ESSAYS ON PRODUCTION AND DEMAND ISSUES

IN THE BOVINE INDUSTRY

By

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CHAPTER I

INTRODUCTION

The beef and dairy industries are very important to the U.S. economy. Currently the U.S. is the world's largest beef producer, with over 10.5 million head of cattle in feedlots (NASS, 2010). In 2009, the beef industry produced over 26.5 billion pounds of beef while the dairy industry produced over 189.2 billion pounds of milk (USDA, 2010). Understanding both supply and demand issues is vital in these industries.

This study seeks to address both production and demand issues in the bovine industry. This study consists of three essays on two main topics important to the bovine industries. The first paper analyzes the economic effects of bovine respiratory disease in feedlot cattle and the second two papers are based on a nationwide survey on consumers' preferences for animal cloning.

Bovine respiratory disease (**BRD**) can cause significant economic losses for cattle producers. The disease causes between $800-900 million annually in economic losses including death losses, reduced feed efficiency, and treatment costs (Chirase and Greene, 2001). Although medical costs attributable to the treatment of BRD are substantial, the economic impact of BRD on animal performance, carcass merit, and meat quality are likely even more devastating. This research assesses the economic effects of BRD in backgrounding and finishing phases with risk assessment of calves based on serum haptoglobin (**Hp**). Cross -bred heifers with expected high-risk of BRD (n=337) were assembled at a Kentucky order buyer facility and delivered to Stillwater, OK in September 2007. Heifers were assigned pens by risk-group according to arrival Hp concentration: Low (serum Hp < 1.0 mg/dL), Medium (1.0 mg/dL < serum Hp < 3.0 mg/dL), and High (serum Hp > 3.0 mg/dL). They were monitored daily for signs of BRD in a 63 day backgrounding phase. After backgrounding, heifers (n=193) were allocated to finishing pens based on number of BRD treatments received: never treated (**0X;** n = 54), treated once (**1X;** n = 54), treated twice (**2X;** n = 34), treated three times (**3X;** n = 39), and chronically ill (**CX;** n = 12). Hp concentration had no significant effect on net returns ($P \geq 0.50$) and was not significantly different across number of BRD treatments ($P \geq 0.11$). However, net returns decreased in the backgrounding phase ($P < 0.0001$) and the combined backgrounding-finishing phases ($P = 0.001$) as number of BRD treatments increased. On average, 0X, 1X, 2X, and 3X groups had $111.12, $92.51, $59.98, and $20.62, respectively, higher net returns than CX ($P < 0.0001$) during backgrounding. When combining phases, 3X and CX groups lost $72.01 and $143.20 more than 0X group ($P \leq 0.03$).

Interest among farmers, food retailers, and regulators regarding market impacts of the introduction of milk from clones was prompted after the FDA’s recent statement that products from cloned animal and their offspring were safe to consume. To address consumers’ preferences for animal cloning, a nationwide survey was administered in the summer of 2008. The purpose of the next two papers is to examine consumers’ perceptions about animal cloning along with their willingness-to-pay (WTP) for products resulting from cloned animals or their offspring.

Because milk from cloned animals is not currently labeled in the market, the first paper utilized a stated preference experiment to determine consumer preferences for the attribute, but also sought to determine whether the survey-based choices were consistent with people's revealed preferences given by scanner data. Our analysis indicates that a pooled model combining stated and revealed preference data exhibits overall better out-of-sample prediction performance than either data set used alone. Results from the pooled model indicate consumers are willing to pay large premiums to avoid milk from cloned cows – an amount that is over three times that for organic or rBST-free milk. The results are used to calculate the value of a mandatory labeling program.

Based on the premise that consumers' preferences are context-independent, data on people's private shopping choices are often used to draw implications about their desires for food policies. The purpose of the final paper is to test this, often implicit, assumption using data from a nationwide survey about animal cloning. We find that although people's private choices indicate a strong desire to avoid meat and milk from cloned cattle, implying a significant willingness-to-pay to ban food from cloned animals, that when directly asked, most people oppose a ban and would demand compensation through lower food prices were a ban enacted. The results suggest caution in inferring public preferences from private choices.

CHAPTER II

ECONOMIC EFFECTS OF BOVINE RESPIRATORY DISEASE ON FEEDLOT CATTLE DURING BACKGROUNDING AND FINISHING PHASES

Introduction

Bovine respiratory disease (**BRD**) is the most common disease among feedlot cattle in the United States. It accounts for approximately 75% of feedlot morbidity and 50 to 70% of all feedlot deaths (Edwards, 1996; Galyean, Perino, and Duff, 1999; Loneragan et al., 2001). The majority of deaths due to BRD occur shortly after arrival to the feedlot or within the first 45 days (Edwards, 1996; Loneragan et al., 2001). In fact, Buhman et al. (2000) reported approximately 91% of calves diagnosed with BRD were diagnosed within the first 27 days after arrival. BRD causes an estimated $800-$900 million in economic losses annually to the U.S. beef cattle industry from death, reduced feed efficiency, and treatment costs (Chirase and Greene, 2001).

Medical costs attributable to the treatment of BRD are substantial, and the economic impacts of BRD on carcass merit and meat quality further increase the economic costs. Gardner et al. (1999) found steers with lung lesions plus active lymph nodes had $73.78 lower net returns. Medicine costs accounted for 21% of the decrease while 79% was attributable to lower carcass weight (8.4% less) and lower quality grade

(24.7% more USDA Standard quality grade carcasses). BRD can also cause economic losses due to decreased gain and carcass values (Duff and Galyean, 2007). A Texas Ranch-to-Rail study found BRD morbidity accounted for 8% higher production costs, not including losses related to decreased performance (Griffin, Perino, and Wittum, 1995). Griffin, Perino, and Wittum (1995) observed cattle with BRD had a 3% decrease in gain compared with healthy cattle and cost the program $111.38 per sick animal. Snowder et al. (2006) estimated economic losses in a 1000 head feedlot from BRD infection due to lower gains and treatment costs to be approximately $13.90 per animal.

Demand for higher quality products and increased value-based marketing have heightened beef producers' awareness of health management practices with potential to increase profitability and beef product quality. Feedlot producers able to purchase calves that are more likely to remain healthy during the feeding period could potentially increase profits through reduced costs and higher revenues. Previous studies document the economic impact from BRD in either backgrounding or finishing programs. The majority of those studies are from animal scientists and veterinarians. Current research relating to animal disease in agricultural economics journals deals with major outbreaks of infectious diseases (e.g. bovine spongiform encephalopathy or bovine brucellosis), tracking systems, and eradication programs (Amosson et al., 1981; Elbakidze, 2007; Hennessy, Rossen, and Jensen, 2005; Kuchler and Hamm, 2000). Limited research on BRD in feedlot cattle is reported in agricultural economic journals. Nyamusika et al. (1994) however, using a stochastic simulation model of BRD, found significant returns to vaccination of cattle. The simulation found vaccination programs combined with treatment of BRD increased net revenues by $44. Further analysis on the economic effects of BRD in the backgrounding phase is warranted along with the effects in the finishing phase and the phases combined.

Knowing the economic impact of BRD on both backgrounding and finishing phases is important. A tool that enables producers to determine whether animals will remain healthy could potentially increase producers' profits. Serum haptoglobin (**Hp**) concentration has been suggested as a tool for making management decisions based on data that shows cattle requiring treatment for BRD had a higher Hp concentration upon arrival than calves that remained healthy throughout the preconditioning phase (Berry et al., 2004; Carter et al., 2002). Hp is an acute-phase protein produced by the liver in response to cellular injury. Based upon Hp concentration measured at arrival, producers could potentially determine animals that would remain healthy.

The overall objective of this research was to determine the economic effects of BRD on backgrounding and finishing phases individually, as well as the two phases combined for the same cattle. In addition, this research measures the effectiveness of using serum haptoglobin concentration to predict BRD occurrence and the economic impact of multiple treatments for BRD in backgrounding on both backgrounding and cattle feeding performance.

Conceptual Framework

Cattle producers are assumed to maximize expected profits. The question is whether the use of serum Hp concentration to predict BRD occurrence has an effect on those expected profits and whether multiple treatments for BRD affect the returns on infected cattle.

Producers' objective function can be expressed as:

(2.1) $\max_x \mathrm{E}(NR) = \boldsymbol{P}'\boldsymbol{Y}(\boldsymbol{x}) - \boldsymbol{r}'\boldsymbol{x}$

where $\mathrm{E}(NR)$ is the expected net revenue per head from their operation, P is the vector of output prices, $\boldsymbol{r}$ is the vector of input prices, $\boldsymbol{Y}(\boldsymbol{x})$ is the final weight of cattle produced, and $\boldsymbol{x}$ is the vector of inputs.

Equation (2.1) does not consider the Hp risk group. Cattle producers would want to maximize expected net returns subject to costs and the Hp risk group. Producers could test serum Hp prior to purchasing calves to estimate their Hp risk group, considered to be low, medium, and high risk in this research. Equation (1) then becomes:

(2.2) $\max_{x,v} \mathrm{E}(NR) = \max\{\boldsymbol{P_v}'\boldsymbol{Y_v}(\boldsymbol{x}) - \boldsymbol{r}'\boldsymbol{x_v} | v = 1, 2, 3\}$

where $\mathrm{E}(NR)$ is expected net returns per head from the operation, $\boldsymbol{P_v}$ is the vector of expected prices for risk group *v* (*v*=1, 2, 3), $\boldsymbol{r}$ is the vector of input prices, $\boldsymbol{Y_v}(\boldsymbol{x})$ is the final weight or number of cattle produced in risk group ***v***, and ***x*** is the vector of inputs for risk group ***v***. The producer would then be maximizing net returns per head.

Materials and Methods

Backgrounding Phase

The current research was conducted according to Oklahoma State University Animal Care and Use Committee approved protocol (#AG-07-14). For this study, 337 cross-bred heifers were purchased by Eastern Livestock order buyers and assembled at the West Kentucky Livestock Market, Marion, KY in September 2007. Heifers were processed after arrival to Stillwater, OK on September 12 and 14 (day 0) and assigned pens by risk-group according to Hp concentration: Low (serum Hp < 1.0 mg/dL), Medium (1.0 mg/dL < serum Hp < 3.0 mg/dL), and High (serum Hp > 3.0 mg/dL). Of the 337 heifers, 86

(25.52%) were in the low-risk group, 98 (29.08%) were in the medium-risk group, and 153 (45.40%) were in the high-risk group. Heifers were fed twice daily, ad libitum, a 65% concentrate receiving/growing ration during the 63-day backgrounding phase costing $111.87 per ton as fed. Specific details regarding rations, animal management, and experimental procedures are described by Holland et al. (2010).

Heifers were evaluated daily for signs of BRD according to standard facility protocol (Step et al., 2008) in which animals were assigned a clinical attitude score (CAS; 1 – 4) based on depression, appetite, and respiratory signs. Antimicrobial therapy was administered when CAS was 1 (mild) or 2 (moderate) and rectal temperature was ≥ 40° C, or when CAS was 3 (severe) or 4 (moribund), regardless of temperature. First treatment was 10 mg tilmicosin/kg of bodyweight (**BW**) costing $1.0814/mg (Micotil 300, Elanco Animal Health, Greenfield, IN), second treatment was 10 mg enrofloxacin/kg of BW costing $0.59/mg (Baytril 100, Bayer Animal Health, Shawnee Mission, KS), and third treatment was two doses of 2.2 mg ceftiofur/kg of BW costing $0.0742/mg (Excenel, Pharmacia & UpJohn, New York, NY) administered 48-h apart. A $0.50 chute charge was added when animals were administered treatments. Chronically ill animals were removed from home pens on or after day 21. Conditions necessary to be classified as chronically ill were: 1) received all three antimicrobial therapies according to protocol; 2) on feed more than 21 days ; 3) experienced a net loss of BW over the preceding 21 days on feed; and 4) they were assigned a BRD severity of ≥3.

Table II-1 shows the number of BRD treatments given to heifers across the Hp risk groups. Of the 337 heifers, there were a total of 113 never treated (33.53%), 98 treated once (29.08%), 42 treated twice (12.46%), 43 treated three times (12.76%), 12 classified as chronically ill (3.56%), and 29 mortalities (8.61%) during the backgrounding phase. High mortality may be attributed to the use of high-risk cattle. The heifers in the study were most likely weaned immediately prior to transporting to the auction market, where they were commingled and then shipped to the feedlot and appeared stressed upon arrival.

Heifers were individually weighed on days 0, 7, 14, 21, 42, and 63. Production data included average daily gain (**ADG**) during the 63-day backgrounding phase, feed intake and costs, vaccination costs, gain to feed (**G:F**), Hp risk group, number of BRD treatments, and cost of BRD treatments. Because animals were pen fed, feed intake of individual animals could not be directly measured during the preconditioning phase. Intake was calculated based on ADG and energy density of the diet using net energy equations (NRC, 2000). Feed intake for mortalities was calculated based on the average feed intake per day from animals that lived times the number of days the dead animal was on the trial. ADG for mortalities was the last recorded weight minus their initial weight divided by the number of days they were on trial. Preconditioning costs included vaccination costs and costs of treatment of eye or other infections. Heifers were vaccinated in the preconditioning phase against infectious bovine herpesvirus-1, bovine viral diarrhea virus (Types I and II), bovine parainfluenza-3, and bovine respiratory syncytial virus costing $1.72 per calf (Pyramid 5, Fort Dodge Animal Health, Overland Park, KS), and clostridial pathogens costing $0.75 per calf (Vision 7 with Spur, Intervet/Schering-Plough Animal Health, DeSoto, KS), deworming with moxidectin costing $0.055/mL (Cydectin, Fort Dodge Animal Health), and implanting with estradiol and trenbalone acetate at $1.34 per calf (Component TE-G, Vetlife, Overland Park, KS).

Heifers were treated with long-acting oxytetracycline costing $0.0742/mL (Bio-Mycin 200, Boerhinger-Ingelheim, Ingelheim am Rhein, Germany).

The initial and day 63 prices were estimated using USDA Agricultural Marketing Services (AMS) feeder cattle weighted-average sale data from the Oklahoma National Stockyards (Oklahoma City, OK). Prices used were from the weeks of arrival and day 63, with adjustments for weights (KO_LS795 for week of 9/12/2007 and 11/14/2007). An ordinary least squares regression for price as a function of the number of head sold per pen, average weight per pen, weight squared, and grade was estimated for both arrival price and day 63 price using the AMS data.

Finishing phase

After the backgrounding phase (63 days), heifers were allocated to finishing pens based on the number of times they were treated for BRD. The classification of groups were: never treated (**0X**), treated once (**1X**), treated twice (**2X**), treated three times (**3X**), and identified as chronically ill (**CX**). Initial classification based on arrival serum Hp was disregarded in the finishing phase. If treatment protocol was not followed in the backgrounding phase (n=5) or the animal was lame (n=1), they were not included in the finishing phase. Heifers that qualified from 2X (n=34), 3X (n=39), and CX (n=12) groups were used in the finishing phase. 54 heifers for 0X and 1X groups were chosen for the finishing phase so that a similar day 63 BW between the selected heifers and the total number of heifers in that group were maintained. Cattle were fed according to standard procedure at the facility and weighed every 28 days. Three diets with increasing concentrate density were fed over the first 19 days until heifers adapted to the final finishing diet, costing $207.11 per ton as fed. Further information on finishing phase procedures and rations are outlined in Holland et al. (2010).

Finishing phase production data included ADG, feed intake and cost, vaccination costs, G:F, and total days on feed. Feed intake in the finishing phase per animal was calculated using as fed pounds per day per pen divided by the number of head in the pen. Heifers were harvested in three groups at the end of the feedlot phase on April 21, May 13, or May 28, 2008 (152, 174, or 189 d on feed, respectively). Harvest dates were based on ADG and estimated carcass characteristics using ultrasound. Heifers were slaughtered when they were finished sufficiently to be expected to grade US choice. All CX group heifers were harvested on the final date (189 days on feed). Carcass data included marbling, yield grade (YG), hot carcass weight (HCW), and back fat measurement. Heifers were priced on a commonly used industry grid from the commercial packing plant where they were slaughtered. Estimated prices were also calculated using alternative grid premiums and discounts based on AMS data (LM_CT155), but were not found to be significantly different from the packing plant's grid prices (National Weekly Direct Slaughter Cattle-Premiums and Discounts for the weeks of: 4/21/2008, 5/12/2008, and 5/26/2008, respectively). The grid premiums and discounts used are included in Table II-2.

During the finishing phase, two heifers were treated for signs of BRD. One heifer was from the 2X group and remained in her home pen throughout the duration of the finishing phase. The other heifer was in the CX group and died. Three more animals died due to digestive causes, one each from 0X, 3X and CX groups. Four additional heifers were not included in final statistics because of incomplete carcass data, two heifers each from 2X and 3X groups.

Data were used to determine the effects of Hp risk groups for BRD, treatment of sick animals, and the risk-treatment interaction on net returns, costs, and animal performance for the backgrounding phase, finishing phase, and backgrounding and finishing phases combined[1].

Economic Analysis

The performance and net return differences across risk groups and number of BRD treatments were analyzed using LS Means and the following model:

(2.3) $$Z = \alpha_0 + \sum_{i=1}^{2} \alpha_i RG_i + \sum_{j=1}^{3} \beta_j C_j + \sum_{i=1}^{2} \sum_{j=1}^{3} \alpha_{ij} RG_i C_j$$

where Z is the independent performance measure, RG_i is the risk group *i* (*i* = low, medium, high), and C_j is the number of BRD treatments *j* (*j* = 0, 1, 2, 3). Significant differences across means were tested using *t*-tests. Performance measures included ADG, G:F, feed costs, day 63 weight, and number of BRD treatments for the backgrounding, finishing, and the phases combined. Carcass measures included HCW, marbling score, and YG. Net returns for the backgrounding, finishing, and the two phases combined were also analyzed. Final live weights for cattle were taken at the feed yard on the day prior to slaughter and were used for finishing phase gain calculations.

The most important factors affecting net returns were also determined. Of interest are the relative effects of each regressor on net returns defined as:

(2.4) $$\mathrm{E}(NR_{ji}) = \beta_{j0} + \beta_{j1}x_1 + \beta_{j2}x_2 + \cdots + \beta_{jn}x_n + \varepsilon_{ji}$$

[1] Complete summary statistics on data collected can be obtained from the author on request.

where E(NR_{ji}) is the net returns per head to be estimated, $\beta's$ are the estimated standardized betas, and the x_i are the variables used for the standardized betas, where *i* represents the individual heifer, *j* represents either the backgrounding phase, the finishing phase, or the total, and, ε_{ji} is the residual error term.

The units of the variables in equation (2.4) are different; therefore, the magnitudes of the individual regression coefficients cannot be directly compared. In order to compare the relative importance of the independent variables, they were normalized to have a mean of zero and a variance of one. Regressing these variables on the normalized net returns yields standardized beta coefficients (SBC). SBCs were calculated from a regression model to determine the influence of each variable on net returns. SBCs were calculated for net returns using the following model:

$$(2.5) \quad \frac{NR-\overline{NR}}{\sigma_Y} = \sum_i \beta_i^* \frac{x_i - \bar{x}}{\sigma_{x_i}} + \epsilon$$

where *NR* is the net revenue, σ is the standard deviation, x_i is the *i*th independent variable of interest, and β_i^* is the SBC for the *i*th independent variable. The new coefficients are calculated:

$$(2.6) \quad \beta_i^* = \beta_i \frac{\sigma_{x_i}}{\sigma_Y}.$$

The SBCs are proportions and the absolute value can therefore be used to rank the relative importance of the independent variables. Coefficients are interpreted such that if x_1 increases by one standard deviation, then *Y* changes by β_1^* standard deviations (Wooldridge, 2006).

The variables for the backgrounding phase included initial BW, ADG, G:F, BRD treatment costs, feed costs on an as fed basis, Hp risk group, and the number of BRD treatments. Variables for the finishing phase included initial finishing phase BW, G:F, feed costs on an as fed basis, HCW, marbling score, YG, Hp risk group, and number of BRD treatments. The combined phase included IBW, ADG for the entire trial, G:F, BRD treatment costs, total feed costs on an as fed basis, HCW, marbling score, YG, Hp risk group, and number of BRD treatments.

Net returns were calculated for the backgrounding phase as transfer revenue/cost less purchase cost of the calves, BRD treatment costs, vaccination costs, and feed costs in the backgrounding phase. Transfer revenue/cost is the day 63 price that is used as the revenue for the backgrounding phase and the initial cost in the finishing phase. Vaccination costs varied depending on the initial BW of the animals. Of all BRD treatment costs, 99.7% were incurred during the 63-day backgrounding phase and a chute charge of $0.50 for the first treatment as added to the respiratory treatment costs to account for processing animals. Two heifers were treated for BRD during the finishing phase.

Average net returns for backgrounding, finishing, and combined phases can be found in Table II-3. The net returns for the finishing phase were calculated by subtracting transfer revenue/cost, vaccination costs, and feed costs for the finishing phase from ending revenue. The total net returns was calculated by subtracting placement cost, all vaccination costs, feed costs, and BRD treatment costs from ending revenue. The transfer revenue/cost was defined as $/head at the end of the backgrounding phase and the beginning of the finishing phase. Ending revenue is $/head based on grid prices. All net returns were calculated based on market conditions at the time the study was conducted.

