to participate in the survey.

Maintaining confidentiality and protecting the research subject are paramount in any research investigation. Subjects must be protected from having their personal information shared with the rest of the world, must not be subjected to harassment or inconvenience outside the scope of a normal day, and must not face potential liability or damage to their financial standing, employment, or reputation. To safeguard all subjects, this survey was completely anonymous. Subjects were not at any time asked for their name or any other unique identifier, characteristic, or mark. There were absolutely no physical means for the subject to be identified by or associated with their responses in the survey once the information was collected.

Potential respondents were asked by the researcher if they were 18 years of age or older and if they were meat purchasers. The introduction and consent request was done according to a predefined script (Appendix A). An affirmative reply to both questions qualified the respondent to participate in the survey. At this point, respondents were shown two table tent displays (Appendix B) which contained facts and observations about the pork chops that were used as examples in the experiment. As respondents were seated in front of the computer, they were reminded that their participation was completely voluntary, and that they could decline to answer a question or could withdraw from the survey at any point without repercussions or penalties. They were then shown a welcome screen on the computer (Appendix C) that initiated the questionnaire for each person. Respondents were given the option of reading the screen or having the researcher read it to them. They were then shown ten pairs of products (Appendix D) with each product having four attribute descriptors. The researcher asked each respondent for their choice with the question below:

"Would you prefer to purchase Product 1, Product 2, or would you not purchase either?"

This question was repeated for a total of 10 sets of observations, with each choice made by the respondent constituting an observation. Respondents' answers were stored in the computer with a sequential identification number only. The researcher placed that same identification number on the written portion of the survey. Respondents were then allowed to fill out and return the survey anonymously, free from observation by the researcher.

The product choice slides (see example in Appendix D) presented two products to choose from. Each product had a picture and four attributes listed. The pictures were identical and remained in place for each slide. The sets of attributes were drawn at random by the computer from a list of potential combinations. Each product had one trait listed for each of the four attribute types. The attributes types and potential responses are listed below.

Attributes

Locale

Unknown; Raised in the U.S.; Raised in Ohio; Raised on a local farm

Meat Type

Standard; Poland China*

Production Method

Standard*; Natural; Certified Organic

Price per Pound

$5.00; $4.50; $4.00; $3.50; $3.00

*"Standard" and "Poland China" are defined on the table tents (Appendix B).

The paper portion of the survey was comprised of eight questions that further examined the consumers' willingness-to-pay and eleven questions that solicited demographic data from the subject (see Appendix E). The survey was designed to provide two important functions: (1) it provided a check against the observations collected on the computer. (2) it provided demographic data that can be tied to the computer responses to perform a complete and thorough statistical analysis.

Data and Results

Genetic Calculations

The thrust of the data comes from the simple mathematical model used to determine the numbers of animals needed to preserve the genetic variability of the species. The key point is "genetic variability," as opposed to mere survival. Reed, Doerr, and Walter's (1986) model is used to determine the population necessary to maintain a diverse genetic pool, which is the focus of the investigation.

It is important to remember that this formula was originally designed for use with wildlife species. However, it is applicable for two reasons: (1) it is still statistically valid, as it is being applied to animal genetics, and is not being used in an inconsistent fashion; and (2) it is simply the best model available. Inbreeding among livestock breeds is certainly an issue, but examination of published research turns up very little in the way of genetic variability maintenance, and quite a bit on focusing breeding to produce a superior animal. Put another way, the difference could be described as maximizing genetic variability versus minimizing harmful inbreeding.

This formula requires eight input factors, four for each gender. They are the number of breeding adults, the number of young born to each adult, the probability that young survive to the age of reproduction *and* reproduce, and the generational length. The model is stated as:

$$\frac{1}{N_e} = \frac{1}{4*L_M*M_{br}*k_M*l_M} + \frac{1}{4*L_F*F_{br}*k_F*l_F}$$

where N_e is the minimum viable population, L_M/L_F is the average age of a breeding adult male or female, M_{br}/F_{br} is the number of breeding males and females, k_M/k_F is the number of young born to each male and female each year, and l_M/l_F is the probability of a male or female surviving to breeding age and reproducing.

The input factors into this formula are difficult to assess because they are clearly subject to managerial decisions and performance. A livestock production business survives based on its ability to earn profits, just as any other business. As a result, animal husbandry decisions also include the element of economics; a particular animal's fitness will contribute less to its retention than its ability to provide a profit.

The first variable, M_{br}/F_{br}, that was obtained was ***the number of breeding adults for the breeds*** in question. The USDA maintains regular reports as to the size and composition of the production swine herd in the United States; however, this report does not separate out any of the individual breeds, as that information is of little relevance to the overall production. The best breed specific reports available come from the USDA-ARS National Animal Germplasm Program. This program is attempting to study the preservation of the nation's production germplasm, albeit from a much more in-depth and biological science-oriented perspective than this project. This program has conducted interviews and examined breed registries in an attempt to accurately determine breed populations (Blackburn, et al., 2003). Since the survey did not differentiate between males and females, an estimate that 10 percent of the adult population were males was assumed for the model used in this project. These numbers are listed in the table below.

Table 1. Current populations for selected swine breeds.

