THESIS

A STUDY OF FACTORS THAT INFLUENCE A HORSE OWNER'S VETERINARY TREATMENT PURCHASING DECISIONS

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ABSTRACT

A STUDY OF FACTORS THAT INFLUENCE A HORSE OWNER'S VETERINARY TREATMENT PURCHASING DECISIONS

There has been very little academic research done to assess and understand how horse owners make treatment decisions for their sick or injured horses. An owner's decision to treat or euthanize their sick or injured horse is not only a financial one, but an emotional one as well. This decision can also impact the veterinarian's overall welfare. The responsibility of performing euthanasia on animals has been linked to decreased job satisfaction, health problems, and increased rates of suicide among the veterinary population. There are also potential financial implications when a veterinarian has to euthanize a patient. When a veterinarian euthanizes a patient, he or she can miss out on thousands of dollars in potential future revenues from the care of that patient. For these reasons, it is imperative that veterinarians understand what influences a horse owner's decision to treat or euthanize their sick or injured horse.

This study used a choice experiment and demographics survey to gather data from Colorado horse owners that was analyzed to better understand the decision-making behavior of horse owners. The main effects fractional factorial choice experiment was designed using SAS 9. In each choice set, the respondents ranked the most preferred and least preferred of three choice alternatives (Treatment A, Treatment B, and Euthanasia) they could hypothetically face if their horse was suffering from obstruction colic. The attributes for Treatment A and Treatment B were price, recovery period length, and success rate. These three attributes varied between choice alternatives and across choice sets. The only attribute for euthanasia was price, which remained constant across all choice sets. The choice experiment was included with a demographics survey and was distributed to Colorado horse owners via

an anonymous Qualtrics link. The demographic questions provided further insight information about the horse owners on an individual level. The data was analyzed using a rank-ordered logit model in STATA. The first of two regressions in this study involved only the treatment attributes and a euthanasia dummy variable, and the other including treatment attributes and demographic interactions. The initial regression found that an increase in price and recovery period decreased the probability that an alternative was ranked as a more-preferred option. An increase in success rate had the opposite effect. When the demographic interactions were included in the analysis, the impact of recovery period on the ranking of an alternative was no longer statistically significant. Only certain demographic interactions were statistically significant as well. Most notably, an increase in income only had a statistically significant effect on how changes in success rate affected the ranking of an alternative. The coefficients from the initial regression were used to calculate the willingness-to-pay (WTP) values for recovery period length, success rate, and avoiding euthanasia. The WTP values suggest that horse owners most value the success rate of a treatment and are willing to pay up to $2,610 for treatment in order to avoid euthanizing their sick or injured horse. This study can serve as a baseline for future research into the veterinary spending behavior of horse, livestock, and pet owners. The results from this study can also be utilized by veterinarians to better understand their clients. With this information, veterinary clinics can make decisions that are better for their patients, their clients, and themselves.

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INTRODUCTION

The equine industry plays a pivotal role not only in Colorado's economy, but also in the personal and professional lives of its residents. Colorado's equine industry affects over 100,000 residents in the state, with over half of those being horse owners. Those involved in the Colorado equine industry pay to compete in shows, own equine-based businesses, and purchase veterinary services for their horses, among other things. All of the employees, volunteers, and horse owners within this industry contribute $1.6 billion annually to Colorado's economy (Deolite, 2005). The financial decisions of these individuals, including those regarding the veterinary care of their horses, have a direct impact on Colorado's economy.

Horse owners are often forced to make difficult treatment decisions regarding the veterinary treatment of their sick or injured horses. An illness or injury severe enough can require owners to make a decision between treating or euthanizing their horse. These decisions are often based on the price of the treatment, the length of the recovery period, and the success rate of the treatment (i.e. the probability the horse will recover completely). The decision to euthanize a sick or injured horse is extremely emotional for both the owner and the veterinarian performing the euthanasia. When owners choose to euthanize their sick or injured horse, the veterinarians who perform this procedure often deal with emotional consequences as a result. There can be financial implications from euthanizing a patient for veterinarians as well. The veterinarians are not only losing potential revenue from treatment of the present injury or ailment, but also all potential revenue from future maintenance care and treatments as well.