Results and Discussion

Hp Risk Group

Least squares means by Hp risk group are in Table II-3. No significant differences were found across risk group for any of the net returns. However, the low-risk group was different (P = 0.03) than the high-risk group for marbling score. Low and high-risk groups were different ($P \leq 0.001$) than the medium-risk group for backgrounding cost of gain. Out of 89 heifers in the medium risk group, 4 had negative ADGs leading to the inflated cost of gain. There was still a tendency for lower COG in the medium risk group compared to the high and low risk groups when these negative ADG were accounted for. Hp risk group was not different ($P \geq 0.11$) across the number of BRD treatments. Step et al. (2008) also observed Hp concentration upon arrival was unrelated to severity of the case or the need for treatment in feedlot cattle. However, Hp has been shown to have some value in assessing treatment efficacy (Berry et al., 2004; Carter et al., 2002; Wittum et al., 1996). Berry et al. (2004) and Carter et al. (2002) observed that upon arrival Hp concentration was elevated for calves treated for BRD compared to animals that were not treated. Berry et al (2004) showed high correlations between the number of treatments and d 0 and d 7 Hp concentrations. Further research needs to be conducted to determine the usefulness of serum Hp as a predictor for BRD in feedlot cattle, especially in light of its cost.

BRD Treatments

Backgrounding Phase. Least squares means by the number of BRD treatments are in Table II-4. Net returns in the backgrounding phase were different ($P < 0.0001$)

across all treatment groups. On average, 0X heifers had $111.12 higher net returns compared to CX heifers (P < 0.0001). Heifers in 1X, 2X, and 3X groups had $92.51, $59.98, and $20.62, respectively, higher net returns than CX (P < 0.0001). Similar findings have shown calves never treated for BRD had significantly higher returns than calves treated once or more than once (Fulton et al., 2002).

Beginning BW for cattle in the backgrounding phase was not different ($P \geq 0.51$) across BRD treatments. However, weights at the end of backgrounding and the start of finishing were different (P < 0.0001) across all treatment groups. 3X and CX groups had lower (P < 0.0001) ADG compared to 0X, 1X and 2X groups. The CX group gained 0.98 kg/d, 0.84 kg/d, and 0.56 kg/d less than heifers in 0X, 1X, and 2X groups during the backgrounding phase (P < 0.002). Buhman et al. (2000) also reported sick heifer calves had lower mean daily gain when compared to those not sick or not removed for treatment. Other studies have also reported increased ADG for steers never treated compared to those treated once or more than once (Gardner et al., 1999; Wittum and Perino, 1995). BRD treatment costs increased (P < 0.0001) as the number of treatments increased. The 1X group averaged $9.63 per head more than 0X treatment group (P < 0.001). 3X and CX groups were not different (P = 0.81) but were different (P < 0.0001) than 0X group with treatment costs over $35 per head more. BRD treatment costs have been shown to range from zero to $21.70 per head (Edwards, 1996; Fulton et al., 2002). Cost of gain also increased as the number of BRD treatments increased (P < 0.002) during the backgrounding phase with 2X treatment group the highest ($2.91/kg of gain).

Finishing Phase. Net returns in the finishing phase were not different (*P* = 0.07) across treatment groups. This may be attributed to the fact that most of the negative effects due to health were realized in the backgrounding phase and not carried through to the finishing phase. All but one heifer (99%) treated for BRD was treated during the backgrounding phase. Buhman et al. (2000) reported 91% of BRD occurrence was within the first 27 days after arrival while Babcock et al. (2008) observed 74% of BRD cases occurred within the first 42 day.

Initial BW in the finishing phase was different ($P < 0.0001$) across BRD treatments. Heifers in 3X and CX groups weighed 47.69 kg and 70.51 kg more, respectively, than 0X group when entering the finishing phase ($P < 0.0001$). ADG across BRD treatments was not different ($P = 0.36$) during the finishing phase. CX group was different ($P = 0.05$) than 0X group for G:F and cost of gain. 0X heifers were 17% more efficient than CX heifers. G:F was approximately 0.11 kg per kg of feed for heifers with three or less treatments. CX heifers cost $0.29 per kg of gain less than 0X group ($P = 0.05$). Heifers in 1X, 2X, and 3X groups did not have difference ($P \geq 0.06$) in cost of gain compared to 0X group with cost of gain over $2.05 per kg of gain for the groups. CX heifers tended to improve in efficiency during the finishing phase. However, CX heifers had significantly ($P = 0.02$) lower HCW than 0X heifers (319.78 kg and 343.23 kg, respectively). There were no differences ($P = 0.30$) across treatment groups for marbling score. 3X group had lower ($P = 0.05$) YG than 0X group (2.94 and 3.35, respectively).

Combined Backgrounding & Finishing Phase. In combining the backgrounding and finishing phases, there were significant differences ($P \leq 0.03$) between 3X and CX groups compared to the 0X group for net returns. Figure II-1 shows net returns across the number of BRD treatments for all three phases. Heifers in 3X and CX groups never seemed to catch up in terms of net returns. Those in 3X and CX groups lost $72.01 and $143.20 more than 0X group when combining phases. The majority of the loss was during the backgrounding phase where CX heifers lost $111.12 more compared to 0X treatment. Heifers in 1X or 2X groups that were treated properly during the backgrounding phase saw no significant differences during the combined phase. Previous research showed similar results (Edwards, 1996; Fulton et al., 2002).

No significant differences ($P \geq 0.327$) were observed for DOF in the finishing phase between OX, 1X, and 2X groups. 3X and CX were on feed approximately 13 days longer than OX group ($P = 0.01$ and $P = 0.05$, respectively). All CX group were harvested on the final date (189-d on feed). When adjusting for animals that died in CX group (n=2) then 0X group was on feed 30 days less than CX group. ADG, when combining backgrounding and finishing phases, was different ($P = 0.001$) between 0X and CX groups (1.42 kg/d and 1.19 kg/d, respectively). Buhman et al. (2000) reported sick calves to have lower ADG in the first 62 d after arrival compared to those never treated and the reduction in ADG continued throughout the remaining feedlot period. During the backgrounding phase in the current study, differences in ADG between 0X, 1X, and 2X were observed, but no differences were found during finishing or when phases were combined. The majority of the BRD incidence occurred during the backgrounding phase. Early detection and proper treatment could contribute to the calf's recovery and compensatory gain during the finishing phase. Similar research showed that compensatory gain was evident in the feedlot after proper treatment of BRD (Snowder et al., 2006).

Figure II-2 shows the cost of gain across the number of BRD treatments for all three phases. During the backgrounding phase, there was over a $1 difference for cost of gain among heifers, but there were no differences ($P \geq 0.06$) in the finishing phase. Once both phases were combined only slight differences in cost of gain were observed. One of the main costs in the backgrounding phase is the BRD treatment costs. When these costs are distributed across the combined phase, the increased gain offsets the effect from BRD treatment costs.

The current study observed heifers in 3X and CX treatment groups tend to "catch-up" in terms of physical measures after early detection and proper treatement once they are in the finishing phase, but the negative impact on overall net returns continues. Those heifers in the 3X and CX treatment groups had longer DOF therefore increasing feed costs and yardage costs. Knowing the potential number of BRD treatments that would be required during backgrounding could potentially increase net revenues for stocker operations and feedlot managers. The ability to choose animals that would remain healthy throughout the production phase would decrease treatment costs. Producers could also pay less for high risk cattle, precondition them, and then potentially resell them at higher prices. Step et al. (2008) showed steers weaned 45 days prior to shipping to feedlots resulted in healthier cattle. A high percentage of calves (91%) are diagnosed with BRD within the first 27 days after arrival at the feedlot (Buhman et al., 2000) and the majority of deaths due to BRD occur shortly after arrival to the feedlot, or within the first 45 days (Loneragan et al., 2001; Edwards, 1996). Potential decreases in BRD outbreaks and increased net revenues for stocker operations and feedlot managers could potentially be seen if cattle were in a 63-day backgrounding phase prior to shipment to the feedlot.

Standardized Beta Coefficients

The purpose of calculating standardized beta coefficients was to determine the most important factors affecting net returns. Tables 5, 6, and 7 report the standardized beta coefficients for the backgrounding, finishing, and combined phases, respectively. ADG was the most significant factor attributed to backgrounding net returns followed by cost as fed and then the amount of BRD treatments given to the heifer. Recall from the least squares means, those never treated had significantly higher ADG compared to those treated at least once. The number of times treated for BRD could have caused the ADG to be affecting net returns.

HCW had the greatest impact on finishing phase net returns and when the two phases were combined. This is similar to research by Ward and Johnson (2005) where weight was the strongest market signal compared to carcass quality characteristics when using grid pricing systems. For the finishing phase, G:F, start weight, and ADG were the next most important factors that impacted net returns. Those never treated for BRD or only treated once did significantly impact net returns compared to chronics based on the least squares means in all phases. The performance characteristics, initial body weight, ADG, and feed-to-gain conversion, also significantly affected total net returns. BRD treatments tend to affect other performance characteristics. As BRD treatments increase, animal performance decreases, especially in the backgrounding phase.

Implications

The current study showed serum Hp concentration upon arrival to the feedlot had no effectiveness in predicting BRD incidence in a backgrounding phase. BRD risk groups, based on serum Hp concentrations, had no effect on net returns. Further studies need to be conducted to examine economic efficiency of using HP concentration to predict the number of BRD treatments given its cost.

As the number of BRD treatments increase, net returns decreased in the backgrounding and combined phases. In the feeding phase alone, that trend was not evident. That is, the primary impact on net returns occurs in the backgrounding phase. Predicting the number of BRD treatments (i.e. BRD incidence) seems especially important for producers considering retained ownership through feeding. Knowing the propensity to contract BRD is of more value to the backgrounding phase but costs associated with Hp sampling exceed its expected predictability benefits at this time.

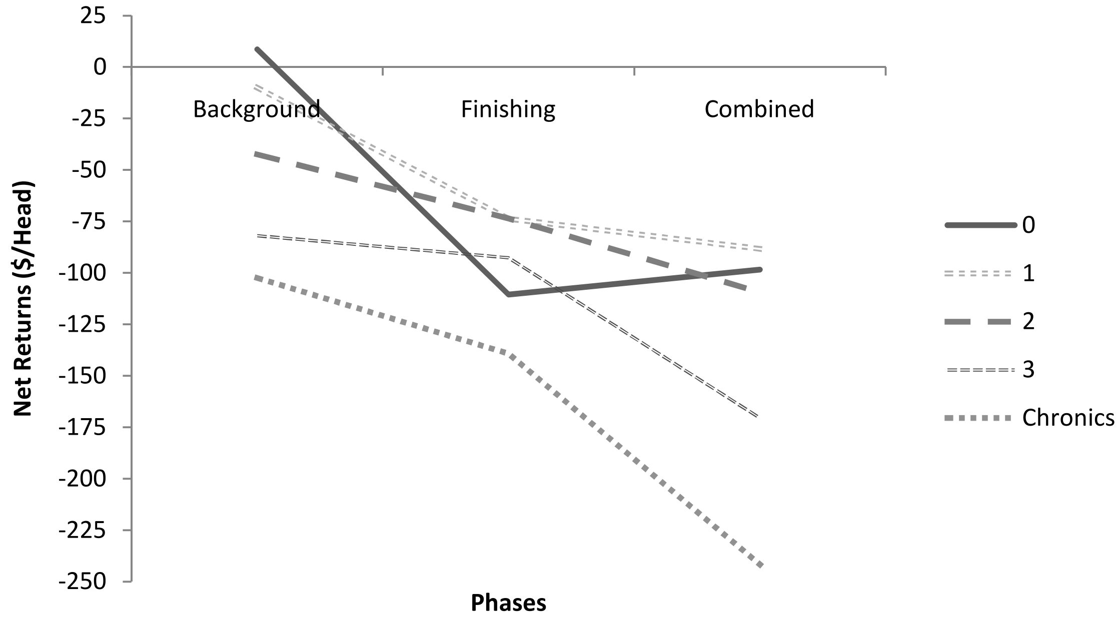

Figure II-1. Differences in net returns ($/head) by number of bovine respiratory disease treatments for the background, finishing, and combined phases

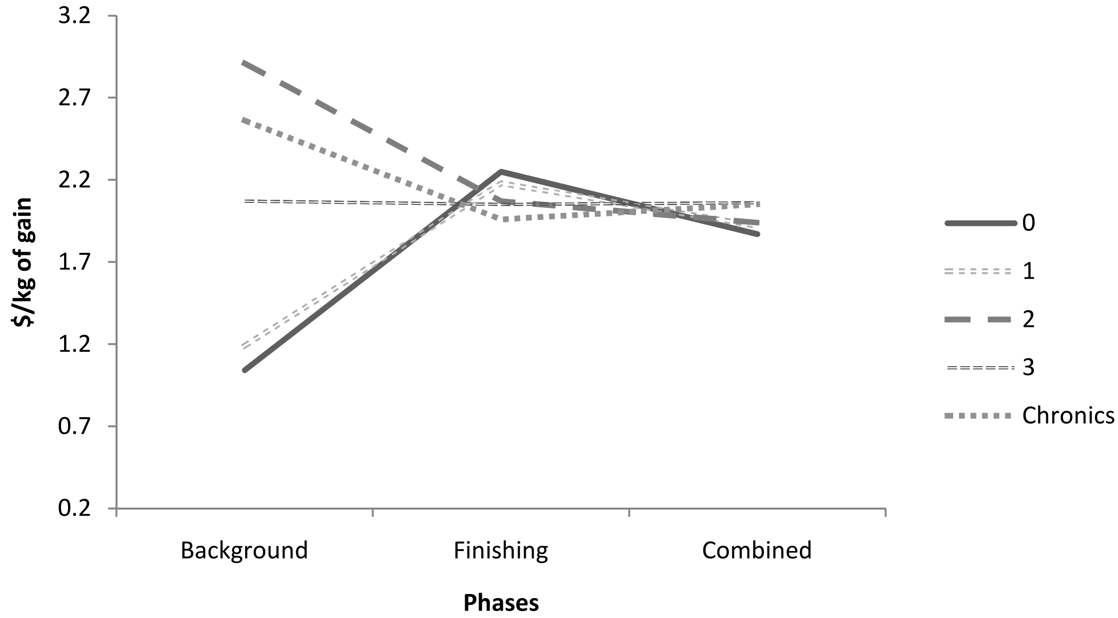

Figure II-2. Differences in cost of gain ($/kg of gain) by number of bovine respiratory disease treatments for the background, finishing, and combined phases

Table II-1. Health Outcome Category of Heifers across Haptoglobin Risk Groups[1] in Backgrounding Phase

Risk Group[1]	Number of Bovine Respiratory Treatments						
	OX	1X	2X	3X	CX[3]	Mortalities	Total
Low	38	25	10	6	2	5	86 (25.52%)
Medium	35	25	11	13	5	9	98 (29.08%)
High	40	48	21	24	5	15	153 (45.40%)
Total	113 (33.53%)	98 (29.08%)	42 (12.46%)	43 (12.76%)	12 (3.56%)	29 (8.61%)	337

[1] Heifers were assigned pens according to Haptoglobin (Hp) concentration: Low (serum Hp<1.0 mg/dL), Medium (1.0 mg/dL<serum Hp<3.0 mg/dL), and High (serum Hp>3.0 mg/DL).

[2]0X = never treated; 1X = treated 1 time for signs of BRD; 2X = treated twice for signs of BRD; 3X = treated 3 times for signs of BRD; CX = classified as chronically ill.

[3] Conditions necessary to be considered a chronic were: received all three antimicrobial therapies according to protocol, on feed more than 21 days, and experienced a net loss of body weight over the preceding 21 days on feed.

Table II-2: Premium/Discount Grid

Slaughter Date	4/21/2008	5/13/2008	5/28/2008
Choice Price	$148.00	$151.50	$153.00
Quality Grade			
Prime	$5.00	$5.00	$5.00
Choice	$0.00	$0.00	$0.00
Select	-$3.00	-$4.00	-$5.00
Standard	-$25.00	-$25.00	-$25.00
Yield Grade			
1	$3.00	$3.00	$3.00
2	$1.50	$1.50	$1.50
3	$0.00	$0.00	$0.00
4	-$25.00	-$10.00	-$10.00
5	-$25.00	-$25.00	-$25.00
Weight Discounts			
< 550	-$40.00	-$40.00	-$40.00
951-1000	-$5.00	-$5.00	-$5.00
> 1000	-$25.00	-$25.00	-$25.00
Other Discounts			
Commercial	-$35.00	-$35.00	-$35.00
Utility	-$50.00	-$50.00	-$50.00
Canner	-$35.00	-$35.00	-$35.00
Dark Cutter	-$35.00	-$35.00	-$35.00
Stag	-$35.00	-$35.00	-$35.00
Bull	-$35.00	-$35.00	-$35.00
Maturity Stand	-$25.00	-$25.00	-$25.00

Table II-3. Least Squares Means for Production Characteristics by Haptoglobin Risk Group[1,2]

Variable	Risk Group Low	Medium	High	SEM[3]
Backgrounding Phase				
Beginning Weight, kg[4]	241.74	236.45	240.28	2.78
Beginning Weight, kg[5]	241.92	239.12	238.99	3.23
Initial Price ($/head)	603.08	592.35	600.25	5.74
ADG, kg/day	0.97	0.93	0.94	0.06
Gain:Feed Conversion	0.11	0.10	0.11	0.005
BRD Treatments Drugs, $/head	22.06	21.8	22.26	0.72
Cost of Feed, $/head	59.41	59.04	58.86	2.76
Cost of Gain, $/kg of gain[6]	2.65[a]	0.71[b]	2.51[a]	0.46
End Weight, kg[4]	302.11	297.86	299.44	4.81
End Price ($/head)[4]	648.64	640.32	643.68	9.07
Net Returns, $/head	-149.43	-145.05	-150.4	4.82
Finishing Phase				
Start Weight, kg[5]	305.01	300.95	297.68	4.94
Start Price ($/head)[5]	654.27	646.16	640.41	9.32
ADG, kg/day	1.45	1.46	1.45	0.04
Gain:Feed Conversion	0.11	0.12	0.12	0.003
Cost of Feed, $/head	498.7	493.35	478.71	12.03
Cost of Gain, $/kg of gain	2.16	2.07	2.07	0.08
Net Returns, $/head	-89.04	-107.07	-97.68	25.94
Combined Phase				
DOF[7]	164.70	168.87	164.29	3.85
Overall ADG, kg/day	1.34	1.34	1.32	0.04
Gain:Feed Conversion	0.11	0.12	0.12	0.003
Cost of Gain, $/kg of gain	2.01	1.94	1.94	0.06
HCW, kg	337.55	334.05	331.78	5.53
Marbling Score	479.82[a]	450.63[a,b]	433.49[b]	17.59
Yield Grade	3.22	3.18	3.1	0.16
Carcass Value ($/head)	1,085.76	1,083.47	1,078.27	17.62
Net Returns, $/head	-130.07	-151.61	-143.27	26.98

[a,b] Indicate means in the same row with different superscript letter differ ($P < 0.05$)
[1] Mortalities are included in net return calculations but not in physical performance measures (average daily gain, cost of gain, or conversion)
[2] Heifers were assigned pens according to Haptoglobin (Hp) concentration: Low (serum Hp < 1.0 mg/dL), Medium (1.0 mg/dL < serum Hp < 3.0 mg/dL), and High (serum Hp > 3.0 mg/DL).
[3]Largest standard error of Least squares mean (SEM) shown
[4]Indicates 337 heifers in backgrounding phase.
[5]Indicates 193 heifers in finishing phase and overall.
[66]4 out of 89 heifers in the medium group, 4 had negative ADG leading to inflated COG.
[7]DOF= Days on feed during finishing phase (all 193 animals in combined phase were on 63-day backgrounding phase)

Table II-4. Least Squares Means for Production Characteristics by Number of Bovine Respiratory Disease Treatments[1]

	Number of Treatments						
Variable	0	1	2	3	Chronics[2]	Mortalities	SEM[3]
Backgrounding Phase							
Beginning Weight, kg[4]	242.84	240.47	239.66	241.34	235.65	236.97	5.19
Beginning Weight, kg[5]	241.99	243.15	237.85	241.42	235.65		5.28
Initial Price, $/head	605.55	600.64	598.85	602.34	590.52	593.46	10.71
ADG, kg/d	1.41[a]	1.27[b]	0.99[c]	0.66[d]	0.43[d]		0.11
G:F Conversion	0.13[a]	0.13[a]	0.11[b]	0.10[c]	0.07[d]		0.01
BRD Treatments Drugs, $/head	0.00[a]	9.63[b]	23.62[c]	35.71[d]	35.34[d]	27.93[e]	1.34
Cost of Feed, $/head	85.05[a]	76.93[b]	63.47[c]	50.53[d]	44.12[d,e]	34.54[e]	5.16
Cost of Gain, $/kg of gain	1.04[a]	1.19[a,c]	2.91[b]	2.07[b,c]	2.56[a,b,c]		0.80
End Weight, kg[4]	331.66[a]	319.84[b]	301.87[c]	282.79[d]	262.84[e]		8.33
End Price, $/head[4]	704.60[a]	682.48[b]	649.02[c]	612.13[d]	572.82[e]		15.72
Net Returns, $/head	8.63[a]	-9.98[b]	-42.51[c]	-81.87[d]	-102.49[e]	-661.56[f]	5.83
Net Returns relative to 0X[6]	0.00	-18.61	-51.14	-90.50	-111.12	-670.19	
Finishing Phase							
Start Weight, kg[5]	333.35[a]	319.31[b]	304.91[c]	285.66[d]	262.84[e]		8.07
Start Price, $/head[5]	707.89[a]	681.51[b]	654.88[c]	617.65[d]	572.82[e]		15.22
ADG, kg/d	1.41	1.45	1.48	1.50	1.42		0.07
G:F Conversion	0.11[a]	0.11[a,b]	0.11 [a,b]	0.11 [a,b]	0.12[b]		0.01
Cost of Feed, $/head	486.18[a]	494.20[a,b]	484.11[a]	516.81[b]	469.97[a]		19.65
Cost of Gain, $/kg of gain	2.25[a]	2.18[a,b]	2.07[a,b]	2.05[a,b]	1.96[b]		0.13
Net Returns, $/head	-110.53	-73.73	-73.49	-92.71	-139.19		42.38
Net Returns relative to OX[6]	0.00	36.80	37.04	17.82	-28.66		

