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Analysis of Producer and Consumer Cattle Surveys

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ABSTRACT

This thesis presents two separate studies focusing on producers and consumers in the United States cattle industry. The objective of the first study was to analyze the differences between a text cheap talk script and a visual cheap talk script in an online choice experiment to see if it decreased or eliminated hypothetical bias. The product evaluated was Tennessee Certified Beef, specifically USDA Choice boneless ribeye, with other attributes to complement the beef product. Using a random parameters logit model, results indicated that willingness to pay (WTP) estimates for respondents who saw the visual cheap talk script were higher than the WTP estimates for respondents who saw the text cheap talk script. The study also evaluated the respondent's preferred learning style (visual or verbal) and found that this too had an impact on WTP. The second study's objective was to analyze the differences between operating and closed dairies in the Southeastern United States through farm and operator characteristics. Probit regression model results indicated variables that were related to the operational status of a dairy such as the number of cows and the dairies average daily production. The study also found there were other factors besides the size of the dairy operation that were significant in determining the operational status of the dairy.

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INTRODUCTION

This thesis is comprised of two separate studies pertaining to producer and consumer cattle surveys. Chapter I's survey was an online choice experiment sent to the primary purchaser of beef in Tennessee households to determine the consumer's willingness to pay for Tennessee labeled beef. Chapter II's survey was a mail survey sent grade A dairy farms in the Southeastern United States to determine the operational status of the dairy.

Chapter I studies the effectiveness of a visual cheap talk script used in an online choice experiment for Tennessee Certified Beef. Consumers in choice experiments typically overstate their willingness to pay (WTP) for goods which is called hypothetical bias. As a means to decrease or eliminate hypothetical bias, cheap talk scripts are included in surveys to inform respondents of hypothetical bias. The difference between a traditional text cheap talk script and a visual cheap talk script with an image that was hypothesized to decrease hypothetical bias was examined.

Chapter II analyses the differences between operational and closed dairies in the Southeastern United States. The United States dairy industry is witnessing changes in the number and sizes of the farms. The Southeast is also experiencing these trends; however, they are noticing them in a more drastic fashion. The differences between farm structure characteristics, operator characteristics, farm management practices, and sources of information that help producers make decisions was analyzed. It was hypothesized that there are certain farm and operator characteristics that contribute to the operational status of a dairy in the Southeastern United States.

CHAPTER I
The Impact of a Visual Cheap Talk Script on Willingness to Pay in an Online Choice Experiment

Abstract

Hypothetical bias is a prevalent issue in choice experiments and causes consumers to overstate their true willingness to pay (WTP) for goods. Research has shown that when participants read a "cheap talk" script prior to choice set selection, this may reduce and possibly eliminate hypothetical bias. The goal of this research is to analyze the use of a "visual" cheap talk script compared to a standard "text" cheap talk script that is presented in a text format to determine if WTP estimates are impacted by the presentation format of the cheap talk. Random parameter logit model results indicate that WTP estimates for participants who saw the visual cheap talk were higher than the WTP estimates from participants who saw the text cheap talk. Furthermore, in addition to each type of cheap talk participants received, each respondent's preferred learning style (e.g., visual or verbal) also had an impact on WTP.

Introduction

There are several approaches for eliciting consumer willingness to pay (WTP) for products including choice experiments (e.g., Merritt et al., 2018; Syrengelas, DeLong, Grebitus, & Nayga, et al., 2018; Lewis, Grebitus, Colson, & Hu, 2017; Lewis, Grebitus, & Nayga, 2016a), experimental auctions (e.g., Lewis, Grebitus, & Nayga, 2016b), and the contingent valuation method (Dobbs et al., 2016). However, it is possible for WTP to be overstated in hypothetical situations since consumers are not actually bound by their decisions to purchase the products in question. This overstatement is referred to as hypothetical bias.

Cummings and Taylor (1999) refer to hypothetical bias as the difference between real and hypothetical valuation. Andor, Frondel, and Vance (2017) also state that WTP estimates in hypothetical situations are substantially overstated. Techniques including cheap talk scripts (Cummings and Taylor, 1999; Tonsor and Shupp, 2011), consequentiality (Herriges, Kling, Liu, & Tobias, 2010; Vossler, Doyon, & Rondeau; Lewis et al., 2016a) and honesty priming (de-Magistris, Gracia and Nayga 2013) have been developed to help reduce or eliminate hypothetical bias. Non-hypothetical experiments are ideal; however, hypothetical choice experiments are preferred due to time commitments and added expenses associated with non-hypothetical choice experiments (de-Magistris, Gracia and Nayga 2013).

Cummings and Taylor (1999) were among the first to use a cheap talk script to reduce hypothetical bias, and Tonsor and Shupp (2011) were the first to assess a cheap talk script's effectiveness in an online choice experiment. However, there is no literature studying the effects of the presentation format of a cheap talk script in an online choice experiment. Given previous research (Mueller, Lockshin, and Louviere, 2010) has found there is a difference between visual

and verbal learners in a discrete choice experiment, it is important to examine if the presentation format of the cheap talk script can have an impact on consumer WTP.

This study will analyze the difference between a visual cheap talk script and a text cheap talk script used in an online choice experiment that elicited Tennessee consumer's willingness to pay for Tennessee Certified Beef, specifically USDA Choice boneless ribeye steaks. This study will also analyze both cheap talk scripts further by considering how the respondent prefers to learn: verbally or visually. It is hypothesized that respondents who prefer to learn visually and received the visual cheap talk script will have lower WTP estimates whereas if they were a visual learner who received a text cheap talk script they will have higher WTP estimates. If the respondent preferred to learn verbally and received a visual cheap talk script, it is hypothesized that their WTP estimates will be higher whereas the ones who received the text cheap talk script and preferred to learn verbally will have lower WTP estimates. This is because we hypothesis that visual and verbal learners will best respond to a cheap talk script that is presented in the way in which they best learn.

Previous Literature

Cheap talk, consequentiality and honesty priming have all been suggested as ways to control hypothetical bias when estimating WTP. Vossler, Doyon, and Rondeau (2012) used policy consequentiality to determine consumer WTP for different tree row planting scenarios through a field experiment. Policy consequentiality expects survey participants to believe their results may affect an outcome (Lewis et al. 2016). They found consequentiality more important than the "real versus hypothetical" distinction when gauging the criterion validity of surveys. Lewis, Grebitus, and Nayga (2016) examined consumer WTP for domestic and foreign sugar and genetically modified labeled sugar using policy consequentiality through an online choice

experiment. Their study found that when survey respondents found their responses as consequential, they were more likely to choose a product to help inform policy makers.

De-Magistris et al. (2013) assessed whether honesty priming could be used as a technique to mitigate or eliminate hypothetical bias in choice experiments. Honesty priming is similar to the social psychology technique solemn oath, which is a mechanism to ask participants to "provide honest answers prior to participating in a second-price auction" (de-Magistris et al., 2013). Targeting consumers who were the primary food buyer of their household, the survey split respondents into two treatments: hypothetical choice experiment and non-hypothetical choice experiment. This was done to see if the honesty priming actually mitigated the hypothetical bias. De-Magistris et al. (2013) found honesty priming to reduce hypothetical bias in hypothetical choice experiments, however, values from the hypothetical choice experiment were not statistically different from the non-hypothetical choice experiment.

Cummings and Taylor (1999) refer to a cheap talk script as a way of mitigating hypothetical bias. Lusk (2003) interprets a cheap talk script, in the context relevant to our study, as a "nonbinding communication between a researcher and survey respondent prior to administration of a hypothetical WTP question". The cheap talk script in this study is used as an ex ante correction approach, meaning it is applied before the choice experiment. Cheap talk scripts were initially implemented by Cummings and Taylor (1999). Using four public goods, which were contributions to four different non-profit environmental organizations, they found that cheap talk reduced hypothetical bias in three of the goods. Cummings and Taylor examined this issue using the contingent valuation method with three different treatments (non-hypothetical treatment, hypothetical treatment, and hypothetical with cheap talk treatment) to determine if there was a significant difference between each treatment. The hypothetical

treatment and hypothetical with cheap talk treatments were found to be significantly different. Meanwhile, the hypothetical treatment with cheap talk was not found to be significantly different from the non-hypothetical treatment.

Carlsson et al. (2005) studied the effects of a cheap talk script on the marginal WTP in a choice experiment through a mail survey mailed to consumers, and found seven of the ten attributes of beef and chicken tested were significantly less valued when the cheap talk script was used. They concluded that choice experiments may suffer from hypothetical bias and that inclusion of a cheap talk script prior to a choice experiment can decrease the degree of inflated WTP values (Carlsson et al. 2005).

Silva et al. (2011) tested a generic, short, and neutral cheap talk script in a field experiment to elicit retail consumer's WTP. The cheap talk they used is different than previous cheap talk scripts because they used a generic script that didn't refer to the product; made it shorter to be more appropriate for a field experiment; and did not use "higher" or "overstate" to avoid bias from a certain side (Silva et al. 2011). Their results indicate that hypothetical bias was present, and their cheap talk script eliminated hypothetical bias. Ladenburg, Bonnichsen, and Dahlgaard (n.d.) also tested the effectiveness of a short cheap talk script in their study and found the script did reduce WTP, but it did not affect it in a significant way.

The first known assessment of a cheap talk script in an online choice experiment setting was studied by Tonsor and Shupp (2011). Comparing hypothetical WTP from respondents who received the cheap talk information and those who did not, Tonsor and Shupp found that cheap talks scripts produce more reliable estimates, such as narrower confidence intervals (2011). They also found that the cheap talk scripts worked better on respondents who were unfamiliar with the attribute being evaluated (Tonsor and Shupp 2011).

Lusk (2003) findings relating to respondents who had no knowledge about golden rice and genetically modified foods, also known as unknowledgeable respondents, were among the same as Tonsor and Shupp (2011). Lusk (2003) used cheap talk prior to a conventional value elicitation technique to determine the WTP for golden rice, however, the cheap talk script did not reduce WTP for experienced/knowledgeable consumers, who were those who knew about golden rice and genetically modified foods. However, the cheap talk script significantly reduced WTP for unknowledgeable consumers. Therefore, Lusk could not conclude that the cheap talk effectively removed hypothetical bias. Champ, Moore, and Bishop (2009) also found knowledgeable respondents in their study to be less sensitive to the cheap talk script.

Grebitus et al. (2015) found that visual attention affects decision making of the average individual. The study focused on refining the understanding of consumer's decision making in choice experiments by examining the relationship between visual attention and choice by using an eye tracking software to study the number and duration of the survey participant's eye fixations. They found that visual attention, or eye fixations, predicts choice more in the three-attribute design for cheddar cheese (price, hormone label, and country of origin) than the five-attribute design for cheddar cheese (price, hormone label, country of origin label, region of origin label, and packaging label). They also concluded from the study from a marketing perspective that the more information on a product the less attention is spent on the product (Grebitus et al. 2015).

Chen et al. (2015) studied a choice experiment using eye tracking technology to explore how visual attention affects choice outcome. They found that those who spent more time looking at the area of interest of the specific product information valued them more. They also found that

the longer the time the respondent spent on visualizing the price attribute, the more sensitive to a price increase (Chen et al. 2015).

Methods and Procedures

Data Collection

An online choice experiment using Qualtics was used to obtain consumer WTP for USDA Choice boneless ribeye steaks consisting of labels related to TCB. Each survey participant was a Tennessee resident over the age of 18, the primary purchaser of beef in their household, and consumed steak. Following random utility theory, it is assumed that all survey participants in each choice set will choose the product that maximizes their utility given their budget (Adamowicz et al., 1998).

All respondents were given a cheap talk script prior to the choice sets; however, the type of cheap talk script the respondent received was randomly assigned to either the Visual Cheap Talk (VCT) Treatment or a Text Cheap Talk Treatment (TCT). In the TCT Treatment, participants saw the following cheap talk script following Tonsor and Schupp (2011):

> "*The experience from previous similar surveys is that people often state a higher willingness to pay than what one is actually willing to pay for the good. For instance, a recent study asked people whether they would purchase a new food product similar to the one you are about to be asked about. This purchase was hypothetical (as it will be for you) in that no one actually had to pay money when they indicated a willingness to purchase. In the study, 80% of people said they would buy the new product, but when a grocery store actually stocked the product, only 43% of people actually bought the new product when they had to pay for it. This difference (43% vs. 80%) is what we refer to as hypothetical bias.*

Accordingly, it is important that you make each of your upcoming selections like you would if you were actually facing these exact choices in a store, i.e., noting that buying a product means that you would have less money available for other purchases."

Meanwhile, participants in the VCT Treatment saw the cheap talk script shown in Figure 1. There were a total of 408 participants; 204 respondents participated in the VCT Treatment and 204 respondents participated in the TCT Treatment.

Table 1 shows the attribute and attribute levels for the USDA Choice boneless ribeye steak choice set. Price levels ranged from $5.99/lb to $11.99/lb. The price levels were chosen based on the present USDA National Retail Report for Beef (2016) Southeast Region average prices for boneless ribeye steaks at the time the survey was launched. Other attributes included Tennessee Certified Beef (TCB), Master Quality Raised Beef (MQRB), Certified Angus Beef (CAB), no hormones administered (NH), and grass fed (GF) (Merritt et al. 2018).

Survey wording and content pretesting occurred from April through August 2016 with 20 undergraduate and graduate students at the University of Tennessee. Scarpa, Campbell, and Hutchinson (2007) and Scarpa et al. (2013) sequential-stage approach was followed to develop the choice set design. Thus, an Ngene orthogonal design with interaction terms (ChoiceMetrics 2016) was first developed assuming zero for the estimated coefficients priors to program the design (ChoiceMetrics 2016). In the beginning of September 2016, a soft launch of the survey using 80 Tennessee consumers took place through a Qualtrics panel. Survey participants answered the choice sets that were developed in the original design with interaction terms with no assumed priors. The second soft launch's data was used to estimate a random parameters logit (RPL) model with interaction terms. The estimated coefficients from the RPL model then were included in the Ngene efficient design with interaction terms as prior information (ChoiceMetrics

2016). The design chosen was the most efficient given the number of choice sets and blocks based on acquiring the minimized D-error (ChoiceMetrics 2016). The survey was launched in September 2016 and a Qualtrics panel collected on 816 Tennessee consumers.

The survey contained two blocks and twelve choice sets within each block. To avoid fatigue effects, only twelve choice set questions were seen by each participant (Savage and Waldman 2008). The choice sets were also randomized to avoid ordering fatigue (Loureiro and Umberger 2007). The choice set the participant was assigned with allowed them to choose between two different attributes or a third option of choosing neither of the products. Figure 2 shows how the choice set was presented to participants.

Model Estimation

Random utility models are used to understand the factors that impact consumer choices. They also allow the utility a consumer receives from either choosing an item or not choosing an item to be calculated (McFadden 1974). The random utility theory was used in this study to determine Tennessee consumer's preferences for TCB, CAB, MQRB, GF, and NH beef. A linear random utility framework was applied to determine the utility each survey participant received from each beef alternative *j*, within each cheap talk script treatment, *c*. Survey participants *n* (1,….,*n*) faced one of two *c* (visual treatment or text treatment) for USDA Choice boneless ribeye steaks. Following Train (2009), the utility maximizing equation for each individual *n* for each beef attribute *j* in each cheap talk script treatment *c* can be represented by:

(1) $U_{njc} = \beta_n X_{njc} + \varepsilon_{njc}$

where X_{njc} are the observed attribute levels that relate to alternative *j* and decision maker *n* for each cheap talk script treatment *c*, β_n is a vector of coefficients of these variables for individual *n*

which represents the consumer's tastes, and ε_{njc} is a random error term that is independent and identically distributed (iid) extreme value (Train 2009).

To estimate the model, the random parameters logit model (RPL), also known as a mixed logit model, was used to calculate the parameter estimates for the non-interaction and interaction terms. The RPL model was used due to the fact it "allows for correlation in unobserved factors over time, random taste variation, and unrestricted substitution patterns" (Lewis et al. 2016; Revelt and Train 1998; Train 2009). It also allows for taste heterogeneity in preferences across consumers by "specifying the attribute coefficients as random, which reflects heterogeneity of individual consumer's preferences" (Merritt et al. 2018; Revelt and Train 1998). Due to the likelihoodness that there is unobserved heterogeneity present in Tennessee consumer's preferences for USDA Choice boneless ribeye steak carrying different attribute labels, a random parameter logit model is appropriate for this study.

The following expands equation (1) to include the beef attributes being evaluated in this study:

(2) $U_{njc} = \beta_0 Price_{njc} + \beta_1 TCB_{njc} + \beta_2 CAB_{njc} + \beta_3 MQRB_{njc} + \beta_4 GF_{njc} + \beta_5 NH_{njc} +$

$\beta_6 TCB_{njc} * CAB_{njc} + \beta_7 TCB_{njc} * MQRB_{njc} + \beta_8 TCB_{njc} * GF_{njc} + \beta_9 TCB_{njc} *$

$NH_{njc} + \beta_{10} None_{njc} + \varepsilon_{njc}$

where *Price* represents the price of one beef alternative *j*, *TCB* represents the dummy variable equal to one if the beef alternative *j* was labeled as TCB and zero if it was not, *CAB* represents the dummy variable equal to one if the beef alternative *j* was labeled as CAB and zero otherwise, *GF* represents the dummy variable equal to one if the beef alternative *j* was labeled as GF and zero otherwise, *NH* represents the dummy variable equal to one if the beef alternative *j* was labeled as NH, and zero otherwise, and *MQRB* represents the dummy variable equal to one if the

beef alternative j was labeled as MQRB and zero otherwise. This equation includes the interactions between TCB and each of the other possible attributes. An example of an interaction variable would be $TCB * CAB$ which represents the dummy variable equal to one if the beef alternative j was labeled as both TCB and CAB, and zero if it was not. *None* is the dummy variable that is equal to one if the participant chose the alternative specific constant option and zero otherwise. This equation was also used in the (Merritt et al. 2018) study.

