# Consumer Demand for a Ban on Antibiotic Drug Use in Pork Production

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Livestock feed and water are routinely supplemented with antimicrobial drugs. In the 1940s, animal scientists demonstrated that higher growth and feed conversion rates could be achieved by adding low amounts of antibiotics to feed and water and that the additional revenues more than offset antibiotic costs. Adding subtherapeutic doses (doses below 200 grams per ton of feed) of antibiotics to feed quickly became a livestock industry standard, leading to lower production costs, adoption of confined production practices, and ultimately lower meat prices. The National Research Council estimates that approximately 19 million pounds of antibiotics are used annually in U.S. animal agriculture for all purposes including growth promotion and disease treatment. The U.S. General Accounting Office, based on data from the Animal Health Institute, put the figure at 13 million pounds of active ingredient in 2002. Although some antibiotics are given to livestock in response to disease, 80% to 90% are used solely for greater weight gain and lower mortality rates (Mellor; Office of Technology Assessment).

The benefits of subtherapeutic antibiotics to livestock producers are clear, but the costs to society are not. Some antibiotic residues are trapped in meat and are ingested by humans. These residues can cause direct health problems through allergic reactions or toxicity. However, these direct health risks are virtually eliminated by federal regulations prohibiting antibiotic use close to slaughter dates. Most health risks from subtherapeutically administered antibiotics are due to the fact that many antibiotics given to livestock are also used by humans (e.g. penicillin). Regularly administered antibiotics increase the chance of bacteria developing resistance. Microbial resistance to antibiotics limits the ability to treat disease in both humans and livestock and can increase human hospital costs by as much as $4 billion per year (Goforth and Goforth; Office of Technology Assesment). Many experts contend that continuous, low dosage feeding of antibiotics to livestock increases the risk of resistance (Levy; National Research Council) and several cases have been documented (e.g., Fey et al.; Mølback et al).[1]

Given the benefits to agricultural producers and the potential health risks to consumers, it is no surprise that antibiotic use in livestock production has been a hotly debated issue in recent years. Concerns over antibiotic use have resulted in proposals to totally or partially eliminate antibiotic use in agriculture. Bans were considered as early as 1977, but recent pressure to follow through on these proposals has been mounting. For example, in 1999 a petition signed by fifty-three health experts and forty-three organizations was sent to the U.S. Food and Drug Administration calling for a ban on subtherapeutic uses of antibiotics in livestock for those antibiotics that are used in, or may be related to those used in, human medicine. (Center for Science in the Public Interest 1999, 2000). This led to the introduction of a number of bills in the U.S. Congress (e.g., the Brown–Slaughter–Waxman Preservation of Antibiotics for Human Treatment Act of 2002). Although no such bill has been passed, pressures from

[1] Many experts believe that human use of antibiotics poses a greater potential human health threat due to resistance than animal use of antibiotics.

consumer interest groups have kept the debate alive. Indeed, the Preservation of Antibiotics for Medical Treatment Act of 2005 was recently introduced in the U.S. Senate, a bill which proposes to withdraw approval of a nontherapeutic use of certain classes of antibiotics in livestock that are also used to treat human illness.

Despite pressure to ban subtherapeutic antibiotic use in livestock production, a number of issues need to be resolved before regulatory action is strongly considered by policy makers. A ban will undoubtedly raise production costs and increase the price of meat. However, consumers could benefit from a ban in two ways. First, consumers might derive a direct benefit from a ban because of preferences for meat with no antibiotic residues and a desire for "natural" products. Although most scientists agree that health risks posed from antibiotic residues are small, consumers may have a preference for residue free and "natural" meat, preferences which are exemplified by the growing popularity of organic food and branded meat products, which advertise among other things production without antibiotics. The second benefit consumers could receive from a ban is an indirect benefit that would result from reducing the risk of microbial resistance to antibiotics. Antibiotic resistance represents an externality created by the use of subtherapeutic antibiotic in livestock production. Unlike the first benefit, the second is unlikely to be provided through the market alone. Previous studies investigating the effect of banning or reducing use of subtherapeutic antibiotics have focused on the magnitude of increased production costs and the effects of these increased costs on welfare. To our knowledge, no previous study has analyzed consumer demand for a ban on subtherapeutic feeding of antibiotics.

As stated by Mathews, analyses of the benefits to society from lower microbial resistance are sparse. Losses resulting from foodborne illness or antibiotics resistance, such as medical expenses, productivity loss, and death are uncertain. Nevertheless, such estimates are needed to determine the socially optimal level of antibiotic use (e.g., Secchi and Babcock; McNamara and Miller). One method of estimating these costs is by obtaining medical records, salary estimates, etc. However, this method is fraught with logistical problems and is quite difficult to implement. As proposed by Hayes et al. (1995), in the context of food safety, another method of estimating the effects of a policy is to estimate consumer willingness-to-pay. Estimates of consumer willingness-to-pay for a ban on antibiotic use in livestock production should capture the perceived costs of illness as well as other opportunity costs. In fact, Hayes et al. (1995) argue that cost-of-illness measures can drastically underestimate the true economic value of a policy, which should be measured by eliciting willingness-to-pay. Thus, willingness-to-pay for a ban on antibiotic use in livestock production should be assessed before overall welfare effects of a policy are determined.

In this study, we estimate the direct and indirect benefits of a ban on feeding subtherapeutic antibiotics in pork production among a sample of grocery shoppers in a Midwestern city. We conduct non-hypothetical experiments involving real food and real money in a grocery store setting. While conducting experiments with grocery shoppers necessarily limits the sample size and generalizability of the results, the advantages of this approach are numerous.[2] Advantages of such field experiments have recently been discussed by Harrison and List, List (2004a, 2004b), Lusk and Fox (2003), and Lusk et al. Perhaps the greatest advantage of conducting such experiments is that the decision context matches that which the researcher is attempting to model. Participants endogenously select into the market and are able to bring all their learned experiences to bear on the task at hand. In the following section, we further discuss the issues surrounding measurement of the direct and indirect benefits of a ban on feeding subtherapeutic antibiotics to pork and details about our specific value elicitation experiments.

**Methods**

Consumer valuation for the attribute of "antibiotic use" is made up of two components: a direct value that is primarily derived from a demand for naturalness and a concern for residues in meat and an indirect value that is derived from a positive externality that results from a reduction in the likelihood that antibiotic resistant bacteria will develop. The direct value component is estimated by eliciting the premium consumers place on a

[2] Despite the disadvantage of the restricted sample, it should be noted that demographics typically play a small or insignificant role in explaining variation in willingness-to-pay. Further, Harrison and Lesley show that behavioral responses of students could be used to accurately predict median willingness-to-pay of the general population.

cut of meat from an animal fed antibiotics versus an "antibiotic free" cut of meat. Although no previous study, to our knowledge, has estimated consumer willingness-to-pay for antibiotic-free meat, several studies have analyzed consumer demand for a reduction in other growth promotants in livestock production (e.g., Lusk, Roosen, and Fox; Dickinson and Bailey; Buhr et al.; Lusk and Fox, 2002). These studies generally show that on average consumers are willing to pay premiums for products produced without growth hormones, but that many consumers are willing to trade off concern for hormone for improvements in other quality characteristics.