Table II-4. Continued

Variable	Number of Treatments 0	1	2	3	Chronics[2]	Mortalities	SEM
Combined Phase							
DOF[7]	159.28^{a}	162.17^{a}	163.72^{a,b}	171.84^{b}	172.73^{b}		6.29
Overall ADG, kg/d	1.42^{a}	1.39^{a,b}	1.37^{a,b}	1.31^{b,c}	1.19^{c}		0.06
G:F Conversion	0.11	0.12	0.12	0.11	0.12		0.01
Cost of Gain, $/kg of gain	1.87^{a}	1.92^{a}	1.94^{a,b}	2.06^{b}	2.05^{a,b}		0.09
HCW, kg	343.23^{a}	337.36^{a,b}	332.80^{a,b}	339.12^{a,b}	319.78^{b}		9.28
Marbling Score	480.43	465.33	444.75	453.56	429.17		29.31
Yield Grade	3.35^{a}	3.25^{a,b}	3.10^{a,b}	2.94^{b}	3.19^{a,b}		0.28
Carcass Value, $/head	1,105.71^{a}	1,101.05^{a}	1,078.40^{a}	1,116.48^{a}	1,010.87^{b}		35.41
Net Returns, $/head	-98.40^{a}	-88.28^{a}	-109.48^{a,b}	-170.41^{b,c}	-241.68^{c}		44.09
Net Returns relative to OX[6]	0.00	10.12	-11.08	-72.01	-143.28		

[a-e] Indicate means in the same row with a different superscript letter differ (*P* < 0.05).
[1] Mortalities are included in net return calculations but not in physical performance measures (average daily gain, cost of gain, or conversion).
[2] Conditions necessary to be considered chronically ill were: received all three antimicrobial therapies according to protocol, on feed more than 21 days, and experienced a net loss of body weight over the preceding 21 days on feed.
[3]Largest standard error of Least squares mean (SEM) shown
[4]Indicates 337 heifers in backgrounding phase.
[5]Indicates 193 heifers in finishing phase and overall.
[6]Net returns relative to 0X treatment group, $/head, based on least squares mean
[7]DOF= Days on feed during finishing phase (all 193 animals in combined phase were on 63-day backgrounding phase)

Table II-5. Standardized Beta Estimates for Backgrounding Phase Net Returns ($/head)[1]

Variable	Estimate	Standard Error	P-Value	Standardized Estimate
Intercept	-61.464	2.360	<.0001	0.000
Beginning Weight, kg	-0.156	0.012	<.0001	-0.058
ADG, kg/day	140.396	3.597	<.0001	1.427
Gain:Feed Conversion	-39.159	14.357	0.007	-0.027
Cost of Feed, $/head	-1.415	0.065	<.0001	-0.661
Low Haptoglobin Risk Group with respect to High Risk Group	-0.090	0.342	0.792	-0.001
Medium Haptoglobin Risk Group with respect to High Risk Group	-0.178	0.331	0.592	-0.002
Zero BRD Treatments with respect to Chronics	35.480	0.869	<.0001	0.389
One BRD Treatment with respect to Chronics	26.014	0.851	<.0001	0.275
Two BRD Treatments with respect to Chronics	12.316	0.865	<.0001	0.097
Three BRD Treatments with respect to Chronics	-0.090	0.824	0.914	-0.001

[1] R^2=0.997, n=308

Table II-6. Standardized Beta Estimates for Finishing Phase Net Returns ($/head)[1]

Variable	Estimate	Standard Error	P-Value	Standardized Estimate
Intercept	-724.091	175.003	<.0001	0.000
Start Weight, kg	-1.441	0.299	<.0001	-0.452
ADG, kg/day	-149.273	76.187	0.052	-0.311
Gain:Feed Conversion	2879.812	1026.068	0.006	0.491
Cost of Feed, $/head	-0.084	0.240	0.728	-0.028
Hot Carcass Weight, kg	2.950	0.294	<.0001	0.801
Marbling Score	0.125	0.048	0.011	0.108
Yield Grade	-18.408	5.002	0.0003	-0.151
Low Haptoglobin Risk Group with respect to High Risk Group	4.737	9.737	0.627	0.020
Medium Haptoglobin Risk Group with respect to High Risk Group	-11.095	9.129	0.226	-0.050
Zero BRD Treatments with respect to Chronics	37.078	21.836	0.0913	0.164
One BRD Treatment with respect to Chronics	52.920	21.328	0.0141	0.235
Two BRD Treatments with respect to Chronics	37.772	21.625	0.083	0.140
Three BRD Treatments with respect to Chronics	25.277	19.828	0.204	0.098

[1]R^2=0.773, n=185

Table II-7. Standardized Beta Estimates for Total Net Returns ($/head)[1]

Variable	Estimate	Standard Error	P-Value	Standardized Estimate
Intercept	-847.175	162.543	<.0001	0.000
Beginning Weight, kg	-1.650	0.301	<.0001	-0.259
ADG, kg/day	-176.702	50.120	0.001	-0.326
Gain:Feed Conversion	3432.691	740.836	<.0001	0.445
Cost of Feed, $/head	-0.105	0.209	0.617	-0.030
Hot Carcass Weight, kg	2.940	0.292	<.0001	0.764
Marble Score	0.124	0.048	0.011	0.102
Yield Grade	-18.506	4.960	0.0003	-0.146
Low Haptoglobin Risk Group with respect to High Risk Group	5.816	9.633	0.547	0.023
Medium Haptoglobin Risk Group with respect to High Risk Group	-10.030	9.016	0.268	-0.043
Zero BRD Treatments with respect to Chronics	76.875	21.418	0.0004	0.325
One BRD Treatments with respect to Chronics	80.080	20.331	0.0001	0.340
Two BRD Treatments with respect to Chronics	49.932	20.740	0.017	0.176
Three BRD Treatments with respect to Chronics	25.644	19.115	0.182	0.095

[1]R^2=0.795, n=185

CHAPTER III

STATED AND REVEALED PREFERENCES FOR ORGANIC AND CLONED MILK: COMBINING CHOICE EXPERIMENT AND SCANNER DATA

Introduction

Food demand analysis has traditionally utilized aggregate time-series data representing consumers' actual food purchases in the marketplace. There are at least two weaknesses of demand analyses carried out with such revealed preference (RP) data. First, the researcher has no control over the data collected. Price changes are often highly co-linear, measured with error, endogenously determined, and may be confounded with changes in quality. Second, it is difficult or impossible to use RP data to infer how consumers will react to the introduction of a new good. In recent years, researchers addressed these difficulties by turning to the use of disaggregated stated preference (SP) data. SP data are useful because consumers can be asked about their willingness to purchase *any* product including those currently unavailable in the marketplace and because the researcher controls the data collection process insuring price changes are uncorrelated with other variables of interest.

That RP data lack information on consumer preferences for new varieties is particularly problematic for the question which prompted this research: how will consumers respond to the introduction of milk from cloned cows? In January 2008, the U.S. Food and Drug Administration (FDA) concluded that, "meat and milk from clones of cattle, swine, and goats, and the offspring of clones from any species traditionally consumed as food, are as safe to eat as food from conventionally bred animals." With this statement, the prospect of food from cloned animals entering the marketplace became a reality. The announcement prompted some consumer groups and food retailers to implement initiatives to assuage perceived consumer concern for the technology. Several large food processors and retailers announced their intention to prohibit the sales of products from cloned animals, and in late 2007, the U.S. Senate passed legislation intended to prohibit the FDA from approving cloned products until further research was conducted (however, the final legislation that was signed into law only "strongly encouraged" the FDA to delay any major decision until additional studies were conducted). Understanding the economic effects of such decisions, and informing businesses and policy makers about the appropriateness of future decisions requires estimates of consumers' willingness-to-pay (WTP) for cloned products.

Previous research on animal cloning has consisted of telephone polls asking consumers questions about their knowledge and attitude towards animal cloning. For example, a study conducted for the Pew Initiative on Food and Biotechnology in 2006 showed that about 65% of consumers have heard about animal cloning (Mellman Group 2006). Sosin and Richards (2005), however, reported that only about 29% of consumers believed that animal cloning is currently used by farmers and ranchers to breed animals. Storey (2006) reported that 73% of consumers had not heard about the FDA report on the use of animal cloning. The Pew study observed that 29% of consumers indicated that they would be willing to purchase milk from the offspring of cloned animals while about 33% indicated that they would never buy milk from the offspring of cloned animals. The International Food Information Council (2006, 2007) showed similar results in their poll, with 41% of consumers indicating that they would be willing to purchase meat, milk, or eggs from the offspring of cloned animals in 2006; a figure which increased to 46% in 2007.

Although previous polling research has provided useful information, the results consist of purchase intentions or attitudes expressed on a five-point scale. It is difficult to use such data to determine the rate at which consumers are willing to trade concern for cloning and a desire for lower milk prices. That is, the data do not provide willingness-to-pay estimates that can be used in cost benefit analysis or in making market share predictions. Moreover, a wealth of evidence indicates such data often poorly predict actual retail behavior (Morrison 1979; Morwitz 1997).

The fact that milk from cloned cows is not currently labeled and sold in the market place necessarily implies that the only way to determine consumer preferences for the attribute is by using SP or experimental methods. Although SP methods permit the estimation of WTP for milk from clones, there exists ample skepticism of people's stated answers to hypothetical questions about what they *would* do when shopping. One potential way of overcoming this weakness is to combine people's SP survey answers with RP data resulting from actual market transactions in an attempt to achieve a more useful and reliable picture of consumer preferences that possess the advantages of RP data (reflecting binding choices made in real markets) and the advantages of SP data (observing choices for new products using an experimental design ensuring no confounds). Thus, although milk from cloned cattle is not currently sold in the marketplace, if the preferences expressed in a SP survey (including the attribute of cloning) are systematically related to the preferences governing choices in RP data, we might be more confident in the reliability of the estimate on consumers' preferences for cloning. Moreover, as von Haefen and Phaneuf (2008) have argued, SP data provide a means of econometrically identifying parameters that would be confounded using RP data alone.

Such logic has led researchers in recent years to combine sources of RP and SP data primarily as it relates to the valuation of environmental amenities (e.g., Adamowicz et al. 1994, 1997; Azevedo, Herriges, and Kling 2003; Huang, Haab, and Whitehead 1997) or transportation (e.g., Swait, Louviere, and Williams 1994). Louviere, Hensher, and Swait (2000) and Hensher, Louviere, and Swait (1998) provide general discussions and overviews on combining SP and RP data. A common feature among many of these studies, however, is that the RP data come from survey-based questions where people are asked to *recall* choices they previously made. Unfortunately, recall of past choices and behaviors is often inaccurate (Vazire and Mehl 2008). For example, Dickson and Sawyer (1990) showed that most grocery shoppers cannot remember the price of the item just placed in their basket. Ideally, *objective* measures of past RP choices would be used, and it is here that household scanner data are quite useful. To our knowledge, Swait and Andrews (2003) represent the only previous attempt to investigate whether SP data could be combined with scanner data. In an application related to laundry detergent, they found that a combined RP-SP model exhibited superior out-of-sample prediction performance relative to models fit to the SP or RP data alone.

In this paper, we seek to determine whether SP choices between milk options can be fruitfully combined with *the same household's* RP choices reflected in scanner data. The current research is similar in spirit to the Swait and Andrews (2003) study, but seeks to validate their findings in a different context of current policy relevance. Whereas, Swait and Andrews (2003) sought to combine SP and RP data from two different samples of individuals, we have SP and RP data from the same households, making for a "cleaner" comparison. In addition to seeking an answer to the methodological question of whether a model can be developed that predicts people's actual milk choices but that includes information on preferences for the new attribute of cloning, this work adds to the growing applied literature on people's demand for milk attributes. For example, Dhar and Foltz (2005) used store-level scanner data to estimate the consumer welfare effects of the introduction of rBST-free and organic labeled milk, Kiesel and Villas-Boas (2007) used household scanner data to estimate the value of the USDA organic seal on milk, and Bernard and Bernard (2009) used experimental auctions to estimate consumer WTP for organic, rBST-free, antibiotic-free, and conventional milk. To our knowledge, no previous study has estimated consumer demand for milk from cloned vs. non-cloned cows; however, it is exactly this information that is currently needed by policy makers and food retailers.

Data and Methods

Our data come from 1,552 households in the Information Resources Inc (IRI) AttitudeLink™ panel. IRI Panelists use handheld scanners to record their bar-coded purchases, which are then transmitted to IRI. In the summer of 2008, we sent an online

SP survey to 4,000 households in the IRI panel. 1,691 people completed the survey, implying a response rate of 42.3%. For each of the 1,691 households, IRI provided RP home scan data on milk purchases (organic and non-organic by fat content) aggregated over the 52 week period prior to the survey. Importantly, the RP home scan data are not based on consumers' potentially unreliable memories of past behavior but instead represent actual purchase histories.

The characteristics of sample of respondents used in this study match up well with that of the U.S. as a whole, except the sample consists of a larger share of females and only of primary grocery shoppers than is present in the U.S. population. These deviations are not problematic given our focus on food choices of the primary shopper in a household.

Of the 1,691 households, 139 were not used due to incomplete information and missing scanner data leaving 1,552 households available for analysis. From the available sample, we randomly drew data from 500 households for use in out-of-sample model validation, and data from the remaining 1,052 households are used for model estimation.

Stated Preference Data

In the online survey, panelists were asked to answer a series of discrete choice questions regarding which milk option (or none) they would buy when grocery shopping. The choice options were defined by four attributes: price per gallon ($2.99 or $5.99), fat content (whole, 2%, 1%, skim), use of rBST (no rBST used or rBST used), and use of cloning (milk from non-cloned animal, milk from cloned animal, or milk from offspring of cloned animal).[2] Because some respondents might have been unknowledgeable of rBST or cloning, we included a very brief description of each. In regards to cloning, respondents were told the FDA definition: "Animal cloning is a process in which scientists can copy the genetic or inherited traits of an animal. Cloned animals are similar to identical twins only born at different times."(U.S. FDA 2009a). With regard to rBST, respondents were informed, "Some of the milk products indicate that they were produced with rBST, which is a bovine growth hormone that increases milk production in cows." (U.S. FDA 2009b). More could have been said about both attributes, however, we felt these brief statements would likely coincide with the information shoppers would have in a grocery store.

In constructing the choice questions, the cloning attribute was treated as alternative-specific, such that option A was always "milk from non-cloned animal," option B, was always "milk from cloned animal," and option C was always "milk from offspring of cloned animal." Option D was added to allow people to indicate "no purchase." More specifically, Option D stated, "If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store." A main effects fractional factorial design was used to determine which milk options to present to respondents. Price and rBST were varied at two levels each and fat content was varied at four levels so there were 2^2 x 4 = 16 possible combinations of milk options that could be created for each choice option A, B, and C. Because there were three milk options in each choice set, there were 16^3 = 4,096 possible choice sets that

[2] We considered including the attribute of organic in the SP survey; however, the attribute was ultimately excluded because we believed respondents would find it unbelievable to find a milk option that was both organic and from a cloned cow. In fact, the USDA's National Organic Standards Board (NOSB) has ruled that milk from a cloned animal or from any of its offspring (or the offspring of the offspring) cannot obtain organic certification.

could be constructed. From this full factorial, 16 choice tasks were selected such that the correlations between attributes, both within and across options, were exactly zero. Each respondent answered 16 SP choice questions, an example of which is shown in figure III-1.

Revealed Preference Data

For each household, IRI provided home scan data for white milk segregated by fat content (whole, 2%, 1%, and skim) and by organic (organic and non-organic), which implies that the RP data consist of eight possible purchase options (4 fat levels x 2 levels of organic). The RP data included total volume (gallons) purchased in the 52 weeks preceding the survey, total expenditures spent on white milk in the 52 weeks preceding the survey, and total number of units purchased in the 52 weeks preceding the survey. Purchase shares for each household were computed for each of the eight options by dividing the volume purchased of each type by the total volume of all milk purchased. Average prices ($/gallon) paid were constructed by dividing total expenditures on each milk type by volume purchased of each type. The raw means for the prices and purchase shares are shown in table III-1.

Because milk prices might be correlated with unobserved quality differences, we followed the approaches outlined in Cox and Wohlgenant (1986) and Park and Capps (1997) which is predicated on the idea that price variation across households reflects differences in quality. Prices for each of the eight types of milk were regressed on region, race, income, gender, age, and average unit size purchased (total volume divided by total number of units). The estimated equation was:

(3.1) $Price_{ij} = \boldsymbol{X_i \delta_{ij}} + e_{ij}$

where $Price_{ij}$ is the price per gallon of milk type *j* purchased by individual *i*, $\boldsymbol{X_i}$ is a vector of demographic variables described above, $\boldsymbol{\delta_{ij}}$ is a conformable vector of parameters, and e_{ij} is the residual. Quality adjusted prices were calculated for each individual by adding the estimated intercept of equation (3.1) to the residuals of equation (3.1) (see Cox and Wohlgenant 1986; Park and Capps 1997). Households that did not purchase a particular type of milk in the preceding year were assigned a price equal to the intercept from equation (3.1).

Econometric Models

Based on the random utility framework, individual *i*'s utility from choice option *j* is specified as a function of a systematic component assumed to depend on the attributes of the choice option (e.g., price, fat content) and a stochastic error term representing individual idiosyncrasies unobservable to the analyst:

(3.2) $U_{ij} = V_{ij} + \varepsilon_{ij}$

For the SP data, the systematic portion of the utility function for milk option *j* is:

(3.3) $$V_{ij} = \beta_1^{SP}(Price)_{ij} + \beta_2^{SP}(whole)_{ij} + \beta_3^{SP}(1\%)_{ij} + \beta_4^{SP}(2\%)_{ij} + \beta_5^{SP}(rBST\ free)_{ij} + \beta_6^{SP}(nonclone)_{ij} + \beta_7^{SP}(clone)_{ij} + \beta_8^{SP}(clone\ off\ spring)_{ij}$$

where *(Price)*$_{ij}$ is the price faced by individual *i* for alterative *j*, the β's are the marginal utilities for the attributes, and the remaining variables are dummy variables indicating the presence/absence of the characteristic in question in alternative *j*. For identification purposes, the utility of the "none" option is normalized to zero. Given this normalization,

β_6, β_7, and β_8 represent the utility of having a gallon of milk from a non-cloned, cloned, and offspring of cloned animal, respectively relative to not purchasing milk at all on the particular shopping occasion. Thus, the relative utility of non-cloned vs. cloned is β_6 - β_7. For the RP data, the systematic portion of the utility function can be similarly written:

(3.4) $$V_{ij} = \beta_1^{RP}(Price)_{ij} + \beta_2^{RP}(whole)_{ij} + \beta_3^{RP}(1\%)_{ij} + \beta_4^{RP}(2\%)_{ij} + \beta_9^{RP}(organic)_{ij}$$

If the error terms in equation (3.2) are distributed iid type I extreme value, McFadden (1974) shows that out of a set of *J* alternatives, the probability of alternative *j* being chosen is the familiar multinomial logit model (MNL):

(3.5) $$P_{ij} = \text{Prob}(\text{option } j \text{ is chosen}) = \frac{e^{\lambda V_{ij}}}{\sum_{k=1}^{J} e^{\lambda V_{ik}}}$$

where λ is a parameter inversely related to the variance of the error term. Within a data set, λ is not separately identified from the preference parameters in (3.3) or (3.4), and is thus normalized to one. However, when SP and RP data are pooled, the relative magnitude of λ across data sets can be identified by setting the parameter equal to one in one data set and estimating the relative size of the parameter for the other data set (see Swait and Louviere 1993).

The parameters of the unrestricted (SP-only and RP-only) models given in equations (3.3) and (3.4) can be estimated by maximizing the respective log-likelihood functions:

(3.6) $$LLF^{SP} = \sum_{i=1}^{N*16}\left(y_{ij} * \ln\left(\sum_{j=1}^{4} P_{ij}\right)\right)$$

(3.7) $$LLF^{RP} = \sum_{i=1}^{N}\left(s_{ij} * \ln\left(\sum_{j=1}^{8} P_{ij}\right)\right)$$

where y_{ij} = 1 if option *j* is chosen by person *i* in the SP data set and 0 otherwise, s_{ij} is the purchase share for alternative *j* and household *i* in the RP data set, and P_{ij} is defined in (3.5).