Breed	Current Population
Berkshire	37912
Poland China	7043
Tamworth	1012
Gloucester Old Spots	225

The next variable of the formula, k_M/k_F, involves the number of ***animals born to each adult***, such that in a breeding pair of pigs that produces ten young, each animal will be credited with five offspring. Simplified, this point looks at the number of young born per litter and the number of litters per year. In the model, the sow is credited with half of all piglets born to her each year, while boars are credited with half of each litter. The question of management style comes into play more forcefully on this point. Heritage breeds are often raised in a special environment according to the methods of the individual farmer. This specialized care tends to reduce the number of young lost, due to increased attention and timely intervention (Gadd, 2005). It also affects the number of litters born each year. Within a herd that has a more commercial emphasis, the desired litter numbers are those that provide the largest economic benefit, balancing an increased number of young against the longevity of the sow. Smaller farmers who handle Heritage breeds often place greater emphasis on extending a sow's longevity. Across the nation in all herds, the average number of pigs per litter is nine, while the average number of litters per sow per year is slightly more than two (National Agricultural Statistics Service, 2006). For the purposes of this model, only those animals that are kept for breeding are considered, since these will be the only animals that maintain the genetic pool. As a result, the number of piglets per litter is much closer to one, since only about one animal will be held out from each litter as a replacement of the breeding stock. Also, the number of litters each sow produces a year was set at one and a half to account for the inefficiency of Heritage livestock that make them less economically attractive to start with.

The next variable, l_M/l_F, was the ***probability of the offspring surviving to the age of reproduction and reproducing***. For the purposes of this model, the weaning mortality rate was used. This number was employed based on the assumption of removing the number of marketed animals from the effective population. The pigs that are sold for meat do not reproduce and cannot be considered in the gene pool. Consideration of weaning mortality rates does not reflect losses that occur over the span of the animal's life. However, the greatest chance of death occurs when the litter is young enough, even if it is already weaned, for the animal that is lost to be replaced with a different member of the litter. Since this animal is outside the scope of the model, it is, in essence, a continuation of the animal's life. Weaning mortality rates are tied to a number of factors, and can range accordingly. Studies have found these rates ranging between 3.68% and 7.92% (Krider, Conrad, & Carroll, 1982). This study employed a rate of 5.6% mortality, which accounts for greater care and husbandry, but is still conservative enough to provide a buffer. The resultant probability of survival and reproduction, l_M/l_F, is 94.4%.

The final variable, L_M/L_F, of the model is based on the ***generational age***, which measures the time span that it takes for the average adult to produce young. This number is often derived from the average age of the population in question. The number that was employed for the purpose of this model was two years of age. Most commercial operations cull sows at two years of age, but Heritage producers generally hold on to their animals for a much longer period due to the relative scarcity of the genetics, such that a sow or boar being productive for four years or more is not rare.

Input values for the variable coefficients for the Poland China breed and the minimum effective population calculated using Reed et al.'s formula is shown below:

Poland China

$L_M = 2 \quad M_{br} = 704.3 \quad k_M = 4.25 \quad l_M = 0.9444$

$L_F = 2 \quad F_{br} = 6338.7 \quad k_F = 6.38 \quad l_F = 0.9444$

$$\frac{1}{N_e} = \frac{1}{4*704.3*4.25*0.9444} + \frac{1}{4*6338.7*6.38*0.9444} \rightarrow \quad N_e = 21{,}056$$

These populations are enumerated in Table 2 below. As can be intuitively expected, the breeds with the largest populations have the greatest effective population. Clearly, the greater the current number of combinations, the greater the effective populations will need to be to preserve the number of diverse alleles. Also of importance is the calculation of the marketable herd, which is the animals from each litter that are not kept for breeding purposes. These animals are the ones which need to be sold to financially support the remaining breeding stock.

Table 2. Calculated minimum viable (M.V.) and total populations for selected swine breeds

Breed	**M.V. Population**	**Total Population**
Berkshire	113,343	461,376
Poland China	21,056	85,710
Tamworth	3,025	12,315
Gloucester Old Spots	672	2,738

Conjoint Experiment

The data collected from the conjoint experiment portion was analyzed using probit modeling. A probit function is an inverse cumulative distribution function, which can be used to create regression models of binary response variables. Plainly put, probit functions can create a model that predicts an outcome based on the variables that are involved in making the decision. Probit comes from "probability unit," and is designed to help the user estimate an outcome based on empirical data.

For this experiment, Limdep software was used to create the probit model. The data was stored in an Excel database, which was then read into a program written in Limdep (Appendix F). Probit modeling relies on differences and interactions, so the variables in the experiment had to be manipulated to achieve these forms. The price and meat type variables of the experiment had equal steps between each level, so a simple difference between the levels, expressed as a "delta," could be employed in the probit model. The assumption that the difference between adjoining levels is equal does not hold for "production location" or "for production method." The difference between "local" and "Ohio" cannot logically be assumed to be the same as the difference between "U.S." and "unknown." For these variables, deltas were created for each level of each attribute. These deltas could then be factored into the probit model.

Demographic data is handled differently in probit modeling. Because it does not directly factor into the choice experiment, it must be worked in through interactions with a delta variable. Thus, demographics such as gender or income must be calculated in relationship to some factor included in the experiment.

The probit model is built through a combination of reason and trial and error. The experimenter generally has a reasonable idea of what factors and interactions will be significant, based on the literature review and preliminary data analysis. However, data collected in the field is still unique and can be completely unpredictable, so the researcher must take pains to examine even those variables that are unlikely to be significant. As a result, every variable and interaction is included at least once, which means that the function must be run ad nausea until all variables have been examined. As the model is run, however, the researcher can see certain trends begin to emerge. Once the variables have all been tested, the researcher can then begin to include variables or interactions that have shown themselves to be significant, and remove those that have been shown insignificant. As a result, as the model will begin to tighten up. For this research the best model was the one having the highest Chi-square value. An easier predictor of the validity of the model was the number of choices correctly predicted. Although not as statistically valid as the Chi-square value, the correctly predicted percentage provides an insight into the practical realities of the model. Namely, given a set of variables, how often can a choice response be correctly predicted? This information is what will be usable for future marketing strategies.