The objective of this research is to understand how Colorado horse owners make the decision to treat or euthanize their sick or injured horse. Taking into account the price, length of recovery period, and the success rate of the treatments offered, this research aims to understand how horse owners

value each attribute when making treatment decisions for their sick or injured horse. This research also seeks to calculate the treatment price point at which the average Colorado horse owner chooses to euthanize instead of treat their horse. It is hypothesized that horse owners are willing spend more on a treatment if the success rate is higher. The impact of a respondent's demographic information on how they react to changes in price, recovery period, and success rate is also assessed. Information from this relationship will provide more insight into how different horse owners make their treatment decisions. The information gained from this research will help to inform veterinarians about how and why their clients choose to treat or euthanize their sick or injured horse. With this information, veterinarians can make appropriate pricing and management decisions given their client base.

BACKGROUND

Colorado Equine Industry

The state of Colorado has a large equine population with a variety of breeds, disciplines, and owner demographics. A 2005 national survey by the American Horse Council Foundation (AHCF) assessed the economic impacts of the equine industry in the United States. In that survey, Colorado was identified as a "break-out state". Data regarding the Colorado equine industry and its economic impact were collected and analyzed to assess the impact of the equine industry on Colorado's economy. The results of the AHCF survey determined that the Colorado equine industry contributed a total of $1.6 billion annually to the state's economy. The $1.6 billion economic contribution was divided by horse use, with $94 million coming from the horse racing industry, $587 million from horse showing, $607 million from recreational use, and $276 million from other equine activities. Of the 102,417 Colorado equine industry participants identified in the AHCF survey, 55,686 were horse owners, 11,631 were employed by an equine-related business, and 35,100 were volunteers. The showing and recreation sectors were found to be the greatest contributors to equine industry employment, followed by other activities and horse racing (Deolite, 2005).

The 2005 AHCF survey identified 55,686 Colorado horse-owning households. These households were primarily located in towns of less than 50,000 people (66%). The majority of Colorado horse-owning households (53%) made less than $75,000 a year. In fact, 30% of horse-owning households made less than $50,000 a year while 23% reported a salary ranging from $50,000 to $74,999. An additional 17% of horse-owning households made between $75,000 and $99,999 annually. Only 27% of horse-owning households had an annual salary of more than $100,000, with three percent of respondents not reporting their income. The AHCF survey also found that the Colorado horse owners surveyed were primarily between the ages of 30 and 59 (73%), with 44% of those respondents being between the ages

of 45 and 59. Of those owners outside of the 30 to 59 age range, 15% were between 18 and 29 and 11% were over the age of 60 (Deolite, 2005).

The total equine population in Colorado identified in the 2005 AHCF industry survey consists of 255,503 horses. The two breeds most represented in the Colorado equine industry were quarter horses and thoroughbreds, contributing 106,624 horses and 17,775 horses to the Colorado equine population, respectively. All other breeds combined, both registered and unregistered, made up a population of 131,300 horses. Of the 255,503 Colorado horses identified in the 2005 survey, 106,624 were used for recreational purposes, 76,979 for showing, 10,113 in racing, and 61,787 were used for other equine activities. Quarter horses were the primary breed used for showing and racing, followed by the "other breeds" category, and, finally, thoroughbreds. The "other breeds" category dominated recreational and other uses, followed by quarter horses and thoroughbreds (Deolite, 2005).

Obstruction Colic

Colic is the second most-common reason for horse deaths, after dying of natural causes (e.g. old age). In 1998, the USDA's National Animal Health Monitoring System conducted a study on equine colic. The study determined that 4.2% of horses in the United States suffer from some form of colic each year. It was also determined that 1.2% of colic cases require surgical treatment and 11% of colic cases are fatal. The study found that equine colic cost American horse owners $118 million in 1998. That number is expected to have increased since the study was performed (House, 2003).