As can be seen by comparing equations (3.3) and (3.4), the SP and RP preference functions have four common parameters related to price and milk fat content. These common parameters can be combined in restricted (pooled) RP-SP model:

$$(3.8) \quad V_{ij} = \beta_1^{pooled}(Price)_{ij} + \beta_2^{pooled}(whole)_{ij} + \beta_3^{pooled}(1\%)_{ij} + \beta_4^{pooled}(2\%)_{ij} + \beta_5^{pooled}(rBST\ free)_{ij} + \beta_6^{pooled}(nonclone)_{ij} + \beta_7^{pooled}(clone)_{ij} + \beta_8^{pooled}(clone\ off\ spring)_{ij} + \beta_9^{pooled}(organic)_{ij}$$

The pooled log-likelihood function is estimated by maximizing the function: $LLF^{pooled} = LLF^{SP} + LLF^{RP}$, in which equation (3.8) acts as the underlying utility function for both SP and RP data.[3]

To determine whether the same preference structure underlies the RP and SP data, we first used an in-sample likelihood ratio test. In particular, two times the sum of the likelihood function values from the two unrestricted models subtracted from the likelihood function of the restricted (pooled) model is compared against the critical chi-square value with four degrees of freedom. The null hypothesis is that the common price and fat content parameters are equivalent across the two data sources: $\beta_1^{SP} = \beta_1^{RP},\ \beta_2^{SP} = \beta_2^{RP},\ \beta_3^{SP} = \beta_3^{RP},\ \beta_4^{SP} = \beta_4^{RP}$.

[3] Because we effectively have 16 times more SP data than RP data, it is possible for the SP data to "dominate" the common parameters in pooled model. To account for this fact, we have also estimated pooled models where each SP choice observation is given a weight equal to 1/16. None of our primary conclusions regarding whether the data can be pooled according to in-sample tests or which model performs best in out-of-sample forecasting tests is affected by whether such weights are used. As such, all the pooled model results presented in the paper are for the un-weighted joint likelihood function.

Swait and Andrews (2003) have shown that even when the hypothesis of common preference parameters is rejected, a combined RP-SP model can exhibit superior out-of-sample prediction performance. To investigate this issue, we use the results from our estimation data set to predict the outcomes of our hold-out data set of 500 household's RP and SP choices. We consider three metrics of out-of-sample prediction performance: mean squared error, the value of the log-likelihood function evaluated at out-of-sample observations (see Norwood, Lusk, and Brorsen 2004), and the percent of out-of-sample choices correctly predicted. Mean squared error (MSE) is simply calculated as the average of the squared difference between the predicted and actual shares for each choice option. For the SP data, we do not have actual shares but rather have dummy variables taking the value of 1 for options that were chosen and 0 for those options that were not chosen. A model with a smaller MSE is more preferred. The out-of-sample log likelihood function (OSLLF) is calculated by multiplying the actual share (or actual choice dummy variable) by the natural log of the predicted share for each choice option and summing these values across all choices in the hold-out data set. Models with higher OSLLF values are preferred. Finally, we say that an out-of-sample choice has been correctly predicted if the choice option that has the highest predicted share also has the highest actual share in the RP data set or was actually chosen in the SP data set.[4]

[4] In addition to the MNL models outlined above, we also estimated a more general random parameter logit (RPL) model which accounts for the repeated nature of the choice data (i.e., each household has 16 SP choices and one RP choice) and allows for preference heterogeneity. The RPL model fits the data better in sample for the SP data but not for the RP data. Despite the good in-sample fit of the RPL models, they never outperform the MNL models in predicting out-of-sample choices. Because the MNL dominated the RPL in terms of out-of-sample prediction performance, we only report the results of the MNL here. Moreover, we had difficulty getting the RPL to converge with the RP data, a fact which we attribute to high correlation between prices and product characteristics in the RP data. Several authors have noted problems with empirical identifiability with the RPL in such data sets (see Cherci & Ortuzar 2008; Chiou & Walker 2007; and Walker 2002). See appendix A for the RPL model estimation results and out-of-sample predictions.

Results

Estimation results are shown in table III-2. Models 1 and 2 are the SP-only and RP-only models. The results are consistent with expectations: people dislike price increases, prefer rBST free to rBST, prefer non-cloned to cloned, and prefer organic to non-organic milk. In both data sets, whole milk is less preferred to skim and 2% is preferred to skim. However, the two data sets differ in terms of the estimated preference for 1% milk. In the RP data set (model 2), skim is preferred to 1%, but in the SP data set (model 1) people, on average, are indifferent between skim and 1% milk.

The third model combines the SP and RP data and estimates a pooled model where the price and fat coefficients are constrained to be equal across the two data sets while allowing for differences in error variance across the two data sets via the relative scale parameter. The log likelihood function for model 3 (the pooled model), -17,636.54 and the sum of the log likelihood function values for models 1 and 2, -17,592.11, is similar; however, results of a likelihood ratio test indicate that the hypothesis of equal SP and RP parameters can be rejected at the 1% significance level (i.e., the chi-square value is 2*(17,636.54-17,592.11) = 88.86, which can be compared against the critical chi-square value with 4 degrees of freedom at the 99% confidence level, which is 13.3).

The results discussed thus far would seem to suggest little support for combining SP and RP data, and might lead one to conclude that people apparently exhibit differing preferences when answering survey questions as compared to shopping in grocery stores. Such a conclusion, however, might be premature. First, we ask, are the preferences displayed in the SP and RP data sets even related to one another? Figure III-2 utilizes the estimates in models 1 and 2 in table III-2 and plots the relationship between the common

SP and RP parameters. For illustrative purposes figure III-2 also plots the value of the organic parameter (in the RP data set only) against the rBST-free parameter. As can be seen in figure III-2, there is clearly a positive relationship between the SP and RP preferences. In fact, the correlation coefficient between the SP and RP coefficients for the four common parameters (price and three fat content parameters) is 0.78. If we add in the rBST free and organic parameters, the correlation coefficient between the SP and RP parameters increases to 0.89. Thus, even though the in-sample likelihood ratio tests indicates that strict equality of parameters is rejected, figure 2 illustrates that the SP and RP choices are clearly related.[5]

Figure III-2 suggests the presence of some common underlying choice patterns in the SP and RP data, and gives some credibility to the idea that a pooled SP-RP model might be beneficial despite the results of the in-sample likelihood ratio tests. Given that the purpose of this study is to predict what shoppers would do if and when cloned milk enters the market, it is prudent, then, to determine the extent to which the three models reported in table III-2 predict the hold-out sample of 500 households' SP and RP choices.

Table III-3 reports the out-of-sample prediction performance of the three estimated models in regards to their ability to predict SP choices, RP choices, and pooled SP-RP choices in the hold-out data set (recall that out of the 1,552 individuals surveyed,

[5] Another way to address this question is to investigate the covariance relationship between SP and RP parameters in an RPL model. We estimated an RPL model fit to the combined SP-RP data set where none of the parameters were restricted to be equal. Of interest are the correlations between parameters that are common across the two data sets (i.e., are the people who preferred 1% milk in the SP data set the same people who preferred 1% milk in the RP data set?) and the correlations between parameters that differ across the two data sets (i.e., are the people who preferred rBST free in the SP data set the same people who preferred organic milk in the RP data set?) The RPL results suggest that the SP and RP parameters are highly related. For example, the correlation between the RP price coefficient and the SP price coefficient is 0.99. The results also indicate that the same people who exhibit stronger preferences for organic when grocery shopping tend to be the same people who preferred rBST-free and were averse to cloned milk when making stated preference choices (correlation coefficients of 0.54 and 0.05, respectively). See appendix A for table of correlations.

data from 1,052 households were randomly selected and used for the model estimation and the remaining 500 were used for validation). The out-of-sample log likelihood functions (OSLLF) and mean-square-error (MSE) prediction criteria yield similar results in terms of the relative model rankings.

In terms of the OSLLF and MSE, results indicate that when predicting SP data that the SP-only model (model 1) and the pooled SP-RP model (model 3) perform equally well. The RP-only model (model 2) exhibits dismal performance in predicting hold-out SP choices. It might seem a bit strange to remark on the ability of RP data to predict SP choices, but recall that we are interested in predicting how consumers will react to the introduction of cloned milk. The RP data has nothing to say about consumer preferences for cloned vs. non-cloned milk, and thus it performs especially poorly in predicting SP choices. This result might be taken to imply that if cloned milk enters the market place, models estimated using RP data only prior to the introduction of cloned would yield incorrect forecasts of future market conditions.

Table III-3 also shows that when predicting the RP hold-out data, the RP-only model (model 2) performs the best according to the OSLLF and MSE criteria. However, the pooled SP-RP model (model 3) only fares slightly worse than the RP-only model (model 2) in predicting RP choices. Moreover, the last three rows of table III-3 indicate that the pooled SP-RP model (model 3) correctly predicts which choice was made in the SP data set equally as well as the SP-only model (model 1) and makes slightly better predictions in the RP data set than the RP-only model (model 2). The combined weight of the evidence in table III-3 suggests that the pooled SP-RP model (model 3) is the preferred model. *The pooled SP-RP model predicts hold-out SP choices much better than* *the RP-model alone and equally as well as the SP-only model, and the pooled SP-RP model predicts hold-out RP choices much better than the SP-model alone and about as well or better than the RP-only model.*

What do the results from the preferred model (model 3) imply about consumer preferences for organic and rBST-free milk and for milk from cloned cattle? Table III-4 reports mean WTP values for selected attributes. The reported statistics are the estimated price differences that would make a consumer indifferent between two milk options that are otherwise identical except for the attribute in question. The values are calculated by dividing the respective attribute coefficients by the negative of the price coefficient. Results reveal consumers are willing to pay about $1.46/gallon for rBST free milk and about $1.51/gallon for organic milk. These estimates are quite a bit higher than the implied premiums obtained by Bernard and Bernard (2009) who, using experimental auctions, found average WTP premiums of about $0.15 and $0.33 per half gallon, but are quite a bit lower than the “virtual prices” estimated for these milk types by Dhar and Foltz (2005). The results in Kiesel and Villas-Boas (2007) suggest WTP premiums for organic milk of $1.46/gallon without the USDA seal and $2.16/gallon with the seal.[6] Our findings are qualitatively similar to Bernard and Bernard (2009) in the sense that we found people were not willing to pay much more for organic milk than for rBST free milk despite the fact that former implies the latter. As another point of comparison, we also calculated the implied demand elasticities using the pooled model assuming a choice set consisting of four options (conventional, rBST free, organic, and “none”) assuming all were non-cloned and of the same fat content. Results reveal that at the prices of $2.80,

[6] These results are calculated using the “after NOP” regression results reported in model 4, table 4 in Kiesel and Villas-Boas (2009).

$4.85, and $5.91 (the average prices reported in Dhar and Foltz (2005)), the own-price elasticities of demand are -0.74, -1.48, and -2.08 for conventional, rBST free, and organic milk, respectively. These can be compared against the respective values of -1.08, -4.40, and -1.37 in Dhar and Foltz (2005) and -0.96, -4.70, and -2.34 in Bernard and Bernard (2009).

One issue addressed in this study that was not addressed in previous studies is consumer preference for cloning. As shown in table 4, people are willing to pay large premiums to avoid cloned milk: $4.71 per gallon. This is over *three times* the amount people are willing to pay for organic or rBST-free milk. The mean WTP estimate might be interpreted with some caution given that the prices in our SP survey only spanned $3 (from $2.99 to $5.99); however, we can be relatively more confident in asserting that WTP for cloned vs. non-cloned milk is *at least* $3 per gallon. That said, one advantage of combining the SP and RP data is that the RP data exhibit larger price variations that more than encompass the WTP estimate (see table III-1).

The results shown in table III-4 also suggest that consumers do not differentiate much between milk from a clone and milk from the *offspring* of a clone. This is important because most of the cattle that are currently being cloned are for use in seed-stock and breeding, i.e, the production of *offspring* for use in commercial production. Such a high WTP value is consistent with the position of many companies who announced their intention to prohibit selling milk and meat from clones in the aftermath of the FDA announcement on the safety of food from clones.

The pooled MNL estimates can also be used to address a key policy issue: the value of a mandatory labeling system. Currently there is no way to track milk from cloned animals or their offspring, and thus most consumers are unaware whether the milk they buy is from cloned animals. In fact, in the survey, we asked respondents whether they thought products from cloned cows were already sold in the grocery store and about 60% indicated they did not know. Such results suggest that in the current market environment, most people are uncertain whether the milk they are buying is from cloned cows. Given this level of uncertainty, we assumed in our policy simulations that that consumers currently believe they have a 50/50 chance of purchasing milk from a clone and non-cloned animal when buying unlabeled milk.

To set the stage for the analysis that follows, imagine a base-line (pre-label) market environment, where consumers have five choices: whole, 2%, 1%, and skim (all assumed non-organic, rBST-free, and all priced at $4), and a “no purchase” option. We also assume that, because consumers are unsure about the presence and use of cloning, that their utility for each milk option is a weighted average of the cloned and non-cloned utility coefficients shown in equation (3.8) (i.e., $0.5\beta_6^{pooled} + 0.5\beta_7^{pooled}$). In effect, we assume that when the consumers go to the grocery store to buy milk they believe that half is from cloned cattle and the other half is from non-cloned cattle. Figure III-3 shows the calculated market shares for the five choices in the assumed base-line (pre-label) condition. Results indicate about a quarter of the shoppers chose not to purchase milk, and conditional on a purchase, 2% fat is most popular. That such a high share predicted to chose none illustrates the potential effect of uncertainty about cloning on market demand. If people are unsure whether the milk they buy is from clones, they are likely to buy less milk than they might if they knew for sure, and it is exactly this sort of reasoning that leads many to advocate for mandatory labels.

The value of a mandatory labeling program depends on assumptions about how retailers will respond to the requirement and on what one assumes about current market conditions. As such, we calculate the value of a mandatory labeling program under three different scenarios that make different assumptions about current and future states of nature:

- Scenario1: In the pre-labeling world, it is assumed that milk from clones is actually sold in stores even though consumers believe there is a 50/50 chance (or mix) of buying cloned and non-cloned milk. Retailers are assumed to respond to the mandatory labeling law by labeling all products as "may contain milk from cloned cattle."
- Scenario 2: In the pre-labeling world, it is assumed that milk from clones is *not* sold in stores even though consumers believe there is a 50/50 chance (or mix) of buying cloned and non-cloned milk. Retailers are assumed to respond to the mandatory labeling law by labeling all products as "milk from non-cloned cattle."
- Scenario 3: In the pre-labeling world, it is assumed that there is a 50/50 chance (or mix) of buying cloned and non-cloned milk from grocery stores and consumers' beliefs are consistent with this reality. Retailers are assumed to respond to the mandatory labeling law by creating a differentiated marketplace offering milk both from cloned and non-cloned cattle.

In scenarios 1 and 2, the mandatory labeling policy does not actually change the underlying quality of the product. The labels simply serve to provide information to consumers about the choices they actually face. In these scenarios, consumers faced choices between four milk options (and none) before the policy and still face a choice between four milk options (and none) after the policy; the difference is that consumers' uncertainty about whether milk is from clones or non-clones has been resolved by the policy. However, because the actual quality of the milk has not changed, conventional welfare measures are inappropriate. Rather, the value of the mandatory labeling policy is calculated by determining the value of information as in Hu, Veeman, and Adamowicz (2005) or Leggett (2002).

In particular, as shown by Leggett (2002), the appropriate welfare measure for scenarios 2 and 3 is:

$$(3.9)\quad \left[\frac{\ln\left(\sum_{k=1}^{5} e^{V_{ik}^{post-label}}\right)-\ln\left(\sum_{k=1}^{5} e^{\tilde{V}_{ik}^{pre-label}}\right)}{-\beta_1}\right]-\left[\frac{\sum_{k=1}^{5} P_k^{pre-label}(V_{ik}^{post-label}-V_{ik}^{pre-label})}{-\beta_1}\right],$$

where β_1 is the price coefficient from the pooled model 3, P_k is the probability of choice defined in equation (3.5), and V_{ik} is defined in equation (3.8). The first term in brackets is the conventional welfare calculation except that the utility in the pre-label world, $\tilde{V}_{ik}^{pre-label}$, is based on consumers' *perceptions* of what they were buying (50/50 cloned and non-cloned) rather than the actual product quality. The second term in brackets captures the value of the adjustment in choices consumers make in response to the revelation of information about milk quality. In the case of scenario 3, consumers' beliefs are assumed to be correct, $\tilde{V}_{ik}^{pre-label}=V_{ik}^{pre-label}$, and retailers are assumed to respond in such a way that consumers actually face a different set of choices. In this case, the conventional welfare measure is appropriate, and is given by:

$$(3.10)\quad \frac{\ln\left(\sum_{k=1}^{9} e^{V_{ik}^{post-label}}\right)-\ln\left(\sum_{k=1}^{5} e^{V_{ik}^{pre-label}}\right)}{-\beta_1},$$

where it is assumed consumers face nine choices in the post-label world (4 fat contents that are either cloned or not-cloned plus the none option). Whereas scenarios 1 and 2 assume constant prices pre- and post-label (because it is assumed the actual product quality has not changed), in scenario 3, we assume that in the post-label world milk from clones is priced at a 5% discount to non-cloned milk ($3.90 vs. $4.10 per gallon) to capture the cost decreases that are likely to result from the technology.

For scenario 1, results indicate that consumers are willing to pay $0.26 per choice for a mandatory labeling system. Recall scenario 1 is one in which the policy simply serves to reveal to consumers that they are consuming cloned milk. Our scanner data indicate that, on average, a household purchases approximately 34.93 units of milk per year (i.e., they made 34.93 choices per year). Thus, the average annual benefit per year would be approximately $9.08 per household. Given that there are 112,377,977 U.S. households (US Census Bureau 2007), the total estimated annual benefit of a mandatory labeling system given the assumptions of scenario 1 would be approximately $1.021 billion.

Scenario 2 assumes that there is no cloned milk currently being sold, and the mandatory labeling policy simply serves to reveal this information to consumers. In this case, WTP for the policy is $0.19 per choice occasion, which in aggregate implies a total estimated annual benefit of approximately $746 million for scenario 2.

Scenario 3 assumes that consumers (correctly) assume there is a mix of milk from clones and non-clones currently on the market, and that retailers respond to the labeling policy by segregating the market by offering cloned and non-cloned varieties for each milk fat content. Figure III-4 shows the predicted market shares for the nine choices when a mandatory labeling is put into place under the assumptions outlined in scenario 3. In this case, the fraction of consumers predicted to refrain from purchasing milk decreases to about 10%. As compared to the prediction in figure 3, providing additional choice options to consumers is projected to increase milk consumption by approximately 16%. Using equation (10), we calculate that consumers are willing to pay $2.12 per choice occasion for a mandatory labeling system under scenario 3, which amounts to approximately $8.322 billion in aggregate. [7]

Conclusions

This study sought to determine consumer preferences for a new attribute currently unlabeled in the market (milk from cloned cows) while seeking to identify whether stated preference choices for the new attribute were congruent with people's revealed preferences given by scanner data. Although we reject the hypothesis of common preference parameters across the revealed and stated preference data sets *in sample*, our analysis suggests that a pooled model exhibits better overall out-of-sample prediction performance than either stated or revealed preference data used in isolation.

Results from the pooled revealed-stated preference model indicate that consumers are quite averse to the use of cloning. Willingness-to-pay to avoid cloned milk was over three times that for organic or rBST-free milk. Additionally, we found consumers do not

[7] The results are based on the assumption that consumers currently assume there is a 50/50 chance (or mix) of buying cloned and non-cloned milk. If, instead, we assume consumers currently believe there is a 40/60 chance (or mix) of buying cloned and non-cloned milk, then the total estimated annual benefit are approximately $1.413 billion, $432 million, and $6.909 billion for scenarios 1, 2 and 3, respectively. If instead we assume that consumers believe there is a 60/40 chance of buying from cloned and non-cloned milk, then the estimated aggregate annual benefits are $707 million, $1.178 billion, and $9.656 billion for scenarios 1, 2, and 3, respectively. The estimated benefits are not particularly sensitive to our assumptions about the prices of milk used in the policy simulations.

differentiate between milk from a clone and milk from the offspring of a clone, a result that is important in considering the desirability of future labeling schemes. Our results also suggest that consumers would value a mandatory labeling system. We are not aware of any studies on the costs of a mandatory labeling system for cloned cattle. At the current time, a label might not be prohibitively costly as only a few thousand clone cows are thought to be in existence; however, as technology progresses and the number of clones increases, the cost of a labeling system is likely to increase as well. Given these arguments, our assessment is that the labeling scenario 2 is most reflective of current realities. In this scenario, we assumed that there was no cloned milk currently being sold although consumers were assumed to be uncertain of whether this was truly the case. If retailers respond to a mandatory labeling policy by revealing to consumers that no cloned milk is in the market place with labels like, “milk from cows that have not been cloned,” the value of this information to consumers is $0.19 per choice occasion or about $746 million annually in aggregate.

There are a number of interesting areas for future research. First, it would be instructive to conduct non-hypothetical experiments to determine whether willingness-to-pay for cloned vs. non-cloned milk increases or decreases when real money and real milk is on the line. Secondly, this paper focused primarily on whether consumers stated preferences could be combined with revealed preferences so as to obtain a more accurate estimate of the value of labeling policies related to cloning, but we did not delve into issues related to *why* consumers may be concerned about cloning technology. Finally, some of our analysis suggests a strong relationship between concern for cloning and preference for organic and future research might seek to determine whether the presence of the organic milk market is sufficient to ameliorate consumer and retailers calls for bans and labels on milk from cloned cows.

Of the fresh milk options shown below, which option would you choose to purchase?