Willingness to Pay

The WTP estimates for non-interaction terms were calculated using the following equation:

(3) $WTP_{non-interaction} = \frac{\beta_k}{\beta_0}$

where β_k is the specific attribute such as TCB or MQRB, and β_0 is the price coefficient. The variance equation for the non-interaction WTP was obtained through Daly, Hess, and De Jong (2012). The non-interaction variance will be calculated using the following equation:

(4) $\sigma^2_{non-interactions} = \left(\frac{\beta_1}{\beta_0}\right)^2 \left(\frac{\omega_{11}}{\beta_1^2} + \frac{\omega_{00}}{\beta_0^2} - 2\frac{\omega_{10}}{\beta_1\beta_0}\right)$

where β_1 is the parameter of the attribute, β_0 is the respective parameter's price, ω_{11} is the variance of the parameter estimate, ω_{00} is the variance of the price, and ω_{10} is the covariance of the price and the specific attribute coefficient. The square root to equation (2) is the standard error of the non-interaction WTP, and will be used to determine the WTP estimate's statistical significance using the t-test ratio. The 95% confidence interval will be calculated by adding and subtracting the standard error multiplied by the 95% critical value of 1.96 from the WTP estimates.

The WTP estimates for the interaction terms (i.e. TCB and CAB) will be calculated using the following equation:

(5) $WTP_{interaction} = (\beta_1 + \beta_2 + \beta_d / -\beta_0)$

where β_1 and β_2 are the coefficients of attributes one and two respectively, β_d is the coefficient of the interaction term of attributes one and two, and β_0 is the coefficient of the price. The interaction variance equation that will be used was attained from Syrengelas et al (2017). The variance will be calculated using the following equation:

(6) $\left(\frac{1}{2}\right)^2 * \left(\omega_{11} + \omega_{22} + \omega_{dd} + 2 * (\omega_{21} + \omega_{d1} + \omega_{d2})\right) + \left(-\frac{1}{\beta_0}\right) * \left(\frac{\beta_1 + \beta_2 + \beta_{d)}}{-\beta_0}\right) *$

$\left(2 * (\omega_{01} + \omega_{02} + \omega_{0d})\right) + \left(\frac{\beta_1 + \beta_2 + \beta_d}{-\beta^2}\right)^2 * \omega_{00}$

where β_0 is the coefficient of the price, ω_{11} is the variance of attribute one, ω_{22} is the variance of attribute two, ω_{dd} is the variance of the interaction coefficient of attributes one and two, ω_{d1} is the covariance of the interaction term and attribute one, ω_{d2} is the covariance of the interaction term and attribute two, β_1 and β_2 are the coefficients of attribute one and two respectively, β_d is the coefficient of the interaction term of attribute one and two, ω_{01} is the covariance of price and attribute one, ω_{02} is the covariance of price and attribute two, ω_{0d} is the covariance of the price and the interaction coefficient, and ω_{00} is the variance of the price. The square root of equation (4) is the standard error of the interaction WTP, and will be used to determine the WTP estimate's statistical significance using the t-test ratio. The 95% confidence interval will be calculated by adding and subtracting the standard error multiplied by the 95% critical value of 1.96 from the WTP estimates.

Estimating Market Share

The market share for each attribute is examined following Tonsor and Shupp (2011) and Merritt et al. (2018). For each of the treatments and attributes, the Krinsky and Robb (1986) method is used to simulate 1,000 WTP estimates. The WTP distribution percentiles are then presented which provide an estimate of the percentage of the population that would pay a definite value for each of the attributes across the WTP distribution range. The difference in WTP distributions between the visual cheap talk script and the text talk script for each attribute is then tested using the Poe, Giraud and Loomis (2005) complete combinatorial test. The same is also done for when we divide the respondents into their preferred learning styles: text treatment that received the visual cheap talk script (TV), text treatment that received the text cheap talk script (TT), visual treatment that received the visual cheap talk script (VV), and visual treatment that received a text cheap talk script (VT).

Results and Discussion

Survey Participant Characteristics

Consumer demographics for participants in the visual and text cheap talk script are presented in Table 2. Demographics are also further evaluated based on the respondents learning preference. T-test were used to determine if the demographics for the visual and text cheap talk script were statistically different as well as if the VV vs VT and TT vs TV treatments were statistically different from each other. The only statistically different mean observed at the 1% level how many respondents were from West TN which was 17.24% for the visual cheap talk script and 29.90% for the text cheap talk script.

Random Parameters Logit Model Results

The RPL model results for the visual cheap talk script are shown in Table 3. Results demonstrate that an increase in price has a negative impact on consumer utility for the visual cheap talk script treatment which is expected. Consumers also elicited a negative utility for the "neither" option which is also expected because consumers will gain a higher utility from choosing any given alternative than they would from not choosing to buy a product.

Positive utility was exhibited by consumers to steak products labeled with all individual attributes: TCB, CAB, MQRB, GF, and NH. Three of the four interaction attributes showed positive significance as well: TCB & CAB, TCB & MQRB, and TCB & NH.

The RPL model results for the text cheap talk script are shown in Table 3. It was found that an increase in price has a negative impact on consumer utility for the text cheap talk script treatment which is expected. Consumers displayed a negative utility for the "neither" option which is also expected because consumers will gain a higher utility from choosing any given alternative than they would from not choosing to buy a product.

All non-interaction variables show positive utility for each individually labeled attribute: TCB, CAB, MQRB, GF, and NH. Of the interaction variables, only two of the four showed positive significance: TCB & CAB and TCB & MQRB.

Willingness to Pay Results

Willingness to pay estimates for the visual cheap talk script are shown in Table 4. Consumers indicated positive WTP estimates for each of the individual attributes and the interactions with TCB. The highest WTP for an individual attribute was the TCB attribute followed by NH. Consumers were willing to pay $3.01 more per pound for steak labeled TCB than unlabeled steak, and $2.65 more per pound for steak labeled NH than unlabeled steak. The

attribute with the lowest WTP estimate was MQRB with a $1.37 per pound premium over unlabeled steak. However, consumers were still willing to pay a premium.

Interactions between TCB and each of the other attributes reaped positive WTP estimates. Steak labeled TCB & NH had the highest WTP estimates followed closely by steak labeled TCB & GF. Consumers were willing to pay $4.65 more per pound for steak labeled TCB & NH than unlabeled steak, and $4.47 more per pound for steak labeled TCB & GF than unlabeled steak. The interaction attribute with the lowest WTP estimate was TCB & MQRB at $2.94 per pound premium over unlabeled steak. Still, consumers were still willing to pay a positive premium for TCB & MQRB.

Referencing Table 4 and Figure 3, the visual cheap talk script WTP estimates are higher than the text cheap talk script for each attribute except MQRB. Therefore, we reject our null hypothesis saying the visual cheap talk script will reduce or eliminate hypothetical bias, because our findings show the visual cheap talk script resulted in higher WTP estimates.

Willingness to pay estimates for the text cheap talk treatment can be seen in Table 4. Consumers showed positive WTP estimates for each individual attribute, but only two of the four interactions with TCB and each of the attributes were positive. The highest individual attribute WTP estimate was the TCB attribute followed by the NH attribute. Consumers were willing to pay $2.42 more per pound for steak labeled TCB than unlabeled steak, and $2.35 more per pound for steak labeled NH than unlabeled steak. The individual attribute with the lowest WTP estimate was GF at $0.95 per pound premium over unlabeled beef. However, the WTP estimate for grass-fed beef is still positive.

The two interaction variables with TCB that were positive were TCB & CAB and TCB & MQRB. Consumers were willing to pay $2.62 more per pound for steak labeled TCB & MQRB

than unlabeled steak, the highest estimate of the two. Steak labeled TCB & CAB yielded a $2.51 per pound premium over unlabeled steak.

Table 4 also shows the text cheap talk script's WTP estimates compared to the visual cheap talk script's estimates. As stated earlier, the null hypothesis was rejected due to the visual cheap talk script having higher WTP estimates than the text cheap talk script.

Market Share

To test the significance between the visual cheap talk script treatment and the text cheap talk script treatment, the Wald Chi^2 test was used. Each attributes Wald Chi^2 estimates are shown in Table 4. The only attributes that were significant were GF and TCB & CAB. Both were significant at the 1% level of significance. While the visual cheap talk script's WTP was always higher than the text cheap talk script's WTP, the Poe et al. (2005) complete combinatorial method did not find the visual cheap talk script and text cheap talk script distributions to be statistically different.

Visual and Verbal Learners

A Likert Scale question later in the survey asked if the participant preferred to learn verbally. The scale ranged from one (strongly disagree) to seven (strongly agree). If respondents indicated greater than four on the scale they were considered verbal (or text) learners, and four and below were considered visual learners. Responses were pooled into two treatments; text and visual. The text treatment contained respondents who prefer to learn verbally while the visual treatment contained respondents who prefer to learn visually. Within each treatment, the responses were further divided into whether they received a visual cheap talk script or a text cheap talk script. Thus, four treatments will occur TV, TT, VV, and VT.

TV Treatment

The RPL model results for the TV treatment are show in Table 5. Results show that an increase in price has a negative impact on consumer's utility for the TV treatment which is expected. Negative utility for the "neither" option is shown by consumers which is also expected because consumers will gain a higher utility from choosing any given alternative than they would from not choosing to buy a product.

All non-interaction attributes exhibited positive utility at the 1% level of significance. All interaction attributes exhibited significant utility, however, TCB & MQRB was the only one at the 1% level of significance. TCB & CAB and TCB & GF were both significant at the 5% level while TCB & NH was significant at the 10% level.

Willingness to pay estimates for the TV treatment can be seen in Table 6. All non-interaction attributes' WTP estimates were significant at the 1% level. TCB had the highest WTP estimate followed by NH. Consumers were willing to pay $3.53 more per pound for steal labeled TCB versus unlabeled beef and $2.61 more per pound for steak labeled NH than unlabeled steak. All interaction attribute's WTP estimates were also significant at the 1% level. TCB & NH yielded the highest WTP followed by TCB & GF. Consumers were willing to pay $4.55 more per pound for steak labeled TCB & NH than unlabeled steak and $4.40 more per pound for steak labeled TCB & GF versus steak that was unlabeled.

Referring to Figure 4, the TV treatment's WTP estimates are higher than the TT treatment's estimates for each attribute except two, TCB & GF and TCB & NH. Therefore, the null hypothesis is accepted because the TV treatment's estimates are greater than the TT treatment's estimates. It is also derived that the visual cheap talk script did not eliminate or reduce hypothetical bias.

TT Treatment

The RPL model results for TT treatment are shown in Table 5. Results show that an increase in price has a negative impact on consumer's utility for the TV treatment which is expected. Negative utility for the "neither" option is shown by consumers which is also expected because consumers will gain a higher utility from choosing any given alternative than they would from not choosing to buy a product.

All non-interaction attributes are positive, yet TCB, MQRB, and NH were the only attributes exhibiting significant utility at the 1% level. Interaction variables were not found to be significant.

Willingness to pay estimates for the TT treatment are presented in Table 6. All non-interaction attributes' WTP estimates are significant at the 1% level. NH yields the highest WTP estimate succeeded by TCB. Consumers are willing to pay $2.55 more per pound for steak labeled NH versus steak that is unlabeled and $2.04 more per pound for steak labeled TCB. All interaction attributes' WTP estimates are significant at the 1% level. The highest estimate is TCB & GF while TCB & NH closely followed. According to the results, consumers are willing to pay $4.71 more per pound for steak labeled TCB & GF over unlabeled steak and $4.69 more per pound for steak labeled TCB & NH versus unlabeled steak.

According to Figure 4, the WTP estimates for the TT treatment are lower for each attribute except two, thus, the null hypothesis is accepted as stated in the previous treatment.

VV Treatment

The RPL model results for the VV treatment are shown in Table 5. Results show that an increase in price has a negative impact on consumers' utility for the TV treatment which is expected. Negative utility for the "neither" option is shown by consumers which is also expected

because consumers will gain a higher utility from choosing any given alternative than they would from not choosing to buy a product.

All non-interaction attributes are positive at the 1% level. For the interaction attributes, TCB & MQRB had significant utility at the 5% level.

Willingness to pay estimates for the VV treatment are displayed in Table 6. All non-interaction attribute's WTP estimates are significant at the 1% level. NH generated the highest estimate over TCB by one cent. Consumer are willing to pay $2.44 more per pound for steak labeled NH over unlabeled steak and $2.43 more per pound for steak labeled TCB versus unlabeled steak. All interaction attribute's WTP estimates are significant at the 1% level as well. The two with the highest estimates are TCB & GF followed by TCB & NH. According to the results, consumers are willing to pay $4.27 more per pound for steak labeled TCB & GF than unlabeled steak and $3.59 for steak labeled TCB & NH versus unlabeled steak.

Alluding to Figure 4, the VV treatment's WTP estimates are higher than the VT treatment's estimates. Therefore we reject the null hypothesis as a result of the VV treatment estimates being higher than the VT treatment's estimates for five attributes (CAB, GF, NH, TCB & CAB, and TCB & GF). Further, the visual cheap talk script did not reduce or eliminate hypothetical bias.

VT Treatment

The results to the RPL model for the VT treatment are shown in Table 5. Results show that an increase in price has a negative impact on consumers' utility for the TV treatment which is expected. Negative utility for the "neither" option is shown by consumers which is also expected because consumers will gain a higher utility from choosing any given alternative than they would from not choosing to buy a product.

All non-interaction attributes possess positive utility at the 1% level except for GF which is significant at the 10% level. Two of the four interaction attributes are significant, TCB & CAB at the 5% level and TCB & MQRB at the 1% level.

Willingness to pay estimates are exhibited in Table 6. All non-interaction attributes' WTP estimates are significant at the 1% level. The attribute with the highest estimate is TCB followed next by NH. Based on the results, consumers are willing to pay $2.68 more per pound for steak labeled TCB versus steak that is not labeled and $2.27 more per pound for steak labeled NH versus unlabeled steak. All of the interaction attributes were significant at the 1% level also. The attributes with the highest estimates are TCB & NH and TCB & GF. Consumers are willing to pay $4.37 more per pound for steak labeled TCB & NH over unlabeled steak and $3.78 more per pound for steak labeled TCB & GF versus unlabeled steak.

As it was mentioned earlier, we reject the null hypothesis due to the VV treatment's estimates being higher than the VT treatment's estimates which can be visibly seen in Figure 4.

Market Share

To test the significance between each treatment, the Wald Chi^2 test was performed and results can be seen in Table 6. For the text treatment, one of the attribute were statistically different between the learning preferences: GF. It was significant at the 5% level. While the respondents who received a visual cheap talk script in this treatment WTP estimates were almost always higher than those who received the text cheap talk script, the Poe et al. (2005) complete combinatorial method did not find the visual cheap talk script and text cheap talk script distributions to be statistically different.

The visual treatment's results can also be seen in Table 6. The only attribute to be statistically different between the learning preferences was TCB & CAB. It was significant at the

1% level. Poe et al. (2005) combinatorial method was also used to test to see if the distributions were statistically different, but there was no statistical difference.

Conclusion

This study was performed to test the significance between a visual cheap talk script and a text cheap talk script in an online choice experiment for TCB. A goal of this study was to determine if consumer choices were affected by a visual attention. This study also examined how different types of learners responded to each cheap talk script.

Results indicate Tennessee consumers in the visual cheap talk treatment exhibit higher WTP estimates than consumers in the text cheap talk treatment despite the fact consumers in both treatments (visual and text cheap talk script) are willing to pay more for a USDA Choice boneless ribeye that is labeled with an attribute in this study versus being unlabeled, meaning the visual cheap talk script did not reduce or eliminate hypothetical bias. Consumers in the visual cheap talk treatment were willing to pay $3.01 more per pound for ribeye steak labeled TCB versus unlabeled steak, and $2.65 more per pound for steak labeled NH than unlabeled steak. Further, consumers in the same treatment were willing to pay $4.65 more per pound for ribeye's labeled TCB & NH than unlabeled, and $4.47 more per pound for steak labeled TCB & GF versus unlabeled steak. Consumers in the text cheap talk treatment were willing to pay $2.42 more per pound for steak labeled TCB than unlabeled steak, and $2.35 more per pound for ribeye's labeled NH than unlabeled steak. Consumers in this treatment were also willing to pay $4.37 more per pound for steak labeled TCB & NH versus steak that was unlabeled, however, this attribute was not statistically significant, but it was the highest WTP estimate for an interaction attribute.

Results also imply that respondents who prefer to learn verbally and received the visual cheap talk script had higher WTP estimates than those in the same treatment who received the text

cheap talk script. Therefore, it can be concluded that the visual cheap talk did not reduce hypothetical bias in those who preferred to learn verbally, which was expected. Respondents who prefer to learn visually and received the visual cheap talk script had higher WTP estimates than those in the same treatment who received the text cheap talk script, which was not expected. Consequently, it is further concluded that the visual cheap talk script did not reduce or eliminate hypothetical bias.