The trend that emerged most strongly in this model was the dominance of production location. This partiality was manifested in two ways, both through a preference for "local" or "Ohio" and disinclination towards "unknown." A problem in pinning down this trend was the changing significance of the "local" and "Ohio" variables. One of the frustrating aspects of probit modeling is the constant dynamics of the model. Variables that are significant at first become insignificant with the inclusion of a separate variable that seems to have no bearing on the first. This fluidity was seen in the "local" and "Ohio" variables, which slipped in and out of significance at the 0.10 level depending on the rest of the model. However, it was clear from their consistent hovering in the area of significance, as well as their importance in demographic interactions, that "local" and "Ohio" were important factors in choice. The two were then combined into one variable, "in-state," the delta of which was then brought into the model. Although not significant in the final model, "in-state" does tighten the model up and make it more significant overall.

The "local" variable does prove to be significant in its interactions with demographic variables, namely "gender" and "country," which divides the respondents into those that live in the country and those that live in a municipality of any size. The "Ohio" variable establishes its relevance through interactions as well. Its interactions with the "income" and "median income" variables are both significant, although the actual impact of the income interaction is negligible.

The "unknown" variable proves the importance of production location through the negative impact that it has on the model. The directly interacted variable of the delta of the unknown was significant in virtually every model that it was included in. It was probably the most consistently significant variable of all those that were used. It was also prominent in several interactions. The only "unknown" interaction in the model is that with "metro," and the overall interaction is insignificant, but the interaction is very close to significance, and continues the trend of the importance of "local."

The final model included 11 input factors and a constant (Appendix G). Three of the factors were variables included in the experiment, seven of the factors are demographic interactions, and the final input is an interaction using a question from the written survey. The final form is a regression function in the form of:

$$y = deltap*x + deltaunk*x + deltain*x + genxlcl*x + agexp*x + age2xp*x + incxoh*x + mincxoh*x + counxlcl*x + mtroxunk*x + seenxp*x + b$$

where *deltap* is Price, *deltaunk* is Unknown, *deltain* is In-state, *genxlcl* is GenderXLocal, *agexp* is AgeXPrice, *age2p* is AgeOver50XPrice, *incxoh* is IncomeXOhio, *mincxoh* is Med.IncomeXOhio, *counxlcl* is CountryXLocal, *mtroxunk* is MetroXUnknown, *seenxp* is SeenHeritageXPrice, and *b* is the constant. Each variable is described in detail later in this section. Results of the final model are listed in Table 3 below.

Table 3. Probit model for conjoint experiment data.

Variable	Regression Coefficient	P-value
Constant	-0.00809	0.8866
Price	0.07495	0.7647
Unknown	-0.67074	0.0000
In-state	-0.08749	0.4718
GenderXLocal	0.54005	0.0006
AgeXPrice	-0.01646	0.0169
AgeOver50XPrice	0.53069	0.0268
IncomeXOhio	5.9946×10^{-6}	0.0064
Med.IncomeXOhio	-0.55553	0.0663
CountryXLocal	-0.42410	0.0362
MetroXUnknown	-0.27349	0.1654
SeenHeritageXPrice	0.26602	0.0517

The three experimental variables are “price,” “unknown,” and “in-state.” Only “unknown” is significant at the 0.10 level, and it provides a coefficient of -0.6707. The sign of the coefficient implies that “unknown” has a negative influence on choice, meaning that people will pick choices that do not have this descriptor. The value of the coefficient implies that the aversion to choosing “unknown” is strong.

The seven demographic interactions involve the variables “gender,” “age,” “age over 50,” “income,” “median income,” “metro,” “country,” and “seen heritage.” All of these interactions were significant at the 0.10 level except for “metro.” As discussed earlier, “gender” and “country” were both interacted with “local.” The coefficient for “gender” was 0.5400; the positive sign indicates that men, coded as ones, are more likely to choose “local” than women, who were coded as zeros. The coefficient for “country” was -0.4241; here, those in municipalities were coded as zeros, and the sign indicates that they are more likely to choose “local.” The variables for “income” and “median income” were interacted with “Ohio”. The “income” interaction had a coefficient of 0.5994 x 10-5. The very small coefficient indicates that income is significant, but does not have significant impact on the overall model. The "median income" interaction, however has a coefficient of -0.5555; respondents under the median income were coded as zeroes, and are shown by the sign of the coefficient to choose "Ohio" more often. The "age" and "age over 50" variables, on the other hand, were interacted with "price." "Age over 50" was a compiled category that separated respondents into those under the age of 50 and those over the age of 50. The "age" interaction and the "age over 50" variables had coefficients of -0.0164 and 0.5306, respectively. Both interactions indicate that older consumers were more likely to choose on price. The final variable, "seen heritage," is derived from a question on the written survey that asked respondents whether they had ever seen the Heritage label before. It was interacted with "price" and had a coefficient of 0.2660, which indicates that consumers who had seen the Heritage label prior to participation would be more likely to choose based on price.