Characteristic	Option A: milk from non-cloned animal	Option B: milk from cloned animal	Option C: milk from offspring of cloned animal	Option D
Fat Content	Whole	Whole	Skim	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$5.99	$2.99	$2.99	
rbSt Use	no rBST used	no rBST used	no rBST used	
I would choose . . .	○	○	○	○

Figure III-1. Example choice question presented to survey respondents

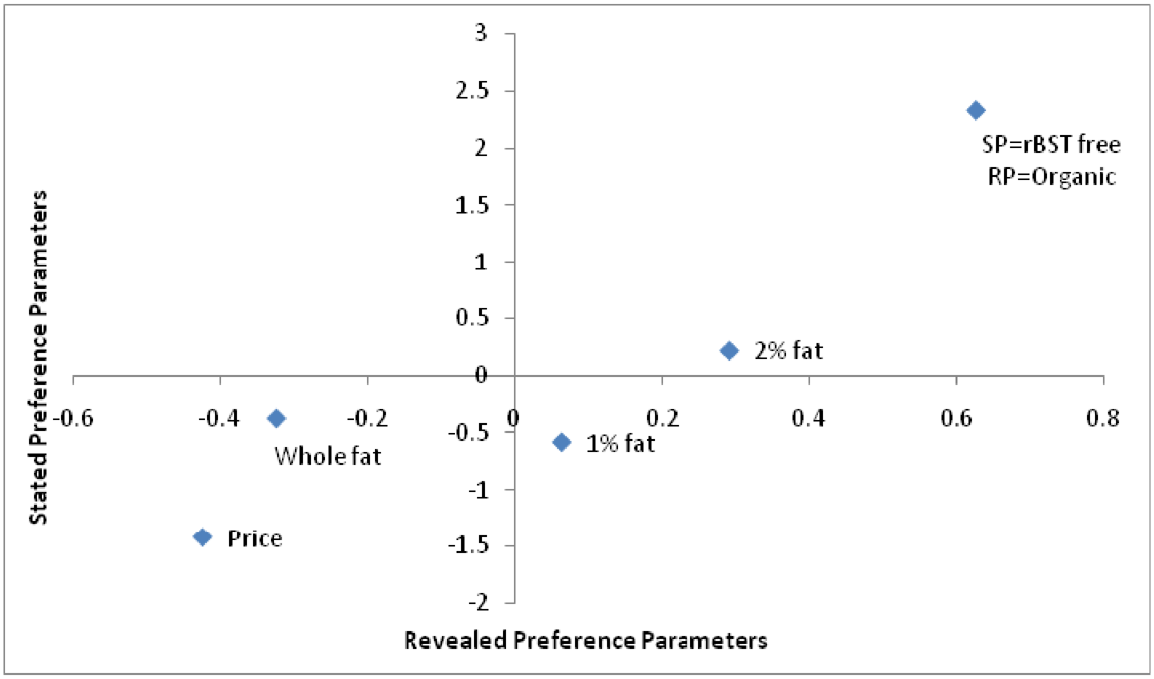

Figure III-2. Relationship between parameters from revealed and stated preference multinomial logit models

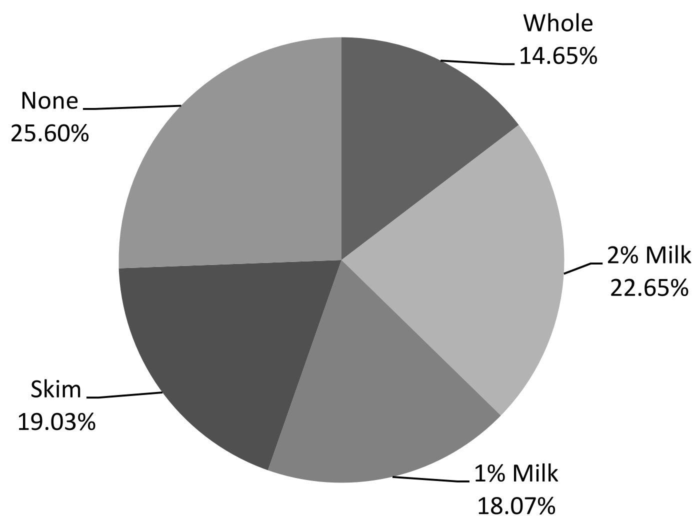

Figure III-3. Market shares of milk without mandatory labeling

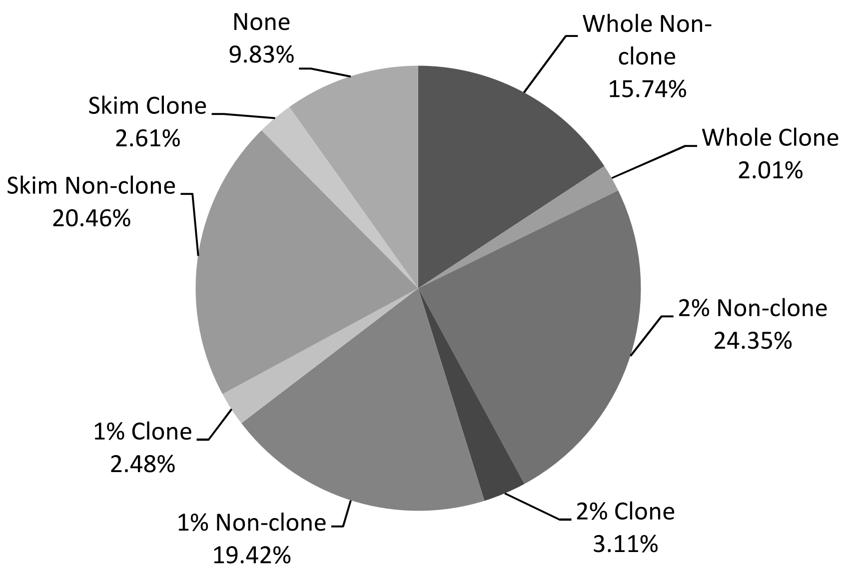

Figure III-4. Market shares of milk in a segregated market with mandatory labeling

Table III-1. Descriptive Statistics from Revealed Preference, Home Scan Data (N = 1,552)

Milk Type	Mean Price ($/gallon)	Mean Purchase Share
Non-Organic		
Fat Free	$4.52	0.218
Low Fat (1%)	$4.42	0.153
Reduced Fat (2%)	$3.98	0.377
Whole	$4.63	0.214
Organic		
Fat Free	$8.63	0.011
Low Fat (1%)	$7.61	0.007
Reduced Fat (2%)	$8.75	0.012
Whole	$8.50	0.008

Table III-2. Multinomial Logit Estimates for Stated Preference (SP) and Revealed Preferences (RP) Data

Milk Attribute	Model 1 SP	Model 2 RP	Model 3 Pooled
Price	-0.424*	-1.423*	-0.437*
	(0.009)[a]	(0.053)	(0.008)
Whole vs skim	-0.342*	-0.374*	-0.262*
	(0.037)	(0.147)	(0.029)
2% vs skim	0.293*	0.218	0.174*
	(0.036)	(0.123)	(0.026)
1% vs skim	0.064	-0.583*	-0.052
	(0.370)	(0.135)	(0.027)
rBST free	0.629*	---	0.638*
	(0.026)		(0.028)
Non-clone vs none	2.385*	---	2.481*
	(0.053)		(0.046)
Clone vs none	0.322*	---	0.422*
	(0.054)		(0.049)
Offspring of clone vs none	0.212*	---	0.321*
	(0.053)		(0.048)
Organic	---	2.338*	0.658*
		(0.268)	(0.069)
Scale[b]			3.139
Log-Likelihood	-16879.7	-712.41	-17636.54
# Parameters	8	5	10
# Obs.	16832	1052	17884

Note: Asterisk (*) represents statistical significance at the 5% level or lower

[a]Numbers in parenthesis are standard errors

[b]The scale of the SP data set is set equal to 1; the estimated value refers to the scale of the RP data set

Table III-3. Out-of-Sample Prediction Performance of Competing Models

Data Set Predicted	Model 1 SP	Model 2 RP	Model 3 Pooled
Out-of-Sample Log-Likelihood			
SP	-8307.55[a]	-28710.09	-8310.03[a]
RP	-530.38	-302.74	-326.85
Pooled	-8837.93	-29012.83	-8636.88
Mean Squared Error			
SP	0.147[a]	0.302	0.147[a]
RP	0.044	0.022	0.024
Pooled	0.136[a]	0.271	0.134[a]
% Correctly Predicted			
SP	52.4%	37.9%	52.4%
RP	70.8%	71.2%	71.9%
Pooled	53.5%	39.9%	53.6%

[a]Indicates that means in the same row with the same superscript are not significantly different at P<0.05.

Table III-4. Willingness-To-Pay for Selected Milk Attributes from Pooled SP-RP Model

Willingness-to-pay ($/gallon) for . . .	
Non-clone vs. cloned	$4.71 (0.112)[a]
Non-cloned vs. offspring of clone	$4.95 (0.115)
Cloned vs offspring of clone	$0.23 (0.097)
No rBST vs. rBST	$1.46 (0.067)
Organic vs. non-organic	$1.51 (0.161)

[a]Numbers in parentheses are standard errors estimated by parametric bootstrapping.

CHAPTER IV

PREFERENCE REVERSALS BETWEEN PUBLIC AND PRIVATE PREFERENCES FOR ANIMAL CLONING POLICIES

Introduction

Economists often study consumer choice for the purpose of drawing inferences about the merits of government intervention. Examples include the study of consumer choice to determine the benefits of food labeling policies (e.g., Dhar and Foltz 2005; Teisl, Bockstael, and Levy 2001; Hu, Veeman, and Adamowicz 2006; Rousu et al. 2007), the benefits of banning certain technologies or food attributes (e.g., Lusk, Norwood, and Pruitt 2006; Lusk et al. 2005), and the use of provision of safer food (Buzby, Ready, and Skees 1995; Hayes et al. 1995; Piggott and Marsh 2004). A key characteristic of such studies is that they use data on consumers' private choices about which products they bought for themselves to *infer* the merits of a public policy. Underlying such an approach is an implicit assumption that consumers' preferences for food attributes are stable in the sense that they would also explain which policies consumers would prefer the government enact. But, are people's preferences reflected in private shopping choices consistent with their preferences for public policies? There are several reasons to suggest that the answer might be no.

Hamilton, Sunding, and Zilberman (2003) argued that even though someone may be unwilling to buy a product, they might be unwilling to vote to ban it because they do not want to constrain their future choices. Voting to ban a product implies giving up the option to change one's mind when more information becomes available. Just as consumers might be unwilling to constrain their own future choices, they might also be unwilling to constrain others' choices either out of a sense of pluralism or altruism. Consumers may be unwilling to impose their beliefs on others or they may believe that other consumers will be happier if left to make their own choices – even if they are not the ones the individual would make themselves. Regardless of whether motivated by selfish option-value or by other-regarding preferences, these arguments would suggest that public support for public policies to ban controversial food products is less pronounced than what people's private shopping choices would imply.

By contrast, Carlsson, Frykblom, and Lagerkvist (2007) argue that people might be *more likely* to vote on a product ban than would be implied by their shopping choices because a ban serves to eliminate free-riding. Stated differently, if an externality exists, people might be willing to vote to ban a product that they currently purchase; a ban forces people to coordinate their purchases and eliminates the potential for free-riding. Some people carry this sort of argument to its extreme arguing that there are moral reasons for banning the sale of certain products. In such cases, it is argued that policy *should* prohibit others' from buying a product because it "goes against nature" or is not "what God intended."

Each of the preceding arguments accept the premise that people's underlying food preferences are stable but assert that people *also* have preferences that extend beyond their individual food choice that cause them to evaluate public policies differently than their individual purchases. That is, preferences for one's future self, preferences for others, or preferences for externalities can help explain why people might choose one thing in a grocery store and another thing in the voting booth. An all-together different hypothesis is that people's preferences somehow change when they enter the voting booth. Blamey, Common, and Quiggin (1995) argue that we have two selves: a consumer and a citizen. The argument is that when we are in "consumer mode" we think about our own private costs and benefits, but when we are in "citizen mode," we are more ethical and public-minded. What we want depends on the role we believe ourselves to be playing. The voting-as-a citizen hypothesis suggests people would be more likely to support public policies, such as a product ban, than their private shopping choices would suggest.

The purpose of this paper is to determine whether people's private preferences, as expressed through individual shopping choices, are consistent with their preferences for public policy. In particular, we ask whether people's willingness-to-pay (WTP) for a policy to ban the use of cloning technology in meat and milk production can be inferred from people's choices of the types of meat and milk they prefer to buy. The topic of animal cloning is of particular interest given the U.S Food and Drug Administration (FDA)'s recent conclusion on the safety of meat and milk from cloned animals. Although producers were requested to voluntarily keep cloned animals from entering the food supply chain in the near term, the FDA's announcement marked the beginning of the process which could potentially lead to food from clones. This prospect has not been well received in all quarters. Many large food processors and retailers announced their intention to prohibit the sales of products from cloned animals, and other groups called for federal policies to ban cloned products all together.

This paper moves beyond previous research in a number of ways. First, previous research on animal cloning has merely asked consumers their intentions to purchase products from cloned animals (IFIC, 2008). The current study aims to estimate consumers' WTP for meat and milk products from cloned animals. Unlike Hamilton, Sunding, and Zilberman (2003) who use stated, open-ended questions to determine WTP for pesticide-free foods and for pesticide reduction policies, the current paper uses the well-established choice experiment framework in which people answer a series of discrete choice purchasing questions from which marginal rates of substitution between attributes can be estimated. Moreover, our approach allows for a direct comparison between WTP for a policy calculated using consumer's private choices as compared to WTP implied from a direct dichotomous choice question about the policy.

Data and Methods

In June 2008, a web-based survey was delivered to participants in the Knowledge Networks (KN) panel. The KN panel consists of individuals recruited using random digit dialing techniques, and as such, represents a true probability sample based on the general U.S. population. To ensure representativeness, individuals are provided with access to the internet if the household does not have availability. Thus, the panel is comprised of both internet and non-internet households. The survey was sent to 3,222 individuals, 2,256 of whom completed at least a portion of the questions, implying a response rate of 70%. We restrict our analysis to the 1,825 who completed all choice questions analyzed in this paper. All subjects were provided information about cloning technology (the exact information statement is provided in appendix B). To help control for a “shock” effect from hearing about a potentially new technology, one half of the sample received the information one week prior to taking the survey and the other half received it only at the time the survey was taken. Because we found virtually identical results across the two treatments, the data is pooled in all the analysis reported here.

Table IV-1 reports the means for selected demographic variables and for other variables used in the analysis. A total of 1,787 of the respondents answered all of the demographic questions. Thus, models that incorporate demographics rely on the sub-set of 1,787 individuals who provided complete demographic information. Overall, the sample is diverse and matches up well with the U.S. population. Approximately 49% of respondents were females and the average age was 49 years. Approximately 31% of the respondents had a bachelor’s degree or higher and over 68% were the primary shopper for their household.

The survey included a number of questions intended to tease out factors that might cause divergence in public and private questions. Three attitudinal questions were administered where respondents were asked to indicate the extent to which they agreed or disagreed with the statement. The statements included: 1) “Some of the meat currently sold in grocery stores is from cloned animals or their offspring,” 2) “The average American is willing to eat meat from cloned animals,” and 3) “I trust the U.S. government to properly regulate the use of animal cloning. Participants were asked to respond to each statement on a five point scale: 1= strongly disagree, 2= somewhat disagree, 3=neither agree nor disagree, 4=somewhat agree, and 5=strongly agree. The first question provides information on people's beliefs about the extent of market penetration of cloning and thus relates to people's beliefs about what they are currently consuming and the impacts of a potential ban on products from clones. The second question was included to provide information on people's beliefs about others' preferences; presumably some people might vote differently than their private shopping choices suggest because they do not want to impose their beliefs on others. Finally, the last question aims to determine people's beliefs about the efficacy of government policies, which is of relation to people's willingness to support regulation.

We also hypothesized that differences in beliefs about the morality of animal cloning might explain differences in public and private choices; those who believe animal cloning is morally wrong are more likely to be willing to enact a ban. To determine consumers' potential objections to cloning on the basis of morality, respondents were asked a series of paired-comparison questions to determine the relative importance of competing objections to animal cloning (including morality). They were asked "Which of the following two statements best describes your views towards animal cloning? X or Y." A total of eight different issues were included in survey. Responses were analyzed using a random parameters logit to determine the relative probability of the eight different issues best reflecting people's views on animal cloning. Here, we focus in on the relative importance an individual attached to the statement "Animal cloning is morally wrong." As show in table 1, the average score for this variable was 0.081, which means that on average there is an 8.1% chance the respondent's would chose "Animal cloning is morally wrong" as the most important objection in relation to cloning. More details on the construction of this variable are provided in Lusk (2008).

Public WTP for a Ban on Meat and Milk from Clones

To directly determine consumers' public preferences for a ban on meat and milk from cloned animals, they were asked to respond to the following contingent valuation question:

> Suppose the next time you went to vote, there was a referendum on the ballot that would ban the practice of animal cloning altogether. Would you vote in favor of this policy if the policy would increase the price you would pay for meat and milk products by **Z**% due to the added enforcement and oversight required by the policy?

Response categories were of the form: "I would vote in favor of a ban and a **Z**% increase in the price of meat and milk" or "I would vote against the ban and the **Z**% increase in the price of meat and milk." Each respondent was randomly assigned a value for **Z%** among the values of 5%, 10%, 15%, 25%, 50%, 75%, or 100%. Answers to this question provide a direct estimate of people's public WTP for that policy to ban animal cloning.

Private WTP for a ban on Meat and Milk from Clones

The survey contained a series of discrete choice questions asking respondents which milk or ground beef option (or none) they would buy when grocery shopping. In constructing the questions, standard practice in the choice experiment literature were followed. Each choice option was described by a set of attributes or characteristics. Milk options were described with four different attributes including price per gallon ($2.99/lb or $5.99), fat content (whole, 2%, 1%, skim), use of rbST (no rbST used or rbST used), and use of cloning (milk from non-cloned animal, milk from cloned animal, or milk from offspring of cloned animal.) A separate set of questions asked about preferences for buying ground beef, where each option differed by price per pound ($1.99/lb or $3.99/lb), percent lean (80%, or 90%), percent saturated fat (5% or 10%), and use of cloning (beef from non-cloned animal, beef from cloned animal, or beef from offspring of cloned animal). The purpose of including several additional attributes other than price and cloning was to present realistic choice options to consumers like the ones they would encounter in the supermarket and to determine the importance of cloning *relative to* these other attributes.

The choice questions were constructed such that the cloning attribute was treated as an alternative-specific; option A was always "milk (meat) from non-cloned animal," option B, was always "milk (meat) from cloned animal," and option C was always "milk (meat) from offspring of cloned animal." Option D was a "no purchase" option that stated, "If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk (ground beef) from this store." An orthogonal main effects fractional factorial design was used to determine which milk (ground beef) options to present to respondents. For the milk questions, price and rBST were varied at two levels each and fat content was varied at four levels, making 2^2 x 4 = 16 possible combinations of milk options that could be created. Because there were three milk options in each choice set, there were 16^3 = 4,096 possible choice sets that could be constructed. From this full factorial, 16 choice tasks were selected such that the correlations between attributes, both within and across options, were exactly zero. Each respondent answered 16 milk conjoint choice questions, an example of which is shown in figure IV-1. For the beef questions, price, percent lean, and percent saturated fat were varied at two levels each so there were $2^3 = 8$ possible combinations of beef options that could be created. Because there were three beef options in each choice set, there were $8^3 = 512$ possible choice sets that could be constructed. From this full factorial, 12 choice tasks were selected such that the correlations between attributes, both within and across options, were exactly zero. Each respondent answered 12 beef conjoint choice questions, an example of which is shown in figure IV-2.

Responses to these choice experiment questions can be used to estimate an attribute-based utility function, which in turn can be used to calculate the private welfare effects of policies such as a ban on cloned milk and ground beef. The exact procedures used to calculate consumer WTP for a ban on meat and milk from clones based on the answers to these choice question is described later in the text.

Econometric Methods

Public WTP (Contingent Valuation Question)

In the contingent valuation question, participants directly voted either in favor or against a policy to ban cloning in meat and milk production assuming that it would increase the price they would pay for meat or milk products by an amount **Z**%. An interval-censored model is used to estimate mean WTP to ban animal cloning (Cameron and James 1987; Cameron 1988). In particular, individual *i*'s public willingness-to-pay (WTP_i^*) can be written as:

(4.1) $WTP_i^* = \boldsymbol{X_i}\boldsymbol{\delta} + u_i$

where $\boldsymbol{X_i}$ is the vector of explanatory variables for individual *i* , $\boldsymbol{\delta}$ is the vector of coefficients, u_i is independently and identically normally distributed error term with mean zero and variance σ^2. Each individual was confronted with a randomly chosen percent increase in price, $\mathbf{Z\%}$. The survey responses identify a range on *WTP**. If the individual votes in favor of the ban, then we know that $WTP_i^* > Z_i$, where Z_i is the randomly assigned price increase assigned to individual *i*. However, if the individual votes against the ban, $WTP_i^* < Z_i$. Accordingly, the following likelihood functions can be used to estimate the determinants of WTP:

$$(4.2) \quad \log L = \sum_{i=1}^{n} y_i \log \Phi\left(\frac{Z_i - \boldsymbol{X_i\delta}}{\sigma}\right) + (1 - y_i) log\left(1 - \Phi\left(\frac{Z_i - \boldsymbol{X_i\delta}}{\sigma}\right)\right)$$

where $y_i = 1$ if the individual voted in favor of the policy at price Z_i and 0 otherwise, Φ is the standard normal cumulative distribution function and the coefficient estimates, $\boldsymbol{\delta}$, can be interpreted as the marginal effect of $\boldsymbol{X_i}$ on WTP_i^* (Cameron 1988). Mean willingness-to-pay can then be calculated as $E(\text{WTP}) = \boldsymbol{\bar{X}\hat{\delta}}$ where $\boldsymbol{\bar{X}}$ is a vector of sample averages of the independent variable. If one is only interested in the location and scale of the willingness-to-pay in the sample, equation (4.1) can be estimated with only a constant as an explanatory variable. The estimated constant is the mean WTP for the policy.