Colic is a generic term used for acute diseases that cause abdominal pain in horses and can result from diseases in any abdominal organ. Common signs of colic are pawing, stretching out, kicking of the abdomen, biting of the abdomen, teeth grinding, bloated abdomen, and rolling. Additional warning signs include loss of appetite, decreased bowel movements, loss of gut sounds, lip curling, depression, and laying down more than normal. Early identification of these symptoms is key to successful treatment (House, 2003).

While some colic cases occur elsewhere in the abdomen, this study focuses on gastrointestinal colic, particularly intestinal accidents, which will be referred to in this paper as "obstruction colic".[1] Other types of colic that can occur in gastrointestinal system are intestinal dysfunction, and intestinal inflammation or ulceration. Obstruction colic is generally the result of a displaced colon, twisted intestines, and strangulation of the intestines. They are considered "accidents" because there are not any methods of preventing the obstructions and they happen randomly. Colon displacement, for example, occurs when a portion of the intestinal tract moves into an abnormal part of the abdominal cavity (House, 2003). Colon displacement can be to either the right or the left side of the abdomen and is usually caused by an accumulation of gas in the colon or changes in motility. Twisted intestines, also known as colon torsion, occur when the colon, and sometimes the cecum, are displaced and twisted around each other, reducing blood flow to the colon and cecum tissue. Abnormal gas distension in the colon is suspected to be the cause, and the majority of torsion (65%) occurs in mares. Strangulation of the small intestine is usually caused by two problems: strangulating lipomas and the trapping of the small intestine into the epiploic foramen. Strangulating lipomas are benign fatty tumors that, as they grow larger, create a rope-like structure around which the bowel can become entangled. This usually occurs in older horses. The epiploic foramen is a small opening between the pancreas and the liver to where the small intestine sometimes migrates. The small intestine can become trapped there when the bowel fills with fluid (House, 2003).

Obstruction Colic Treatments

In a 1997 study of equine colic incidence and mortality, 31 horse farms in two adjacent counties in Maryland and Virginia were monitored to estimate the morbidity and mortality rates of equine colic. The study tracked 1427 horses over the course of a year. In this study, 86 horses were reported to have had an episode of colic. Of these horses, 72 had only one episode of colic during the research period, 11

[1] An overview of the anatomy of the equine gastrointestinal system can be found in the appendix.

had two episodes, two horses had three episodes, and one horse had four episodes. Out of the 104 total colic episodes reported, 15 resolved on their own, 88 were treated by the owner or a veterinarian, 18 received pain medication without first being evaluated by a veterinarian, five were examined by a veterinarian but were not given any medication, and 65 were examined by a veterinarian and provided with medical treatment. Four horses in this study required surgical treatment. The four surgical cases were the result of strangulating lipoma, stomach impaction, large colon torsion, and testicular torsion. The horses suffering from strangulating lipoma and large colon torsion had to be euthanized at surgery (Tinker et al., 1997).

While obstruction colic can sometimes be treated through purely with medicine, torsion and intestinal strangulation often require surgical treatment. Colon displacement to the left side of the abdomen can be treated medicinally or through the rolling of the horse. Colon displacement to the right usually requires surgical treatment. Colon torsion requires immediate veterinary action, as the condition of the horse can deteriorate very quickly. Treatment for colon torsion begins with aggressive medical treatment to stabilize and prepare the horse for emergency surgery. Emergency surgery is also required if the bowel becomes strangulated. Because the bowel tissue cannot survive without blood flow and oxygen, the strangulated portion may have to be resected during surgery. Success rates for surgeries involving colon torsion or strangulated bowels have improved from about 40% to 50% survival rates twenty years ago to between 70% and 80% in more recent years (Tinker et al., 1997).