Although estimating the value consumers would be willing-to-pay for "antibiotic free" meat might be important for determining marketing opportunities for livestock producers, meat packers, and meat retailers, it does not capture the entire value consumers might place on a ban on antibiotics. The primary concern with antibiotic use in livestock production is the development of resistant bacteria. This concern cannot likely be mitigated through voluntary labeling efforts. Resistance can only be slowed if most producers cease routine feeding of antibiotics to livestock. Thus, consumers might be willing to pay for a ban on all feeding of antibiotics to livestock that goes beyond a simple willingness-to-pay for the attribute of "antibiotic free" meat. This is the positive externality that we refer to as the indirect benefit. Estimating both of these value components will be important for fully understanding the role of government policy.

*Measurement of Direct Benefit – Non-Hypothetical Choices*

To measure the direct benefit consumers place on antibiotic use, we conducted a non-hypothetical choice task where individuals decided whether and what type of pork chop they desired at varying price levels. Our approach can be considered a type of choice-based conjoint analysis (Louviere, Hensher, and Swait) and is probably most similar to that used by Loureiro, McCluskey, and Mittelhammer. A booth was set up near the meat counter in a grocery store. Shoppers passing by the booth were asked to participate in a research study in exchange for a chance to enter a drawing for $500 in free groceries and another free gift. Individuals that agreed were asked to first read a brief information statement about antibiotic use in pork production. Because antibiotic use is a controversial subject with many competing view-points, we used three different information sheets. Consumers randomly received one of three types of information: a) the WHO perspective compiled using information from the National Academy of Science (National Research Council) and World Health Organization, b) the industry perspective compiled in consultation with representatives from pork producer organizations, or c) no information. The appendix contains copies of the first two information sheets. After reading the information, all consumers were presented the following task:

> "We would like to offer you one of three gifts. One gift is an antibiotic-friendly pork chop. Antibiotic-friendly pork refers to pork from hogs that were not administered antibiotics at an adolescent age, unless the hogs were sick. **Please**

**recognize that we are conducting objective research, and are not trying to persuade you to consume antibiotic-friendly pork**. Please think about your decision and make the choice that best matches your preferences. . . . All pork chops were purchased and packaged by [grocery store]. Each pork chop is approximately one-inch thick, boneless and weighs approximately 1/2 pound."[3]

Then, consumers where asked to make one of three choices: Gift A: one free antibiotic friendly pork chop, Gift B: one free regular pork chop plus a coupon for $X off their total grocery bill, or Gift C: a coupon for $X+$Y off their total grocery bill. An example of the decision task is shown in figure 1. Each consumer received a different coupon value, $X, which ranged from $0.10 and $4.15. Prior to the study, the coupon values were drawn from a uniform random number generator, with over-sampling of values in the range $0.10 to $1.00. These randomly drawn coupon values were pre-printed on each individualized survey. The value $Y was set randomly at either $0.05 of $0.10. The purpose of adding the third option (Gift C) was to allow individuals who did not want to consume pork a chance to participate in the study. Had only Gifts A and B been available, individuals that did not want to purchase pork would likely choose Gift B simply to receive the coupon, artificially inflating the value of the regular pork chop.

To determine the value individuals placed on antibiotic friendly pork, we utilize a random utility model. Define a random utility function with a deterministic ($V_{ij}$) and

[3] The term "antibiotic friendly" was used instead of "antibiotic free" to prevent misleading consumers into believing no antibiotics were used in the production process.

a stochastic ($\varepsilon_{ij}$) component: $U_{ij} = V_{ij} + \varepsilon_{ij}$, where $U_{ij}$ is the i$^{th}$ consumer's utility of choosing option j, $V_{ij}$ is the systematic portion of the utility function determined by a constant identifying the pork chop type and a coupon amount, and $\varepsilon_{ij}$ is a stochastic element. The probability that a consumer chooses alternative j is given by: $\text{Prob}\{V_{ij} + \varepsilon_{ij} \geq V_{ik} + \varepsilon_{ik};\ \text{for all}\ k \in C_i\}$ where $C_i$ is the choice set for respondent i, i.e., $C_i$ = {Gift A, Gift B, Gift C}. Louviere, Hensher, and Swait show that if $\varepsilon_{ij}$ are iid extreme value, the probability of consumer i choosing alternative j is equal to:

$$(1) \qquad \text{Prob}\{\text{j is chosen}\} = \frac{e^{\mu V_{ij}}}{\sum_{k \in C} e^{\mu V_{ik}}}$$

where $\mu$ is a scale parameter. In this application, the utility of consuming Gifts A, B, and C, are respectively parameterized as follows: $V_{GiftA} = \alpha_0$, $V_{GiftB} = \alpha_1 + \alpha_2\$X$, and $V_{GiftC} = \alpha_2(\$X+\$Y)$. One welfare measure of relevance is an individual's maximum willingness-to-pay (WTP) for an antibiotic friendly pork chop over a regular pork chop (i.e., compensating variation for a change from antibiotic friendly to regular), which is $(\alpha_0 - \alpha_1)/\alpha_2$.[4] This value can be interpreted in one of two ways: a) assuming antibiotic friendly pork and regular pork are both available for sale, if antibiotic friendly pork were priced $(\alpha_0 - \alpha_1)/\alpha_2$ higher than regular pork, the average consumer would be indifferent to purchasing antibiotic friendly or regular pork, and/or b) the price

[4] We use the term WTP loosely here. Individuals never had to actually pay any money; they received coupons. Thus, one might be temped to interpret these values as willingness-to-accept measures. However, in this framework, there is no distinction between willingness-to-pay and willingness-to-accept as the point of endowment is neutral.

difference between antibiotic friendly and regular pork that would make the average individual indifferent to moving from a world where only regular pork was for sale to a world where only antibiotic friendly pork was for sale given that a purchase would take place in either world.

Although this is a valid welfare measure under the assumptions stated above, it ignores the fact that individuals are free to choose "none" when shopping and that consumers' actual choices are uncertain. As such, an additional welfare measure is perhaps more relevant for this analysis. In particular, Small and Rosen, as well as Morey, show that the expected maximum utility from a making a choice from particular choice set is given by: $CV = \ln(\sum e^{V_j}) + C$, where C is Euler's constant. Thus, the welfare change that occurs when moving from a situation given by $CV^0$ to a situation given by $CV^1$ is: 1/(marginal utility of income)*[$(CV^1) - (CV^0)$]. This calculation represents the most consumers would be willing to pay per choice occasion to face the choices in situation 1 versus situation 0. Of course, this raises a question about the definition of a choice occasion. This is an issue we revisit latter in the paper. It should be clear that if there is 100% certainty a pork chop will be purchased and there is only one pork chop in the choice set per choice occasion, that the aforementioned WTP for antibiotic friendly pork results: $(\alpha_0 - \alpha_1)/\alpha_2$.

To make concrete why this welfare measure is important, consider that some consumers are currently able to buy both antibiotic friendly and regular pork from various markets; however, a ban would prohibit the sale of the latter. In this case, consumers would lose the ability to purchase regular pork. The welfare change that would result from moving from a world where consumers could choose between regular pork, antibiotic friendly pork, and none to a world with where the choice was only between antibiotic friendly pork and none is:

$$(2) \qquad \frac{1}{\alpha_2}\left[\ln\left(e^{\alpha_0-\alpha_2 P_{antibiotic}}+e^{\alpha_1-\alpha_2 P_{regular}}+1\right)-\ln\left(e^{\alpha_0-\alpha_2 P_{antibiotic}}+1\right)\right].$$

This value can be interpreted as the maximum amount consumers would pay to keep regular pork in their choice set per choice occasion.