Our question was phrased such that it asked whether people were willing to pay a particular percentage price increase. Thus, estimates from equation (4.2) are in terms of *percentage* price increases people are WTP. To make a direct comparison to the private choice questions, the percentage WTP needs to be converted to a dollar amount that would make consumers indifferent between banning cloning and not banning cloning. In June 2008, when the survey was conducted, uncooked ground beef was approximately $3.01 per pound (U.S. Bureau of Labor Statistics, 2008) and retail prices for milk were $3.75 per gallon for whole milk (USDA, 2008). Thus, we can re-estimate equation (4.2), and replace Z_i with $P_i = (1 - Z_i) * P_o$, where P_o, is the market price of the meat or milk.

In this case, the statistic reveals the extra dollar amount people are willing to pay per pound of ground beef or gallon of milk for the ban assuming the same quantity is consumed after the ban. Although this latter assumption may be somewhat dubious, it is somewhat immaterial in relation to our key finding. We find that differences in public and private WTP for a ban are not differences in the magnitude of WTP, but rather of a reversal in preference for the ban.

Private WTP (Choice Experiment Questions)

Responses to the choice experiment questions regarding which meat or milk option (or none) a consumer would buy when grocery shopping can be used to estimate an attribute-based utility function, which in turn can be used to calculate the private preferences for policies such as a ban on cloned milk and ground beef. Responses can be analyzed by using the random utility framework of McFadden (1973). In particular, individual i's utility for choice option j, U_{ij}, is defined by a systematic component (V_{ij}) assumed to depend on the attributes of the choice option (i.e. price, fat content) and a stochastic error term (ε_{ij}) representing consumers' idiosyncrasies unobservable to the analyst:

(4.3) $U_{ij} = V_{ij} + \varepsilon_{ij}$

If the error term in equation (4.3) are independently and identically distributed with a type I extreme value distribution, then the probability of alternative *j* being chosen out of a set of *J* alternatives is the familiar multinomial logit model (MNL):

(4.4) $P_{ij} = \text{Prob}(\text{option } j \text{ is chosen}) = \frac{e^{V_{ij}}}{\sum_{k=1}^{J} e^{V_{ik}}}$

The systematic portion of the utility functions for milk and ground beef is, respectively:

(4.5) $V_{ij}^{milk} = \alpha_1(price)_{ij} + \alpha_2(whole)_{ij} + \alpha_3(2\%)_{ij} + \alpha_4(1\%)_{ij}$
$+\alpha_5(rBST\ free)_{ij} + \alpha_6(nonclone)_{ij} + \alpha_7(clone\ off\ spring)_{ij}$
$+\alpha_8(none)_{ij}$

(4.6) $V_{ij}^{beef} = \beta_1(price)_{ij} + \beta_2(\%\ lean)_{ij} + \beta_3(\%\ saturated\ fat)_{ij}$
$+\beta_4(nonclone)_{ij} + \beta_5(clone\ off\ spring)_{ij} + \beta_6(none)_{ij}$

where $(price)_{ij}$ is the price faced by individual *i* for alternative *j*, the α's and β's are the marginal utilities for the milk and beef attributes, respectively, and the remaining variables are dummy variables indicating the presence/absence of the characteristic in question. The utility of the "clone" option is normalized to zero for identification purposes, and therefore, $\alpha_6, \alpha_7,$ and α_8 ($\beta_4, \beta_5,$ and β_6) represent the utility of having a gallon of milk (pound of ground beef) from a non-cloned, offspring of a cloned animal, or not purchasing at all relative to purchasing milk (ground beef) from a cloned animal on the particular shopping occasion. To facilitate comparison with the results of the "direct" question on WTP for a ban, equations (4.5) and (4.6) can be re-specified from "preference space" to "WTP space" following the approach in Scarpa, Thiene, and Train (2008). Marginal WTP for an attribute is the attribute's coefficient divided by the negative of the price coefficient. For example, WTP for whole milk relative to skim milk is equal to $\alpha_2/-\alpha_1$. Equations (4.5) and (4.6) can be re-written in WTP space as follows:

(4.7) $V_{ij}^{WTPmilk} = \alpha_1(price)_{ij} - \alpha_1\theta_2(whole)_{ij} - \alpha_1\theta_3(2\%)_{ij} - \alpha_1\theta_4(1\%)_{ij}$
$-\alpha_1\theta_5(rBST\ free)_{ij} - \alpha_1\theta_6(nonclone)_{ij}$
$-\alpha_1\theta_7(clone\ off\ spring)_{ij} - \alpha_1\theta_8(none)_{ij}$

(4.8) $V_{ij}^{WTPbeef} = \beta_1(price)_{ij} - \beta_1\lambda_2(\%\ lean)_{ij} - \beta_1\lambda_3(\%\ saturated\ fat)_{ij}$

$$-\beta_1\lambda_4(nonclone)_{ij} - \beta_1\lambda_5(clone\ off\ spring)_{ij} - \beta_1\lambda_6(none)_{ij}$$

where θ_k and λ_k are consumer WTP for attribute *k* (i.e., $\theta_k = \alpha_k / -\alpha_1$).

Our overall goal is not to estimate the marginal WTP for cloning *per se*, but rather to calculate the consumers' WTP for a ban on animal cloning using the preference functions given in equations (4.7) and (4.8), which are determined by people's private shopping choices. In particular, we can use the estimated utility functions to calculate consumers' expected maximum utility in a world without the ban where there is some chance that consumers might buy ground beef or milk products from cloned animals and compare it to the expected maximum utility in a post-ban world in which animal cloning has been banned and there is no chance of buying ground beef or milk products from cloned animals.

To set up the pre-ban scenario, we assume that consumers believe there is currently a 50/50 chance of purchasing ground beef or milk products from cloned animals when buying ground beef or milk.[8] For example, when a consumer purchases a pound of ground beef they believe there is a 50% chance of buying meat from a cloned animal and a 50% chance that it is from a non-cloned animal. Our simulation assumes that when purchasing a gallon of milk, consumers have five choices: whole, 2%, 1%, or skim milk (all assumed with no rBST at a price of $3.75 per gallon), and an option to not purchase. When purchasing a pound of ground beef, our simulation assumes consumers have three choices: 80% or 90% lean (both assumed to have 7.5% saturated fat and cost $3.01 per

[8] Currently there is no way to track meat or milk from cloned animals or their offspring, and thus most consumers are unaware whether the meat or milk they purchase is from cloned animals. In fact, in the survey we asked respondents whether they thought products from cloned beef were already sold in the grocery store and about 60% indicated they did not know. Such results suggest that in the current market environment, most people are uncertain whether the meat or milk they are purchasing is from cloned animals. Given this level of uncertainty, we assumed in our policy simulations that that consumers currently believe they have a 50/50 chance of purchasing meat or milk from a clone and non-cloned animal when purchasing meat or milk. Later, we report sensitivity of the results to this assumption.

pound), and an option to not purchase. Because we assume in the pre-ban world that consumers perceive a 50/50 chance of purchasing ground beef or milk from a cloned animal, their utility for each meat or milk option is a weighted average of the non-cloned utility coefficient shown in equations (4.7) and (4.8) (i.e., $0.5\theta_6$ or $0.5\lambda_4$; recall the utility of cloned has been normalized to zero). In effect, we assume that when the consumers go to the grocery store to buy ground beef or milk they believe that half is from cloned cattle and the other half is from non-cloned cattle, and not being able to tell which is which, the expected utility of an option is given by the probability of observing cloned times the utility of getting cloned.

In the post-ban world, consumers can be assured all meat/milk is from non-cloned animals. We assume consumers still face the same five choices when purchasing a gallon of milk and the same three choices when purchasing a pound of ground beef as in the pre-ban world, the only difference is that now they know the meat/milk products are from non-cloned animal (i.e., $0.5\theta_6$ is replaced with θ_6 and $0.5\lambda_4$ is replaced with λ_4). Consumers' WTP for a ban on animal cloning based on their private meat and milk purchases is calculated by comparing consumers' expected maximum utility in the pre- and post-ban worlds, and dividing by the marginal utility of income. In particular, consumers' projected WTP for a ban (per choice of meat or milk option) is:

(4.9) $$WTP_{Private} = 1/\gamma[\ln\left(\sum_{k=1}^{J} e^{V_{ik}^{post-ban}}\right) - \ln\left(\sum_{k=1}^{J} e^{V_{ik}^{pre-ban}}\right)]$$

where V_{ik} is defined in equation (4.7) for the milk purchases and equation (4.8) for the beef purchases, and where γ is the marginal utility of income given by $-\alpha_1$ for milk and $-\beta_1$ for beef.

Results

Table IV-2 reports the multinomial logit estimates fit to the private, choice experiment data as well as the interval censored regressions fit to the public, contingent valuation data. Looking first at the private choices, the estimates reveal that, as expected, consumers dislike price increases as indicated by the negative price coefficient. For ground beef, consumers are WTP about $0.048 for each 1% increase in leanness and are WTP $0.152 for each 1% reduction in saturated fat content. For milk, skim is preferred over whole or 1% milk, but 2% is preferred to skim. Consumers also prefer rBST-free milk to milk containing rBST. For both milk and ground beef, products from non-cloned animals are strongly preferred over products from cloned animals. For example, consumers are willing to pay a $3.46 premium for a one pound package of ground beef from a non-clone as compared to a clone, and consumers are willing to pay a $3.40 premium for one gallon of milk from a non-clone as compared to a clone. Consumers do not differentiate much between products from offspring of cloned animals and the clones themselves. The results also indicate that people would rather purchase milk from cloned animals than not purchasing at all, but the reverse is true for ground beef.

The estimated preference parameters from the private choices can be substituted into equation (4.9) to determine the implied WTP to ban ground beef or milk from clones. The results indicate that, based on consumers' private shopping choices, consumers are WTP $1.73/lb for ground beef and $1.70/gallon for milk to ban products from cloned animals, respectively, each time they purchase the products.[9]

[9] The calculations assume consumers currently believe there is a 50/50 chance of buying cloned and non-cloned meat and milk. If consumers instead believe there was a 60/40 chance of purchasing non-cloned vs. cloned products, then they would be willing to pay an additional $1.38/lb and $1.36/gallon each time they purchased meat or milk, respectively to ban animal cloning. Then if they believe it is a 40/60 chance of

Table IV-2 also reports the results from the interval censored regression fit to the contingent valuation question in which consumers were directly asked about their WTP to ban meat and milk from clones. The results reveal that consumers are *not* WTP for a ban on cloned products. In fact, the data indicates that ground beef prices would have to *fall* by $0.78/lb and milk prices would have to *fall* by $0.98/gallon for people to be indifferent to the ban. Our results indicate a preference reversal: *people's private choices imply they want one thing whereas their public voting preferences imply they want another*.

The question now is *why* people exhibit differences in preferences when making private vs. public choices. Given the direction of the reversal (people were less supportive of the ban in the public voting question than in their private choices), we can rule out two possible explanations mentioned previously in the introduction. First, consumers apparently do not believe there is an externality or public good that would cause higher support for a ban than private choices would imply. Secondly, consumers are apparently *not* voting as citizens. Voting as a citizen would tend to cause someone to be more likely to vote in favor of public policies than their private choices would suggest, which is exactly the opposite of what we observed.

To delve into this issue more deeply, we re-ran the regressions reported in table 2 to investigate how demographics and beliefs affected WTP for a ban on cloned products. For the public preference, contingent valuation questions, this task is easily accomplished by adding demographic variables linearly into the interval censored regression. For the

buying non-cloned vs. cloned products, they would pay an additional $2.08/lb for ground beef and $2.04/gallon for milk each time they purchased to ban animal cloning. Even if consumers believe there is currently no chance of buying cloned meat/milk, the implied WTP from the private choices is zero, which still remains higher than what is implied from the public voting choices.

private choice, questions, we modified equations (4.7) and (4.8) and specified the "Non-cloned vs. Cloned" variable as a function of demographic and attitudinal variables. In particular, the coefficients from equations (4.7) and (4.8), θ_6 and λ_4, then become: $\theta_6 = (\boldsymbol{X_i \tau})$ and $\lambda_6 = (\boldsymbol{X_i \omega})$**,** where $\boldsymbol{X_i}$ is a vector of demographic, belief, and attitudinal question variables for individual *i*, and $\boldsymbol{\tau}$ and $\boldsymbol{\omega}$ are the vectors of parameters. The demographic variables included age, gender, income level, education level, region, and whether or not they were the primary shopper for their households' food products. Four belief questions, previously described, were included in the regression along with variables indicating how often the respondent purchased meat or purchase milk.

Models incorporating demographics and beliefs are reported in Table IV-3. Results reveal that females are WTP \$0.33 more to avoid ground beef from cloned animals compared to males, but by contrast males are WTP \$0.20 more to avoid milk from cloned animals compared to females. Results from the contingent valuation data reveal that females are WTP \$1.18 and \$1.47 more for beef and milk, respectively for a ban on animal cloning than are males.

Consumers who agree that meat from cloned animals is currently sold in the grocery store are WTP about \$0.13 less for ground beef and \$0.19 less for milk from cloned animals than those who do not believe the statement. This statement however has no significant effect on their WTP for a ban. The statements that "the average American is willing to eat meat from cloned animals" and "I trust the U.S. government to properly regulate the use of animal cloning," significantly affect private and public WTP; however the magnitudes of the effects are much higher for the WTP for the ban. A one-unit increase (on a scale of 1 to 5) in agreement with the statements reduces WTP between

$1.63 to $2.03 for the ban but only $0.35 and $0.34 for purchases of meat or milk, respectively, from a non-cloned animal. Consumers that believe that animal cloning is morally wrong are WTP significantly more for products from non-cloned animals and to ban animal cloning. Again, a one-unit change in the morality variable has a much more pronounced effect on WTP for a ban as compared to WTP for products from non-cloned animals compared to cloned animals. These estimates suggest that certain demographics and beliefs affect the differences between private and public preferences.

To illustrate the relationship between public WTP for a ban and private WTP to avoid cloned products, figure IV-3 plots each consumer's predicted WTP resulting from the regression equations shown in table IV-3.[10] A majority of the people favor a ban on animal cloning based on private shopping choices, but only four consumers are projected to vote against the ban based on private shopping choices. The figure clearly shows that the two preferences (public and private) are positively correlated, but the line is shifted downward and is steeper than what would be implied by a 45-degree line coming from the origin.

One interesting question that arises is whether there are significant differences between the types of people who reverse preferences and those that do not. Recall that the private choices predicted that practically everyone (all but four people) would vote in favor of a ban. However, the public choices indicated that only 40.29% would vote in favor (i.e., their predicted WTP is greater than zero) and 59.71% would vote against (i.e., their predicted WTP is less than zero). Table IV-4 compares the two groups of consumers: those who reversed their preferences and those that did not. A majority of females (63%) were consistent in their preferences and did not reverse preferences; by

[10] This graph shows the results for ground beef, the figure for milk is virtually identical to the one for beef.

contrast, most men (61%) voted against the cloning ban when their private shopping choices implied they would prefer it. Those people who expressed preference reversals were more likely to agree that the average American is willing to eat meat from cloned animals compared to those that vote for the ban (3.29 vs. 2.09, respectively), suggesting people's votes are sensitive to how they believe it will affect others. Those expressing preference reversals were also more likely to trust the government to regulate the use of animal cloning and purchased meat and milk more often than those that vote for the ban based on public choices (3.24 vs. 1.69, 4.15 vs. 3.05, and 3.92 vs. 3.65, respectively). People who were consistent in their private and public choices were much more likely to believe morality is a concern with cloning than were those who voted against.

Conclusions

This study sought to determine whether people's private preferences, as expressed through individual shopping choices, are consistent with their preferences for public policy. Choice experiments regarding which meat or milk option (or none) a consumer would buy when grocery shopping were used to measure private preferences while a contingent valuation question focused on a ban on the practice of animal cloning was used to measure public preferences. The current study found a preference reversal: whereas private shopping choices imply people are WTP to ban cloned meat and milk, when directly asked, most people would demand compensation were a ban actually enacted. Private choices implied that practically everyone would favor a ban, however the public choices predict that only 40.29% have a positive WTP for the ban.

The results reveal an inadequacy in the conceptual approach used to translate preferences expressed in private shopping situations into preferences in public policy. In particular, people apparently have beliefs and preferences about the policy itself that need be taken into consideration. Our results are not supportive of the notion that the differences in public and private choices are a result of people "voting like a citizen" in contingent valuation questions nor do they support the notion that people believe there to be large externalities associated with cloning technology. The results are more consistent with the hypothesis that, when evaluating the merits of public policy, people are sensitive to the impacts on other consumers and want to have the option to adjust their beliefs as more information becomes available. In addition, beliefs about the morality of cloning appear to play a significant role in explaining the difference in public and private preferences.

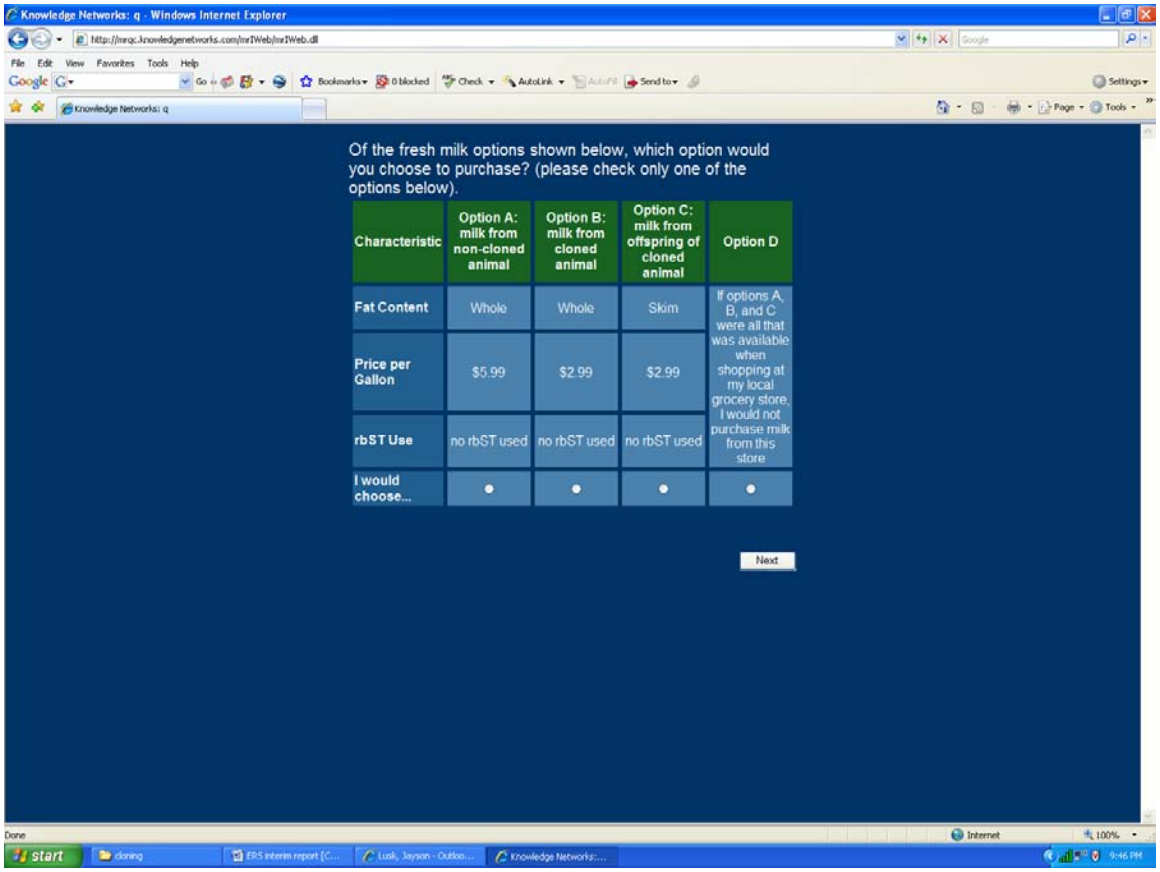

Figure IV-1. Example milk choice question presented to survey respondents

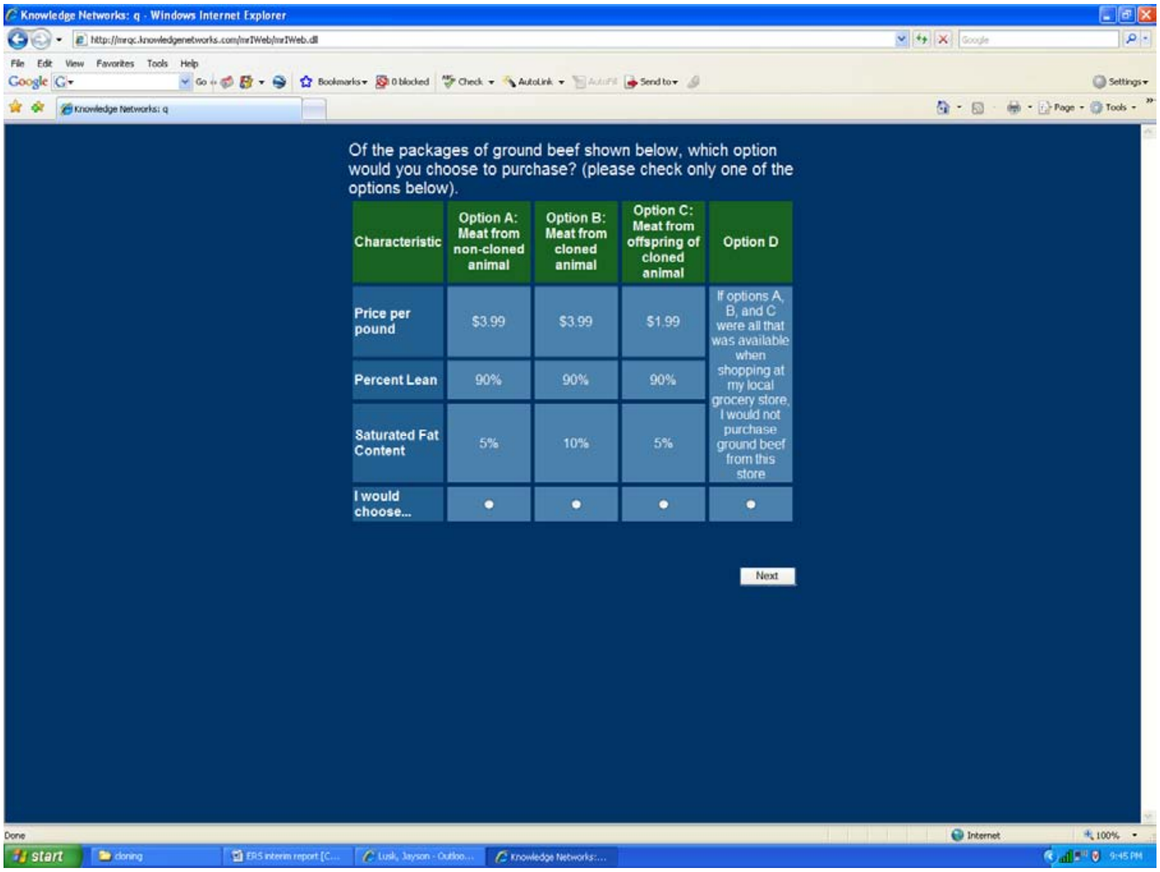

Figure IV-2. Example beef choice question presented to survey respondents

Figure IV-3. Private versus public willingness-to-pay for ban on animal cloning

Table IV-1. Characteristics of Survey Respondents (n=1787)[a]