This research contributes valued information in further evaluating cheap talk scripts, notably a new method to cheap talks scripts. The study revealed consumers decision making is affected by visual attention due to every interaction and non-interaction attribute for the visual cheap talk script, except MQRB, being higher than the interaction and non-interaction attributes for the text cheap talk script. Future research could use a different visual cheap talk script than the one created for this study to see if it would reduce or eliminate hypothetical bias. More research should also be done to understand how different types of 'learners' respond to WTP elicitation methods. One limitation present in our study is the presentation of the choice sets. Our study used pictures of ribeye steaks. The presentation style to our choice set could have altered the respondent's choices, therefore, other studies should also look at different presentation styles.

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Appendix A Tables and Figures

Table 1. Attribute description and levels for USDA Choice boneless ribeye beef steak

Attribute	Attribute Levels
Price	$5.99/lb
	$7.99/lb
	$9.99/lb
	$11.99/lb
Tennessee Certified Beef	Tennessee Certified Beef label
	None
	Master Quality Raised Beef
Master Quality Raised Beef	label
	None
Other attributes likely to appear on beef from Tennessee	Certified Angus Beef label
	Grass-fed label
	No hormones administered label
	None

Note: Price levels were based on the average weighted price for each beef product obtained from
the National Retail Report for beef from the USDA at the time the survey was launched in

Table 2. Sample demographics for the visual and text cheap talk script treatment arranged by respondents learning preference

Variable	Visual Treatment			Text Treatment			
	Full Sample n=203	Text Learner n=118	Visual Learner n=85	Full Sample n =204	Text Learner n=129	Visual Learner n=75	U.S. Population
Gender *(% Female)*	70.94%	75.42%	64.29%	78.92%	78.74%	78.67%	50.8%[1]
Age	41.7	41.7	41.7	42	43.3	40.2	37.9
White *(% White)*	88.18%	86.44%	89.41%	83.33%	80.62%	85.33%	76.6%[1]
Education *(Bachelor's degree or higher)*	32.02%	30.51%	34.52%	26.96%	24.41%	32.00%	30.9%[1]
Household Income	$ 44,000.00	$ 43,000.00	$ 44,000.00	$ 43,000.00	$ 42,000.00	$ 44,000.00	$ 57,652.00
Household Size	2.95	2.86	3.07	2.97	3.07	2.82	2.63%[1]
East TN	41.87%	43.22%	39.49%	33.33%	35.43%	30.67%	36%[2]
West TN	17.24%[a]	16.10%	19.05%	29.90%	27.56%	33.33%	23.5%[2]
Middle TN	40.89%	40.68%	41.67%	36.76%	37.01%	36.00%	40.4%[2]

[1]U.S. Census Bureau, 2018; 2 City-Data, 2017;[a]Denotes statistically significant different means between Visual Treatment full sample and the

Text Treatment full sample at the 1% level using a t- test

Table 3. Visual and text cheap talk script parameter estimates

Attributes	Text Cheap Talk Script	Visual Cheap Talk Script
	Parameter Estimates	
Random Parameters in Utility Functions		
TCB	1.22938***	1.72331***
CAB	.60415***	1.04799***
Grass-Fed	.48292**	1.11648***
MQRB	.70683***	.78195***
No Hormones Administered	1.19278***	1.51911***
TCB & CAB	-.55596**	-.73545**
TCB & Grass-Fed	0.28592	-0.2834
TCB & MQRB	-.60344***	-.82294***
TCB & No Hormones Administered	-0.19897	-.57889*
No Choice Option	-7.07391***	-7.03384***
Nonrandom Parameters in Utility Functions		
Price	-.50834***	-.57226***
Standard Deviation of RPs		
TCB	.95086***	1.05622***
CAB	.49787**	.58816***
Grass-Fed	.78739***	1.18556***
MQRB	0.18124	0.0765
No Hormones Administered	1.93001***	2.41151***
TCB & CAB	0.30239	0.19619
TCB & Grass-Fed	0.12778	.43563*
TCB & MQRB	0.26311	0.37413
TCB & No Hormones Administered	0.64945	1.08937
No Choice Option	3.41977***	3.47270***
Observations	2,448	2,488
Log likelihood	-1715.351	-1688.60857
McFadden Pseudo R-squared	0.3621815	0.3721251
AIC/N	1.419	1.397
# of parameters	11	11

***, **, * indicate significance at the 1%, 5%, and 10% level respectively

Table 4. Willingness to pay estimates ($/lb) and confidence intervals for USDA Choice ribeye steaks by treatment

Attributes	Text Cheap Talk Script		Visual Cheap Talk Script		WTP Treatment Difference	
	WTP Estimates					
TCB	$ 2.42	***	$ 3.01	***	$	0.59
	(1.65, 3.19)		(1.82, 4.20)			(0.6768)
CAB	$ 1.19	***	$ 1.83	***	$	0.64
	(0.42, 1.96)		(1.12, 2.54)			(1.4427)
Grass-Fed	$ 0.95	**	$ 1.95	***	$	1.00
	(0.17, 1.73)		(1.18, 2.73)			(3.1881) ***
MQRB	$ 1.39	***	$ 1.37	***	$	- 0.02
	(0.90, 1.88)		(1.02, 1.71)			(0.0062)
No Hormones Administered	$ 2.35	***	$ 2.65	***	$	0.31
	(1.54, 3.15)		(1.53, 3.78)			(0.1915)
TCB & CAB	$ 2.51	***	$ 3.56	***	$	1.04
	(1.78, 3.25)		(2.90, 4.22)			(4.3128) ***
TCB & Grass-Fed	$ 3.93	***	$ 4.47	***	$	0.54
	(3.03, 4.83)		(3.67, 4.47)			(0.7632)
TCB & MQRB	$ 2.62	***	$ 2.94	***	$	0.32
	(1.77, 3.47)		(2.18, 2.94)			(0.3010)
TCB & No Hormones Administered	$ 4.37	***	$ 4.65	***	$	0.28
	(3.21, 5.54)		(3.63, 4.65)			(0.1258)

***, **, * indicate significance at the 1%, 5%, and 10% level respectively. 95% Confidence Intervals calculated by the delta method present in parenthesis below WTP estimates. WTP treatment difference $Wald\ Chi^2$ test statistics present in parenthesis below WTP difference.

Table 5. Text and visual treatment parameter estimates by cheap talk script

Attributes	Text Treatment		Visual Treatment	
	Text Cheap Talk Script	Visual Cheap Talk Script	Text Cheap Talk Script	Visual Cheap Talk Script
	Parameter Estimates			
Random Parameters in Utility Functions				
TCB	0.82842***	2.15310***	1.60705 ***	1.43347***
CAB	0.52645*	1.40886***	0.69442***	0.72195***
Grass-Fed	0.64322**	1.44701***	0.4559*	0.95487***
MQRB	0.50956***	0.88736***	0.94475***	0.73455***
No Hormones Administered	1.03964***	1.59352***	1.36492***	1.43751***
TCB & CAB	-0.12495	-1.08496**	-0.89599**	-0.5492
TCB & Grass-Fed	0.44404	-0.91385**	0.20786	0.13172
TCB & MQRB	-0.39299	-0.97756***	-0.81137***	-.79300**
TCB & No Hormones Administered	0.4145	-0.96901*	-0.34607	-.75011
No Choice Option	-6.24153***	-6.85658***	-8.16653***	-7.34338***
Nonrandom Parameters in Utility Functions				
Price	-0.40703***	-0.61041***	-0.60040***	-0.56613***
Standard Deviation of RPs				
TCB	0.45906**	1.13431***	1.37639***	0.59035**
CAB	0.69273**	0.75646***	0.22258	0.09663
Grass-Fed	0.5256	1.23282***	0.61718	1.54812***
MQRB	0.14095	0.13945	0.441	0.0145
No Hormones Administered	1.28383***	2.24341***	2.32756***	2.27618***
TCB & CAB	0.76872**	0.72489*	0.52201	1.29735***
TCB & Grass-Fed	0.06374	0.24847	0.3364	0.29294
TCB & MQRB	0.16699	0.83378*	0.21872	1.28207***
TCB & No Hormones Administered	0.60036	0.38738	0.9816	1.8736
No Choice Option	2.98968***	3.20317***	4.08056***	3.54994***
Observations	900	996	1548	1368
Log likelihood	-672.56429	-678.8354	-1023.46037	-938.89988
McFadden Pseudo R-squared	0.319784	0.3796159	0.3981952	0.3752752
AIC/N	1.541	1.405	1.349	1.403
# of parameters	11	11	11	11

***, **, * indicate significance at the 1%, 5%, and 10% level respectively

Table 6. Willingness to pay estimates for text and visual treatment by cheap talk script

	Visual Treatment				Text Treatment					
	Visual Learner		Text Learner		WTP Treatment Difference	Visual Learner		Text Learner		WTP Treatment Difference
Attributes	WTP Estimates					WTP Estimates				
TCB	$ 3.53	***	$ 2.43	***	$ 1.10	$ 2.04	***	$ 2.68	***	$ (0.64)
	(1.01, 6.04)		(1.04, 3.82)		0.562554	(0.87 , 3.20)		(1.14, 4.21)		0.426558
CAB	$ 2.31	***	$ 1.22	***	$ 1.09	$ 1.29	***	$ 1.16	***	$ 0.13
	(0.76, 3.86)		(0.54, 1.91)		1.571896	(0.51, 2.08)		(0.56, 1.66)		0.073591
Grass-Fed	$ 2.37	***	$ 1.62	***	$ 0.75	$ 1.58	***	$ 0.76	***	$ 0.82
	(0.61, 4.13)		(0.59, 2.64)		0.523365	(0.63, 2.53)		(0.36, 0.76)		2.446193**
MQRB	$ 1.45	***	$ 1.24	***	$ 0.21	$ 1.25	***	$ 1.57	***	$ (0.32)
	(0.82, 2.09)		(0.79, 1.69)		0.277844	(0.79, 1.72)		(1.00, 1.57)		0.735956
No Hormones Administered	$ 2.61	***	$ 2.44	***	$ 0.17	$ 2.55	***	$ 2.27	***	$ 0.28
	(0.65, 4.57)		(0.81, 4.06)		0.018248	(1.08, 4.03)		(0.79, 2.27)		0.069304
TCB & CAB	$ 4.06	***	$ 2.73	***	$ 1.33	$ 3.02	***	$ 2.34	***	$ 0.68
	(2.98, 5.14)		(1.80, 3.66)		3.329775***	(1.64, 4.41)		(1.49, 3.19)		0.675507
TCB & Grass-Fed	$ 4.40	***	$ 4.27	***	$ 0.13	$ 4.71	***	$ 3.78	***	$ 0.93
	(3.06, 5.74)		(2.85, 5.69)		0.017556	(3.11, 6.31)		(2.62, 4.94)		0.838703
TCB & MQRB	$ 3.38	***	$ 2.33	***	$ 1.05	$ 2.32	***	$ 2.90	***	$ (0.58)
	(2.08, 4.68)		(1.07, 3.59)		1.288434	(0.77, 3.87)		(1.85, 3.95)		0.365627
TCB & No Hormones Administered	$ 4.55	***	$ 3.59	***	$ 0.96	$ 4.69	***	$ 4.37	***	$ 0.32
	(2.91, 6.19)		(1.88, 5.31)		0.627332	(2.72, 6.67)		(2.94, 5.80)		0.065225

***, **, * indicate significance at the 1%, 5%, and 10% level respectively. 95% Confidence Intervals calculated by the delta method present in parenthesis below WTP estimates. WTP treatment difference Wald Chi^2 test statistics present in parenthesis below WTP difference.

While the choices you are about to make are purely hypothetical, please make your choices as though you are at a store and you actually have to pay money for these products. Remember, buying a product means that you would have less money available for other purchases.

Figure 1. Visual cheap talk script image

Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

○
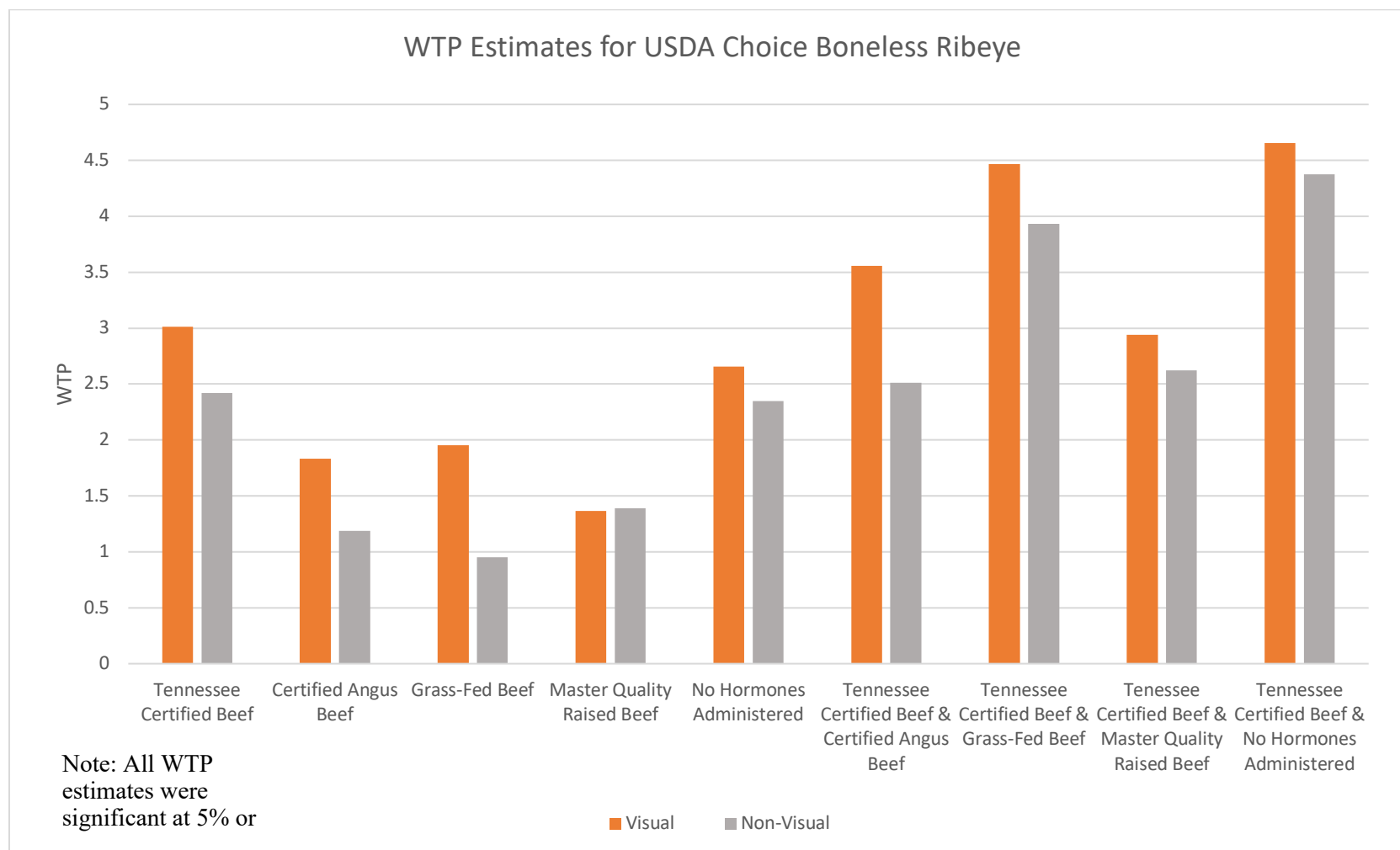- $9.99 per pound
- Tennessee Certified Beef
- Certified Angus Beef
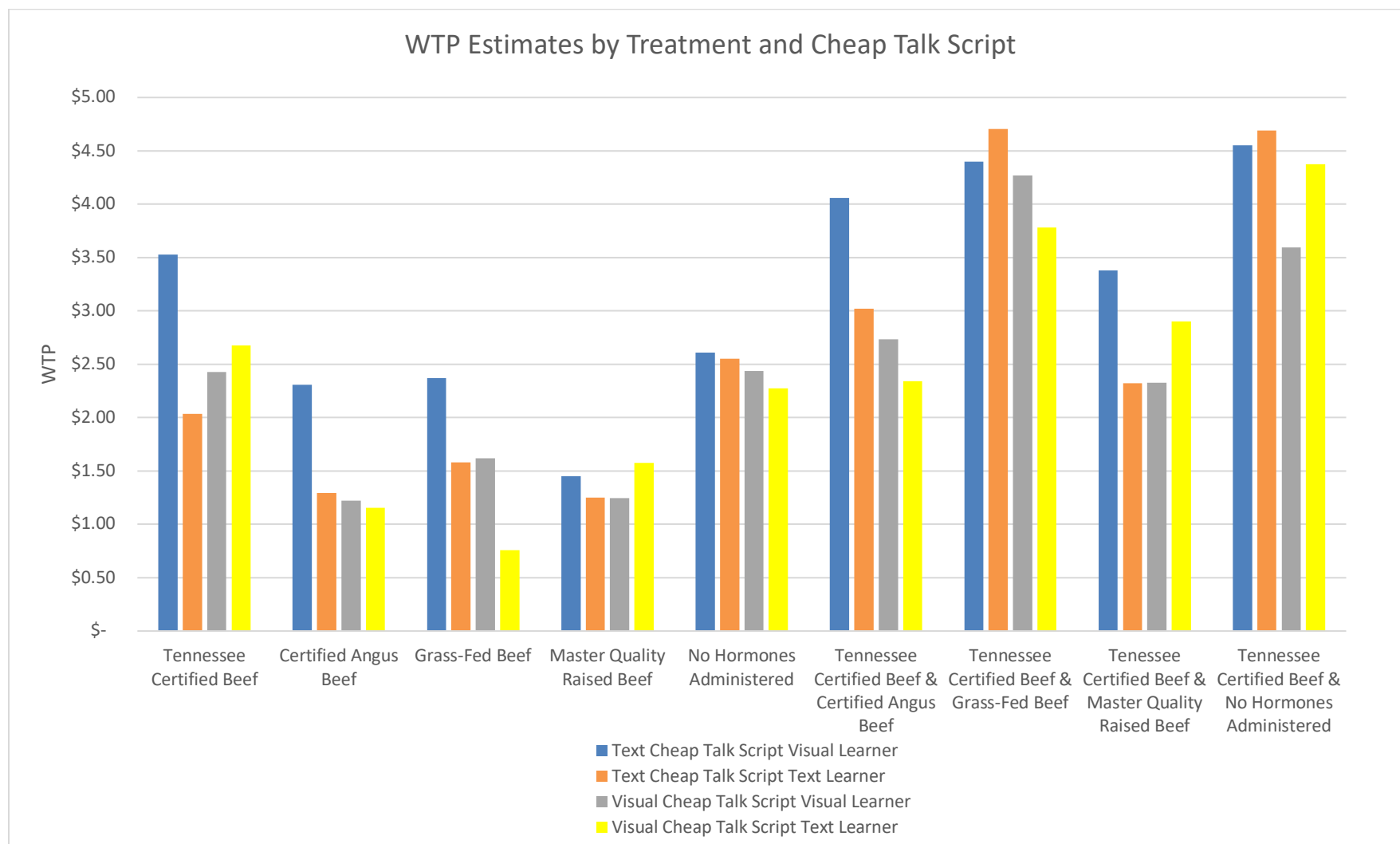

○
- $5.99 per pound
- Certified Angus Beef

○ Neither

Figure 2. Example of choice set

Figure 3. Willingness to pay estimates for USDA Choice boneless ribeye for visual cheap talk and text cheap talk treatment

Figure 4. Willingness to pay estimates for verbal and visual treatments by cheap talk received

Appendix B Consumer Survey

Participant Info (all participants saw this information before beginning the survey)

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This study is being conducted by researchers from the University of Tennessee. The purpose is to determine consumer willingness to pay for Tennessee (TN) produced and branded beef products. It is hoped that by studying consumer willingness to pay for TN beef, knowledge can be gained on the market desire for TN beef. Results from the study could be used to help gain information on developing a market channel for TN produced, finished, and harvested beef as well as determining whether this venture could be profitable for TN cattle producers.