In subsequent analysis, we test whether data from the three information treatments can be pooled. To carry out this test, we estimate the relative scale parameter, μ, across data sets (see Swait and Louviere) to control for potential differences in variance. The test for parameter equality is $-2(LL_J - \sum LL_i)$, which is distributed $\chi^2$ with $K(M-1)$ degrees of freedom, where $LL_J$ is the log likelihood value for the pooled model after controlling for scale, $LL_i$ are the log likelihood values of separate models from each information treatment, $K$ is the number of restrictions, and $M$ is the number of information treatments (see Louviere, Hensher, and Swait for more detail).

Before proceeding, it is important to mention the advantages of the valuation approach. First, the decision task is non-hypothetical. A significant amount of research suggests individuals overstate the amount they are willing to pay in hypothetical settings as compared to when real money is on the line (e.g., see List and Gallet for a review). In our experiment, if an individual chooses the antibiotic friendly chop, they must give up at least $X. An individual would not choose the antibiotic friendly chop unless their value for it exceeded the value for the regular chop and the coupon amount. Second, Lusk and Fox (2003) found that the valuation setting (store versus laboratory) can influence willingness-to-pay estimates, and as such, our approach places individuals in the more relevant decision setting – a grocery store. Third, unlike some previous in-store experiments (e.g., Lusk et al.; Lusk and Fox, 2003), in this application individuals are simply required to make a discrete choice as they do when shopping as opposed to the relatively unfamiliar task of formulating an auction bid.

As with any approach, there are also some disadvantages. Ideally, one could place antibiotic free pork on the shelf and observe revealed behavior.[5] Indeed, some stores currently sell meat products raised without antibiotics; however, this production practice is typically bundled with other attributes such as organic such that it is impossible to isolate the effect of antibiotic use. The difficulty with placing antibiotic free pork on the grocery shelf is that it would be comparatively more difficult to manipulate prices to trace out the demand for antibiotic free pork, not to mention the signals such price changes might send to consumers (see the discussion in Bockstael and Shogren et al.). Even if scanner data were available, it would likely suffer from

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[5] We do have limited data on sales of antibiotic free pork, which was placed on sale in the grocery store *after* our experiment was completed. This sales data is discussed later in the paper.

aggregation and endogeneity problems. Further, demographic information from each shopper is often unavailable with scanner-type data, which limits the ability to make inferences about the effect of sample characteristics on behavior. Finally, with our approach the marginal utility of money, $\alpha_2$, is estimated by varying the coupon amount given to individuals. However, when shopping individuals must give up their *own* money to obtain goods they desire. Neoclassical economic theory makes no distinction between the marginal utility of money given and money taken away. However, if individuals are loss averse, as in Kahneman and Tversky, the psychological effects of a loss (spending one's own money) will loom larger than an equivalent gain (obtaining a coupon). The consequence of such an effect, if present, would be to generate willingness-to-pay estimates for antibiotic free pork which are higher than what would be obtained if individuals were spending their own money. Despite this, utilizing coupons was an integral part of our recruitment design and offering coupons drastically increased the response rate compared to other studies we have conducted without such inducements. Using coupons also avoids the problem of cash constrained individuals in a store setting, e.g., many consumers come to a store planning to pay by credit card or check and do not have any cash to participate in a value elicitation experiment.

*Measurement of Indirect Benefit – Non-hypothetical Donations*

In addition to measuring the direct value individuals placed on meat from swine that were not fed antibiotics, one must determine the value individuals place on the externality associated with antibiotic resistance if the consequences of a ban are to be fully assessed. In this paper, we take two approaches to measure this value, the first of which is explained in this sub-section.

Champ et al. suggested using actual donations to public goods as an estimate of an individuals' value for the public good. They showed that donations could serve as a lower bound for an individual's true compensating surplus even in the presence of warm glow, where warm glow is defined as the utility derived from the act of giving. Intuitively, donations can serve as a lower bound estimate because individuals are likely to free-ride off contributions of others in a donation scenario. The original Champ et al. approach was criticized by Chilton and Hutchinson, who questioned the appropriateness of the technique to provide a lower bound for compensating surplus in cases where the public good is provided by the government through taxes. Nevertheless, the donation method still has appeal and has been used in recent analyses such as that by Champ and Bishop. The appeal of the donation mechanism is that it provides a means of estimating the value of a public good based on non-hypothetical money allocation decisions by consumers. Importantly, donations are not equivalent to compensating surplus, the statistic needed to fully evaluation policy effect; however, as shown in Champ et al., under certain assumptions, donations can serve as a lower bound for compensating surplus and they avoid problems associated with hypothetical bias.

To implement this method, we used the same recruitment protocol discussed above. Shoppers were asked to participate in a research study in exchange for a chance to enter a drawing for $500 in free groceries and another free gift. Participants in this part of the study were only given the information statement related to the WHO perspective. Then consumers were asked to choose between a coupon for $Z off their grocery bill or to make a donation of $Z+$2 to a cause. The value $Z was randomly set at either $2 or $4. The number and type of causes were varied across individuals. In one treatment of the experiment, individuals were simply asked to choose between the coupon and a donation that benefited antibiotic resistance. This donation took one of two forms; individuals were either asked whether they would donate: a) $Z+$2 to approved non-profit organizations seeking to promote antibiotic-friendly pork or b) $Z+$2 worth of antibiotic-friendly pork chops to other randomly selected shoppers at the grocery store. For this application, it was difficult to identify a perfect donation mechansim to reduce antibiotic resistance, so we chose these two rather distinct options that both have their own advantages and disadvantages. The key is that, for either donation option, individuals were giving up their own money in an effort to reduce the antibiotic resistance. An example of the simplest donation decision task is shown in figure 2 where individuals were asked to decide whether they wanted a coupon for $4 off their grocery bill or whether they wanted us to make a donation of $6 to an approved non-profit organizations seeking to promote antibiotic-friendly pork.

Although Champ et al. argue that donations represent a lower bound on compensating surplus, their analysis did not consider transactions costs associated with giving. If warm glow is a particularly large component of giving behavior, individuals might not care which charity they give to *per se*, and will donate to any charity for which it is easy to give. By simply offering individuals the chance to donate to an antibiotic cause, we have effectively reduced the transactions costs of donating to this cause relative to other donation opportunities. As suggested by Norwood and Lusk, we alleviate this concern by offering multiple donation opportunities. To be clear, adding additional donation opportunities does not increase the number of donation opportunities, it only makes more donation opportunities equally convenient. All alternative donations are well-known and could be sent donations outside of the experiment. By making alternative donations just as convenient as donations to the antibiotic cause, we remove what Norwood and Lusk term an intrument-induced bias. In addition to the treatments where only one donation option was present, we conducted other treatments with four, six, and ten donation options involving charities such as the Red Cross, the Human Society, and the Make-A-Wish Foundation. An example of a decision task with ten donation options is shown in figure 3. The competing donation options and their descriptions were chosen based on the public-goods experiments used in Eckel and Grossman. Each decision making task contained *one* of the two donation opportunities involving antibiotic friendly pork. When multiple donation opportunties were utilized, the order and type of donation options were randomized across surveys.

Donation data can be manipulated in a variety of ways to estimate a "maximum willingness to donate." For example, a probit model could be estimated where the likelihood of donating to the antibiotic cause is regressed on the price of donating ($2 or $4) and the number of other donation options. Standard formulas (e.g., Hanemann) could be applied to estimate mean willingness-to-donate by dividing the resulting constant by the price coefficient. However, becase the donation method is meant to provide a lower-bound estimate of compensating surplus, we simply calculate the Turnbull lower bound willingness-to-donate by multiplying the percentage of individuals donating by the price of donating (see Haab and McConnell). We also utilize this approach because our two donation options differ with regard to the cost to the subject and the benefit they provide to the charity, a fact which is not easily handled with the probit model.