Variable	Definition	Mean
Age	age in years	49.56
Gender	1 if female; 0 if male	0.485
Income1	1 if annual household income <$25,000; 0 otherwise	0.180
Income2	1 if annual household income $25,000 to $99,999; 0 otherwise	0.661
Income3	1 if annual household income ≥ $100,000; 0 otherwise	0.159
Bachelors	1 if Bachelor's degree or higher; 0 otherwise	0.311
Northeast	1 if resides in Northeast U.S Census Region; 0 otherwise	0.174
Midwest	1 if resides in Midwest U.S Census Region; 0 otherwise	0.231
South	1 if resides in South U.S Census Region; 0 otherwise	0.368
West	1 if resides in West U.S Census Region; 0 otherwise	0.227
Primary Shopper	1 if primary shopper for household's food products; 0 otherwise	0.681
Some of the meat currently sold in grocery stores is from cloned animals or their offspring	1=strongly disagree; 5=strongly agree[b]	2.790
The average American is willing to eat meat from cloned animals	1=strongly disagree; 5=strongly agree [b]	2.811
I trust the U.S. government to properly regulate the use of animal cloning	1=strongly disagree; 5=strongly agree [b]	2.621
Morals		0.081
Meat Purchase[c]	How often meat is purchased per month	3.700
Milk Purchase[c]	How often milk is purchased per month	3.813

[a]Used the 1,787 respondents that answered all demographic and attitudinal questions .

[b]Response to question, “To what extent do you agree or disagree with each of the following statements?” Response categories were: 1=strongly disagree, 2= somewhat disagree, 3=neither agree nor disagree, 4=somewhat agree, and 5=strongly agree.

[c]Response to question: Approximately how often do you purchase meat (milk)? 1=Never, 2=a few times a year, 3= about once a month, 4=about once a week, 5=every day. The responses were converted to a monthly consumption basis using the following; never purchased=0, a few times a year=1/12, about once a month=1, about once a week=52/12, and daily =30.

Table IV-2. Comparison of WTP for a Ban on Ground Beef and Milk from Clones from Private and Public Choices

	Ground Beef			**Milk**		
	Private Choices[a]		**Public Vote**[b]	**Private Choices**[a]		**Public Vote**[b]
	Preference Space	WTP Space ($)	Policy ban ($)	Preference Space	WTP Space ($)	Policy ban ($)
Price	-0.645*[c]	-0.645*		-0.420*	-0.420*	
	(0.012)[d]	(0.012)		(0.007)	(0.007)	
Leanness	0.031*	0.048*				
	(0.002)	(0.004)				
Saturated Fat	-0.098*	-0.152*				
Content	(0.004)	(0.008)				
Whole vs skim				-0.203*	-0.483*	
				(0.025)	(0.060)	
1% vs. skim				-0.136*	-0.323*	
				(0.026)	(0.062)	
2% vs. skim				0.281*	0.700*	
				(0.025)	(0.060)	
rBST Free				0.626*	1.493*	
				(0.019)	(0.049)	
Non-cloned vs.	2.229*	3.458*		1.430*	3.403*	
Cloned	(0.026)	(0.065)		(0.020)	(0.065)	
Cloned offspring	0.320*	0.496*		-0.143*	-0.342*	
vs. Cloned	(0.030)	(0.048)		(0.025)	(0.060)	
None vs. Cloned	0.512*	0.795*		-1.028*	-2.451*	
	(0.201)	(0.315)		(0.038)	(0.067)	
Intercept			-0.783*			-0.976*
			(0.390)			(0.486)
Scale			5.901*			7.352*
			(1.050)			(1.308)

Table IV-2. Continued

	Ground Beef			Milk		
	Private Choices[a]		**Public Vote[b]**	**Private Choices[a]**		**Public Vote[b]**
	Preference Space	WTP Space ($)	Policy ban ($)	Preference Space	WTP Space ($)	Policy ban ($)
WTP for Ban ($/Choice)		$1.729[e] (0.033)	-$0.783[f] (0.390)		$1.701[g] (0.033)	-$0.976[h] (0.486)
LLF	-20080.50	-20080.50	-1185.92	-32820.00	-32820.00	-1185.92
# of Choices	21,900	21,900	1,825	29,200	29,200	1,825
# Respondents	1,825	1,825	1,825	1,825	1,825	1,825

[a]Estimates from multinomial logit model fit to the conjoint-choice data
[b]Estimates from interval censored regression model fit to the contingent valuation choice data
[c]One asterisk represents statistical significance at the p=0.05 level or lower
[d]Numbers in parentheses are standard errors
[e]95% confidence interval for the mean WTP determined by parametric bootstrapping is [1.662, 1.790].
[f]95% confidence interval for the mean WTP is [-1.563, -0.003].
[g]95% confidence interval for the mean WTP determined by parametric bootstrapping is [1.635, 1.765].
[h]95% confidence interval for the mean WTP determined by parametric bootstrapping is [-1.948, -0.004].

Table IV-3. Comparison of the Effects of Individual-Specific Attitudes and Characteristics on WTP for Non-Cloned vs. Cloned Ground Beef and Milk from Private and Public Choices

	Ground Beef		**Milk**	
	Private Choices[a]	**Public Vote**[b]	**Private Choices**[a]	**Public Vote**[b]
	WTP Space ($)	Policy Ban ($)	WTP Space ($)	Policy Ban ($)
Price	-0.675*[c]		-0.425*	
	(0.013)[d]		(0.007)	
Leanness	0.047*			
	(0.004)			
Saturated Fat Content	-0.151*			
	(0.007)			
Whole vs. skim			-0.455*	
			(0.061)	
1% vs skim			-0.302*	
			(0.062)	
2% vs skim			0.704*	
			(0.060)	
rBST Free			-1.496*	
			(0.049)	
Cloned offspring vs cloned	0.471*		-0.340*	
	(0.046)		(0.060)	
None vs cloned	0.599*		-2.464*	
	(0.310)		(0.068)	
Determinants of Preferences for Non-Cloned vs. Clones				
Intercept (Non-cloned vs	5.469*	6.330*	5.407*	7.887*
cloned)	(0.173)	(1.348)	(0.205)	(1.680)
Age in years	-0.003	0.001	-0.004*	0.0001
	(0.002)	(0.012)	(0.002)	(0.013)
Female vs. Male	0.324*	1.183*	-0.199*	1.473*
	(0.052)	(0.414)	(0.067)	(0.516)
Inc1 (<25,000) vs. Inc3	-0.157	1.446*	-0.235*	1.801*
(>100,000)	(0.086)	(0.669)	(0.112)	(0.834)
Inc2 (25,000 to 100,000) vs.	0.005	1.039*	-0.067	1.294*
Inc3 (>1000,000)	(0.067)	(0.536)	(0.088)	(0.668)
Bachelor or higher vs. less	-0.361*	-0.301	-0.584*	-0.375
than Bachelor degree	(0.054)	(0.390)	(0.070)	(0.486)
Northeast vs. West	0.230*	0.460	0.265*	0.573
	(0.075)	(0.539)	(0.097)	(0.672)
Midwest vs. West	0.043	-0.235	0.283*	-0.292
	(0.070)	(0.503)	(0.090)	(0.626)

Table IV-3. Continued

	Ground Beef		Milk	
	Private Choices[a]	**Public Vote**[b]	**Private Choices**[a]	**Public Vote**[b]
	WTP Space ($)	Policy Ban ($)	WTP Space ($)	Policy Ban ($)
South vs. West	0.235*	0.346	0.515*	0.431
	(0.063)	(0.453)	(0.081)	(0.565)
Primary Shopper	-0.166*	-0.136	0.025	-0.170
	(0.056)	(0.401)	(0.072)	(0.500)
Agree "Some of the meat currently sold in grocery stores is from cloned animals or their offspring"	-0.132*	-0.149	-0.265*	-0.185
	(0.030)	(0.213)	(0.038)	(0.265)
Agree "The average American is willing to eat meat from cloned animals"	-0.349*	-1.631*	-0.335*	-2.032*
	(0.029)	(0.336)	(0.037)	(0.419)
Agree "I trust the U.S. government to properly regulate the use of animal cloning"	-0.344*	-1.594*	-0.124*	-1.986*
	(0.023)	(0.310)	(0.029)	(0.386)
Morals	2.209*	8.308*	2.466*	10.350*
	(0.201)	(1.766)	(0.231)	(2.200)
How often purchase meat	0.008	-0.089*	-0.005	-0.111*
	(0.005)	(0.038)	(0.006)	(0.048)
How often purchase milk	0.018*	0.036	0.014*	0.045
	(0.006)	(0.039)	(0.007)	(0.049)
Scale		5.023		6.258
		(0.845)		(1.053)
# of Choices	21,444	1,787	28,592	1,787
# of Respondents	1,787	1,787	1,787	1,787

[a]Estimates from multinomial logit model fit to the conjoint-choice data with the "Non-cloned vs. Cloned" variable a function of demographic and attitudinal variables
[b]Estimates from interval censored regression model fit to the contingent valuation choice data with demographic variables added linearly
[c]One asterisk represents statistical significance at the p=0.05 level or lower
[d]Numbers in parentheses are standard errors

Table IV-4. Comparison of Consumers Predicted to Vote Consistently between Private and Public Choices for a Ban on Ground Beef and Milk from Clones[a]

	No Preference Reversal[b]	Reversed Preferences[c]	P-value[d]
Percent Predicted to vote in favor based on Private Choices	40.29%	59.49%	
Mean Age	49.6	49.49	0.886
Female	62.92%	38.95%	<0.001
Male	37.08%	61.05%	
Income < $25,000	22.36%	15.05%	
Income $25,000 to $100,000	67.36%	65.29%	<0.001
Income > $100,000	10.28%	19.66%	
Less than Bachelors degree	76.25%	64.16%	<0.001
Bachelors degree or Higher	23.75%	35.84%	
Northeast Region	16.94%	17.69%	
Midwest Region	21.81%	23.89%	0.424
South Region	39.17%	35.37%	
West Region	22.09%	23.05%	
Primary Shopper	70.56%	66.32%	0.060
Agree "Some of the meat currently sold in grocery stores is from cloned animals or their offspring"	2.53	2.96	<0.001
Agree: "The average American is willing to eat meat from cloned animals"	2.09	3.29	<0.001
Agree: "I trust the U.S. government to properly regulate the use of animal cloning"	1.69	3.24	<0.001
Morals	0.145	0.04	<0.001
How often purchase meat	3.05	4.15	<0.001
How often purchase milk	3.65	3.92	0.204
# of Respondents	720	1063	<0.001

[a]There were a total of 1,787 observations. 4 observations are not included that opposed both the ban implied from the private choices and from the policy question.

[b]Consistent voters are classified as voters who voted in favor of the ban based on both the public private choices.

[c]Inconsistent voters are classified as voters who voted against the ban based on public choices but voted in favor of the ban based on private choices.

[d]P-value from χ^2 test of independence for categorical variables, for continuous variables p-value is from *t*-test.

CHAPTER V

CONCLUSIONS

The current study examines both demand and supply issues in the bovine industry. The first paper asses the most common disease among feedlot cattle in the U.S., bovine respiratory disease (BRD) and the potential use of serum haptoglobin (Hp) to identify the severity of it. The final two papers use a survey on consumers' preferences for animal cloning to address potential market impacts from cloning while also examining the effectiveness of the survey method.

Knowing BRD risk of calves entering the feedlot could potentially increase net revenues for stocker operations and feedlot managers. The first essay sought to determine if Hp could be used as a tool for predicting BRD outbreak and the impact of multiple treatments for BRD. It also sought to determine the economic effects of BRD in a backgrounding and finishing phases of the feedlot. Cross-bred heifers were assigned pens by risk-groups according to arrival Hp concentrations (low, medium, or high). Heifers were monitored daily and treated for BRD during a 63-day backgrounding phase. Following the backgrounding phase, the heifers were assigned finishing pens according to the number of times they were treated for BRD. The current essay found serum Hp concentration upon arrival to the feedlot to be a poor predictor of BRD and had no significant impact on net returns. However, as the number of BRD treatments increases, net returns decreased during the backgrounding phase and the combined backgrounding-finishing phase. On average, net returns were $111.12 and $143.20 less for heifers that were classified as chronically ill compared to those that were never treated for BRD in the backgrounding phase and combined phases, respectively. This trend was not evident during the finishing phase alone. The ability to predict the incidence of BRD is especially important. Further studies need to be conducted to examine economic efficiency of using HP concentration or other predictors to predict the number of BRD treatments given their cost. Knowing the propensity to contract BRD is of more value to the backgrounding phase but costs associated with Hp sampling exceed its expected predictability benefits at this time.

The final two essays examined different model estimation techniques used based on the survey of consumer's preferences for animal cloning. Recently the U.S. Food and Drug Administration concluded that meat and milk from cloned animals was safe to eat which could potentially lead to products from cloned animals entering the market in the near future. Controversy has begun to stir about this topic and many large food processors have announced that they will prohibit the sale of these products while some groups have asked for federal policy to ban animal cloning. Stated preference or experimental methods are necessary to determine consumer's preferences for cloned milk since it is not currently labeled and sold in the market place. In particular, this study used a choice-experiment model in which respondents were asked a series of discrete choice purchasing questions in order to determine consumer's preferences for meat and milk from cloned animals.

The second essay also sought to determine whether the survey-based choices were consistent with people's revealed preferences given by scanner data. Both SP and RP data have weaknesses in their demand analysis; however these weaknesses can be overcome by combining the two data sets. Thus, although milk from cloned cattle is not currently sold in the marketplace, if the preferences expressed in a SP survey (including the attribute of cloning) are systematically related to the preferences governing choices in RP data, we might be more confident in the reliability of the estimate on consumers' preferences for cloning. The current analysis suggests that a pooled model exhibits better overall out-of-sample prediction performance than either stated or revealed preference data used in isolation even though the hypothesis of common preference parameters across the revealed and stated preference data sets in sample was rejected.

Based on the pooled model, consumers are WTP large premiums to avoid milk from cloned animals, $4.71 per gallon, which is three times larger than their WTP for organic or rBST-free milk. Consumers were also found to value a mandatory labeling system. If retailers respond to a mandatory labeling policy by revealing to consumers that no cloned milk is in the market place with labels like, "milk from cows that have not been cloned," the value of this information to consumers is $0.19 per choice occasion or about $746 million annually in aggregate. Future research could be conducted to determine if willingness-to-pay for cloned vs. non-cloned milk increases or decreases when real money and real milk is on the line. Further research could also be conducted to delve into issues related to why consumers may be concerned about cloning technology.

The third and final essay uses the discrete choice questions regarding which meat or milk option a consumer would purchase to measure private preferences while a contingent valuation question focused on a ban on the practice of animal cloning was used to measure public preferences. The purpose of this essay is to determine if these private preferences, as expressed through individual shopping choices, are consistent with their preferences for public policy. A preference reversal was found in the current study: whereas private shopping choices imply people are WTP to ban cloned meat and milk, when directly asked, most people would demand compensation were a ban actually enacted. Based on consumers' private shopping choices, consumers are WTP $1.73/lb for ground beef and $1.70/gallon for milk to ban products from cloned animals, respectively, each time they purchase the products. The results based on the public preferences reveal that consumers are not WTP for a ban on cloned products. In fact, the data indicates that ground beef prices would have to fall by $0.78/lb and milk prices would have to fall by $0.98/gallon for people to be indifferent to the ban. The results of the study appear to be consistent with the hypothesis that, when evaluating the merits of public policy, people are sensitive to the impacts on other consumers and want to have the option to adjust their beliefs as more information becomes available. In addition, beliefs about the morality of cloning appear to play a significant role in explaining the difference in public and private preferences.

CHAPTER VI

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CHAPTER VII

APPPENDICES

APPENDIX A-- TABLES FOR RANDOM PARAMETER LOGIT (RPL) ESTIMATES FOR STATED PREFERENCE (SP) AND REVEALED PREFERENCES (RP)

Table A-1. Random Parameter Logit (RPL) Estimates for Stated Preference (SP) and Revealed Preferences (RP)

Milk Attribute	Model 4 SP	Model 5 RPL
Price	-1.018*	-1.160*
	(0.020)[a]	(0.020)
Whole vs skim	-1.084*	-0.707*
	(0.089)	(0.080)
2% vs skim	0.520*	0.821*
	(0.078)	(0.079)
1% vs skim	0.374*	0.422*
	(0.070)	(0.066)
rBST free	1.659*	1.492*
	(0.052)	(0.053)
Non-clone vs none	6.607*	6.565*
	(0.116)	(0.116)
Clone vs none	1.225*	2.127*
	(0.127)	(0.135)
Offspring of clone vs none	0.738*	1.138*
	(0.132)	(0.148)
Organic	---	0.201
		(0.498)
Scale[b]		0.750
Log-Likelihood	-9167.16	-10038.16
# Parameters	44	54
# Obs.	16832	17884

Note: Asterisk (*) represents statistical significance at the 5% level or lower
[a]Numbers in parenthesis are standard errors
[b]The scale of the SP data set is set equal to 1; the estimated value refers to the scale of the RP data set

Table A-2. Selected Correlations between Random Parameters in the Pooled Stated and Revealed Preference Model from Random Parameter Logit (RPL) Model

Random Parameters	Correlations
Price (RP) vs. Price (SP)	0.99
Whole (RP) vs. Whole (SP)	0.35
2% fat (RP) vs. 2% fat (SP)	0.97
1% fat (RP) vs. 1% fat (SP)	0.96
Organic (RP) vs rBST free (SP)	0.54
Organic (RP) vs (Non-clone - Clone) (SP)	0.05

Table A-3. **Out-of-Sample Prediction Performance of Random Parameter Logit (RPL) Models**

Data Set Predicted	Model 4 RPL	Model 5 RPL
Out-of-Sample Log-Likelihood		
SP	-8491.05	-8723.19
RP	-487.04	-448.39
Pooled	-8968.55	-9164.15
Mean Squared Error		
SP	0.149	0.151
RP	0.037	0.035
Pooled	0.136[a]	0.138
% Correctly Predicted		
SP	50.9%	51.0%
RP	70.8%	71.0%
Pooled	52.2%	52.3%

[a]Indicates that means in the same row with the same superscript are not significantly different at $P<0.05$.

APPENDIX B –SURVEY ON CONSUMER PREFERENCES FOR CLONING ADMINISTERED ONLINE BY IRI AND KN

The following survey was sent to IRI and KN who created an online version and administered it to their panel of respondents.

Section 1: Most important issues when purchase food

First we would like to ask you a few repeated questions regarding the importance of several general issues when you purchase food. For each question indicate which of the two issues is the most important issue to you when purchasing food.

1. Is **X** or **Y** more important when you purchase foods?

[Ask 11 such questions, where the two food issues **X** and **Y** are randomly chosen from the list of 11 issues below. Note 1: in total, there are (11*11-11)/2=55 possible questions that that can be created representing all possible combinations of pairings of the issues listed below. Note 2: for data collection we will need to know which two choices were presented to the respondent and which choice was made for each of the 11 of the randomly selected questions for each individual.]