You are being asked, as a consumer of beef, to participate in a research project through taking an online survey. We expect the online survey might take about 20 minutes of your time. You can be assured that your answers are confidential and will only be released as summaries. Your name will not be collected as part of your survey response and thus can never be associated with the data. Your responses will not be individually identified or publicized. Your answers are strictly voluntary. You are free to withdraw from the survey at any time or leave any questions unanswered. You must be 18 or older to participate.

The submitted data will be used for statistical purposes only and statistical results will be reported in research papers, technical reports and academic journals. In the future, the statistical data may be used for subsequent research in the area of consumer preferences, as a basis for comparison to future results, and as an example in teaching. There are no anticipated risks to participating in this study. Benefits include a broader understanding of consumer preferences of beef that can contribute to the formation of public policy.

If you have questions at any time about the study or the procedures, (or you experience adverse effects as a result of participating in this study,) you may contact the researcher, Dr. Karen Lewis, at klewis39@utk.edu, and (865) 974-7465. If you have questions about your rights as a participant, you may contact the University of Tennessee IRB Compliance Officer at utkirb@utk.edu or (865) 974-7697. Completing the survey and clicking the next arrow to continue will be considered your consent to participate.

Icebreaker Questions

Q1> What is your age? _____
   If less than 18, skip to end of survey.

Q2> Do you currently live in Tennessee?
   o   Yes
   o   No
   If participant chooses "No", skip to end of survey.

Q3> What beef products do you purchase (select all that apply)?
   o   Steak
   o   Ground Beef
   o   Neither
   If participant chooses "Steak", evenly sort into one of the three steak treatments, then evenly distribute between Steak Block 1 and Steak Block 2.
   If participant chooses "Ground Beef", evenly sort into one of the two ground beef treatments, then evenly distribute between Ground Beef Block 1 and Ground Beef Block 2.
   If participant chooses "Neither", skip to end of survey.

Q4> What is your gender?
   o   Male
   o   Female

Q5> Are you responsible for food shopping in your household?
   o   Always
   o   Sometimes
   o   Never
   If participant chooses "Never", skip to end of survey.

Cheap Talk Only Steak (Treatment 1)

Now, please take time to carefully read the following instructions before proceeding.

Imagine you are in your usual grocery store and considering the purchase of boneless ribeye beef steaks. In the following screens you will see 12 choice scenarios (decision situations). Each decision situation includes a description of different product features. All features of the product in each decision situation are identical except that they vary in their price, and whether it is Tennessee Certified Beef, Master Quality Raised Beef, Certified Angus Beef, grass-fed or no hormones administered. In each decision situation, please indicate the decision you would make based on your own preferences. Specifically, in each choice scenario that will be visible to you on the screen, you are asked which product you would CHOOSE to purchase. Alternatively, you may choose NOT TO PURCHASE either product. Please carefully examine each option before you make a decision and select the decision that you would make based on your own preferences.

IMPORTANT:

CHOOSE one of the options on each page. Or you may choose NOT TO PURCHASE either product. Assume that the options on each page are the only ones available. Do not compare options on different pages.

You might see a few options that may seem counter-intuitive (e.g., a lower price but a higher quality in your personal opinion). Be assured that this is not an error but part of the design of the survey. Simply choose the option in each choice scenario that you prefer most, based on its characteristics.

The experience from previous similar surveys is that people often state a higher willingness to pay than what one is actually willing to pay for the good. For instance, a recent study asked people whether they would purchase a new food product similar to the one you are about to be asked about. This purchase was hypothetical (as it will be for you) in that no one actually had to pay money when they indicated a willingness to purchase. In the study, 80% of people said they would buy the new product, but when a grocery store actually stocked the product, only 43% of people actually bought the new product when they had to pay for it. This difference (43% vs. 80%) is what we refer to as hypothetical bias.

Accordingly, it is important that you make each of your upcoming selections like you would if you were actually facing these exact choices in a store, i.e., noting that buying a product means that you would have less money available for other purchases.

Cheap Talk and Labeling Information Steak (Treatment 2)

In the next section you will see information describing five different beef labels.

Tennessee Certified Beef Label Definition:

Tennessee Certified Beef declares that the animal was born, raised and harvested in Tennessee and graded USDA Choice or Prime.

Master Quality Raised Beef Label Definition:

Master Quality Raised Beef ensures that the beef purchased originated from cattle that were raised throughout their entire lifespan by farmers who are certified in the following two programs:

(1) Advanced Master Beef Producer Program

(2) Beef Quality Assurance Program

Each program is now defined below:

Advanced Master Beef Producer Program:

The Advanced Master Beef Producer Program (AMBPP) is an educational program provided by the University of Tennessee designed to help cattle farmers improve cattle health management and cattle farm profitability. This program is open to any cattle farmers in the United States. The AMBPP certification is given to producers who complete the program.

Beef Quality Assurance Program:

Beef Quality Assurance (BQA) is a nationally coordinated, state implemented program that provides systematic information to U.S. beef producers and beef consumers of how common husbandry techniques can be coupled with accepted scientific knowledge to raise cattle under optimum management and environmental conditions. BQA guidelines are designed to make certain all beef consumers can take pride in what they purchase – and can trust and have confidence in the entire beef industry.

Certified Angus Beef Label Definition:

USDA graders inspect black-hided cattle (typical of the Angus breed) and give it a grade. All beef considered for the brand must grade in the top two thirds of Choice or Prime.

Grass-Fed Label Definition:

This label indicates that the animal was fed only grass and forage.

No Hormones Administered Definition:

The term "no hormones administered" may be approved for use on the label of beef products if sufficient documentation is provided to the United States Department of Agriculture by the beef producer showing no hormones have been used in raising the animals.

Now, please take time to carefully read the following instructions before proceeding.

Imagine you are in your usual grocery store and considering the purchase of boneless ribeye beef steaks. In the following screens you will see 12 choice scenarios (decision situations). Each decision situation includes a description of different product features. All features of the product in each decision situation are identical except that they vary in their price, and whether it is Tennessee Certified Beef, Master Quality Raised Beef, Certified Angus Beef, grass-fed or no hormones administered. In each decision situation, please indicate the decision you would make based on your own preferences. Specifically, in each choice scenario that will be visible to you on the screen, you are asked which product you would CHOOSE to purchase. Alternatively, you may choose NOT TO PURCHASE either product. Please carefully examine each option before you make a decision and select the decision that you would make based on your own preferences.

IMPORTANT:

CHOOSE one of the options on each page. Or you may choose NOT TO PURCHASE either product. Assume that the options on each page are the only ones available. Do not compare options on different pages.

You might see a few options that may seem counter-intuitive (e.g., a lower price but a higher quality in your personal opinion). Be assured that this is not an error but part of the design of the survey. Simply choose the option in each choice scenario that you prefer most, based on its characteristics.

The experience from previous similar surveys is that people often state a higher willingness to pay than what one is actually willing to pay for the good. For instance, a recent study asked people whether they would purchase a new food product similar to the one you are about to be asked about. This purchase was hypothetical (as it will be for you) in that no one actually had to pay money when they indicated a willingness to purchase. In the study, 80% of people said they would buy the new product, but when a grocery store actually stocked the product, only 43% of people actually bought the new product when they had to pay for it. This difference (43% vs. 80%) is what we refer to as hypothetical bias.

Accordingly, it is important that you make each of your upcoming selections like you would if you were actually facing these exact choices in a store, i.e., noting that buying a product means that you would have less money available for other purchases.

Visual Cheap Talk Steak (Treatment 3)

Now, please take time to carefully read the following instructions before proceeding.

Imagine you are in your usual grocery store and considering the purchase of boneless ribeye beef steaks. In the following screens you will see 12 choice scenarios (decision situations). Each decision situation includes a description of different product features. All features of the product in each decision situation are identical except that they vary in their price, and whether it is Tennessee Certified Beef, Master Quality Raised Beef, Certified Angus Beef, grass-fed or no hormones administered. In each decision situation, please indicate the decision you would make based on your own preferences. Specifically, in each choice scenario that will be visible to you on the screen, you are asked which product you would CHOOSE to purchase. Alternatively, you may choose NOT TO PURCHASE either product. Please carefully examine each option before you make a decision and select the decision that you would make based on your own preferences.

IMPORTANT:

CHOOSE one of the options on each page. Or you may choose NOT TO PURCHASE either product. Assume that the options on each page are the only ones available. Do not compare options on different pages.

You might see a few options that may seem counter-intuitive (e.g., a lower price but a higher quality in your personal opinion). Be assured that this is not an error but part of the design of the survey. Simply choose the option in each choice scenario that you prefer most, based on its characteristics.

While the choices you are about to make are purely hypothetical, please make your choices as though you are at a store and you actually have to pay money for these products. Remember, buying a product means that you would have less money available for other purchases.

Steak Block 1

Q1> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

✓ $7.99 per pound
✓ Master Quality Raised Beef
✓ Grass-fed

✓ $11.99 per pound
✓ Tennessee Certified Beef
✓ Master Quality Raised Beef

✓ Neither

Q2> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

✓ $9.99 per pound
✓ Tennessee Certified Beef
✓ Certified Angus Beef

✓ $5.99 per pound
✓ Certified Angus Beef

✓ Neither

Q3> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $11.99 per pound
- ✓ No hormones administered

- ✓ $7.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Master Quality Raised Beef

- ✓ Neither

Q4> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $9.99 per pound
- ✓ Tennessee Certified Beef

- ✓ $5.99 per pound
- ✓ Master Quality Raised Beef
- ✓ Certified Angus Beef

- ✓ Neither

Q5> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $9.99 per pound
- ✓ Master Quality Raised Beef
- ✓ No hormones administered

- ✓ $5.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Certified Angus Beef

- ✓ Neither

Q6> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $5.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Master Quality Raised Beef
- ✓ Grass-fed

- ✓ $7.99 per pound
- ✓ No hormones administered

- ✓ Neither

Q7> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $5.99 per pound
- ✓ No hormones administered

- ✓ $9.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Grass-fed

- ✓ Neither

Q8> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $7.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Grass-fed

- ✓ $11.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Master Quality Raised Beef
- ✓ No hormones administered

- ✓ Neither

Q9> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $7.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Master Quality Raised Beef

- ✓ $9.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Master Quality Raised Beef
- ✓ Certified Angus Beef

- ✓ Neither

Q10> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $11.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Certified Angus Beef

- ✓ $9.99 per pound
- ✓ Master Quality Raised Beef

- ✓ Neither

Q11> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $9.99 per pound
- ✓ Master Quality Raised Beef
- ✓ Certified Angus Beef

- ✓ $11.99 per pound
- ✓ No hormones administered

- ✓ Neither

Q12> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $11.99 per pound
- ✓ Master Quality Raised Beef
- ✓ Grass-fed

- ✓ $9.99 per pound
- ✓ No hormones administered

- ✓ Neither

Steak Block 2

Q1> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $5.99 per pound
- ✓ Master Quality Raised Beef
- ✓ Grass-fed

- ✓ $9.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Master Quality Raised Beef
- ✓ Grass-fed

- ✓ Neither

Q2> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $11.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Master Quality Raised Beef
- ✓ Certified Angus Beef

- ✓ $9.99 per pound
- ✓ Master Quality Raised Beef

- ✓ Neither

Q3> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $9.99 per pound
- ✓ Master Quality Raised Beef
- ✓ Certified Angus Beef

- ✓ $7.99 per pound
- ✓ Tennessee Certified Beef

- ✓ Neither

Q4> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $7.99 per pound
- ✓ No hormones administered

- ✓ $5.99 per pound
- ✓ Tennessee Certified Beef

- ✓ Neither

Q5> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $7.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Certified Angus Beef

- ✓ $11.99 per pound
- ✓ Grass-fed

- ✓ Neither

Q6> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $5.99 per pound
- ✓ Tennessee Certified Beef

- ✓ $7.99 per pound
- ✓ Master Quality Raised Beef
- ✓ Grass-fed

- ✓ Neither

Q7> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $5.99 per pound
- ✓ Master Quality Raised Beef
- ✓ No hormones administered

- ✓ $7.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Certified Angus Beef

- ✓ Neither

Q8> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $5.99 per pound

- ✓ $11.99 per pound
- ✓ Master Quality Raised Beef
- ✓ No hormones administered

- ✓ Neither

Q9> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

✓ $9.99 per pound
✓   Tennessee Certified Beef
✓   Master Quality Raised Beef
✓   No hormones administered

✓ $5.99 per pound
✓   Tennessee Certified Beef
✓   Master Quality Raised Beef
✓   Grass-fed

✓   Neither

Q10> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

✓ $7.99 per pound

✓ $11.99 per pound
✓   Tennessee Certified Beef
✓   No hormones administered

✓   Neither

Q11> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $11.99 per pound
- ✓ Tennessee Certified Beef
- ✓ Master Quality Raised Beef
- ✓ Grass-fed

- ✓ $7.99 per pound
- ✓ Master Quality Raised Beef
- ✓ Grass-fed

- ✓ Neither

Q12> Assume you are in the grocery store and you wish to purchase a boneless ribeye beef steak that is USDA Choice. Which of the following products presented below do you prefer? Please choose one of the two alternatives or choose the neither option.

- ✓ $11.99 per pound
- ✓ Tennessee Certified Beef

- ✓ $5.99 per pound
- ✓ Certified Angus Beef

- ✓ Neither

Q26> Please place a check mark indicating your level of agreement or disagreement.

	Strongly Disagree 1	Moderately Disagree 2	Slightly Disagree 3	Neither Agree nor Disagree 4	Slightly Agree 5	Moderately Agree 6	Strongly Agree 7
I prefer to learn verbally							

CHAPTER II
Analysis of Closed Versus Operating Dairies in the Southeastern United States

Abstract

The United States dairy industry is the fourth leading agricultural sector in the United States (US) with $38 billion milk sales in 2017. While the number of US dairy cows in the past decade has remained constant at approximately 9 million head, the number of dairy operations has decreased, resulting in larger dairies. In 2007, there were 69,763 US dairy operations; however, by 2017 there were only 40,219 diaries, a 42% decrease. Dairies in the Southeastern US have especially been decreasing, with only 2,410 dairies still in operation as of 2017. This study analyzes the difference between dairies that have closed compared to dairies still operating in the Southeastern United States using primary survey data collected through a mail survey of grade A dairies in Georgia, Mississippi, Kentucky, North Carolina, South Carolina, Tennessee, and Virginia. A probit regression model was used to determine which farm and operator characteristics were associated with the dairy's operational status. Results indicate that as a dairy farm had greater cow numbers (totcows) and greater average milk production (avgprod) it was more likely to be operational. For each additional 100 pounds of milk a dairy produced, they were 32% more likely to be operational. For each 100 additional cows a dairy had, they were 4% more likely to be operational. The finding suggests that operations capable of leveraging scale effects are more likely to remain operational. The analysis also identifies nonpecuniary determinants of operational status for Southeastern US dairies.