Written Survey

The written survey (Appendix E) portion of the field work focused on purchasing motivations and the values that respondents placed on particular meat attributes. Respondents were first asked if where their meat was produced mattered to them, and an overwhelming 83% answered "yes." Respondents were then asked to rank the top three reasons from a list of six why they would buy locally grown meat. The possible reasons were "Flavor," "Safety," "Nutritional value," "Freshness," "Support local farmers/ economy," and "Knowledge of my food's source." These responses were scored as three points for a number one ranking, two points for a second place, one point for a third, and zero points for not being ranked. Under this method, "Support local farmers/economy" was first with 134 points, and "Freshness" was second with 133 points. "Safety," "Flavor," and "Knowledge of my food's source" hovered in the middle with point scores of 75, 60, and 57, respectively. "Nutritional value" was clearly the least chosen reason with a score of 19. The strong showings of "Support local farmers/ economy" and "Freshness" distinguish them from the other reasons chosen as the key points in why people may chose to purchase meat from a farmers market.

The next section of questions dealt with respondents' familiarity with and receptiveness to "Heritage Meat" labeling. Respondents were asked to rate their willingness to purchase Heritage labeled meat on a one to ten scale, with one being the least willing. The majority of respondents, 80%, had not seen Heritage labeling prior to participating in the survey. They then read a short paragraph (Question A-6, Appendix E) describing Heritage products, and reevaluated their willingness to buy on the same one-to-ten scale. The average score of respondents before reading the paragraph was a 6.08, with a median score of 5, while the average score of respondents after reading the paragraph was 7.48 with a median of 8. Both the first and second scores had minimums and maximums of 1 and 10, respectively, and standard deviations for both were very close to 2.5. The difference between the two scores was calculated separately. The average improvement between the two scores was 1.46, with a standard deviation of 2.59, and median improvement of 1.

The third section of the written survey asked participants to respond to statements about organic and natural foods with "Strongly Disagree," "Disagree," "Neutral," "Agree," and "Strongly Agree." Certified organic and natural are two attributes that Heritage labeling is often seen in conjunction with. Their appeal, or lack thereof, can affect the way that Heritage products that possess these traits are viewed. Furthermore, these are characteristics about which something is already known. The results, in terms of the percentage of respondents that selected that particular choice, are listed in Table 4 below.

Table 4. Participants' responses to questions on certified organic and natural products.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Certified organic food is safer for consumption than food not certified organic.	1.39%	13.89%	44.44%	30.56%	9.72%
2. There is a difference between foods labeled 'certified organic' and those labeled 'natural.'	0.00%	2.74%	31.51%	53.42%	12.33%
3. Price and all things being equal, 'certified organic' or 'natural' labeling would influence my purchase.	1.37%	6.85%	21.92%	49.32%	17.81%
4. Foods labeled 'natural' or 'certified organic' have a better taste and texture than others.	2.74%	10.96%	56.16%	24.66%	4.11%
5. Foods labeled 'certified organic' or 'natural' are worth more than others.	2.74%	12.33%	31.51%	42.47%	10.96%

The strongest choice categories selections were for "Neutral" and "Agree." Either form of "Disagree" was much less widely used, and "Strongly Agree" was comparable to "Disagree", lacking the same appeal as "Neutral" or "Agree." Statements 2 and 3 showed the strongest inclination, with 65.7% and 67.1% of respondents choosing either "Agree" or "Strongly Agree." The largest negative inclination appeared in Statement 1, with 15.3% of respondents choosing either "Disagree" or "Strongly Disagree." Statement 4, which differentiated between the taste and texture of certified organic and natural products, showed more than half of the individuals responding as neutral to the statement, and nearly 14% choosing one of the forms of "Disagree."

The fourth section of the written survey asked consumers to state the premium in cents per pound that they would pay for certain listed meat attributes. The attributes that were listed were commonly used trait- or location-based marketing identities: "Locally Grown," "Heritage Meat," "Labeled 'Certified Organic'," "Labeled 'Natural'," and "National Brand." The results are reported in Table 5 in terms of the percentage of respondents willing to pay the premium.

Table 5. Consumers' willingness to pay a premium for selected meat attributes.

	Premium in Cents per Pound							
Attribute	**None**	**1-9**	**10-24**	**25-49**	**50-74**	**75-99**	**100-149**	**150**
Locally Grown	12.16%	10.81%	14.86%	12.16%	17.57%	12.16%	12.16%	8.11%
Heritage Meat	12.33%	15.07%	15.07%	15.07%	12.33%	15.07%	8.22%	6.85%
Labeled 'Certified Organic'	17.81%	16.44%	6.85%	17.81%	13.70%	12.33%	9.59%	5.48%
Labeled 'Natural'	19.44%	15.28%	15.28%	18.06%	8.33%	8.33%	9.72%	5.56%
National Brand	36.99%	12.33%	19.18%	12.33%	6.85%	5.48%	5.48%	1.37%

Within the responses for the selected attributes, there were no really consistent patterns or trends that could be observed in the data. The only numbers that stand out are in the "National Brand" category, where 36.9% of respondents would not pay any premium and only 1.37% would pay a 150-cent premium.

Data Interpretation

The effective populations for preserving the genetic diversity of each breed are roughly one-third of the current population. These numbers are slightly misleading, as they seem to indicate that the herds are fairly well preserved, and that they must be maintaining their genetic diversity easily. In actuality, these numbers merely represent the number of animals that must be kept to maintain the current level of genetic variation; there is no recuperation of that which is already lost. However, there is a positive note in that it is a very achievable number of animals that must be kept, which would indicate that it is possible to stop the loss of any more genetic diversity…given incentives to increase production of these breeds. Although tens or hundreds of thousands of hogs seem like very large numbers, they are, in actuality, quite small in comparison to the 55.6 million hogs that were marketed in 2006 (National Agricultural Statistics Service, 2007).