In one donation case, it cost individuals $2 to give the charity $4 and in the other case, it cost individuals $4 to give $6. In effect, our approach provided a "matching" contribution where the price of donating $1 to the charity equaled either $0.50 or $0.67. We provided these matches because many contribution mechanisims utilize matches, and as such, this approach would be familiar to the individual. To net-out the effect of these matching contributions, we need to determine the effect of increasing the price of contributing $1 to a charity from $0.50 or $0.67 to exactly $1. Eckel and Grossman, in an experimental setting, found that the price-elasticity of donating (for matching donations) was -0.938. So, if the price of donating was increased from $0.50 to $1.00, the price of donating would increase 100%, and as such we would expect donations to fall 93.8%. Alternatively, if the price of donating was increased 50% (from $0.67 to $1.00), donations would be expected to fall 46.9%. Thus, if the Turnbull lower bound willingness-to-donate from the $2 donation scenario is $\$WTD_2$, we reduce this this figure by 93.8% to arrive at our final lower-bound estimate for the $2 donation scenario. Similarly, if the Turnbull lower bound willingness-to-donate from the $4 donation scenario is $\$WTD_4$, we reduce this this figure by 46.9% to arrive at our final lower-bound estimate from the $4 donation scenario. Finally, we average the reduced willingness-to-donate figures across the $2 and $4 scenarios to provide an overall estimate of willingness-to-donate.

One point of clarification is in order. Some might argue that in the multiple-donation treatments individuals might choose not to donate to an antibiotic cause simply because they have a higher value for one of the alternative donation opportunities. For example, an individual's value for the antibiotic cause might be relatively high, but their value for the Humane Society might be higher still. That some individuals value other charities more than the antibiotic cause and makes such a choice accordingly does not invalidate using the Turnbull lower bound esimate as an esimate of individuals value of the antibiotic cause. What would invalidate using the percentage of individuals that chose the antibiotic cause to calculate a lower bound on welfare is if individuals chose the anbiotic cause over the Humane Society, for example, simply because it was easier (e.g., there where fewer transactions costs) to give to the former than the later. Even when the treatment where the antibotic cause is the only donation option, individuals still have the option to donate to the Humane Society, for example, by taking the coupon amount in the experiment and mailing in a donation to the Humane Society when they got home. Our multiple-donation approach aleviates the bias caused by the instrument itself making one donation more conveeint than others.

*Measurement of Indirect Benefit – Contingent Valuation*

As another means of estimating the indirect value individuals placed on the ban, we utilized a standard contingent valuation question. Regardless of whether an individual participated in the pork-chop decision task or the donation decision task, they were subsequently asked to respond to a contingent valuation question. In particular, individuals were asked to answer the following question:

> "Suppose the next time you go to vote, there was a referendum on the ballot to ban the feeding of antibiotics to adolescent hogs, except in instances when the hog is sick. If the referendum passes, tax revenues will be used to enforce the ban. If **YOUR** federal income taxes increased by **$T** per year due to the ban,

would you vote **FOR** or **AGAINST** the ban? Please answer as if you were actually voting on a real referendum involving real taxes."

The value $T was varied randomly across individuals ranging from a low of $1 to a high of $1,000. As shown in Hanemann, WTP for the ban can be determined by estimating a logit/probit model, where the dependent variable is the probability of a FOR vote and independent variables are a constant and $T. WTP is simply the ratio of the parameter on the constant to the parameter on $T. As with the pork-chop choice exercise, we will test whether pooling data across information treatments and experiments (public vs. private) is appropriate.

Although this approach has the advantage of providing a direct measure of the statistic of interest, previous research suggests WTP estimates will likely be prone to hypothetical bias and might be overstated (List and Gallet). As such we interpret WTP from the contingent valuation questions as an upper bound on true compensating surplus for the ban.

**Results**

The study was carried out over a 6-day period in August 2004. Overall, 442 individuals participated in the research, with 291 taking part in the pork chop choice experiment and 151 taking part in the donation experiment. Table 1 reports summary statistics describing the characteristics of individuals who took part in this study. Overall, the sample make-up was very similar across the two experiments. The majority of study participants were female, which is not surprising given the setting of the study. Despite drastic changes in the number of women in the work force, females are still, by a large margin, the primary grocery shoppers in most households (Progressive Grocer). About half the study participants had a college degree and about 10% of the sample was comprised of students. Income data indicate that half the participants earned household incomes less than $39,999/year. This figure is similar to U.S. census data, which indicates that the 2003 median household income was $43,318 across the entire U.S. and $35,902 in the specific state where the research was conducted.

The primary results from the pork chop choice experiment are summarized by multinomial logit model estimates. The following documents the steps taken to specify our final model. First, we estimated three separate multinomial logit models corresponding to the three information treatments; the sum of the log-likelihood function values across the three models was -301.32. Then, we pooled the data and estimated a model where utility parameters were constrained to be equal across information treatments, but where the relative scale was allowed to vary; the resulting log-likelihood function value was -303.61. Comparing the two likelihood function values via a likelihood ratio test indicates that null hypothesis of parameter equality across information treatments cannot be rejected at any standard level of significance. Further, none of the estimated scale parameters are significantly different than one.

These findings imply that information had no effect on choices between pork chops. Consumers with no information exhibited preferences consistent with those that received either the industry or WHO perspective. This could be due to strong priors held by consumers or to the fact that the underlying message in all treatments is effectively the same: that antibiotic use in livestock production *may* pose a human health threat. As a result of these findings, table 2 reports results of a pooled multinomial logit model with identical parameters and scales across information treatments.[6]

Results indicate that either of the pork chops is preferred to none as indicated by the positive constants relative to gift option C. On average, consumers preferred the antibiotic friendly chop over the regular chop as indicated by the relative magnitudes of the estimated constants. The positive coefficient on coupon price indicates that individuals were more likely to choose options that had higher coupon prices, *ceteris paribus*. Applying the simple welfare measure, we find that average WTP for antibiotic friendly pork over regular pork was $1.86 per choice, given that there is no uncertainty regarding choice. This represents a 76.7% premium for antibiotic friendly pork over regular pork. Ninety-five percent confidence intervals suggest a wide range for mean WTP values, from $0.59 to $4.09. On the surface, this premium appears quite high.

[6] We have also estimated a nested logit model with an initial branch between "choose a pork chop" and "do not choose a pork chop." However, the data were not supportive of the nested logit specification; the inclusive value was not significantly different than one and likelihood function values were very similar to the non-nested model.

However, there are several factors that suggest the estimate is not unreasonable. First, to carry out this research, we purchased regular pork loins in addition to “antibiotic free” loins at market prices from large, reputable pork packers. We were charged $16/loin for regular loins and $24/loin for “antibiotic free” loins – a 50% premium. Second, after our experiments were completed, we possessed a number of excess loins, which we gave to the participating grocery store. The grocery store agreed to sell, for the first time, antibiotic free loins side-by-side with their conventional product at a $1.00/lb (or 25%) premium. Despite this premium, the grocery store sold more antibiotic free pork than regular pork during over the two-week time the antibiotic free pork was sold. We cannot reject the hypothesis that the market share of antibiotic free pork predicted from the model reported in table 2 is different than the market share of antibiotic free pork in the actual store sales. Finally, although the store did not sell any pork or beef that was advertised free of antibiotics, it carried a chicken brand “Smart Chicken®” that advertised, among other things, no antibiotic use. Although the chicken is often priced at a level twice that of regular chicken, anecdotal evidence from the butchers suggests sales of Smart Chicken and regular chicken are comparable.