Keywords: Southeastern US dairies, closed dairies, probit model

JEL Code: Q13

Introduction

The United States dairy industry generated $38 billion from milk sales in 2017 making it one of the top agricultural products for the U.S. following cattle and calves, corn, and soybeans (United States Department of Agriculture (USDA) Economic Research Service (ERS), 2016; USDA National Agricultural Statistics Service (NASS), 2018a). In 2007, the U.S. was home to 69,763 dairy operations; however, by early 2017 total operations decreased to 40,219, a 42% decrease, which can be seen in Figure 5 (USDA NASS, 2009; USDA NASS, 2019b). The average farm size for a U.S. dairy in 2008 was around 170 cows per farm while the average farm size for 2018 is about 234 cows per farm (Figure 10) (USDA NASS, 2009; USDA NASS, 2019b). While the number of dairy operations has decreased, the total number of dairy cows in the U.S. has remained around 9 million head for the past two decades (Figure 5) (USDA, 2010; USDA NASS, 2017). The ten-year trend in milk production and average milk per cow can be seen in Figure 6. As of 2018, milk production was 215 million pounds in the U.S., up 13% from 2008 (Figure 6) even though the total number of dairy cows has stayed constant (USDA NASS, 2009; USDA NASS, 2019b). Thus, in the past decade, milk per cow increased 12% from 20,396 pounds to 22,941 pounds (Figure 6) (USDA NASS, 2009; USDA NASS, 2018c; USDA NASS, 2019b).

Milk consumption has also changed drastically over the last couple of decades. U.S. consumers' fluid milk consumption decreased from 198 pounds in 1998 to 154 pounds per capita in 2016 (USDA ERS, 2016). Yet, yogurt and cheese consumption saw increased consumption from 1998 through 2016 (USDA ERS, 2016). The decrease in fluid milk consumption is due to many reasons. Consumers today eat breakfast more on the go rather than eating a traditional breakfast containing cereal (American Farm Bureau, 2018). In fact, cereal consumption is

decreasing roughly 3.3% each year (American Farm Bureau, 2017). Consumers are also drinking more plant-based drinks such as almond, soy, and coconut milk. Plant based beverage's market share in July 2018 was 13% while milk beverage's market share has decreased from 90% in 2015 to 87% in 2018 (American Farm Bureau, 2018). Lastly, the USDA credits the decline in fluid milk is also related to the declining number of children in our population (2017). Over the past decade, U.S. imports and exports of fluid milk have increased (USDA FAS, 2018). Imports in 2008 totaled 137,000 metric tons; however, 2018 imports totaled 141,000 metric tons (USDA FAS, 2018). Exports increased from 131,000 metric tons in 2008 to 347,000 metric tons in 2018 (USDA FAS, 2018).

Overall, the U.S. dairy industry has seen several structural changes over the past decade including a decrease in the number of dairy farms, farms having more cows and a decline in milk prices. The average Class I fluid milk price in 2008 for all milk was $18.33/cwt (cwt = hundredweight) while the prices in 2018 was $16.18/cwt, a 12% decrease in the past decade (USDA NASS, 2019a). This ten year trend in the average milk prices can be seen in Figure 7. In particular, many changes have occurred in the Southeastern United States. The Southeastern U.S. dairy industry does not produce enough milk for the region, which causes a milk net deficit, and as of early 2018, the deficit was 41 billion pounds of milk (Athey, 2018)[1]. This deficit causes production to be more expensive thus creating a loss for the industry since grocery stores in the Southeast have to import their milk from other regions, such as the Midwest, to meet the Southeastern consumer's demand (McCausland, 2018). This leads to Southeastern dairy farms to

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[1] Southeastern states include Tennessee, Kentucky, Virginia, North Carolina, South Carolina, Georgia, Alabama, Florida, Mississippi, Louisiana, and Missouri.

be frozen out of their own local market because of the incentives to keep the Southeast at a deficit by Midwest producers (McCausland, 2018). Athey (2018) also contributes some of the movement of the dairy industry to increased heat and humidity, which is prevalent in the Southeastern U.S.

According to Herndon (2011) dairy farms in the Southeastern United States are expected to decline 56.7% from 2010 to 2025. In the past decade, the number of dairy cows in the Southeast decreased from 676,000 to 563,000, a 17% decrease (Figure 8) (USDA NASS, 2009; USDA NASS, 2019b). On a per state basis, Alabama had the least amount of cows at 6,000 while Florida had the highest population of cows at 124,000 (USDA NASS, 2018c). Average production per cow in 2017 in the Southeast was 16,377 pounds whereas the average for the U.S. was 22,941 (Figure 10) (USDA NASS, 2018c). While the number of dairy farms and cows has decreased in the Southeastern U.S., average milk production per cow in the Southeast has increased 3% in the past decade (USDA NASS, 2009; USDA NASS, 2018c). The most productive cows in the Southeast came from Georgia while the least productive cows came from Missouri (USDA NASS, 2018c). Milk production in the Southeastern U.S. in 2017 was 11 billion pounds, which accounts for only 5% of the total milk produced by the United States (USDA NASS, 2018c). In the past decade, the Southeastern U.S. has decreased its milk production by 3% (Figure 9) (USDA NASS, 2009; USDA NASS, 2018c). Florida had the highest production and Alabama had the lowest (USDA NASS, 2018c). This ten-year trend of the Southeast's total milk production and average milk production per cow can be seen in Figure 9.

When comparing the Southeast's average farm size and average production per cow to the U.S., the Southeastern U.S. numbers have been consistently lower the past decade than the

U.S as a whole (Figure 10) (USDA NASS, 2009; USDA NASS, 2018c). The Southeast also only holds a small portion of the dairy farms and cows within the United States (Figure 11) (USDA NASS, 2009; USDA NASS, 2018c). Given the steady decline in the number of dairy farms in the Southeastern U.S., this study analyzes a survey of Southeastern U.S. dairies to examine the difference between dairies that have closed compared to dairies still operating. In particular, this study analyzes farm structure characteristics, operator characteristics, farm management practices, and the sources of information for mastitis information in dairy farms in the Southeastern Unites States. It is hypothesized that certain producer and farm characteristics will contribute to explaining the operation status of the dairy.

Materials and Methods

Data

A 2013 mail survey was sent to grade A dairy farms in Georgia, Mississippi, Kentucky North Carolina, South Carolina, Tennessee, and Virginia who are either still in operation or closed since 2006. The survey included questions pertaining to producer experiences, perceptions, and attitudes toward mastitis and mastitis management. Mailing of the survey occurred in October and November 2013 with four attempts at contact. Answered by the primary decision maker of the operation, the survey had a 29% overall response rate. Of the completed surveys, 579 were completed by operational dairies. To benchmark survey response patterns relative to regional farm population numbers, poststratification weights were developed and used with the summary statistics and regression analysis (Lohr, 2010).

Empirical Model

Attributes hypothesized to affect the operational status of a dairy include farm structure characteristics, operator characteristics, farm management practices, and the sources of information for mastitis information (Table 7). For producer *i* and period *t,* we hypothesized operational status ($OpStatus_{it}$) is explained as a function (*f*) of the following factors:

$$OpStatus_{it} = f(FSC_i, OC_i, FMP_i, IS_i, u_i)$$

where *FSC* are variables associated with farm structure characteristics, *OC* are operator characteristics, *FMP* are farm management practices, *IS* recognizes information sources the producers received information about mastitis, and u_i is a random disturbance term outside the producer's control. Discussion of the variables used in our model in their respective category follows.

Farm Structure Characteristics We hypothesized that larger farms would be operational due to efficiencies generated by scale economies (Kumbhaker et al., 1991). The total number of cows and average milk production serve as measurements of the size of a dairy and may be associated with the operational status of a dairy. On average, operational dairies managed 219 milk cows and had an average production of 59.12 kg/d wheras closed dairies had 92 milk cows (*P*<0.01) and had an average production of 46.08 kg/d (*P*<0.01) (Table 9). Processors or coops may offer incentives or inforce penalties if their producers obtain a certain bulk tank somatic cell count (BTSCC). We hypothesized that dairies whose coop or processor imposes penalties (*penalties*) or incentives (*incentives*) will likely still be in operation. Operational dairies who received penalties from their coop or processor represented 74.28% whereas 50% of closed operations received penalties (*P*<0.01). Operational dairies who received incentives for

obtaining a certain BTSCC on average represented 87.78% whereas 63.89% represented closed dairies ($P<0.01$).

The percent of operational dairies who had other operations unrelated to the dairy (*otherop*) was 33.76% while 52.78% of closed dairies had other operations ($P<0.05$). These producers may rely on other operations to generate their main source of income therefore we hypothesized that operations that have other operations besides their dairy were more likely to be closed because the operator did not have enough time to dedicate towards the dairy. We were uncertain how the business structure of the operation (*partner* and *solprop*) would affect the operational status of the dairy. However, we did hypothesize that the structure may be correlated with the operational status of a dairy. Operational dairies that indicated they operated as a sole proprietorship was 58.2% compared to 80.56% of closed dairies ($P<0.01$).

Operator Characteristics We hypothesized that operators who spoke the same language as their employees were more likely to be operational (*language* =1). The reasoning we used to come to this hypothesis was that managers and employees who speak the same language reduce the risk of misunderstanding instructions that could affect work time. On average, 84.89% of operational dairies had operators and employees who spoke the same language, and 97.67% of closed dairies had operators and employees who spoke the same language. Kumbhaker et al. (1991) found that education and the productivity of a dairy farm were positively associated. Therefore, we hypothesized that dairies that had operators who had a college degree (*college* =1) were more likely to be operational. Thirty-one percent of both operational and closed dairy operators had a college education; however, the means are not statistically different.

We expected that age would reflect a higher knowledge of the dairy industry; however, we hypothesized that as the age of the operator increased the less likely the dairy would be in operation. This is due to the possibility of an older operator not adapting to newer and better technologies that might make the operation profitable.

Farm Management Practices We hypothesized that producers who observed milking everyday (*everyday*) were less likely to still have an operating dairy. Operators who had to be more involved in the milking would not have time to allocate to other important management activities such as financing and marketing. The percent of operators from an operational dairy who participated in the milking everyday was 35.05% while 66.66% operators of closed dairies were involved ($P<0.01$).

Mastitis is one of the most common diseases affecting dairy cattle by reducing milk production (Pighetti and Elliot, 2011; National Mastitis Council, 1999). It is a bacterial infection that causes the mammary glands to become inflamed, pain, and redness (Pighetti and Elliot, 2011). BTSCC is a metric used to detect clinical mastitis infections while also serving as a metric for the quality of the milk (Oliver et al., 2004). Therefore, we evaluated a group of Likert-scale questions related to farmer perceptions of mastitis and mastitis management (Table 8) to create summary factors associated with perceived farmer control and concern about mastitis. Factor scores were calculated using principal component analysis (PCA). An example of a question is, "Please indicate the extent to which you disagree or agree with each of these statements: Mastitis is a significant concern of mine relative to other issues affecting my dairy." Response options ranged from 1 = strongly disagree to 5 = strongly agree. Due to the nature of these questions, we estimated the factors using a polychoric PCA (Kolenikov and Ángeles, 2004). Criteria we used to decide what factors should be included followed Johnson and Wichern

(2002) by considering statements with a rotated factor loading with an absolute value of 0.40 or greater. Following Goforth (2015), we calculated Cronbach's α, which measures the internal reliability of a set of test items. The more independent the Likert-scale questions, the closer to zero the Cronbach's α. The higher the Cronabch's α, the variables are highly related to each other (Goforth, 2015). Using our factor analysis, the Cronabch's α for factor 1 and factor 2 were 0.7253 and 0.6417, respectively, when using a rotated factor loading with an absolute value of 0.40 or greater. We hypothesized that producers who are more concerned about mastitis (higher scores on *concern about mastitis* factor), and have more control over their mastitis prevention practices (higher scores on *mastitis is hard to control* factor) would have a dairy still in operation. The average score for *concern about mastitis* was 6.05 and 6.01 for operational and closed dairies, respectively. The average score for *mastitis is hard to control* was 1.16 and 1.64 for operational and closed dairies, respectively.

We hypothesized that the BTSCC level that caused the producer concern (*BTSCC_concern*) would also help determine the operational status of the dairy, specifically, operators who reported a lower BTSCC concern level were more likely to be in operation. On average, operational dairy operators reported a lower BTSCC concern level (337,000 cells/ml) than dairies that have closed (401,000 cells/ml) ($P<0.05$).We also hypothesized that operators who acted on bacterial cultures in the milk sample (*act*) were more likely to be operational. If producers are actively trying to control mastitis, we expected them to be operational. On average, 35.37% of operational dairies were acting on bacterial cultures whereas 58.33% of closed dairies were acting on cultures ($P<0.05$). Also concerning mastitis, we examined how the use of vaccines used to control mastitis (*vaccine*) affected the operational status of a dairy. We hypothesized that dairies that used vaccines were more likely to be operational because they

were taking the steps to help control mastitis to better their milk quality. On average, 48.87% of operational dairies used vaccines while 19.44% of closed operations used vaccines ($P<0.01$). Multiple programs can help detect and manage mastitis outbreaks. Dairy Herd Improvement Association (*dhia*) provides a network to help detect, manage and prevent mastitis. We hypothesized that producers who participate in DHIA testing were more likely to be operational. Operational dairies had 61.09% involvement and closed dairies had 41.67% involvement ($P<0.05$). Electronic record keeping (*adopt_dart*) can provide early and accurate detection of mastitis. We hypothesized that producers who used an electronic record keeping system were more likely to be operational. On average, 25.08% of operational dairies had electronic record keeping and 11.11% of closed dairies had it ($P<0.05$).

 Information Sources We hypothesized that producers that received information to help them make better decisions from veterinarians (*vet*), other producers (*othprod*), milk cooperative representatives (*cooprep*), county extension agents (*extension*), farm journals (*journal*), and drug companies (*drug*) were more likely to be operational. However, the relationship between operational and closed dairies did not have statistically different means.

Methods

 We used a probit model to determine which farm structure characteristics, operator characteristics, farm management practices, and information sources were associated with the dairy's operational status. Probit models measure the probability of how likely an event will occur with two categories in the dependent variable (Liao, 1994; Morgan et al., 2004). The dependent variable $OpStatus_i$ could only take two values: closed or open. For operator *i*, *OpStatus* was regressed on farm structure characteristics, operator characteristics, farm management practices, and information sources:

$$OpStatus_i = \beta_0 + FSC_i + OC_i + FMP_i + IS_i + u_i$$

with antecedents

(a) Farm Structure Characteristics: $FSC_i = \beta_1 \cdot avgprod_i + \beta_2 \cdot totcows_i + \beta_3 \cdot penalty_i + \beta_4 \cdot incentive_i + \beta_5 \cdot percoffinc_i + \beta_6 \cdot otherop_i + \beta_7 \cdot solprop_i + \beta_8 \cdot partner_i$,

(b) Operator Characteristics: $OC_i = \beta_9 \cdot language_i + \beta_{10} \cdot college_i + \beta_{11} \cdot age_i + \beta_{12} \cdot newpractice_i + \beta_{13} \cdot financial_{conseq_i} + \beta_{14} \cdot expindex_i$,

(c) Farm Management Practices: $FMP_i = \beta_{15} \cdot concern_i + \beta_{16} \cdot control_i + \beta_{17} \cdot everyday_i + \beta_{18} \cdot BTSCC_{action_i} + \beta_{19} \cdot mastplan_i + \beta_{20} \cdot cull_i + \beta_{21} \cdot act_i + \beta_{22} \cdot hygiene_i + \beta_{23} \cdot vaccine_i + \beta_{24} \cdot antibiotic_i + \beta_{25} \cdot biosecurity_i + \beta_{26} \cdot dhia_i + \beta_{27} \cdot adopt\_dart_i$,

(d) Information Sources: $IS_i = \beta_{28} \cdot info\_vet_i + \beta_{29} \cdot info\_cooprep_i + \beta_{30} \cdot info\_extension_i + \beta_{31} \cdot info\_journal_i + \beta_{32} \cdot info\_drug_i$,

where u_i is an independent and identically distributed (iid) error term with a mean zero and constant variance, and β_0 to β_{32} are coefficients corresponding with the independent variables. Definitions of variables used in our model can be seen in Table 6.

Results

Table 4 displays the probit model results and associated marginal effects. In our model, there were 311 operational dairies and 36 closed dairies equating to 347 dairies. The mean VIF was 1.36 with 2.22 being the highest value. Thus, multicolinnearity was not a concern. The model explained 48% of the variation in the current operational status of the dairy.

Farm Structure Characteristics

Results indicate that as a dairy farm had greater cow numbers (*totcows*) and greater average milk production (*avgprod*) it was more likely to be operational (Table 10). For each additional 100 pounds of milk a dairy produced, they were 32% more likely to be operational *(P<0.01)*. For each 100 additional cows a dairy had, they were .04% more likely to be operational (*P<0.05*). The likelihood of a dairy to still be in operation increased 7% (*P<0.05*) if their coop or processor imposed penalties (*penalty)* and 8% (*P<0.05*) if the dairy was incentivized to perform at a certain level (*incentive*).

Operator Characteristics

Dairies likelihood of still being operational increased 7% (*P<0.05*) if the operator and employees spoke the same language *(language)*. The age of the operator of the dairy decreased the probability of the operational status *(age)*. For a year increase in the operator's age, dairies were 0.3% less likely to be operational (*P<0.01*). Producers who found financial consequences associated with mastitis troublesome *(financial_conseq)* were 3% less likely to have an operational dairy, however it was not significant.