Interpreting the data from the conjoint yields a few conclusions. The first conclusion is that the presence of local labeling – be it either "local" or "state" – is attractive to consumers, and can influence them to purchase a specific product based on the use of "local" labeling. This point is an important marketing concept for small producers, as most of what they produce is already marketed in their area, which means that it is simply a matter of providing this information. In turn, the data indicates that they may be able to generate a premium for their product that will make its production more attractive from an economic standpoint. Tying into this point is consumer aversion to the "unknown" factor of some products. By labeling a product's source, the unknown factor of the other products sharing the case becomes more obvious, increasing the attractiveness of the labeled product.

A second conclusion that could be drawn from the data analysis is that men and consumers who do not live in the country are more likely to purchase meat that has a "local" label. There are several possible reasons for this, not all of which are even related to meat consumption in general. It could be that "local" meat is perceived as more prestigious, or that "local" labeling taps into some innate yearning for a rustic or simpler life in the country. Regardless of motivation, this data suggests that there are some potential market segments that are interested in these types of products that could be tapped into by producers. Marketing aimed specifically at these groups could prove to be more influential than a similar effort targeting a broad audience.

The written survey provides a few more insights that were not seen in the conjoint experiment, as well as showing some interesting contrasts. The importance of source knowledge in meat products was reiterated in the first written question, in which the majority of respondents indicated that they cared where their meat was produced. The reasons for which people purchased meat at a local farmers' market also provided some insight. The most chosen reason was "Support local farmers/economy," followed closely by "freshness." The first reason is a societal value, while the second is a personal and/or health reason. In effect, the social importance of supporting farmers is as valuable to people as the benefits they derive from increased freshness. This combination would indicate that a farmer's location is as important to consumers as the products that they produce. Small farmers who are having difficulty competing on price or product, may capture increased prices in recognizing that their location is valuable to consumers in and of itself.

The Heritage labeling section reveals two important points. First, four-out-of-five people had never seen Heritage labeling, which indicates that penetration into the market is fairly limited. There are a lot of potential customers who have never seen the Heritage label on the products that they are buying. Further, respondents showed a positive response to the Heritage idea once they were aware of what it meant. However, they did not extend this willingness to choice behavior when presented with the opportunity to buy meat from a Heritage breed (Poland China) in the conjoint experiment (Polands were described but not using the "Heritage" descriptor in the experiment setup). Consumers seem to like the idea of Heritage, but are not significantly influenced to buy the products when they see them. A key point of any marketing campaign is going to require some driver to push acceptance into action.

The last two sections of the written portion did not provide much insight into consumer preferences. The "Neutral" category was chosen nearly as much as any other response. The most positively received statements involved "certified organic" and "natural" products as having better taste characteristics and influencing choices. However, respondents did not show the inclination to use production method as a relevant influence in choice in the conjoint experiment. Within the premium selection section, there were no premiums proposed to be paid that stood out as different or significant. "National Brand" products were most likely to achieve no premium paid and the least likely to achieve the highest premium available. This reluctance is an interesting side note, as consumers regularly pay premiums for national brands. Without that willingness, national brands would not achieve the brand equity that they do.

Conclusion

This project was intended to answer three research questions, which could be posed in short as: Is it feasible to preserve a genetically diverse population of heritage breeds of swine? What kind of attributes are consumers looking for in meat products? How can the answers to these to questions be understood and applied?

The genetic model that was constructed from wildlife biology formulas clearly indicates that the sizes of the populations that are required are feasible. It is physically possible for producers to maintain the numbers of these animals required to preserve their genetic diversity. Providing the economic incentive to producers is a matter of providing consumers with the attributes or awareness of attributes that they desire. Consumers were the most interested in buying meat and meat products that were raised locally or within the state. Since most small Heritage breed producers are already selling locally, labeling them as such may lead to the premiums that they need to justify the production inefficiencies of these breeds.

Preservation of genetic resources will always be an important subject in relation to any species. Keeping the diverse populations of these animals in the production chain is vital to the overall goal of genetic preservation. Absent the provision of a public preservation program, producers need a market premium to ensure that suitable populations are maintained. This pilot study would indicate that consumers are willing to pay for the attributes that they value the most, such as local production, and can provide the premium to producers that offer the products with the attributes that they desire.

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Appendix A

Preserving America's Heritage Livestock Breeds
Using Marketing to Maintain a Genetically Viable Population

Intercept Survey Tool

Introduction and Consent Request Script

Introduction

"Good morning. My name is (insert name here) and I am a researcher at Ohio State University. I am conducting a survey about consumers' attitudes toward pork characteristics. We are looking for volunteers; could you take a few minutes to participate?" (If 'yes', proceed; if 'no', go to Rejection Response.)

"I just need to ask you to qualifying questions. First, are you 18 years of age or older?" (If 'yes', proceed; if 'no', go to Rejection Response.)

"Do you or are you willing to purchase pork?" (If 'yes', proceed; if 'no', go to Rejection Response.)

Rejection Response:

"Thank you for your time. I appreciate your stopping by. Have a nice day."

Survey Proceedings

At this point, respondents will be shown two table tent displays (attached) which contain facts and observations about the pork chops that will be used as examples in this experiment. As they are seated at the computer, the researcher will remind the respondent:

"Again, this survey is completely voluntary. You do not have to answer any question that makes you uncomfortable, and you can withdraw from participation without any problems or repercussions. Just let me know; it will not be a problem."

They will then be shown a welcome screen on the computer (screen shot attached) that sets up the scenario for each person. Respondents will be given the option of reading the screen or having the researcher read it to them. They will then be shown ten pairs of products (sample screen shot attached), with each product listing four attribute descriptors. The researcher will ask each respondent for their choice.