Although the estimated 76.7% premium is quite large, several factors should be considered before concluding that a ban is justified. First, there is very little evidence to suggest that consumers actually know that most pork is produced with subtherapeutic antibiotics. If awareness levels are low and a ban was enacted, prices would rise due to increased production costs, but demand might remain unchanged due to lack of knowledge. If such a situation occurred, our estimates suggest a welfare loss of $1.14 per choice occasion would occur. We arrive at this estimate by assuming pork chops sold for $3.05/lb ($1.525/half lb) prior to the ban, the 2003 average retail price for pork chops (LMIC). After the ban, we assumed retail pork prices would increase 0.81% to $3.07/lb ($1.537/half lb). The 0.81% retail pork price increase was obtained by utilizing the cost estimates in Brorsen et al. (which assumed farm-level production costs would increase roughly 2% after a total ban on subtherapeutic use of antibiotics in pork production) and their equilibrium displacement model with a perfectly elastic long-run farm supply curve. Based on these assumptions, the welfare change when consumers are unaware of the ban is $\frac{1}{\alpha_2}\left[\ln\left(e^{\alpha_1-\alpha_2 1.537}+1\right)-\ln\left(e^{\alpha_1-\alpha_2 1.525}+1\right)\right]$.

Another reason to believe that such a large premium may not justify a ban is that if consumers are indeed willing to pay such a large premium for antibiotic free pork (e.g., data in table 2 suggest a value of $1.14, on average, per choice occasion even when choice uncertainty is taken into consideration), the market could readily provide this product without a ban. It might be argued that consumers have imperfect information about product quality. While such an argument might justify the need for a policy on labeling of meat produced with subtherapeutic antibiotics, it hardly justifies the need for a total ban. Finally, even if consumers are aware of current production practices, one must consider the fact that a ban will eliminate an option from consumers' choice sets. At present, some consumers can buy both regular and antibiotic free pork in grocery stores, but if a ban was enacted only antibiotic free pork would be available. The last row in table 2 reports an estimate of the lost option value assuming antibiotic friendly and conventional pork are readily available to all consumers prior to a ban. Results indicate that consumers would suffer a welfare loss of $1.32 per choice occasion if regular pork were removed from the choice set. This estimate was obtained by substituting the aforementioned prices into equation (2).

While consumers' private preferences for antibiotic free pork might be a factor to consider when evaluating the economics of a ban, it may not be the primary concern. A ban on antibiotic use in livestock production is being proposed primarily to eliminate the externality that is antibiotic resistant bacteria. Table 3 reports statistics related to consumers' behavior when presented with the opportunity to make a donation to reduce antibiotic resistance. Several general findings warrant attention. First, when only one donation option was present a larger frequency of individuals made donations to contributing pork to other shoppers than did individuals donating cash to non-profit organizations seeking to promote antibiotic friendly pork. Second, increasing the number of donation options drastically reduces the percentage of shoppers making donations toward the antibiotic cause. Statistical tests suggest the percentage of individuals that chose the antibiotic donation was the same in treatments that had four or more donation options. For that reason and to ease of exposition, we simply pooled data from all treatments that had more than four donation options. In the most dramatic case, 71.4% of shoppers gave up $2 to donate $4 worth of antibiotic friendly pork to other shoppers when only one donation option was present, but this number dropped to only 12.5% when at least 4 donation options were present. These results clearly support the need to incorporate alternative donation opportunities when attempting to use donations as a lower bound estimate for compensating surplus. We also find that a much lower frequency of shoppers made donations when they had to give up $4 as when they only had to give up $2.[7]

Table 3 also reports the lower bound estimates for compensating surplus with the matching subsidy and the implied lower bound estimate without the subsidy, inferred using the price elasticity of donating from Eckel and Grossman. Overall, results indicate very low willingness-to-donate. On average, individuals were only willing to donate $0.04 to non-profit organizations that seek to promote antibiotic friendly pork when the effect of the matching subsidy is removed and more than one donation option was present. On average, individuals were only willing to donate $0.01 worth of antibiotic friendly pork to other shoppers when the effect of the matching subsidy is removed and more than one donation option was present.

[7] Results from a logit model confirm the statistical significance of all these findings. The logit model estimates (with t-statistics in parentheses) are: 0.80(1.69)-1.77(3.13)*(dummy for coupon amount 1=$4, 0=$2)-1.13(2.06)*(dummy variable for type of antibiotic donation)-1.74(2.38)*(dummy for 4 donation options) -2.98(2.72)*(dummy for 6 donation options) -3.21(2.96)*(dummy for 10 donation options), where the dependent variable is 1 if a donation was made to an antibiotic cause, 0 otherwise.

The final portion of the data collection exercise involved asking individuals whether they would vote for or against a ban on use of subtherapeutic antibiotics in pork production after the weaning stage. As a first step in analyzing the data, we tested whether the voting data could be pooled across the three information treatments in the pork chop choice experiment and the two treatments of the donation experiment. First, separate logit models were estimated for each information treatment; the sum of the log-likelihood values from all five treatments is -270.74. Then we estimated a model that constrained parameters to be equal across treatment, but allowed variance to differ and the resulting log likelihood function value was -274.69. A likelihood ratio tests cannot reject the hypothesis (p=0.44) of equality of parameters across treatment. We also estimated a model constraining variance to be constant across treatment (log likelihood value = -275.99) and were unable to reject the hypothesis of equality of variance. As a result of these findings, table 4 reports results of a pooled logit model where parameters and variance are equal across treatment.

Results indicate the tax level had a statistically significant effect on the probability of voting for the ban, with a higher tax rate associated with a lower likelihood of an affirmative vote. Mean WTP for the ban is $125, with 95% confidence intervals between $78 and $208. Although the non-hypothetical donations implied a very low value placed on the externality of antibiotic use, estimates from the hypothetical contingent valuation question imply a much higher value. Even in absence of hypothetical bias, one would expect a value from a ban to be higher than a donation due to free riding.

**Market Impacts and Discussion**

Thus far, discussion has been limited to valuation statistics at the individual level; however, to assess the impacts of policy, the aggregate effects must be assessed. While recognizing that our sample is geographically restricted, it can be instructive to use our estimates to investigate the aggregate effects of a ban on antibiotic use in pork production. Importantly, these inferences are based on the very strong assumption that our data is representative of the entire U.S. population.

To investigate the effects of a ban, we must make a number of additional assumptions. Although a number of previous authors have investigated the supply-side effects of a ban, e.g., Allen and Burbee; Gilliam et al.; Hayes et al. 1999, 2001, 2002; Mann and Paulsen; Mathews; Wade and Barkley, (see Mathews, 2001 for one summary), we utilize the recent cost estimates reported by Brorsen et al., who concluded that a ban would increase production farm-level production costs by 2.02%. While our consumer valuation questions focused only on a partial (and less costly ban) after the weaning stage, we utilize the Brorsen estimate of 2.02% as it provides a more costly estimate of the effect of a ban. As stated above, if this cost estimate is plugged into the equilibrium displacement model of Brorsen et al., with the only change being that the long-run supply curve is perfectly elastic, we find that retail pork prices would be expected to increase 0.81%.[8] As a further simplifying assumption, we assume welfare changes accruing to pork chops choices can be used to represent welfare changes from all pork consumption choices. Thus, as above, we assume pork chops sell for $3.05/lb ($1.525/half lb) prior to the ban.