Farm Management Practices

One of the factor analysis variables in our model was statistically significant. As producers found mastitis to be hard to control (*mastitis is hard to control*), they were 4.5% more likely to be operational (*P<0.05*). Producers who were involved in the milking everyday *(everyday)* were 8% less likely to have an operational dairy (*P<0.01*). As the BTSCC level that caused the operator concern increased *(BTSCC_concern),* the dairy was 3% (*P<0.01*) less likely to be in operation. If the operation had a mastitis management plan in place (*mastplan*), they were 8% (*P<0.01*) less

likely to be in operation. Acting on bacterial cultures in milk samples *(act)* decreased the likelihood of the dairy to be in operation by 8% (*P*<0.01). Using antibiotic therapy to treat clinical mastitis *(antibiotic)* decreased the likelihood of the dairy to still be in operation by 9% (*P*<0.05). These results show opposite signs from our hypotheses of each of these variables.

Information Sources

Dairy producers who received their information about mastitis from farm journals *(journal)* were 5% less likely to have an operational dairy (*P*<0.10). Yet, if producers received their mastitis information from coop representative *(cooprep)*, they were 3% more likely to have an operational dairy. However, this variable was not significant in our model.

Discussion

Several studies have examined how farm management practices and operator characteristics affect the operational status of dairy farms (e.g. Bigras-Poulin, 1985; Haden and Johnson, 1989; Ford and Shonkwiler (1994); Bergevoet et al., 2003; Stup et al., 2006). Our research contributes to the body of research by analyzing primary survey data from Tennessee, Virginia, Georgia, North Carolina, South Carolina, Kentucky, and Mississippi. The analysis determined how farm characteristics and operator characteristics affected the operational status of dairies in this particular region. Haden and Johnson (1989) specifically studied the factors that contribute to financial performance in Tennessee dairies. Our study contributes to this body of research by including Southeastern states as well as giving an update to Tennessee's dairy industry. In our research, we found that average production of cows and the herd size of a farm were significant variables in explaining a dairies operational status which supports the findings in Haden and Johnson (1989), Ford and Shonkwiler (1994), and Mosheim and Lovell (2009). We also found

economies of scale in the Southeastern dairy industry similar to the findings in Short (2004), Mosleim and Lovell (2009), and Jette-Nantel (2018). In our study, we found that producers who received a penalty for reaching a certain BTSCC level were more likely to have an operational dairy similar to findings in Janson et al. (2009).

Our study found 86% of producers spoke the same language as their employees, which is similar to the Stup et al. (2006) where they found 29% of the dairies surveyed had employees who did not speak the same language. In our study, however, language was a significant variable in explaining whether dairies were still in operation. This finding is logical, as language barriers could potentially cause miscommunication, which can further lead to complications. Age was a significant variable in our study, and it was found that, as producers get older the less likely they would have an operational dairy. This is not alarming either because as producers get older the less likely they will adopt new technologies or expand their dairy, which is viable to remain profitable.

Variables used to understand the mastitis management practices of the dairies as it relates to the operational status of the dairy proved significant in our model. Those who were involved in the milking everyday were more likely to operate a dairy not in production anymore. This result tells us that being involved in the milking everyday takes the manager away from other obligations needed to keep the dairy operating. Producers who implemented a mastitis management plan, acted on bacterial cultures in milk samples, used hygienic supplies for milking, routinely used antibiotic therapy to treat mastitis were less likely to have an operational dairy. Logically, one would think the more proactive the producer, the better off the operation, so these results are opposite of what we hypothesized. The *control* factor was related to dairies that were still in operation. This is expected due to operational farmers being responsible by

controlling mastitis outbreaks to keep the dairy open. In the United States, the legal BTSCC level

is 750,000 cells/ml (USDA Animal Plant Health Inspection Service (APHIS), 2018). Milk

quality performance is outlined in the Pasteurized Milk Ordinance (PMO), and it outlines the

regulatory actions imposed on dairy producers if they were to have BTSCC levels above the

legal limit (USDA APHIS, 2018). Regulatory actions include: suspending the producers permit,

foregoing permit suspension if the milk is not sold as Grade A and imposing monetary penalty in

place of permit suspension if the milk sold is not sold as Grade A (USDA APHIS, 2018).

However, the European Union (EU) has a legal BTSCC level of 400,000 cells/ml, and if U.S.

producers' milk have four consecutive rolling three-month BTSCC averages higher than 400,000

cells/ml, they cannot export milk to the EU (USDA APHIS, 2018). Therefore, U.S. producers are

'incentivized' to have some control over their BTSCC levels to help insure they have a market

for their milk, domestic and foreign.

One variable in our information source section was significant: information from farm

journals. However, its sign was negative. This means that producers who rely on getting their

information from farm journals are less likely to be open. Interpreted, this could mean these

producers who rely on the farm journals could be relying on dated information due to the lag of

publication time, or they are relying on ads in journals that are not giving full or accurate

information.

Conclusion

The goal of this research was to analyze the difference between dairies that are in operation and

are closed in the Southeastern United States. We found that average production, herd size, age,

the BTSCC level that causes producers to take action, having a mastitis management plan, and

receiving information about mastitis from a farm journal were some of the significant factors in

determining the operational status of the dairy. We also found dairies who received a penalty for reaching a certain BTSCC were 7% more likely to be in operation. On the contrary, producers who received an inventive for reaching a certain BTSCC were 8% more likely to still be in operation. The results provide useful information regarding farm management practices, operator characteristics, farm structure characteristics, and information sources on BTSCC management for operational and non-operational dairies in the Southeastern United States. Results show not only operations that are capable to leverage scale effects are more likely to be operational, but also there are other significant factors when determining the operational status of a Southeastern U.S. dairy.

This study adds to the body of research on dairy farm management and operator practices that help determine the operational status. A specific limitation to our study, however, is that this survey was about mastitis with no financial questions asked. These questions would be beneficial to understand the financial performance of the dairy as well as their financial ratios to help further understand the differences of operational and closed dairies

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Appendix C Tables and Figures

Table 7. Variable definitions and hypothesized signs

Variable	Definition	Hypothesized Signs	Units
Farm Structure Characteristics			
avgprod	Average milk production per cow per day	+	kg/d
totcows	Number of cows	+	
penalty	1 if co-op/processor imposes a penalty for exceeding BTSCC	+	
incentive	1 if co-op/processor imposes a incentive for achieving a particular BTSCC	+	
percoffinc	Total income from off farm	+	%
otherop	1 if have farm operation not related to dairy	-	%
solprop	1 if the dairy business is a sole proprietorship	+/-	%
partner	1 if the dairy business is a partnership	+/-	%
Operator Characteristics			
language	1 if the employee speak same language as owner/farm mangager	+	%
college	1 if college degree	+	%
age	How old the operator is	-	
newpractice	Likert-scale question regarding how important it is to the farmer to adopt new practives and technology[1]	+	
fiancial_conseq	Likert-scale question reqarding mastitis being a financial consequesnce[1]	+	
Farm Management Practice			
Factor 1: Concern about mastitis	Factor 1 of the 18 Likert-scale questions regarding farmer perceptions of mastitis[1]	+	
Factor 2: Mastitis is hard to control	Factor 2 of the 18 Likert-scale questions regarding farmer perceptions of mastitis[1]	+	
everyday	1 if in the parlor and doing the milking at almost every milking	-	%
BTSCC_action	Lowest level of BTSCC that causes the farmer to take action	+	cells/ml
mastplan	1 if farmer has and implements mastitis management plan	+	
cull	1 if farmer culls cows based on SCC information or other mastitis indicator	+	
act	1 if farmer analyzes and acts on bacterial culturing of milk samples	+	
hygiene	1 if using hygienic supplies for milking	+	
vaccine	1 if using vaccines to contril coliform mastitis	+	
antibiotic	1 if using antibiotic therapy to treat clinical mastitis cases	+/-	
biosecurity	1 if using biosecurity practices, such as pre-testing or quarantine, for replacement heifers and cows	+	
dhia	1 if participates in dhia testing	+	%
adopt_dart	1 if uses an electronic record keeping system for tracking mastitis (PC-DART/DairyComp-360[2])	+	%
Information Source			
vet	1 from a veterinarian	+	%
othprod	1 from another dairy producer	+	%
cooprep	1 from milk cooperative representative	+	%
extension	1 from county agent/ extension	+	%
journal	1 from farm journal	+	%
drug	1 from drug company	+	%

[1]Scale: 1 = strongly disagree to 5 = strongly agree [2]PC-DART, Dairy Records Management System, Ames Iowa and
Raleigh, North Carolina (http://www.drms.org/); DairyComp, Valley Agricultural Software, Tulare, California (http://web.vas.com/en/Support)

Table 8. Factor analysis of perceptions of mastitis and its management (n=344)

Item[2]	Mean	SEM	Rotated factor loading	
			Factor 1: Concern	Factor 2: Control
It is extremely important to me to reduce the number of clinical mastitis cases on my dairy	4.2993	0.0385	**0.7999**	-0.1669
Mastitis is a significant concern of mine relative to other issues affecting my dairy	4.0430	0.0430	**0.7281**	0.2252
It is extremely important to me to decrease my bulk tank SCC	4.2384	0.0415	**0.7195**	-0.0259
Mastitis is a significant concern to the dairy industry in the Southeast	4.3191	0.0326	**0.7022**	0.0782
My milking practices play an important role in mastitis outbreaks	3.9385	0.0597	**0.5440**	-0.3173
The weather and climate play an important role in mastitis outbreaks	4.2478	0.0378	**0.5413**	-0.0849
My dairy barn and equipment play an important role in mastitis outbreaks	3.9477	0.0484	**0.4958**	-0.1233
I know what procedures to use in the parlor to decrease my bulk tank SCC or maintain my already low SCC	4.0098	0.0414	**0.4439**	**-0.6067**
Mastitis causes are difficult to manage	3.7672	0.0547	**0.4050**	**0.5471**
My dairy has had a serious mastitis problem one or more times	3.5830	0.0573	**0.3742**	0.2913
The spread of mastitis from one cow to others in the herd is difficult to control	2.9613	0.0589	**0.2725**	0.5115
Mastitis seems to persist despite my efforts to control it	3.1964	0.0566	**0.2583**	**0.6601**
Mastitis is currently under control at my dairy	3.5956	0.0520	0.1457	**-0.6681**
I can afford to do what is necessary to decrease my bulk tank SCC or maintain my already low SCC	3.6752	0.0483	0.1801	**-0.4883**

[1]Factor analysis was conducted using weights. Cronabch's α when considering statements with a rotated factor loading with an absolute value of 0.6785.

[2]Questions were presented as: "Please indicate the extent to which you disagree or agree with each of these statements," with 1 = strongly disagree, 5 = strongly agree

Table 9. Means for the model by operational status

Variable	All Dairies n=349		Open Dairies n=316		Closed Dairies n=33	
	Mean	*SEM*	*Mean*	*SEM*	*Mean*	*SEM*
Farm Structure Characteristics						
avgprod	56	0.88	59.02***	0.84	46.45	2.42
totcows	204.24	30	216.34***	31.80	86.97	11.33
penalty	72.80%	-0.03	74.37%***	0.02	48.48%	0.09
incentive	86.79%	0.02	88.61%***	0.02	57.58%	0.09
percoffinc	2.05%	0.08	2.03%	0.07	2.27%	0.24
otherop	35.29%	0.03	33.24%	0.03	48.48%	0.09
solprop	61.07%	0.03	58.86%**	0.03	78.79%	0.07
partner	22.68%	0.03	22.47%	0.02	12.12%	0.06
Operator Characteristics						
language	83.98%	0.02	85.13%	0.02	90.91%	0.05
college	29.23%	0.03	31.33%	0.03	30.30%	0.08
age	51.24	0.83	50.41***	0.78	57.82	1.89
newpractice	33.80%	0.03	34.17%	0.03	39.39%	0.09
fiancial_conseq	4.44	-0.04	4.45	0.04	4.52	0.10
expindex	54.70%	0.01	54.73%	0.01	58.18%	0.04
Farm Management Practice						
Factor 1: concern	6.17	0.04	6.19	0.04	6.15	0.11
Factor 2:control	-0.16	0.05	-0.16	0.04	-0.16	0.12
everyday	42.78%	0.03	37.03%***	0.03	69.70%	0.08
BTSCC_action	345,000	0.07	337,000**	0.07	403,000	0.31
mastplan	68.69%	0.03	68.04%*	0.03	81.82%	0.07
cull	84.08%	0.02	86.39%*	0.02	72.73%	0.08
act	38.73%	0.03	36.71%*	0.03	54.55%	0.09
hygiene	86.37%	0.02	88.61%	0.02	87.88%	0.06
vaccine	44.35%	0.03	50%***	0.03	15.15%	0.06
antibiotic	81.48%	0.02	81.96%	0.02	90.91%	0.05
biosecurity	9.13%	0.02	9.49%	0.02	12.12%	0.06
dhia	42.78%	0.03	60.13%*	0.03	42.42%	0.09
adopt_dart	19.50%	0.02	24.05%***	0.02	9.09%	0.05
Information Source						

Table 9 Continued. Means for the model by operational status

Variable	All Dairies n =349		Open Dairies n=316		Closed Dairies n=33	
	Mean	SEM	Mean	SEM	Mean	SEM
vet	89.89%	0.02	91.77%	0.15	87.88%	0.06
othprod	76.50%	0.02	75.95%	0.02	84.84%	0.06
cooprep	50.65%	0.03	51.27%	0.03	51.51%	0.09
extension	31.55%	-0.03	32.91%	0.03	27.27%	0.08
journal	56.66%	0.03	56.65%*	0.03	72.73%	0.08
drug	28.54%	0.03	32.59%	0.03	21.21%	0.07

*P < 0.10, **P <0.05, ***P < 0.01

Table 10. Probit model results and marginal effects: determinants of operational status

Variable	Coefficient	SE[1]	Marginal Effects	Std Err.
Farm Structure Characteristics				
$avgprod$	0.0334***	0.0121	0.0032***	0.0011
$totcows$	0.0041***	0.0016	0.0004**	0.0002
$penalty^2$	0.6918**	0.3285	0.0662**	0.0305
$incentive^2$	0.8398**	0.3704	0.0804**	0.0350
$percoffinc^2$	-0.0239	0.1153	-0.0023	0.0111
$otherop^2$	-0.3873	0.2647	-0.0371	0.0257
$solprop^3$	0.0636	0.4387	0.0061	0.0419
$partner^3$	0.5064	0.4603	0.0485	0.0429
Operator Characteristics				
$language^2$	0.7389*	0.3879	0.0707**	0.0353
$college^2$	0.0353	0.3303	0.0034	0.0316
age	-0.0374***	0.0111	-0.0036***	0.0011
$newpractice$	0.0493	0.2867	0.0047	0.0275
$fiancial\_conseq$	-0.3470	0.2448	-0.0332	0.0236
Farm Management Practice				
Factor 1: Concern about mastitis	0.1050	0.2141	0.0101	0.0206
Factor 2: Mastitis is hard to control	0.4737**	0.1950	0.0453**	0.0191
$everyday^2$	-0.8817***	0.3004	-0.0844***	0.0284
$BTSCC\_concern$	-0.3468***	0.1034	-0.0332***	0.0096
$mastplan^2$	-0.8114***	0.3010	-0.0777***	0.0283
$cull^2$	0.3968	0.2926	0.0380	0.0279
act^2	-0.8233***	0.2846	-0.0788***	0.0263
$hygiene^2$	-0.3516	0.4086	-0.0337	0.0391
$vaccine^2$	0.4709*	0.2857	0.0451*	0.0271
$antibiotic^2$	-0.9671***	0.3677	-0.0926**	0.0373
$biosecurity^2$	0.2998	0.3831	0.0287	0.0369
$dhia^2$	-0.4399	0.2921	-0.0421	0.0274
$adopt\_dart^2$	-0.1907	0.3870	-0.0183	0.0375
Information Source				
vet	0.0331	0.4077	0.0032	0.0391
$othprod$	-0.3812	0.3119	-0.0365	0.0299
$cooprep$	0.2772	0.2612	0.0265	0.0248
$extension$	-0.2402	0.2961	-0.0230	0.0287
$journal$	-0.5087*	0.2893	-0.0487**	0.0275
$drug$	0.0192	0.3229	0.0018	0.0309
Constant	3.6630*	1.9563		
Observations	347		347	
Psuedo R^2	0.4843			

[1]SE is the robust regression standard error. [2]Coded as 1 if selected and -1 otherwise