"Would you prefer to purchase Product 1, Product 2, or would you not purchase either?"

This question would be repeated for a total of 10 sets of observations. Respondents' answers will be stored in the computer with a sequential identification number only. The researcher will place that same identification number on the written portion of the survey. Respondents will then be allowed to fill out and return the survey anonymously, free from observation by the researcher.

Appendix B

Poland China

- Purebred type of pigs
- Raised on U.S. farms for decades
- Known for larger pork chop size and greater proportion of flavorful fats
- Declining in numbers due to less efficient growth
- Generally raised on smaller, less production-intensive farms

Appendix B

Standard

- Combination of best traits from several breeds
- Provide consistent–quality product
- Grown by the majority of producers in the U.S.
- Has mixed genetic background
- Generally raised in larger facilities employing the latest management and nutritional science

Appendix C

1

Welcome

Imagine you are standing in front of your grocer's meat case, picking out some pork chops for dinner. Your grocer, in an effort to provide customers with more information about the available products, is now displaying the product's production method and locale, if available. In a joint effort with the new information campaign, the grocer has begun offering two different types of pork, and has provided the following descriptions to aid in consumers' decision-making process. These choices are illustrated on the table displays next to the computer.

Assume that both choices have same weight and size, and that the meat cuts are identical in appearance, marbling, and overall quality. In each case, the two packages of meat differ only in the characteristics we will describe. Please remember that you, as do all consumers, have a limited amount of funds available for food purchases. Try to make your purchase decision just as you would in real life.

When presented with a set of products, please indicate your choice in each case.

When you are ready to proceed, click on the Continue button. ==>

Continue

Appendix D

	Product 1:		Product 2:	
Location of Production:	Unknown		Unknown	
Meat Type:	Standard		Standard	
Production Method:	Standard		Standard	
Price per pound:	$	5.00	$	5.00

3

Appendix E

ID:_________

Section A: About your food purchases.

A-1. Does it matter to you where the meat that you buy was raised? ❑ Yes ❑ No

A-2. Please check the box that best completes this phrase: I would prefer to buy meat raised: *(please check only one)*

- ❑ near my store
- ❑ in this state
- ❑ in the United States
- ❑ outside the United States
- ❑ anywhere – I do not care where it was raised.

A-3. Below are some possible reasons for purchasing locally grown meat. Please mark the top three reasons that you would purchase locally grown meat, placing a '1' beside the most important reason, continuing down to '3' for the third most important reason.

- ___ Flavor
- ___ Safety
- ___ Nutritional value
- ___ Freshness
- ___ Support local farmers/economy
- ___ Knowledge of my food's source

A-4. Have you ever seen the term "Heritage" or "Heritage Meat" used to market a meat product?

❑ Yes ❑ No

A-5. Please rate your willingness to purchase meat that is labeled as "Heritage," with a score of "1" being unwilling to buy it and "10" being the most willing. ________

A-6. Please read the following statement before answering the next question.

Heritage breeds are types of animals that have been traditionally raised in the United States. These animals are often considered to produce more flavorful meat, but their numbers are declining because they are less efficient to raise.

Having read this statement, please rate your willingness to purchase meat that is labeled as "Heritage," with a score of "1" being unwilling to buy it and "10" being the most willing. ________

A-7. Please indicate the degree to which you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Certified organic food is safer for consumption than food not certified organic.	❑	❑	❑	❑	❑
2. There is a difference between foods labeled 'certified organic' and those labeled 'natural.'	❑	❑	❑	❑	❑
3. Price and all things being equal, 'certified organic' or 'natural' labeling would influence my purchase.	❑	❑	❑	❑	❑
4. Foods labeled 'natural' or 'certified organic' have a better taste and texture than others.	❑	❑	❑	❑	❑
5. Foods labeled 'certified organic' or 'natural' are worth more than others.	❑	❑	❑	❑	❑

A-8. Please check the box that corresponds to the premium that you would be willing to pay for the following attributes.

	Premium in Cents per Pound							
Attribute	None	1-9	10-24	25-49	50-74	75-99	100-149	150
Locally Grown	❑	❑	❑	❑	❑	❑	❑	❑
Heritage Meat	❑	❑	❑	❑	❑	❑	❑	❑
Labeled 'Certified Organic'	❑	❑	❑	❑	❑	❑	❑	❑
Labeled 'Natural'	❑	❑	❑	❑	❑	❑	❑	❑
National Brand	❑	❑	❑	❑	❑	❑	❑	❑

Appendix E

Section B: About you and your household.

********These questions are required for statistical analysis use. We will not ask your name******
and all answers will be kept strictly anonymous.

B-1. Are you: ❑ Female ❑ Male

B-2. Are you the primary food shopper in your household? (primary = making half or more of all food purchases)

❑ Yes ❑ No

B-3. What is your current age? _________

B-4. How many of the people in your household, including yourself, are in the following age groups? (Please write the appropriate number of people in each category.)