To determine aggregate welfare changes, we must determine a method for identifying the number of choice occasions an individual faces in a year. First, we note that per-capita consumption of pork was 51.8/lbs/person in 2003 (LMIC) and that that there were 290.9 million individuals in the US in 2003 (U.S. Census Bureau), implying that a total of 15,064 million pounds of pork were consumed in the U.S. in 2003. Second, given the price data above, our multinomial logit model (table 2) predicts that if faced with a choice between conventional pork and "none" (the present choice situation for most consumers), 55.8% of consumers would choose to buy pork. This implies that a total of 26,975 million choices in 2003 would rationalize consumption levels in 2003 (i.e., 15,064/0.558 = 26,975). This amounts to roughly 93 choices/per person/year. If one recognizes that: a) the choices are in half-pound increments and that most shoppers buy more than a half a pound of pork when shopping, i.e., they make multiple half-pound choices on a single shopping visit, and b) consumers buy pork in other places besides

[8] A 2.02% increase in farm costs does not translate into an identical retail price increase even under the assumption of perfectly elastic supply because of the presence of the marketing sector. Because the farmers' share of the retail dollar is 0.4, a 2.02% supply shift translates into a 2.02*0.4 = 0.81% retail price increase.

grocery stores, this figure does not seem too unreasonable. This is especially true in light of the fact that data from the National Pork Board suggests 83% of shoppers go to the supermarket once a week or more and that over half of grocery shoppers always visit the meat case on grocery trips. Finally, to arrive at aggregate welfare changes occurring from market effects, the per-choice welfare measures in table 2 are multiplied by the total number of choices in a year, 26,975 million.

We evaluate the aggregate effects of a ban under several scenarios, none of which can be ruled out *a priori*. In the first case (second column of table 5), we assume consumers are unknowledgeable about antibiotic use in pork production before and after the ban. In this case, pork production costs increase, but demand remains constant. In this case, consumer surplus losses occurring from increased pork prices are estimated at $185 million (table 5). Our estimate of consumer surplus loss is strikingly similar to the long-run estimate of $180 million obtained by Brorsen et al., who also assumed demand remained constant after a ban. This similarity in welfare estimates is noteworthy when one considers that the demand curve used in Brorsen et al. is based on an assumed own-price elasticity of -0.35 from a time-series econometric model, whereas the "demand curves" used in our study is based on consumers' choices in the experiment and the estimated MNL model.

Unlike the study of Brorsen et al., and all other supply-side studies, our analysis can say much more about consumer welfare changes. Even if consumers were unknowledgeable, they would still derive non-market benefits from reduction in antibiotic resistance. The lower bound estimate is derived based on the donation data, where we found that average willingness to donate was about $0.04, which we interpret as a per-household, per-year value. Given that there are 105.48 million households in the U.S. according to the 2000 census, a lower bound estimate of the benefit derived from reduction in antibiotic resistance is 4.22 million. An upper bound estimated of the non-market benefit is derived from the contingent valuation question. Multiplying an average WTP of $125/household/year by the number of households yields an aggregate benefit of $13,193 million. The first column of results in table 5 shows the net effects of the ban under these assumptions. Results indicate total surplus may decline by as much as $182 million or increase by as much as almost $13 billion depending on whether one uses the upper or lower bound to define non-market benefits of reduction of antibiotic resistance. Even if the upper bound estimate of the non-market benefit is reduced by half, following the recommendations of the NOAA panel for hypothetical contingent valuation questions, total surplus would still increase by more than $6 billion.

The second case considered in table 5 is the case where consumers are perfectly informed about antibiotic use in pork production and where consumers can now only purchase regular pork fed subtherapeutic antibiotics. Under such assumptions, when a ban is enacted, consumer surplus will increase by $1.14 per choice occasion or $30.6

billion in aggregate. Even without considering the non-market benefits, total surplus would substantially increase under such a scenario as shown by the second column of results in table 5.

The final case considered is that where consumers are perfectly informed about antibiotic use in pork production, but where they are presently able to purchase antibiotic friendly pork in addition to pork from swine fed antibiotics. Under such a situation, consumer surplus will fall $1.32 per choice occasion after the ban due to the loss of the option to purchase regular pork, which results in an aggregate consumer surplus loss of $35.5 billion. These losses dominate the non-market benefits from a reduction in antibiotic resistance as shown in the final column of table 5.

A few comments about the results in table 5 are in order. First, it is important not to confuse the finding that the information treatments had no effect on behavior with the results in table 5 showing that assumptions about consumer awareness significantly influence the welfare effects. What table 5 shows is that the welfare effects depend on whether consumers are aware of whether a ban is in place and whether current production practices utilize subtherapeutic antibiotics. These are different assumptions regarding *which* pork product individuals are valuing, the conventional or antibiotic friendly pork, which has little to do with the effect of an information script on valuations for antibiotic friendly pork. Second, that the range of estimated benefits in table 5 is wide does not necessarily imply that little can be learned from this study. To our knowledge, this is the first study to report any valuation estimates for antibiotic use in pork, thus, we have at least provided a starting point from policy makers and future research can begin. Further, our approach is valuable in the sense that it identifies the factors that influence the welfare effects of a ban. In that regard, we note that the range of non-market benefits is swamped by the assumptions about consumer awareness as can be seen by comparing results across columns in table 5. Thus, future research would be well served to gather more information on consumers' knowledge about antibiotic use in pork production and the extent to which consumers are able to currently purchase antibiotic free pork.

**Conclusions**

This study investigated consumer demand for pork from swine that were not administered subtherapeutic antibiotics. Over 440 individuals took part in experiments held near the meat counter of a grocery store. In one set of experiments, we elicited consumers' direct or private value for antibiotic free pork by having consumes make non-hypothetical choices between conventional and antibiotic free pork chops. The price of competing pork chops was varied by offering coupons of differing magnitudes to each subject participant. In another set of experiments, we elicited consumers' indirect value for antibiotic free pork, which is derived from a reduction in antibiotic resistance, by asking consumers to make non-hypothetical choices between receiving coupons to reduce their total grocery bill or making a donation to reduce antibiotic resistance. Using a novel approach, we allowed consumers the option of making donations to a cause aimed at reducing antibiotic resistance in addition to other charities. Finally, a conventional contingent valuation question was posed to all study participants to provide another estimate of consumers' value of reducing antibiotic resistance via a ban on feeding of subtherapeutic antibiotics in pork production.

Results of the analysis suggest consumers place substantial premiums on pork produced without antibiotics. Although these findings suggest there may be profitable marketing opportunities for firms interested in selling these products or that policy makers may need to consider legislation to reduce information asymmetries about product quality, they do not, in and of themselves, justify a ban. We base this conclusion on two factors. First, consumers may be unknowledgeable about current production practices, and if so, demand will not respond when a ban is enacted. Thus, increased production costs resulting from the inability to utilize subtherapeutic antibiotics will increase pork prices to consumers, who will, in turn, demand less pork resulting in surplus losses to producers and consumers. Second, even if consumers are knowledgeable about current pork production practices, there are currently opportunities to buy both regular and antibiotic free pork. A ban will eliminate the ability to purchase regular pork, which results in consumer surplus loss. This welfare loss can be substantial and might be many times larger than producer surplus losses.

The extent of this loss depends heavily on one's perception of the ability of the pork market to provide differentiated products.