LITERATURE REVIEW

Human-Equine Relationship

The relationships between horses and humans, as well as the emotional implications of euthanasia for horse owners, are well documented in peer-reviewed literature. Horses were historically economically valued as livestock, used as tools for travel and work. In more recent years, horses have become emotionally valued companion animals for families (Endenburg, 1999). In a 2015 equine industry survey completed by Zoetis, 67.4% of horse owners considered their horses as members of their family while only 22.4% of owners characterize their horses as investments (Zoetis, 2015). Given the strong emotional connection between owners and horses, the decision to euthanize can be emotionally challenging for owners. A 1999 study of the veterinarian's role in the process of equine euthanasia used grief index values from one to ten to measure the level of grief experienced by an owner after the euthanasia of their horse. On this scale, one was the lowest level of grief experience by the owner and ten was the highest. This study found that the average grief index value for horse owners who had to euthanize their horse was 8.5 and the grief period lasted an average of 4.4 months. These values show that the grief experienced by the owner after the euthanasia of their horse is powerful and persistent. The respondents to this study were primarily women (98%), indicating the potential for possible gender bias (Endenburg et al., 1999).

Veterinarians and Euthanasia

Euthanasia is not only emotionally difficult for the owners, but has health and welfare implications for the veterinarians performing the procedure as well. Performing euthanasia procedure on an animal has negative impacts on the emotional, physical, and mental wellbeing of a veterinarian. It has been shown that the act of performing euthanasia decreases job satisfaction and increases job burnout (Hansez et al., 2008). The physical ailments associated with the stress of performing euthanasia

include ulcers, high blood pressure, and substance abuse. The mental conditions associated with the performance of euthanasia procedures include depression, grief, and trouble sleeping (Woods et al., 2010).

The performance of euthanasia procedures has been shown to be a major stress factor for veterinarians that, in conjunction with other factors, can lead to increased risk of suicide (Platt et al., 2010). Veterinarians are four times more likely than members of the general population to commit suicide. While long hours, lack of work-life balance, and poor work environments contribute to depression and suicide rates among veterinarians as well, exposure to euthanasia is also a major factor. The relationship between exposure to euthanasia and fearlessness towards death leads to increased rates of death by suicide, as fearlessness towards death is a predecessor to fatal suicide attempts (Witte et al., 2012).

Horse Owner Decision Making

Many factors influence an owner's decision to treat their sick or injured animal. A 2008 study by Wolf et al. shows that client spending is largely correlated with household income. As average household income increased over the span of the study, from 1980 to 2005, the amount spent on pet care also increased. The increase in average household income allowed for an increase in the human-animal bond that was previously discussed. Additionally, as the age of the pet owner increased, the probability of their household having veterinary expenses also increased. The region in which the owner lived also impacted how money was spent on pet care. Pet owners in the Western United States had, on average, 1.3% to 1.6% higher veterinary expenses than those in the Northeast. Race was influential on a household's veterinary spending. African American, Asian, and Native American households were 9.8%, 9.2%, and 3.8% less likely to have veterinary expenditures, respectively. Homeownership was correlated with the probability of having veterinary expenditures as well. Pet owners who rent their residence were 2.9% less likely to have veterinary expenditures than those who own their home (Wolf et al., 2008).

Some animal owners, especially those with multiple pets and children, make mental budgets with consideration to their disposable income. Often, these mental budgets affect the way owners make financial decisions for the veterinary care of their animals. Pet owners consider future potential costs for the health of their children and pets. They may choose to forego expensive veterinary treatments for one pet, in order to preserve funds for the care of the children and other pets. The anticipation of financial guilt can influence an owner's decision to purchase treatment, particularly when children and other financial responsibilities are taken into account. Financial guilt is dependent on the owner's perceived social-responsibility regarding the treatment of their animal (Brockman et al., 2006).