_____ Under 5 years
_____ 5 to 9 years
_____ 10 to 14 years
_____ 15 to 19 years
_____ 20 to 24 years
_____ 25 to 34 years
_____ 35 to 44 years
_____ 45 to 54 years
_____ 55 to 64 years
_____ 65 to 74 years
_____ 75 years or more

B-5. Approximately how much does your household spend each week on food purchases? _$_________

B-6. Approximately how much does your household spend each week on meat purchases? _$_________

B-7. Please mark the category which best describes the community in which you currently live: *(please check only one)*

❑ City
❑ Suburb
❑ Small town
❑ Non-farm country residence
❑ Farm

B-8. Were you born in the United States? ❑ Yes ❑ No

B-9. How do you describe your ethnic heritage? *(please check only one)*

❑ Hispanic or Latino
❑ Black or African American
❑ White
❑ Asian
❑ Native Hawaiian or Pacific Islander
❑ American Indian or Alaska Native
❑ Other

B-10. What was the total income of all in your household in 2005? *(please check only one)*

❑ Less than $10,000
❑ $10,000 – $14,999
❑ $15,000 – $24,999
❑ $25,000 – $34,999
❑ $35,000 – $49,999
❑ $50,000 – $74,999
❑ $75,000 – $99,999
❑ $100,000 – $149,999
❑ $150,000 – $199,999
❑ $200,000 or more

B-11. What is your home zip code? __________

Appendix F

```
read  ;file=c:\heritagedata\conjointdata3.xls ;format=xls  ;names $
skip
create ; if(choice=3) choice=-999 $
create ; if(choice=2) choice=0 $
create ; if(price1=0) p1=5 $
create ; if(price1=1) p1=4.5 $
create ; if(price1=2) p1=4 $
create ; if(price1=3) p1=3.5 $
create ; if(price1=4) p1=3 $
create ; if(price2=0) p2=5 $
create ; if(price2=1) p2=4.5 $
create ; if(price2=2) p2=4 $
create ; if(price2=3) p2=3.5 $
create ; if(price2=4) p2=3 $
create ; deltaP=p1-p2 $
create ; deltamt=meat1-meat2 $
create ; deltaprd= prod1-prod2 $
create ; stand1=0 ; stand2=0 ; natural1=0 ; natural2=0 ; organic1=0 ; organic2=0 $
create ; if (prod1=0) stand1=1 ; if (prod2=0) stand2=1 ; deltastn=stand1-stand2 $
create ; if (prod1=1) natural1=1 ; if (prod2=1) natural2=1 ; deltanat=natural1-
natural2 $
create ; if (prod1=2) organic1=1 ; if (prod2=2) organic2=1 ; deltaorg=organic1-
organic2 $
create ; local1=0 ; local2=0 ; unknown1=0 ; unknown2=0 ; state1=0 ; state2=0 ; us1=0
; us2=0 $
create ; deltaloc= locale1-locale2 $
create ; if (locale1=0) unknown1=1 ; if (locale2=0) unknown2=1 ; deltaunk=unknown1-
unknown2 $
create ; if (locale1=1) us1=1 ; if (locale2=1) us2=1 ; deltaus=us1-us2 $
create ; if (locale1=2) state1=1 ; if (locale2=2) state2=1 ; deltaOH=state1-state2 $
create ; if (locale1=3) local1=1 ; if (locale2=3) local2=1 ; deltalcl=local1-local2 $
create ; if (locale1<=1) out1=1 ; if (locale2<=1) out2=1 ; deltaout=out1-out2 $
create ; if (locale1>=2) in1=1 ; if (locale2>=2) in2=1 ; deltain=in1-in2 $
create ; plus50=0 $
create ; if (age>50) plus50=1 $
create ; if (age=-999) plus50=-999 $
create ; if (medinc=-999) medinc=-999 $
create ; if (income=-999) income=-999 $
create ; orgXstn=deltaorg*deltastn $
create ; ageXp=age*deltap $
create ; age2Xp=plus50*deltap $
create ; seenXp=seenher*deltap $
create ; mtroXunk=metro*deltaunk $
create ; incXoh=income*deltaoh $
create ; mincXoh=medinc*deltaoh $
create ; genXlcl=gender*deltalcl $
create ; counXlcl=coun*deltalcl $
?USING MIX 2
dstat ; rhs=choice, p1, p2, locale1, locale2, meat1, meat2, prod1, prod2, deltap,
deltalcl, deltaprd, orgXstn,
genXlcl, ageXp, incXoh, medinc, counXlcl, mtroXunk  $

probit ; lhs=choice ; rhs=one, deltap, deltaunk, deltain,
genXlcl, age2Xlcl, ageXp, incXoh, mincXoh, counXlcl, mtroXunk, seenXp ; marginal
effects $

reset;
```