Aside from any changes resulting in consumer demand for pork itself, a ban on subtherapeutic use of antibiotics in pork production will likely be valued by consumers because it would decrease the chance of development of antibiotic resistant bacteria. Results of our non-hypothetical experiment indicate consumers were only willing to donate about $0.04/household/year to organizations promoting antibiotic friendly pork. However, this estimate is a lower-bound estimate for consumers' true compensating surplus as individuals can readily free ride off contributions of others. Hypothetical contingent valuation questions indicated that consumer value for the ban might be as much as $125/household/year. Even if this figure is reduced by half to account for hypothetical bias, a total surplus gain resulting from reduction of antibiotic resistance of over $6.5 billion is implied.

Taken together, the net welfare effects of a ban are difficult to quantify. The results depend heavily on assumptions about consumers' awareness of antibiotic use in pork production and the extent to which consumers are able to currently purchase antibiotic free pork. Future research might focus on obtaining such information in addition to investigating the generalizability of our results. Future research might also focus on the robustness of our valuation estimates to alternative types of information. For example, valuations might change if individuals were informed of potential benefits of antibiotic use such as improved environment or animal welfare or were informed of risks of antibiotic resistance from human uses of antibiotics. This paper represents an initial attempt to understand the consumer-side of the problem that has all too often been ignored when investigating the effects of a ban on subtherapeutic antibiotics in livestock production. The results presented in this paper are not *the* answer but one piece of information needed to more accurately determine the complex welfare effects of a ban on antibiotic use in livestock production.

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**Table 1 – Characteristics of Study Participants**

| Variable | Definition | Pork Chop Experiment | Donation Experiment |
|---|---|---|---|
| Gender | 1 if female; 0 if male | 0.648 | 0.647 |
| Age | age in years | 46.512 | 47.331 |
| Degree | 1 if obtained college degree; 0 otherwise | 0.460 | 0.527 |
| Student | 1 if currently attending college; 0 otherwise | 0.139 | 0.100 |
| Income1 | 1 if annual household income before taxes is less than $20,000; 0 otherwise | 0.264 | 0.285 |
| Income2 | 1 if annual household income before taxes is $20,000 to $39,999; 0 otherwise | 0.238 | 0.208 |
| Income3 | 1 if annual household income before taxes is $40,000 to $59,999; 0 otherwise | 0.212 | 0.229 |
| Income4 | 1 if annual household income before taxes is $60,000 to $79,999; 0 otherwise | 0.143 | 0.090 |
| Income5 | 1 if annual household income before taxes is $80,000 to $99,999; 0 otherwise | 0.077 | 0.125 |
| Income6 | 1 if annual household income before taxes is greater than $100,000; 0 otherwise | 0.066 | 0.056 |
| Eat1 | 1 if eat pork about once a week; 0 otherwise | 0.512 | 0.567 |
| Eat2 | 1 if eat pork about once a month; 0 otherwise | 0.341 | 0.280 |
| Eat3 | 1 if rarely or never eat pork; 0 otherwise | 0.146 | 0.153 |
| Number of Observations | | 291 | 151 |

**Table 2 – Private Demand for Antibiotic Friendly Pork: Multinomial Logit Model Estimates**

| Variable | Estimate |
|---|---|
| Antibiotic Friendly Constant | 1.125** [a] |
| | (0.241)[b] |
| Conventional Constant | 0.636** |
| | (0.160) |
| Coupon Price | 0.264* |
| | (0.112) |
| | |
| *Welfare Measures Assuming No Choice Uncertainty* | |
| WTP Price Premium for Antibiotic Friendly over Conventional Pork ($/choice occasion) | $1.855 |
| | [$0.586, $4.086][c] |
| Percent Price Premium for Antibiotic Friendly over Conventional Pork | 76.704% |
| | [11.989%, 209.294%] |
| | |
| *Welfare Measures Assuming Choice Uncertainty* | |
| Welfare change from ban assuming no demand shift ($/choice occasion)[d] | -$0.007 |
| | [-$0.005, -$0.008] |
| Welfare change from ban assuming a demand shift and no loss of option ($/choice occasion)[d] | $1.136 |
| | [$0.354, $2.608] |
| Welfare change from ban with a loss of option to buy conventional pork ($/choice occasion)[d] | -$1.318 |
| | [-$0.499, -$7.966] |

Number of observations = 291; Log-likelihood function value = -305.19

[a]One (*) and two (**) asterisks represent 0.05 and 0.01 levels of statistical significance, respectively

[b]Numbers in parentheses are standard errors

[c]Numbers in brackets are 95% confidence intervals obtained via Krinsky-Robb bootstrapping method

[d]Assumes the price of conventional pork chops are $3.05/lb ($1.525/half lb), the 2003 average retail price, and that antibiotic friendly pork chops are $3.07 ($1.537/half lb), a 0.81% increase in price (Brorsen et al.)

**Table 3 – Responses in Non-Hypothetical Donation Experiment**

| | Actual Frequency of Donations to Antibiotic Cause When Only One Option is Present | Actual Frequency of Donations to Antibiotic Cause When Four to 10 Options are Present |
|---|---|---|
| *Donations to non-profit organizations that seek to promote antibiotic friendly pork* | | |
| Percent of Shoppers Donating $2 | 40.00% [n=10] | 6.67% [n=30] |
| Percent of Shoppers Donating $4 | 7.14% [n=14] | 3.23% [n=31] |
| Willingness-to-Donate with matching subsidy[a] | $0.50 | $0.13 |
| Willingness-to-Donate without matching subsidy[b] | $0.11 | $0.04 |
| *Donations of antibiotic friendly pork to other shoppers* | | |
| Percent of Shoppers Donating $2 | 71.43% [n=14] | 12.50% [n=16] |
| Percent of Shoppers Donating $4 | 29.41% [n=17] | 0.00% [n=20] |
| Willingness-to-Donate with matching subsidy[a] | $1.29 | $0.11 |
| Willingness-to-Donate without matching subsidy[b] | $0.38 | $0.01 |

[a]Calculated as the weighted average of the Turnbull lower bound estimates from the $2 and $4 donation options: $[n_{\$2}*(\%Donating_{\$2}*\$2)+ n_{\$4}*(\%Donating_{\$4}*\$4)]/( n_{\$2}+n_{\$4})$

[b]Calculated as $[n_{\$2}*(\%Donating_{\$2}*\$2)*(1+\varepsilon*\%PI_{\$2})+ n_{\$4}*(\%Donating_{\$4}*\$4)*(1+\varepsilon* \%PI_{\$2})]/( n_{\$2}+n_{\$4})$, where ε is the price elasticity of donating, set at -0.938, which was the value estimated in Eckel and Grossman for matching contributions, and $\%PI_{\$i}$ is the percentage increase in the price of donating required to increase the effective price to $1, which by definition is set at 100% for the $2 donation case and 66.67% for the $4 donation case.