The relationship of an owner with their animal plays an important role in a client's willingness to pay for treatment. According to Brockman et al. (2016) those with deeper emotional attachments are willing to spend more on veterinary care, regardless of the success of the treatment. The emotional attachment in some owners is often so strong, they are not willing to let go of the pet, even if it is for the good of the animal. Those with deep emotional relationships with their pets can feel guilty if they do not purchase the expensive treatment for their pet. Those who value their pets as less-than-human can feel guilty if they do purchase the expensive treatment, as they could use that money for other important purchases. An owner's decision to treat their animal is also influenced by their relationship with their veterinarian (Brockman et al., 2006).

Trends in Demand for Veterinary Care

There is literature regarding the emotional impacts of euthanasia on owners and veterinarians, as well as the health ramifications of performing euthanasia on veterinarians. However, there is very little literature about the financial implications of euthanasia. According to a study by Wolf et al. (2008), overall veterinary spending in the United States was on the rise before the great recession of 2008. When owners have a more emotional relationship with their horses, their willingness to seek veterinary care for their sick or injured horse increase. Because the relationships between owners and their horses

have become more emotional in recent years, it follows that veterinary spending was on the rise. As a horse ages, their emotional value to the owner increases even further. Subsequently, the owner's willingness to seek veterinary care also increases. Additionally, as a horse ages, it becomes more prone to develop health problems, leading to potentially higher veterinary care costs (Ireland et al., 2010).

Willingness-to-Pay

A common measure used in economics to estimate the value of a good or service is an individual's maximum willingness-to-pay (WTP) for it (Gafni, 1998). The WTP value is important in marketing research to determine consumers' attitudes towards a good or service (Vlosky et al., 1999). WTP research has been conducted for natural resource conservation and endangered species protection as well (Pate and Loomis, 1997; Kotchen and Reiling, 2000). The WTP measurement has also been used to understand how consumers value organic produce and humanely raised food animal products (Didier and Lucie, 2008; Dransfield et al., 2005).

Consumer choice behavior, and thus WTP values, are dictated by an individual's emotions, perceptions, and thought processes. These processes determine the choice alternative chosen by an individual in a market situation (Svenson, 1979). The quality of a product or service is the function of the perceived quality and the objective quality. Perceived quality is the value or quality assigned to a product or service through the consumer's emotions, perceptions, and thought processes. The measurable, technical, and verifiable aspects of a product or service determine its objective quality. Perceived quality can be broken into two contributing categories: intrinsic and extrinsic attributes. Intrinsic attributes are the physical aspects of the product or service such as its physical appearance or the components of the service provided. Extrinsic attributes are those that are related to the product or the service but are not a physical component, such as price, branding, country of origin, quality assurance programs, and production information (Espejel et al., 2007). Other factors that contribute to an individual's WTP for a product or service are the individual's demographic information. This includes

age, gender, household income, and education, as well as other demographic factors. An individual's demographic information influences how they evaluate the attributes associated with a product or service, the choices they make, and their WTP for the product or service (Hensher and Bradley, 1993). Age, gender, household income, and education are suggested to be the most influential when determining and individual's WTP for a good or service (Krystallis and Chryssohoidis, 2005). Other factors that influence an individual's WTP for a product or service include their attitudes and feelings towards the product or subject of the service.

Stated Preferences vs. Revealed Preferences

Stated preferences and revealed preferences are two different methods used when estimating individuals' WTP for a product or service. Stated preferences data are derived from responses to hypothetical situation and intended behaviors. Researchers utilize the stated preferences method when actual market values cannot be derived from market transactions. For example, this method is often used to value environmental amenities because there is no direct use of the resource, and thus no actual market transactions to track (Louviere, 1988). The stated preferences model can also be used when revealed preferences techniques could be utilized, but their effectiveness would be hindered by a lack of independent variation in the resource being researched. This leads to an inability to estimate the resource's impact on consumer behavior. Stated preference models tend to be survey-based studies in which respondents are asked questions, often modeled as hypothetical choice situations, through which the respondents' preferences and attitudes towards the product or service in question can be determined (Freeman et al., 2014).