Appendix G

```
=================================================================
Variable        Mean          Std.Dev.        Minimum         Maximum      Cases
=================================================================
--------------------------------------------------------------------------------
All observations in current sample
--------------------------------------------------------------------------------
CHOICE     .497198880      .500342656      .000000000      1.00000000        714
P1         3.96824324      .691142213      3.00000000      5.00000000        740
P2         4.00945946      .705126966      3.00000000      5.00000000        740
LOCALE1    1.49189189      1.11391212      .000000000      3.00000000        740
LOCALE2    1.55945946      1.10134853      .000000000      3.00000000        740
MEAT1      .493243243      .500292494      .000000000      1.00000000        740
MEAT2      .463513514      .499004238      .000000000      1.00000000        740
PROD1      .954054054      .807976002      .000000000      2.00000000        740
PROD2      1.01621622      .812458310      .000000000      2.00000000        740
DELTAP    -.412162162E-01  1.01343673     -2.00000000      2.00000000        740
DELTALCL  -.108108108E-01  .664093095     -1.00000000      1.00000000        740
DELTAPRD  -.621621622E-01  1.24046596     -2.00000000      2.00000000        740
ORGXSTN   -.255405405      .436383803     -1.00000000      .000000000        740
GENXLCL    .833333333E-02  .465723598     -1.00000000      1.00000000        720
AGEXP     -1.39500000      49.1873812     -152.000000      144.000000        700
INCXOH    -2378.78788      69344.1835     -200000.000      200000.000        660
MEDINC     .500000000      .500391083      .000000000      1.00000000        640
COUNXLCL   .270270270E-02  .294272329     -1.00000000      1.00000000        740
MTROXUNK   .135135135E-02  .452026932     -1.00000000      1.00000000        740

--> probit ; lhs=choice ; rhs=one, deltap, deltaunk, deltain,
    genXlcl, age2Xp, ageXp, incXoh, mincXoh, counXlcl, mtroXunk, seenXp ; mar...


+----------------------------------------------+
| Binomial Probit Model                        |
| Maximum Likelihood Estimates                 |
| Model estimated: Apr 19, 2007 at 02:23:26PM.|
| Dependent variable                 CHOICE    |
| Weighting variable                   None    |
| Number of observations                584    |
| Iterations completed                    5    |
| Log likelihood function       -331.6227    |
| Restricted log likelihood     -404.7432    |
| Chi squared                    146.2409    |
| Degrees of freedom                   11    |
| Prob[ChiSqd > value] =         .0000000    |
| Hosmer-Lemeshow chi-squared =   7.52827    |
| P-value=  .48085 with deg.fr. =       8    |
+----------------------------------------------+
```

Appendix G

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
	Index function for probability				
Constant	-.00809993	.05680041	-.143	.8866	
DELTAP	.07495514	.25041675	.299	.7647	-.02482877
DELTAUNK	-.67074796	.15057897	-4.454	.0000	.01369863
DELTAIN	-.08749545	.12159399	-.720	.4718	-.02397260
GENXLCL	.54005569	.15807601	3.416	.0006	-.00513699
AGE2XP	.53069169	.23969182	2.214	.0268	-.00684932
AGEXP	-.01646787	.00689587	-2.388	.0169	-1.56164384
INCXOH	.599468D-05	.220000D-05	2.725	.0064	-2251.71233
MINCXOH	-.55553389	.30250434	-1.836	.0663	-.00171233
COUNXLCL	-.42410954	.20249898	-2.094	.0362	.00684932
MTROXUNK	-.27349452	.19715645	-1.387	.1654	.00171233
SEENXP	.26601852	.13669890	1.946	.0517	-.01883562

Partial derivatives of E[y] = F[*] with respect to the vector of characteristics. They are computed at the means of the Xs. Observations used for means are All Obs.

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Elasticity
	Index function for probability				
Constant	-.00323084	.02265275	-.143	.8866	
DELTAP	.02989756	.09988444	.299	.7647	-.00150709
DELTAUNK	-.26754306	.06006659	-4.454	.0000	-.00744081
DELTAIN	-.03489955	.04850056	-.720	.4718	.00169857
GENXLCL	.21541348	.06304948	3.417	.0006	-.00224663
AGE2XP	.21167844	.09560429	2.214	.0268	-.00294356
AGEXP	-.00656858	.00275055	-2.388	.0169	.02082587
INCXOH	.239111D-05	.877511D-06	2.725	.0064	-.01093107
MINCXOH	-.22158731	.12066139	-1.836	.0663	.00077034
COUNXLCL	-.16916573	.08076955	-2.094	.0362	-.00235239
MTROXUNK	-.10908950	.07864090	-1.387	.1654	-.00037924
SEENXP	.10610753	.05452626	1.946	.0517	-.00405766

Appendix G

```
+----------------------------------------+
| Fit Measures for Binomial Choice Model |
| Probit   model for variable CHOICE     |
+----------------------------------------+
| Proportions P0= .506849   P1= .493151  |
| N =     584 N0=     296   N1=     288  |
| LogL =  -331.62269 LogL0 =  -404.7432  |
| Estrella = 1-(L/L0)^(-2L0/n) = .24133  |
+----------------------------------------+
|     Efron |  McFadden  |  Ben./Lerman  |
|    .22792 |    .18066  |       .61321  |
|    Cramer | Veall/Zim. |     Rsqrd_ML  |
|    .22631 |    .34474  |       .22152  |
+----------------------------------------+
| Information  Akaike I.C. Schwarz I.C.  |
| Criteria        1.17679    739.68418   |
+----------------------------------------+
Frequencies of actual & predicted outcomes
Predicted outcome has maximum probability.
Threshold value for predicting Y=1 = .5000
            Predicted
------  ----------  +  -----
Actual      0    1  |  Total
------  ----------  +  -----
  0       217   79  |    296
  1        85  203  |    288
------  ----------  +  -----
Total     302  282  |    584

=======================================================================
Analysis of Binary Choice Model Predictions Based on Threshold =  .5000
-----------------------------------------------------------------------
Prediction Success
-----------------------------------------------------------------------
Sensitivity = actual 1s correctly predicted                     70.486%
Specificity = actual 0s correctly predicted                     73.311%
Positive predictive value = predicted 1s that were actual 1s    71.986%
Negative predictive value = predicted 0s that were actual 0s    71.854%
Correct prediction = actual 1s and 0s correctly predicted       71.918%
-----------------------------------------------------------------------
Prediction Failure
-----------------------------------------------------------------------
False pos. for true neg. = actual 0s predicted as 1s            26.689%
False neg. for true pos. = actual 1s predicted as 0s            29.514%
False pos. for predicted pos. = predicted 1s actual 0s          28.014%
False neg. for predicted neg. = predicted 0s actual 1s          28.146%
False predictions = actual 1s and 0s incorrectly predicted      28.082%
```