[3]Compared to a corporation or other entity definition *P < 0.10, **P <0.05, ***P < 0.01
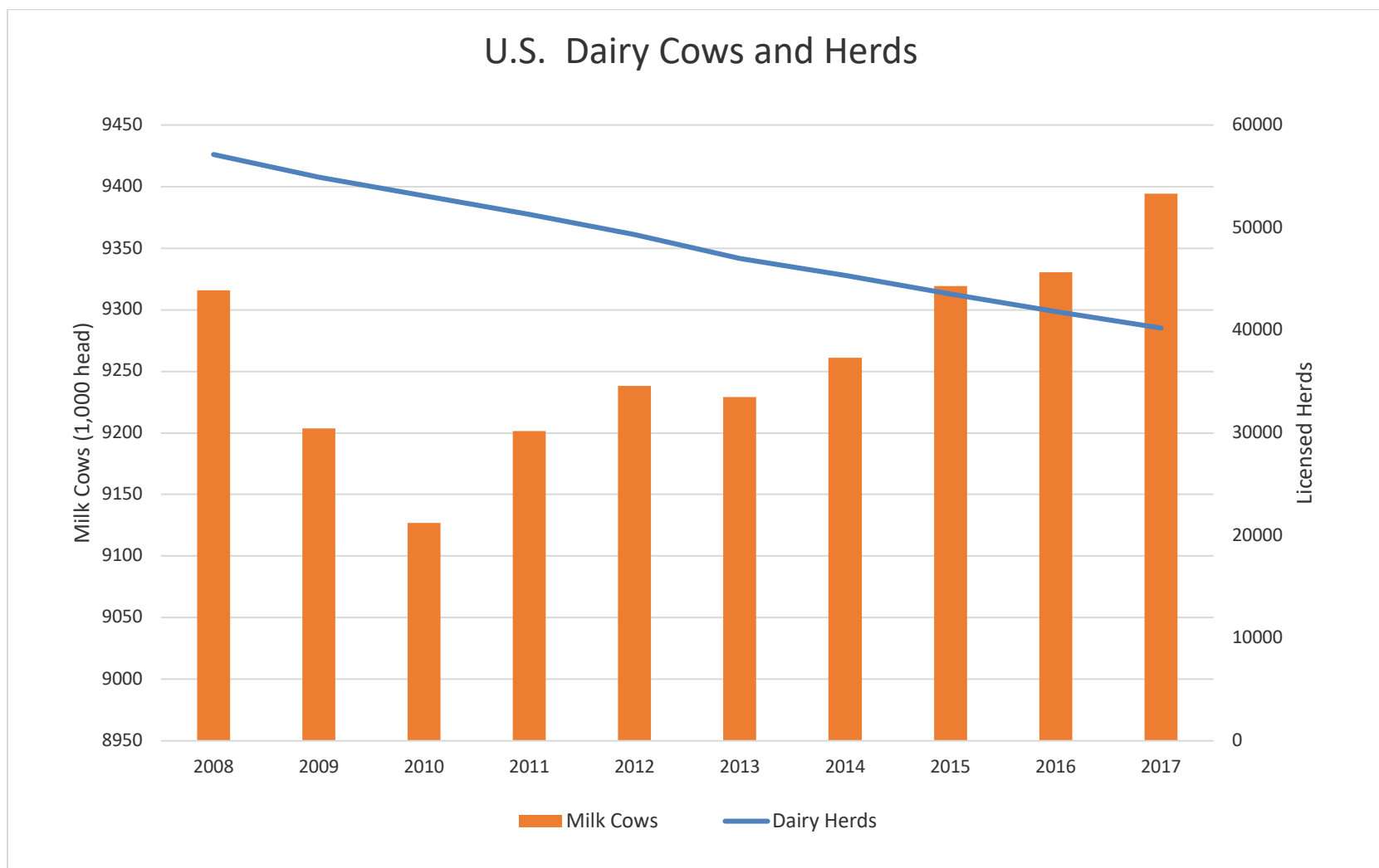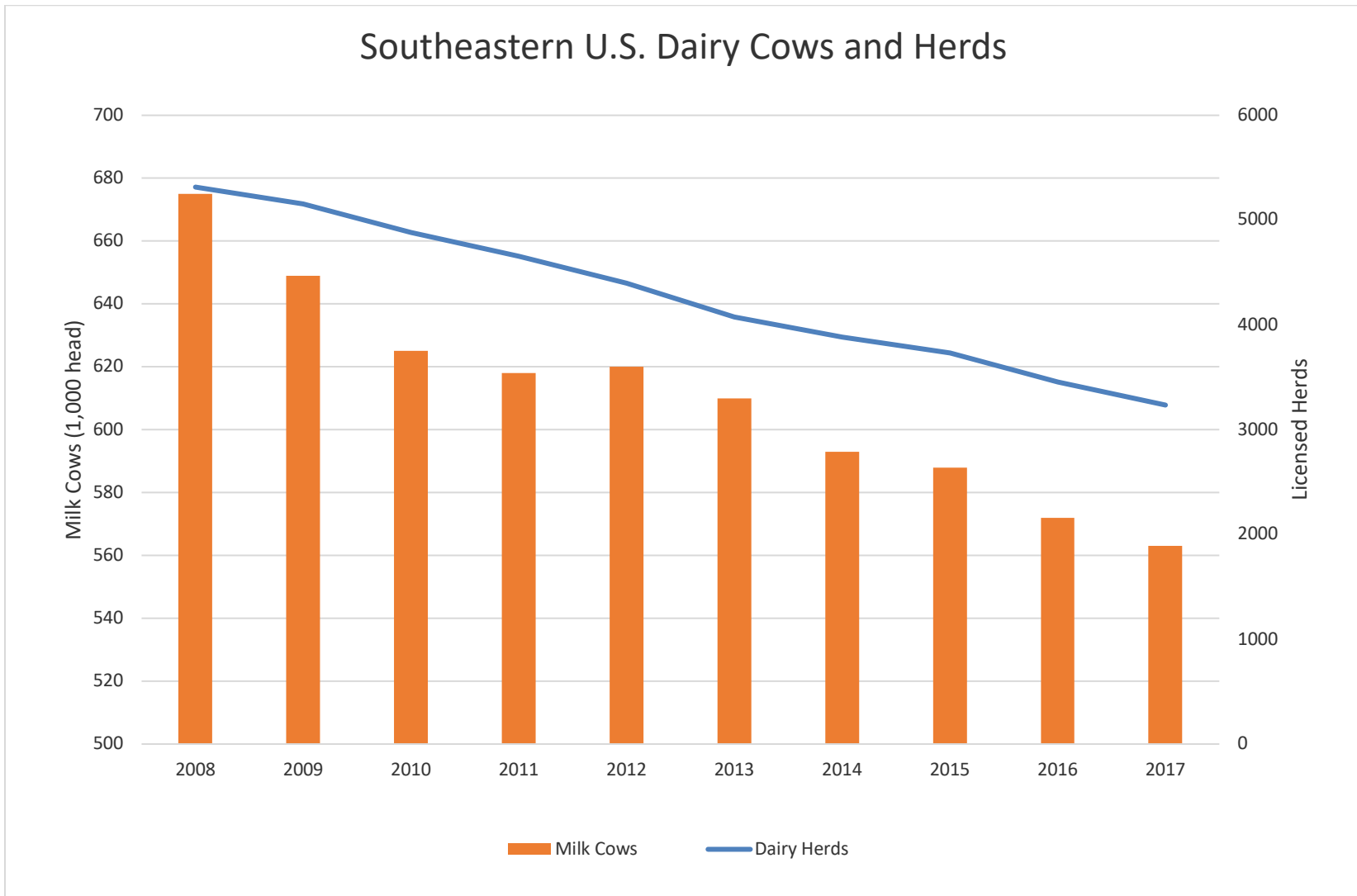
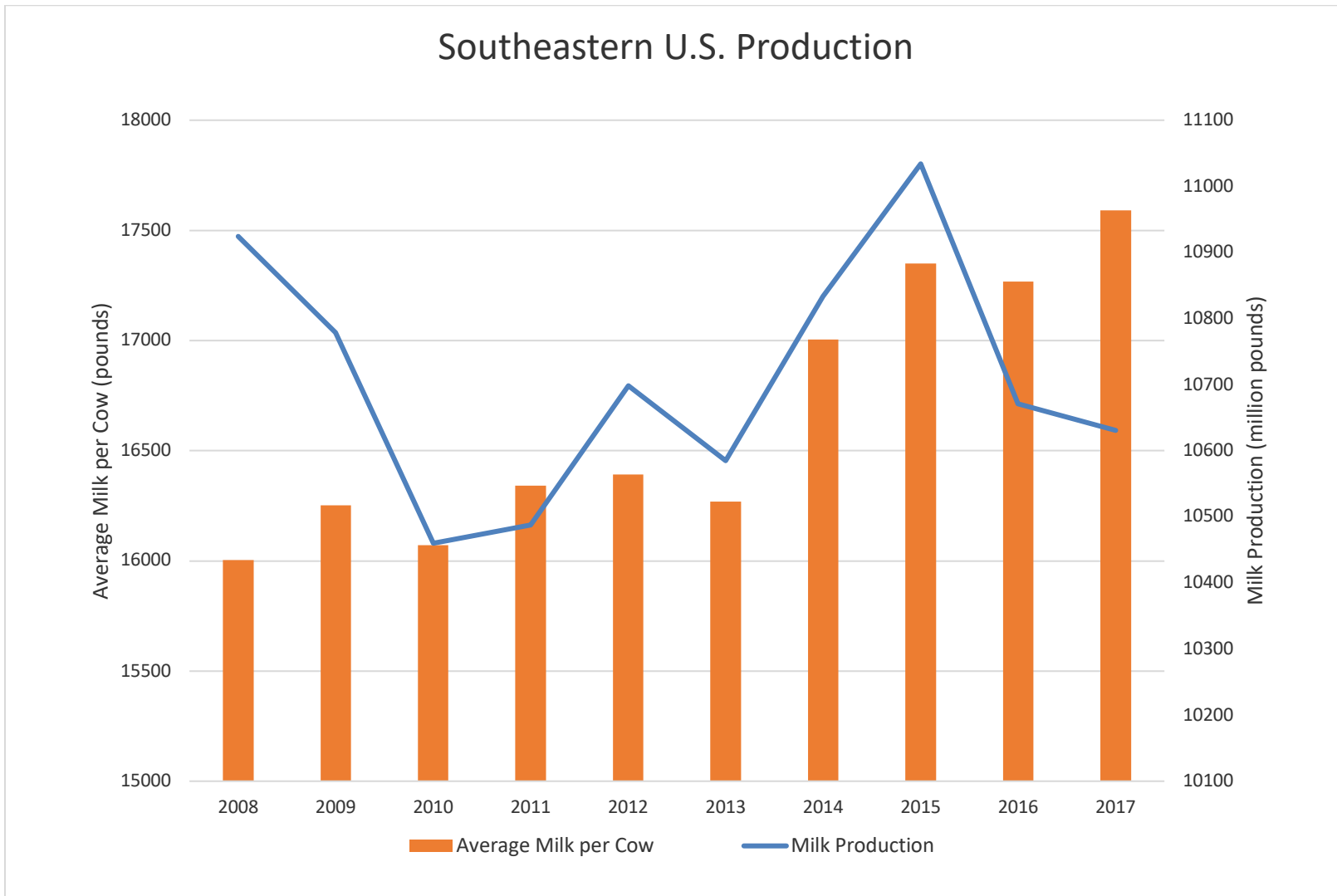**Figure 5.** U.S. Dairy Cows and Herds (2008 – 2017)
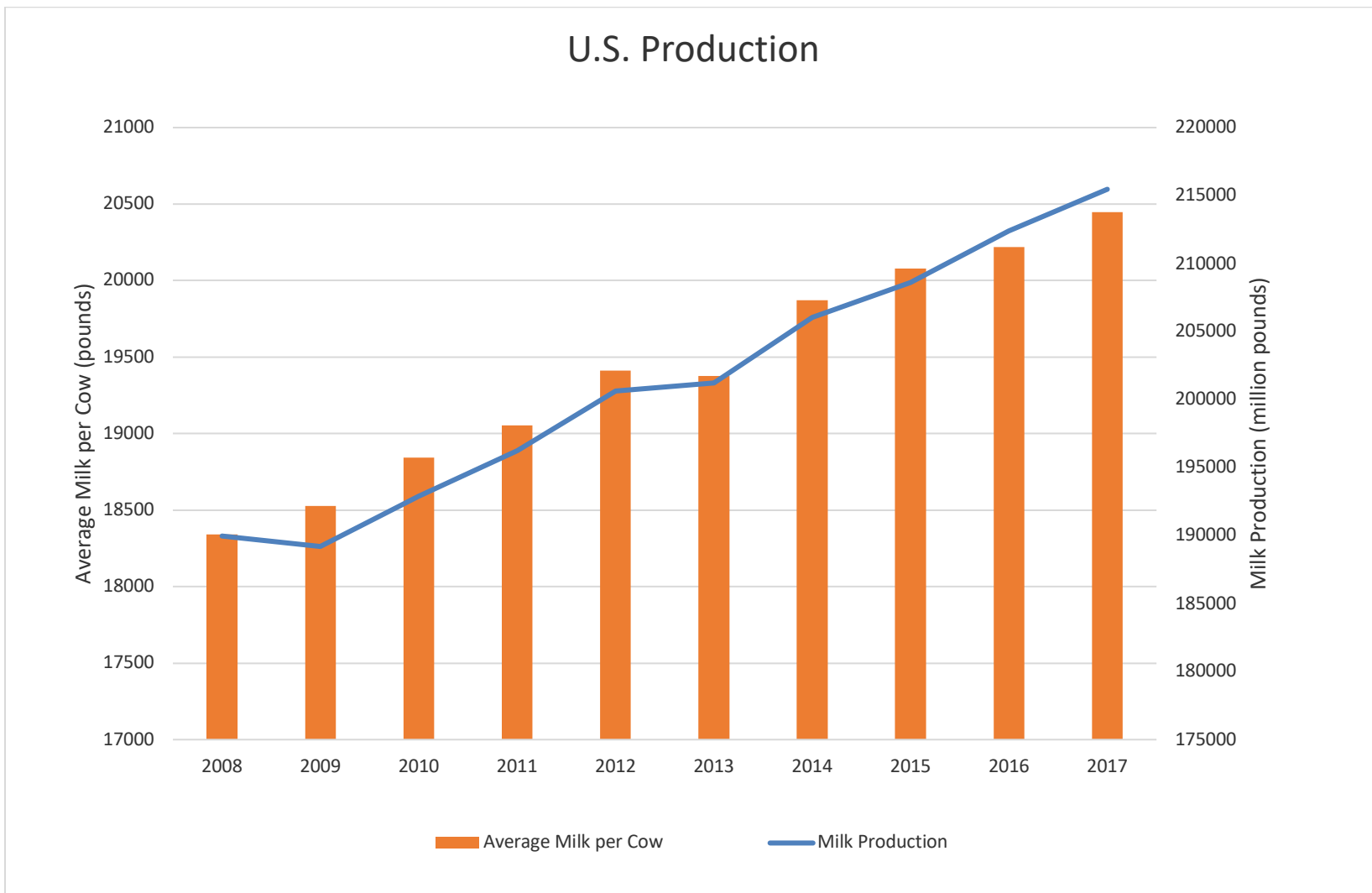
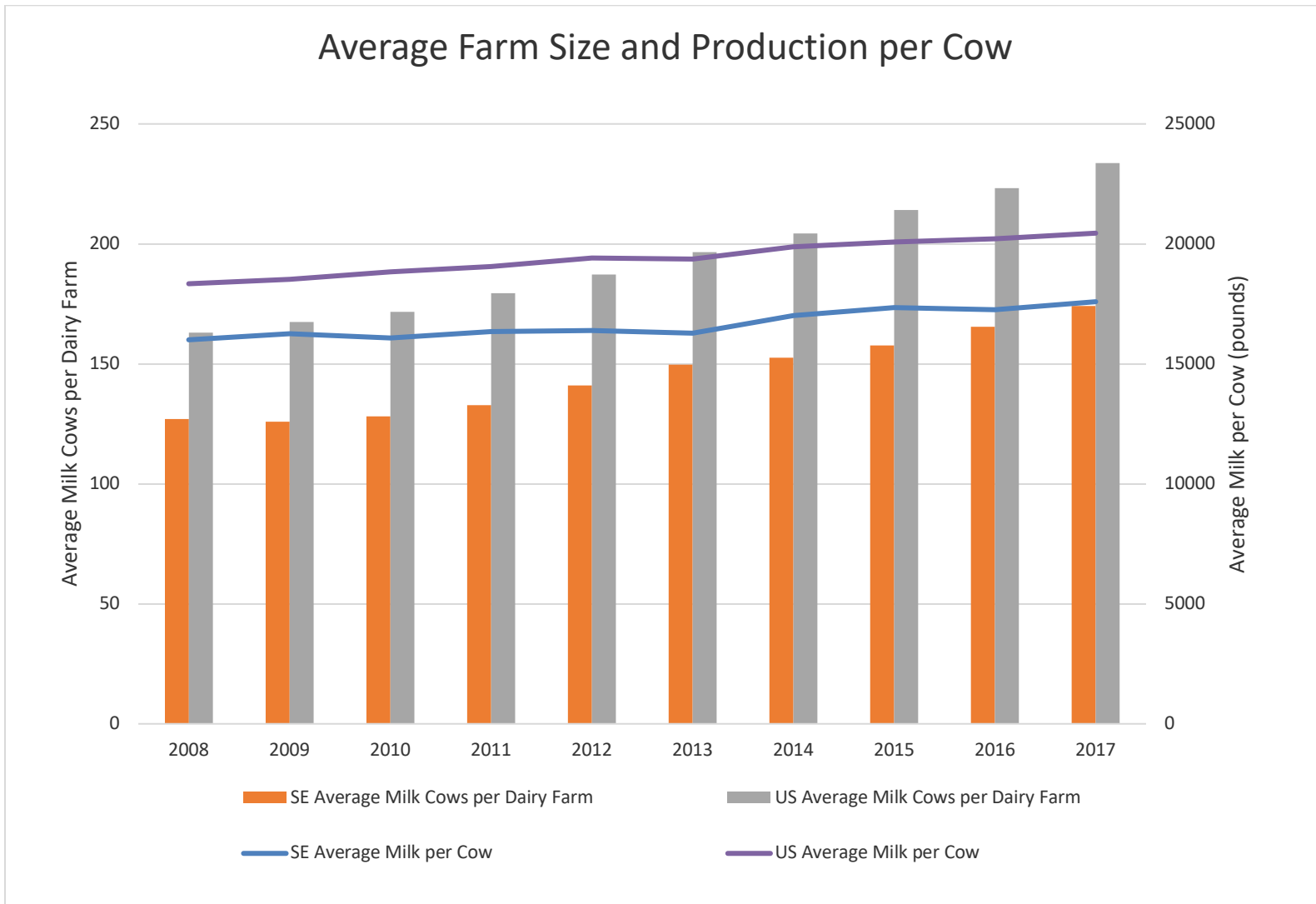**Figure 6.** U.S. Annual Dairy Production (2008 – 2017)
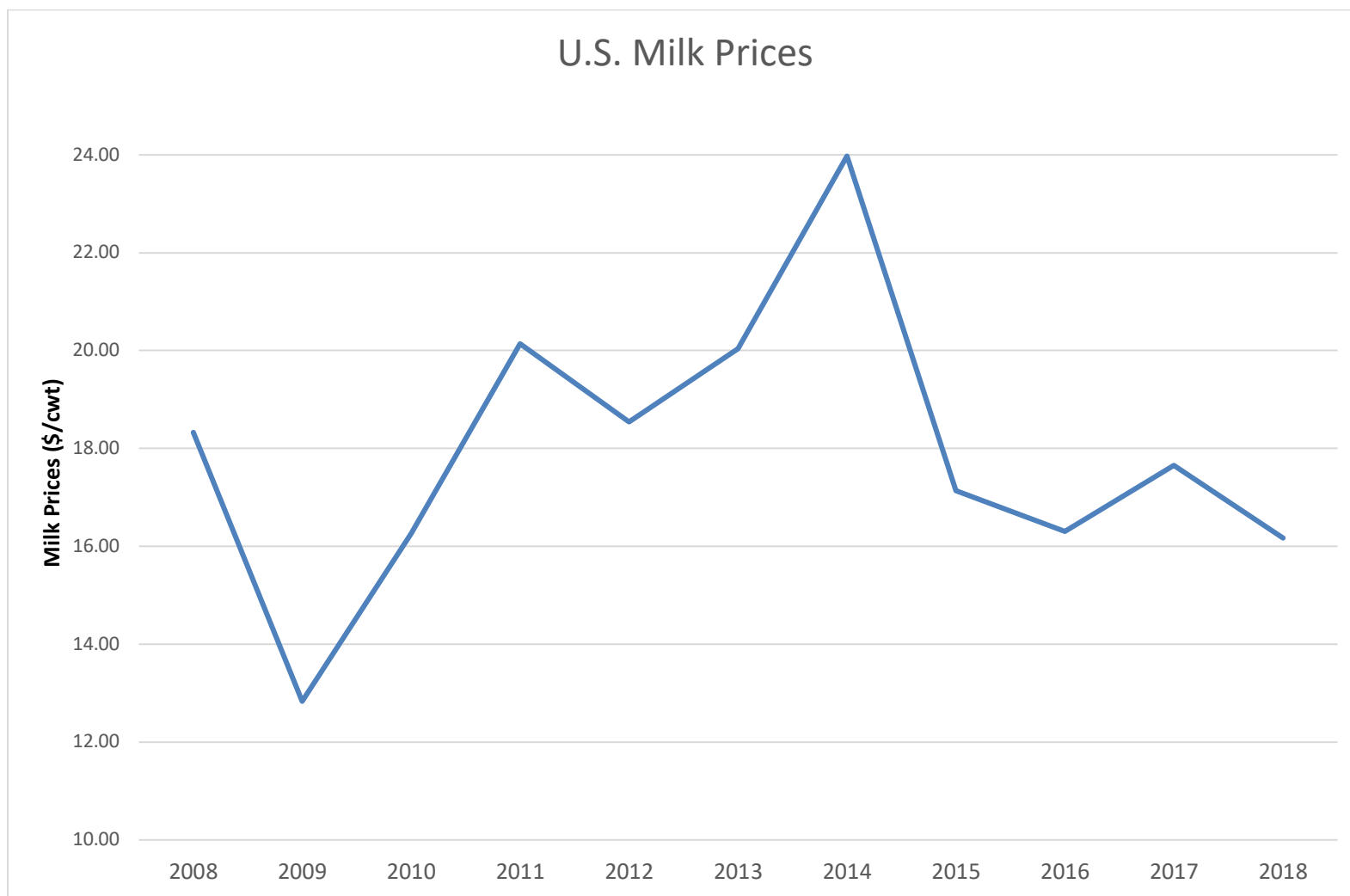
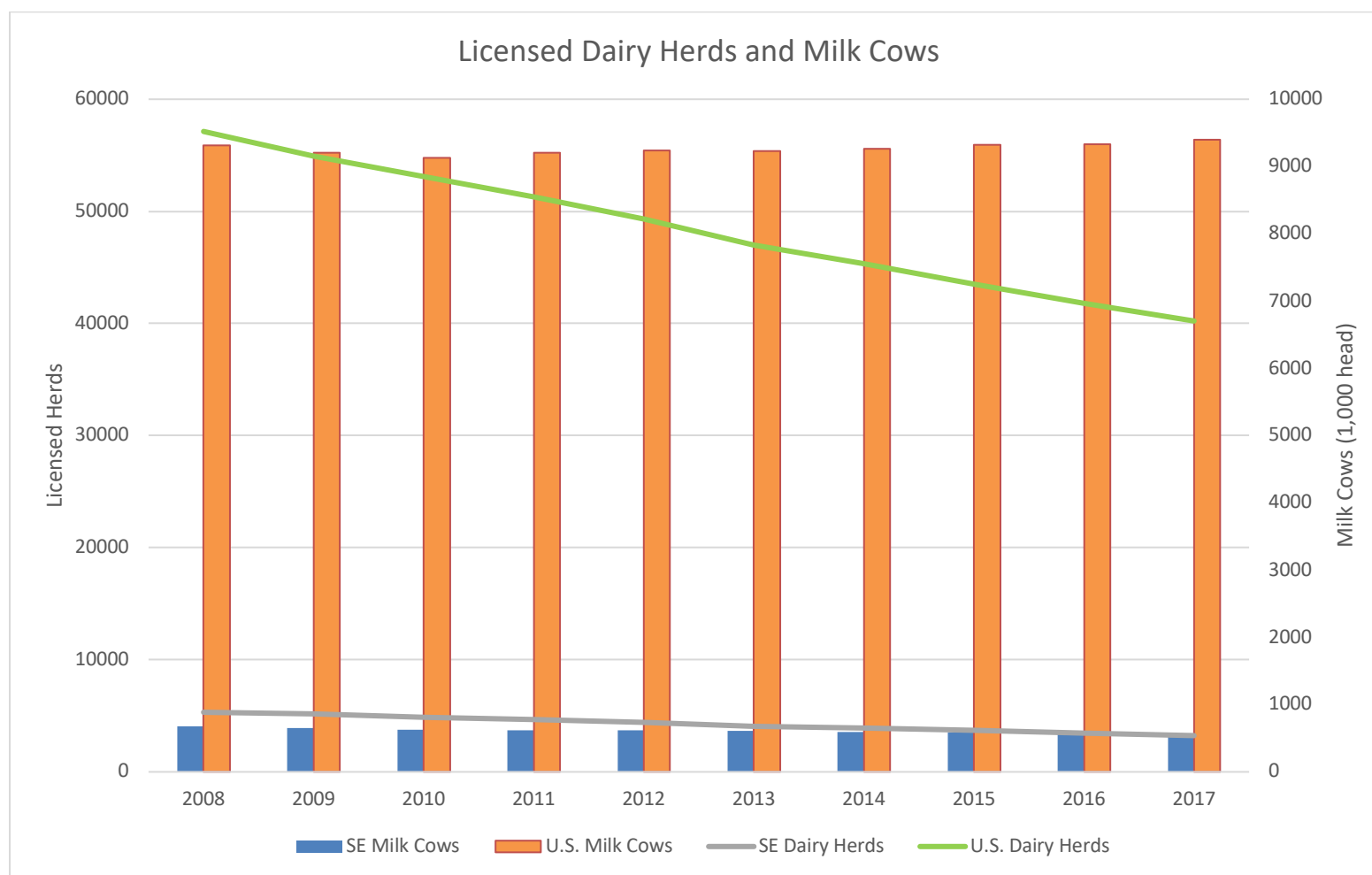**Figure 7.** U.S. Average Annual Milk Prices (2008 – 2018)