Food Issues

1. Naturalness (extent to which food is produced without modern technologies)
2. Taste (extent to which consumption of the food is appealing to the senses)
3. Price (the price that is paid for the food)
4. Safety (extent to which consumption of food will not cause illness)
5. Convenience (ease with which food is cooked and/or consumed)
6. Nutrition (amount and type of fat, protein, vitamins, etc.)
7. Tradition (preserving traditional consumption patterns)
8. Origin (where the agricultural commodities were grown)
9. Fairness (the extent to which all parties involved in the production of the food equally benefit)
10. Appearance (extent to which food looks appealing)
11. Environmental Impact (effect of food production on the environment

Example Questions:
QA1:
Is Naturalness (extent to which food is produced without modern technologies) or Taste (extent to which consumption of the food is appealing to the senses) more important when you purchase foods? [response categories:1=Naturalness, 2=Taste].
.
QA11:
Is Price (the price that is paid for the food) or Appearance (extent to which food looks appealing)
more important when you purchase foods? [response categories:1= Price, 2=Appearance]

Section 2: Knowledge of Animal Breeding Technologies

Overall, how much have you heard or read about each of the following assisted reproduction technologies that are sometimes used to breed animals for meat and milk production? [response categories: 1 = nothing at all; 2 = a little; 3 = a moderate amount; 3 = quite a bit; 4 = a great deal]

12. Artificial Insemination
13. In vitro fertilization
14. Biotechnology
15. Embryo transfer
16. Cloning

Section 3: Information on Animal Cloning

The next section of the survey will ask several questions specifically about animal cloning. What follows is a brief description of cloning.

Animal cloning is a process in which scientists can copy the genetic or inherited traits of an animal. Clones are similar to identical twins only born at different times. Similar to in vitro fertilization, cloned animals begin in a laboratory, but then are born to surrogate mothers in the usual way and grow up just like other animals.

This reproductive breeding technique is appealing to some ranchers and farmers because it enables them to create "identical twins" of their best breeding stock – allowing them to more quickly breed desirable traits into herds. The technique is also appealing to some consumers because it has the potential to lower the price and increase the quality of meat and milk.

This reproductive breeding technique is opposed by some people on moral and ethical grounds. Other people are opposed to animal cloning because, given current technology, only a small percentage of attempts at cloning are successful and many of the clones die during all stages of gestation and birth and the procedures may carry risks for the mother. Although these symptoms are a downside to cloning, they are not necessarily unique to cloning in comparison to other reproductive techniques.

In January 2008, after years of detailed study and analysis, the U.S. Food and Drug Administration (FDA) concluded that, "meat and milk from clones of cattle, swine, and goats, and the offspring of clones from any species traditionally consumed as food, are as safe to eat as food from conventionally bred animals." The FDA's science-based risk assessment, which was peer-reviewed by a group of independent scientific experts in cloning and animal health, concluded:

1. Cloning poses no unique risks to animal health compared to the risks found with other reproduction methods including natural mating.
2. The composition of food products from cattle, swine, and goat clones, or the offspring of any animal clones, is no different from that of conventionally bred animals.
3. Because of the preceding two conclusions, there are no additional risks to people eating food from cattle, swine, and goat clones or the offspring of any animal clones traditionally consumed as food.

A copy of FDA's report can be found at: http://www.fda.gov/cvm/cloning.htm.

Section 4: Animal Cloning Questions

Now, we would like to ask you several questions about cloning and government involvement in cloning.

To what extent do you agree or disagree with each of the following statements? [response categories: 1=strongly disagree, 2= somewhat disagree, 3=neither agree nor disagree, 4= somewhat agree, 5=strongly agree; note: these items should ideally be randomly ordered across surveys].

17. Some of the meat currently sold in grocery stores is from cloned animals or their offspring.
18. I am willing to eat meat from cloned animals.
19. I am willing to eat meat from the offspring of cloned animals.
20. I am willing to consume milk products from cloned animals.
21. I am willing to consume milk products from the offspring of cloned animals.
22. The U.S. government can trace the meat from cloned animals back to the farm on which the animal lived.
23. The U.S. government is doing everything it can to ensure the safety of food products.
24. In general, the meat and milk I buy from grocery stores is safe to eat
25. The meat from cloned animals is safe to eat
26. Animal cloning is carefully regulated by the U.S. government.
27. The average American is willing to eat meat from cloned animals.
28. Animal cloning is unacceptable.
29. Animal cloning will result in beneficial outcomes to me.
30. I trust the U.S. government to properly regulate the use of animal cloning.
31. I trust information about cloning from the U.S. Department of Agriculture (USDA).
32. I trust information about cloning from the U.S. Food and Drug Administration (FDA).
33. I trust information about cloning from U.S. Environmental Protection Agency (EPA).
34. I trust information about cloning from University scientist and researchers.
35. If I learned that the meat products I regularly purchase came from cloned animals, I would continue to buy the meat products as usual.
36. If I learned that the milk products I regularly purchase came from cloned animals, I would continue to buy the milk products as usual.

We would not like to ask you how you would vote on three different policies were you given the opportunity to do so. When answering each question, please assume that the particular policy in question is the only one on the ballot. That is, please answer each of the next three questions individually assuming only one policy option was under consideration.

37. Suppose the next time you went to vote, there was a referendum on the ballot that would require the U.S. government to implement a policy that required a tracking system on all cloned animals. Would you vote in favor of this policy if the policy would increase the price you would pay for meat and milk products by **X**% due to the added enforcement and oversight required by the policy? [response categories: 1=I would vote in favor of a mandatory tracking system and a **X**% increase in the price of meat and milk; 2=I would vote against the mandatory tracking system and the **X**% increase in the price of meat and milk] [Note: the percentage price increase, **X** is to be randomly chosen for each individual among the values of 5, 10, 15, 25, 50, 75, and 100 percent.]

38. Suppose the next time you went to vote, there was a referendum on the ballot that would require firms to place a label on all meat and milk products derived from cloned animals or the offspring of cloned animals. Would you vote in favor of this policy if the policy would increase the price you would pay for meat and milk products by **Y**% due to the added enforcement and oversight required by the policy? [response categories: 1=I would vote in favor of a mandatory labeling policy on meat and milk from cloned animals and their offspring and a **Y**% increase in the price of meat and milk; 2=I would vote against the mandatory labeling policy and the **Y**% increase in the price of meat and milk]
[Note: the percentage price increase, **Y** is to be randomly chosen for each individual among the values of 5, 10, 15, 25, 50, 75, and 100 percent.]

39. Suppose the next time you went to vote, there was a referendum on the ballot that would ban the practice of animal cloning altogether. Would you vote in favor of this policy if the policy would increase the price you would pay for meat and milk products by **Z**% due to the added enforcement and oversight required by the policy? [response categories: 1=I would vote in favor of a ban on cloned animals and a **Z**% increase in the price of meat and milk; 2=I would vote against a ban on cloned animals and the **Z**% increase in the price of meat and milk]
[Note: the percentage price increase, **Z** is to be randomly chosen for each individual among the values of 5, 10, 15, 25, 50, 75, and 100 percent.]

[Note: Questions 37, 38, and 39 should ideally be randomly ordered across surveys]

Some people are in favor of animal cloning and some people object to the practice. We are interested in your opinions about a few of the objections that some people have about animal cloning. For each of the following questions, please indicate which of the two statements *best* describes your views toward animal cloning. We recognize that, in some cases, you may not particularly agree with either statement; however, please choose which of the two statements *best* matches your views.

40. Which of the following two statements best describes your views toward animal cloning? **X** or **Y**

[Ask 8 such questions, where the two statements **X** and **Y** are randomly chosen from the list of 8 issues below. Note 1: in total, there are (8*8-8)/2=28 possible questions that that can be created representing all possible pairs of the issues listed below. Note 2: for data collection we will need to know which two statements were presented to the respondent and which choice was made for each of the 8 of the randomly selected questions for each individual.]

Statements

1. Animal cloning is morally wrong
2. Meat and milk from clones and their offspring is unsafe to eat
3. Animal cloning will lead to human cloning
4. Cloning will result in unhealthy farm animals
5. Cloning is "unnatural" because it is not a process that occurs in nature
6. Cloning will reduce genetic diversity to an unacceptable level
7. Cloning results in animals being viewed as "objects' to be produced as opposed to being valuable in and of themselves
8. The scientists and biotechnology companies who developed cloning technology cannot be trusted to look out for my best interest

Example:

Q40:

Which of the following two statements best describes your views toward animal cloning? "Animal cloning is morally wrong" or "Meat and milk from clones and their offspring is unsafe to eat." [response categories: 1= Animal cloning is morally wrong, 2= Meat and milk from clones and their offspring may be unsafe to eat]

.

.

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Q48:

Which of the following two statements best describes your views toward animal cloning? "Cloning will result in unhealthy farm animals" or "Animal cloning will lead to human cloning." [response categories: 1= Cloning will result in unhealthy farm animals, 2= Animal cloning will lead to human cloning]

Now we will ask you several repeated questions about your preferences for ground beef with different characteristics.

[Note: below are 12 choice-based conjoint questions, where the 3 ground beef characteristics are chosen from the levels shown below according to an experimental design.]

i. Price per Pound
   1. $1.99/pound
   2. $3.99/pound
ii. Percent Lean
   1. 80%
   2. 90%
iii. Saturated Fat Content
   1. 5%
   2. 10%

49. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: Meat from non-cloned animal**	**Option B: Meat from cloned animal**	**Option C: Meat from offspring of cloned animal**	**Option D**
Price per pound	$3.99	$3.99	$1.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	90%	90%	90%	
Saturated Fat Content	5%	10%	5%	
I would choose . . .	[]	[]	[]	[]

50. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	Option A: Meat from non-cloned animal	Option B: Meat from cloned animal	Option C: Meat from offspring of cloned animal	Option D
Price per pound	$1.99	$3.99	$1.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	90%	80%	80%	
Saturated Fat Content	10%	5%	5%	
I would choose . . .	[]	[]	[]	[]

51. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	Option A: Meat from non-cloned animal	Option B: Meat from cloned animal	Option C: Meat from offspring of cloned animal	Option D
Price per pound	$1.99	$3.99	$3.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	90%	90%	90%	
Saturated Fat Content	10%	10%	10%	
I would choose . . .	[]	[]	[]	[]

52. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: Meat from non-cloned animal**	**Option B: Meat from cloned animal**	**Option C: Meat from offspring of cloned animal**	**Option D**
Price per pound	$3.99	$3.99	$3.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	80%	80%	90%	
Saturated Fat Content	5%	5%	10%	
I would choose . . .	[]	[]	[]	[]

53. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: Meat from non-cloned animal**	**Option B: Meat from cloned animal**	**Option C: Meat from offspring of cloned animal**	**Option D**
Price per pound	$1.99	$1.99	$1.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	80%	80%	90%	
Saturated Fat Content	10%	10%	10%	
I would choose . . .	[]	[]	[]	[]

54. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	Option A: Meat from non-cloned animal	Option B: Meat from cloned animal	Option C: Meat from offspring of cloned animal	Option D
Price per pound	$3.99	$1.99	$3.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	90%	90%	80%	
Saturated Fat Content	10%	5%	10%	
I would choose . . .	[]	[]	[]	[]

55. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	Option A: Meat from non-cloned animal	Option B: Meat from cloned animal	Option C: Meat from offspring of cloned animal	Option D
Price per pound	$3.99	$3.99	$3.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	80%	80%	80%	
Saturated Fat Content	10%	10%	5%	
I would choose . . .	[]	[]	[]	[]

56. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: Meat from non-cloned animal**	**Option B: Meat from cloned animal**	**Option C: Meat from offspring of cloned animal**	**Option D**
Price per pound	$3.99	$1.99	$1.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	90%	80%	80%	
Saturated Fat Content	5%	10%	10%	
I would choose . . .	[]	[]	[]	[]

57. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: Meat from non-cloned animal**	**Option B: Meat from cloned animal**	**Option C: Meat from offspring of cloned animal**	**Option D**
Price per pound	$1.99	$3.99	$1.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	80%	90%	80%	
Saturated Fat Content	5%	5%	10%	
I would choose . . .	[]	[]	[]	[]

58. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	Option A: Meat from non-cloned animal	Option B: Meat from cloned animal	Option C: Meat from offspring of cloned animal	Option D
Price per pound	$1.99	$1.99	$3.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	90%	80%	90%	
Saturated Fat Content	5%	5%	5%	
I would choose . . .	[]	[]	[]	[]

59. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	Option A: Meat from non-cloned animal	Option B: Meat from cloned animal	Option C: Meat from offspring of cloned animal	Option D
Price per pound	$1.99	$1.99	$3.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	80%	90%	80%	
Saturated Fat Content	5%	10%	5%	
I would choose . . .	[]	[]	[]	[]

60. Of the packages of ground beef shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: Meat from non-cloned animal**	**Option B: Meat from cloned animal**	**Option C: Meat from offspring of cloned animal**	**Option D**
Price per pound	$3.99	$1.99	$1.99	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase ground beef from this store
Percent Lean	80%	90%	90%	
Saturated Fat Content	10%	5%	5%	
I would choose . . .	[]	[]	[]	[]

Now we will ask you several repeated questions about your preferences for milk with different characteristics. Some of the milk products indicate that they were produced with rbST, which is a bovine growth hormone that increases milk production in cows.

[Note: below are 16 choice-based conjoint questions, where the 3 ground beef characteristics are random chosen from the levels shown below.]

iv. Price
   1. $2.99
   2. $5.99
v. Fat Content
   1. Skim
   2. 1%
   3. 2%
   4. Whole
vi. rbST (bovine growth hormone that increases milk production in cows.)
   1. no rbST
   2. rbSt

61. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	Whole	Whole	Skim	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$5.99	$2.99	$2.99	
rbSt Use	no rbSt used	no rbSt used	no rbSt used	
I would choose . . .	[]	[]	[]	[]

62. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	Whole	Skim	1%	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$2.99	$2.99	$5.99	
rbSt Use	rbSt used	no rbSt used	rbSt used	
I would choose . . .	[]	[]	[]	[]

63. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	2%	Skim	Whole	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$2.99	$2.99	$2.99	
rbSt Use	no rbSt used	rbSt used	no rbSt used	
I would choose . . .	[]	[]	[]	[]

64. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	Skim	Skim	Skim	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$5.99	$5.99	$5.99	
rbSt Use	rbSt used	rbSt used	no rbSt used	
I would choose . . .	[]	[]	[]	[]

65. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	Skim	2%	2%	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$2.99	$2.99	$5.99	
rbSt Use	no rbSt used	no rbSt used	no rbSt used	
I would choose . . .	[]	[]	[]	[]

66. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	Option A: milk from non-cloned animal	Option B: milk from cloned animal	Option C: milk from offspring of cloned animal	Option D
Fat Content	Whole	2%	Whole	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$5.99	$5.99	$5.99	
rbSt Use	no rbSt used	rbSt used	rbSt used	
I would choose . . .	[]	[]	[]	[]

67. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	Option A: milk from non-cloned animal	Option B: milk from cloned animal	Option C: milk from offspring of cloned animal	Option D
Fat Content	2%	Whole	2%	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$5.99	$2.99	$5.99	
rbSt Use	rbSt used	rbSt used	rbSt used	
I would choose . . .	[]	[]	[]	[]

68. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	Whole	1%	2%	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$2.99	$5.99	$2.99	
rbSt Use	rbSt used	rbSt used	no rbSt used	
I would choose . . .	[]	[]	[]	[]

69. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	2%	2%	1%	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$5.99	$5.99	$2.99	
rbSt Use	rbSt used	no rbSt used	no rbSt used	
I would choose . . .	[]	[]	[]	[]

70. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	Skim	1%	1%	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$5.99	$2.99	$2.99	
rbSt Use	no rbSt used	rbSt used	rbSt used	
I would choose . . .	[]	[]	[]	[]

71. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	1%	Skim	2%	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$5.99	$5.99	$2.99	
rbSt Use	no rbSt used	no rbSt used	rbSt used	
I would choose . . .	[]	[]	[]	[]

72. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	2%	1%	Skim	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$2.99	$5.99	$5.99	
rbSt Use	no rbSt used	no rbSt used	rbSt used	
I would choose . . .	[]	[]	[]	[]

73. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	1%	2%	Skim	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$2.99	$2.99	$2.99	
rbSt Use	rbSt used	rbSt used	rbSt used	
I would choose . . .	[]	[]	[]	[]

74. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	Skim	Whole	Whole	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$2.99	$5.99	$2.99	
rbSt Use	rbSt used	no rbSt used	rbSt used	
I would choose . . .	[]	[]	[]	[]

75. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	1%	Whole	1%	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$2.99	$5.99	$5.99	
rbSt Use	no rbSt used	rbSt used	no rbSt used	
I would choose . . .	[]	[]	[]	[]

76. Of the fresh milk options shown below, which option would you choose to purchase? (please check only one of the options below).

Characteristic	**Option A: milk from non-cloned animal**	**Option B: milk from cloned animal**	**Option C: milk from offspring of cloned animal**	**Option D**
Fat Content	1%	1%	Whole	If options A, B, and C were all that was available when shopping at my local grocery store, I would not purchase milk from this store
Price per Gallon	$5.99	$2.99	$5.99	
rbSt Use	rbSt used	no rbSt used	no rbSt used	
I would choose . . .	[]	[]	[]	[]

Section 5: Background Questions

Finally, we would like to ask you some question about your background.

Need information on :
Age,
Gender
Education
Income
Race

Also, we would like to ask the following questions (if they are not already in the standard set of demographics)- we want to ask them in this manner to compare to some previous survey work we've done

77. Do you or someone you are related to own or work on a ranch or farm?

3. Yes
4. No

78. Are you the primary shopper for your household's food products?

5. Yes
6. No

79. Approximately how often do you purchase meat, such as beef, pork, or poultry?

7. Never
8. A few times a year
9. About once a month
10. About once a week
11. Every Day

80. Approximately how often do you purchase milk?

12. Never
13. A few times a year
14. About once a month
15. About once a week
16. Every Day

81. Are there any children under the age of 12 in your household?

Yes
No

APPENDIX C – INSTITUTIONAL REVIEW BOARD LETTER

Oklahoma State University Institutional Review Board

Date:	Tuesday, May 20, 2008
IRB Application No	AG0823
Proposal Title:	Consumer Preferences on Animal Cloning
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved   Protocol Expires: 5/19/2009

Principal Investigator(s):

Kathleen Brooks	Jayson Lusk
421A Ag Hall	411 Ag Hall
Stillwater, OK 74078	Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Shelia Kennison, Chair
Institutional Review Board

VITA

Kathleen Rae Brooks

Candidate for the Degree of

Doctor of Philosophy

Thesis: ESSAYS ON PRODUCTION AND DEMAND ISSUES IN THE BOVINE INDUSTRY

Major Field: Agricultural Economics

Biographical:

Education:

Completed the requirements for the Doctor of Philosophy in Agricultural Economics at Oklahoma State University, Stillwater, Oklahoma in July, 2010.

Completed the requirements for the Master of Science in Agribusiness at Illinois State University, Normal, IL in May 2007.

Completed the requirements for the Bachelor of Science in Agribusiness at Kansas State University, Manhattan, Kansas in May 2005.

Experience: Employed as office manager at Century 21 Irvine Real Estate in Manhattan, KS, October 2001 to August 2005; employed as graduate research assistant at Illinois State University, Department of Agricultural, Normal, IL August 2001 to July 2007; employed as graduate research assistant at Oklahoma State University, Department of Agricultural Economics, Stillwater, OK, August 2007 to July 2010.

Professional Memberships: Agriculture and Applied Economics Association, Southern Agricultural Economics Association, Western Economics Association, American Society of Animal Science, North American Colleges and Teachers of Agriculture

Name: Kathleen Rae Brooks Date of Degree: July, 2010

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: ESSAYS ON PRODUCTION AND DEMAND ISSUES IN THE BOVINE INDUSTRY

Pages in Study: 135 Candidate for the Degree of Doctor of Philosophy

Major Field: Agricultural Economics

Scope, Method of Study, and Findings: This three-essay dissertation seeks to address both production and demand issues in the bovine industry. The first essay assesses the economic effects of bovine respiratory disease (BRD) in backgrounding and finishing phases with risk assessment of calves based on serum haptoglobin (**Hp**). During a 63-day backgrounding phase, heifers (n=337) were grouped by Hp level and monitored daily for signs of BRD. After backgrounding, heifers (n=193) were allocated to finishing pens based on number of BRD treatments received. Hp concentration had no significant effect on net returns and was not significantly different across number of BRD treatments. However, net returns decreased in the backgrounding phase and the combined backgrounding-finishing phases as number of BRD treatments increased.

The final two papers use data from a nationwide survey to elicit consumer's preferences for meat and milk from cloned products. The U.S. Food and Drug Administration recent announcement that products from cloned animals is safe to consumer, prompted interest among farmers, food retailers, and regulators in the market impacts of the introduction of milk from clones. Because milk from cloned animals is not currently labeled in the market, we utilized a stated preference experiment to determine consumer preferences for the attribute. The second essay also sought to determine whether the survey-based choices were consistent with people's revealed preferences given by scanner data. Our analysis indicates that a pooled model combining stated and revealed preference data exhibits overall better out-of-sample prediction performance than either data set used alone. Results from the pooled model indicate consumers are willing to pay large premiums to avoid milk from cloned cows – an amount that is over three times that for organic or rBST-free milk. The results are used to calculate the value of a mandatory labeling program

The purpose of the third essay is to test the often implicit assumption that data on people's private shopping choices are often used to draw implications about their desires for food policies. We find that although people's private choices indicate a strong desire to avoid meat and milk from cloned cattle, implying a significant willingness-to-pay to ban food from cloned animals, that when directly asked, most people oppose a ban and would demand compensation through lower food prices were a ban enacted. The results suggest caution in inferring public preferences from private choices.

ADVISER'S APPROVAL: Dr. Jayson L. Lusk