**Table 4 – Consumer Demand for a Ban on Antibiotic Use: Logit Model Estimates**

| Variable | All Data |
| --- | --- |
| Constant | 0.608** [a] |
| | (0.110) [b] |
| Tax | -0.005** |
| | (0.001) |
| | |
| Mean WTP for Antibiotic Ban | $125.08 |
| | [$78.53, $207.98] [c] |

Number of observations = 432; Log-likelihood function value = -275.99

[a] Two asterisks (**) 0.01 level of statistical significance

[b] Numbers in parentheses are standard errors

[c] Numbers in brackets are 95% confidence intervals obtained via Krinsky-Robb bootstrapping method

**Table 5 - Welfare Effects of Ban on Antibiotic Use in Pork Production under Various Assumptions (in millions of dollars/year)**

| | Scenario | | |
|---|---|---|---|
| | Uninformed Consumers/No Demand Shift | Informed Consumers With Demand Shift/Antibiotic Friendly Pork Not Currently Available | Informed Consumers/ Antibiotic Friendly Pork Currently Available |
| Change in Consumer Surplus; Market Effects | -$185.94 | $30,636.50 | -$35,547.37 |
| Non-Market Benefits (lower bound)[a] | $4.22 | $4.22 | $4.22 |
| Non-Market Benefits (upper bound)[b] | $13,193.44 | $13,193.44 | $13,193.44 |
| Total Consumer Welfare Change (lower bound) | -$181.72 | $30,640.72 | -$35,543.15 |
| Total Consumer Welfare Change (upper bound) | $13,007.50 | $43,829.94 | -$22,353.93 |

[a]Based on an average willingness-to-pay of $0.04/household/year from donation data and 105.48 million U.S. households

[b]Based on an average willingness-to-pay of $128.08/household/year from contingent valuation data and 105.48 million U.S. households

**Figure 1 – Example Private-Good Choice Question**

Please Check the **ONE** Gift You Prefer Below

| GIFT A | GIFT B | GIFT C |
|---|---|---|
| One free antibiotic-friendly pork chop | One free regular pork chop PLUS a coupon for $1.85 off all grocery purchases today | A coupon for $1.95 off all grocery purchases today |
| I Prefer Gift A ☐ | I Prefer Gift B ☐ | I Prefer Gift C ☐ |

**Figure 2 – Example Donation Choice Question with Single Donation Option**

Please Check the **ONE** Option You Prefer Below

| Option 1: Coupon | Option 2: Donation |
| --- | --- |
| A coupon for $4 off your total grocery bill at <<grocery store name>> today | A donation of $6 will be made to approved non-profit organizations seeking to promote antibiotic-friendly pork |
| I Prefer Option 1 ☐ | I Prefer Option 2 ☐ |

**Figure 3 - Example Donation Choice Question with Multiple Donation Options**

Please Check the **ONE** Option You Prefer Below

| Option 1: Coupon | Option 2: Donation | Option 3: Donation | Option 4: Donation |
|---|---|---|---|
| A coupon for $2 off your total grocery bill at <<grocery store name>> today | A donation of $4 will be made to the Humane Society of the United States, promoting compassionate treatment of all animals | A donation of $4 will be made to the American Red Cross, promoting community health and specializing in disaster relief worldwide | A donation of $4 will be made to the Make-A-Wish Foundation, creating strength and hope for children with life-threatening illnesses by granting their one most hearfelt wish |
| I Prefer Option 1 ☐ | I Prefer Option 2 ☐ | I Prefer Option 3 ☐ | I Prefer Option 4 ☐ |

| Option 5: Donation | Option 6: Donation | Option 7: Donation | Option 8: Donation |
|---|---|---|---|
| A donation of $4 will be made to the United Way, whose mission is to improve people's lives by mobilizing the caring power of communities | A donation of $4 will be made to the Environmental Defense, promoting the use of scientific and economic analyses to solve environmental problems | A donation of $4 will be made to the American Civil Liberties Union, dedicated to preserving individual rights and liberties | A donation of $4 will be made to the Habitat For Humanity, using donated funds, materials and labor to help needy families build simple decent homes |
| I Prefer Option 5 ☐ | I Prefer Option 6 ☐ | I Prefer Option 7 ☐ | I Prefer Option 8 ☐ |

| Option 9: Donation | Option 10: Donation | Option 11: Donation |
|---|---|---|
| A donation of $4 will be made to the American Cancer Society, dedicated to controlling cancer through research, education and service | A donation of $4 will be made to approved non-profit organizations seeking to promote antibiotic-friendly pork | A donation of $4 will be made to the Conservation Fund, protecting open space, wildlife habitat, public recreation areas, river corridors and historic places through the purchase of land |
| I Prefer Option 9 ☐ | I Prefer Option 10 ☐ | I Prefer Option 11 ☐ |

## Appendix A – Information Sheet Reflecting the WHO Perspective

Thank you for participating in this survey. This survey is part of a [university] research project to study consumer preferences for pork. All that is required of you is to select a gift of your choice and answer several questions. Your responses are anonymous will be held strictly confidential. By participating, you are eligible to win $500 of free groceries from [grocery store]! In addition, we would like to give you a choice between several gifts. To help you decide which gift you would like, please read the information below.

### Antibiotic Use in Pork Production

- ✓ Antibiotics are routinely administered to hogs, even if the hog is not sick. This is referred to as ***nontherapeutic*** antibiotic use. Nontherapeutic antibiotic use helps hogs grow faster, leading to lower pork prices.

- ✓ Nontherapeutic antibiotic use can lead to antibiotic residues in meat, but most scientists agree these residues pose little to no human health threat.

- ✓ Also, nontherapeutic antibiotic use can result in the development of disease-causing bacteria that are resistant to antibiotics. **If antibiotic-resistant bacteria develop, it becomes more difficult and more expensive for medical doctors to treat human diseases.**

- ✓ A ban on nontherapeutic antibiotic use for adolescent hogs can reduce these health risks. A similar ban in Denmark reduced total antibiotic use in swine production by 50%. The World Health Organization stated this ban "reduces the threat of resistance to public health."

- ✓ We refer to pork raised under such a ban to be ***antibiotic-friendly pork.*** The purpose of this survey is to elicit your preferences for antibiotic-friendly pork.

## Appendix B – Information Sheet Reflecting the Industry Perspective

Thank you for participating in this survey. This survey is part of a [university] research project to study consumer preferences for pork. All that is required of you is to select a gift of your choice and answer several questions. Your responses are anonymous will be held strictly confidential. By participating, you are eligible to win $500 of free groceries from [grocery store]! In addition, we would like to give you a choice between several gifts. To help you decide which gift you would like, please read the information below.

**Antibiotic Use in Pork Production**

- ✓ Antibiotics are routinely administered to hogs, even if they are not sick. This is referred to as sub-therapeutic or growth promotion antibiotic use. Sub-therapeutic or growth promotion antibiotic use helps hogs stay healthier, grow faster, and produce less waste, leading to lower pork prices.

- ✓ All antibiotic use can lead to antibiotic residues in meat, but laws requiring proper withdrawal times ensure little to no residues or human health threat.

- ✓ All uses of antibiotics can result in the development of disease-causing bacteria that are resistant to antibiotics. Particular attention has been focused on sub-therapeutic or growth promotion antibiotic usage. If antibiotic-resistant bacteria develop, it becomes more difficult and more expensive for medical doctors to treat some human food-borne diseases.

- ✓ <u>A ban on growth promotion antibiotic use for growing hogs</u> can reduce total antibiotic usage and reduce human health risks, although the exact risk reduction is uncertain. For example:

    - A ban of growth promotion antibiotic usage in Denmark reduced total antibiotic use by 50%.
    - A World Health Organization study of the Denmark ban found no reduction in food-borne illness and no demonstrable public health benefit.

We refer to pork raised under such a ban to be antibiotic-friendly pork. The purpose of this survey is to elicit your preferences for antibiotic-friendly pork. Pork from pigs that may have received growth promotion levels of antibiotics will be referred to as regular pork. It can be assumed that, for both types of pork, the proper withdrawal times have been observed for any antibiotics used and that the meat contains no illegal residues.