Figure 8. Southeastern U.S. Dairy Cows and Herds (2008 – 2017)

Figure 9. Southeastern U.S. Milk Production (2008 – 2017)

Figure 10. Average Farm Size and Production per Cow for the Southeastern U.S. and U.S.

Figure 11. Licensed Dairy Herds and Milk Cows in the Southeastern U.S. and U.S.

Appendix D Producer Survey

YOUR PAST DAIRY OPERATION

1. In what year was your <u>dairy</u> operation last open?

On the final page, we'll ask very important questions about other, non-dairy farm operations and the outcome of your dairy.

_____.

2. Which of these best describes your closed dairy business? _(check one)_

☐ Sole proprietorship   ☐ Partnership   ☐ Corporation   ☐ Other _____

5. How many cows were typically on your farm at any given time in the last 2 years of operation?

_____ # lactating   _____ # dry

6. What was your average milk production per day in your last year of operation?

_____ lbs.

8. What was your bulk tank somatic cell count (monthly average SCC):
(please answer all)

Last year of operation _____   One year before closing _____   Three years before closing _____

9. Did the co-op or processor you sold your milk to offer an incentive for achieving a particular bulk tank SCC? _(check one)_

☐ Yes, and the incentive was _____   ☐ No price incentive

10. Did the co-op or processor you sold your milk to impose a price penalty for exceeding a particular bulk tank SCC? _(check one)_

☐ Yes, and the penalty was _____   ☐ No price penalty

12. Were you participating in Dairy Herd Improvement Assoc. (DHIA) testing prior to your closing?   ☐ Yes   ☐ No

13. How often were you in the parlor and OBSERVING milking?

☐ Never   ☐ less than once a month   ☐ about once a month   ☐ about once a week

☐ about once a day   ☐ almost every milking

SCC, MASTITIS, AND YOU

16. Please indicate what levels of SCC and clinical mastitis best matched your thoughts and actions.

What was the lowest level of bulk tank SCC that caused you concern?

- ☐ 100,000 cells/ml
- ☐ 200,000 cells/ml
- ☐ 300,000 cells/ml
- ☐ 400,000 cells/ml
- ☐ 500,000 cells/ml
- ☐ 600,000 cells/ml
- ☐ **>**600,000 cells/ml
- ☐ other _____

PERCEPTIONS OF MASTITIS AND MASTITIS MANAGEMENT

19. Please indicate the extent to which you disagree or agree with each of these statements.
(Mark one "X" for each row.)

	STRONGLY DISAGREE	DISAGREE	NEITHER	AGREE	STRONGLY AGREE
Mastitis is a significant concern to the dairy industry in the Southeast.	☐	☐	☐	☐	☐
Mastitis was a significant concern of mine relative to other issues affecting my dairy.	☐	☐	☐	☐	☐
Mastitis causes are difficult to manage.	☐	☐	☐	☐	☐
The weather and climate play an important role in mastitis outbreaks.	☐	☐	☐	☐	☐
Bad luck plays an important role in mastitis outbreaks.	☐	☐	☐	☐	☐
My dairy barn and equipment played an important role in mastitis outbreaks.	☐	☐	☐	☐	☐
My milking practices played an important role in mastitis outbreaks.	☐	☐	☐	☐	☐
Mastitis was under control at my dairy during its last year of operation.	☐	☐	☐	☐	☐
My dairy had a serious mastitis problem one or more times.	☐	☐	☐	☐	☐
It was extremely important to me to reduce the number of clinical mastitis cases on my dairy.	☐	☐	☐	☐	☐
It was extremely important to me to decrease my bulk tank SCC.	☐	☐	☐	☐	☐
I knew what procedures to use in the parlor to decrease my bulk tank SCC or maintain my already low SCC.	☐	☐	☐	☐	☐
I could afford to do what was necessary to decrease my bulk tank SCC or maintain my already low SCC.	☐	☐	☐	☐	☐
Milk quality premiums available to me were adequate to cover the costs I incurred in producing quality milk.	☐	☐	☐	☐	☐

Mastitis seemed to persist despite my efforts to control it.	☐	☐	☐	☐	☐
The spread of mastitis from one cow to others in the herd was difficult to control.	☐	☐	☐	☐	☐
There was uncertainty and conflicting information about controls and treatment of mastitis.	☐	☐	☐	☐	☐
Mastitis is a disease of lactating and dry cows and not a problem in bred heifers.	☐	☐	☐	☐	☐

EXPERIENCES WITH SCC & MASTITIS CONTROL

20. Please indicate what experience you had with each of these practices. First, indicate whether you were using it, never tried it, or tried and discontinued it. Then, evaluate each practice first based on your perception of its *effectiveness* and then for its *practicality/cost*.

Practices:	Used this approach? (check "was using it" if you were using that practice when your dairy closed)
Having and implementing a mastitis management plan	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Training employees in milking procedures to reduce bulk tank SCC	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Delegating responsibility to employees for mastitis treatment (including antibiotic use)	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Evaluating employees based on performance with mastitis and bulk SCC control measures	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Culling based on SCC information or other mastitis indicator	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Milking mastitis and treated cows in separate groups	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Analyzing and then acting on bacterial culturing of milk samples	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Using hygienic supplies (gloves and fresh towels for each cow) for milking	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Disinfecting teats of all cows before milking (pre-dipping)	☐ Was using it ☐ Never used it ☐ Tried it, but stopped

Disinfecting teats of all cows after milking (post-dipping)	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Using vaccines to control coliform mastitis (e.g., J5)	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Routinely using antibiotic therapy to treat clinical mastitis cases	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Routinely using antibiotic therapy and/or teat sealant for dry cows	☐ Was using it ☐ Never used it ☐ Tried it, but stopped
Using biosecurity practices, such as pre-testing or quarantine, for replacement heifers and cows	☐ Was using it ☐ Never used it ☐ Tried it, but stopped

SOURCES OF INFORMATION ABOUT MASTITIS

21. Please tell us whether you used any these sources of information about mastitis management. Then rate each source twice: first according to your opinion about its reliability and second based on how easy you think the information was to understand and act upon. Please rate each source, whether or not you used it.

Information source:	Did you seek information from this source?
Veterinarian	Yes
Another dairy producer	Yes
Milk cooperative representative	Yes
County agent or other Extension representative	Yes
Farm journals	Yes
Drug company representatives	Yes
Information products from Extension online	Yes
Other online information sources (please identify): _____	Yes
Other: _____	Yes

YOUR GOALS

22. Please indicate how important each of these BROAD GOALS was for you and your dairy operation.
(Mark one X for each row.)

	VERY UNIMPORTANT	UNIMPORTANT	NEITHER	IMPORTANT	VERY IMPORTANT

ABOUT YOUR FARM'S SUCCESSION

23. Did you have farm operations not related to your dairy? (Feed production
and value added dairy products are considered part of your dairy operation)

☐ Yes ☐ No

ABOUT YOU ☐ ☐ ☐ ☐ ☐

26. In what state and zip code is/was your farm located?

State _____ Zip Code _____

27. How old are you? _____

29. Did your employees primarily speak the same language(s) as you?

☐ Yes ☐ No

31. What is the highest level of education you've reached?

☐ less than a high school degree   ☐ high school degree   ☐ some college or technical education   ☐ college degree

CONCLUSION

This thesis presented two studies relating to cattle producers and consumers in the United States through surveys. The objective of the first study was to analyze the difference between a text cheap talk script and a visual cheap talk script used in an online choice experiment for Tennessee Certified Beef. Survey participant learning style (visual versus verbal) was also taken into account to determine how this impacted the completion of the choice set.. The goal was to see if the visual cheap talk script reduced or eliminated hypothetical bias that has been witnessed in previous choice experiments. Results indidcate that consumers in the visual cheap talk script treatment had higher WTP estimates than those in the text cheap talk script treatment meaning the visual cheap talk script did not eliminate or reduce the hypothetical bias. The study did find that consumers were willing to pay more for USDA Choice boneless ribeye that is labeled with some attribute used in the study versus unlabeled steak. Results also indicated that respondents who prefer to learn verbally and received a visual cheap talk script had higher WTP estimates than those learners who received the text cheap talk script. This indicates that the visual cheap talk script did not reduced the hypothetical bias for verbal learners as anticipated. However, visual learners who received the visual cheap talk script had higher WTP estimates than visual learners who received the text cheap talk script. This also was not hypothesized; therefore, it further collaborates that the visual cheap talk script did not decrease or eliminate the hypothetical bias.

The objective of the second study was to analyze the differences between operating and closed dairies in the Southeastern United States through farm structure characteristics, operator characteristics, farm management practices, and sources of information that help operators make decisions. Results indicate that there were, in fact, certain farm and operator characteristics that

help determine the operational status of a dairy in the Southeastern United States. The size of the dairy (number of total cows and the daily average production) were significant variables in the model. As a diary was larger it was more likely that the dairy would be operational. This alone shows that operations capable of leveraging scale effects were more likely to be operational. However, other significant variables in the model indicate that there are other variables unrelated to the size of the dairy that influence the operational status of the dairy.

Results from both studies provide useful information that can be further evaluated and used in behavioral and livestock economics.

VITA

After graduating from Macon County High School in May 2014 in Lafayette, TN, Jade began her education at The University of Tennessee at Knoxville. Jade decided to complete her collegiate studies by enrolling in the Accelerated BS-MS Program in the Department of Agricultural and Resource Economics. She completed her Bachelor of Science degree in Agriculture and Resource Economics in December 2017 while beginning her Master's program the same semester. Jade accepted a graduate research assistantship at The University of Tennessee at Knoxville with the Department of Agricultural and Resource Economics. She received her Master of Science degree in Agricultural and Resource Economics in May 2019.