Revealed preferences data are representative of consumer behavior since they are derived from actual market behavior that is either observed by researchers or reported by individual consumers. Revealed preference data can be collected for one or more time periods and through different types of experiments (Ben-Akiva et al., 1994). Laboratory experiments measures an individual's WTP through

market simulations in which participants are given a sum of money and asked to spend said money on a specific assortment of goods or services, where the choices and their prices are changed systematically. Another type of an experiment to gather revealed preferences data is field experiments. In field experiments, participants are aware of the fact that they are participating in an experiment and it is conducted within a "test market". In these "test markets", individuals often take longer to respond to price changes and tend to have higher expenditures than those in lab experiments (Breidert et al., 2006).

Both stated and revealed preference models have been used to evaluate consumer preferences and market behavior, but stated preference methods are preferred when studying health care decisions, as well as other similar scenarios. In addition to being useful when a real market does not exist, stated preference methods are also ideal when it is unrealistic to obtain data from the real market. Both stated preference and revealed preference methods have benefits and drawbacks. However, the benefit of the stated preference method is that it can often be used when measuring WTP values through revealed preferences methods is not possible, or may be inaccurate (Adamowicz et al., 1994). Additionally, using stated preference methods provides researchers with more control over the attributes, attribute levels, and hypothetical questions being asked (Bates, 1988). Drawbacks of the stated preference method are that the data has the potential to be bias because of unrealistic estimation of what respondents would do in a real-life situation. Other factors, such as survey fatigue, misunderstanding, and distractions may also affect the accuracy of the responses given (Bates, 1988). Revealed preference models, alternatively, are based on real decisions made by consumers, as opposed to hypothetical ones. Drawbacks to revealed preferences methods include the fact that individuals may not be aware of the options available to them. Collinearity is also a potential problem in revealed preference models due to the limited variation in attributes and products in the real-life situations (Brownstone et al., 2000).

Conjoint Analysis and Choice Experiments

Conjoint analysis has been frequently used in economics to understand consumer choice behavior, as well as in psychology and mathematics. Conjoint analysis is a method used to predict consumers' preferences for various goods or services that possess multiple attribute options and estimate the utility consumers derive from a good or services. The estimation of consumers' utility allows researchers to calculate a measure of individuals' WTP for the good or service being researched (Green and Srinivasan, 1978). Over the past few decades, theory and methods of conjoint analysis have morphed and evolved to allow for the development of choice experiments. These choice experiments are a form of conjoint analysis that collect responses from participants that identify a "best" and "worst" options among the choices proposed. The analysis of data obtained through choice experiments can then serve to forecast consumer purchasing behavior (Louivere, 1988).

Choice experiments are often used to understand how consumers value products or services. Within the human health industry, choice experiments are used to assess client experiences, health outcomes, utility weights of health care choices, job choices, health professional preferences, and other topics. WTP is a common output measure for choice experiments. It allows researchers to measure the marginal value of an attribute in addition to the total value of that attribute (Bekker-Grob et al., 2010). In a choice experiment, respondents are presented with a variety of choice sets, each with multiple options from which to choose. The respondents are asked to choose from the options given in the choice set based on the attributes that are specific to each option. The attributes for each option vary between choice sets. Based on the choices made by respondents, researchers can determine which option is most desirable. The main advantage of this research method is that researchers have control over the choice sets, allowing them to design the experiment in a way that that derives the most information from the respondents (Lusk and Norwood, 2005).

When designing a choice experiment, one must consider level balance, orthogonality, minimum overlap, and utility balance. Level balance occurs when the levels of each attribute are shown equally often. Orthogonality exists when attribute levels occur with equal frequency as the levels of other attributes in each choice set. A proper choice experiment also exhibits minimum overlap of attribute levels in each choice set. Utility balance ensures that the probability of each option being chosen in a choice set is nearly equal.

Identification and efficiency are also important factors when designing a choice experiment. Identification ensures that the effects of each attribute can be estimated separately from the effects of others. The accuracy with which these effects are estimated is the efficiency (Kuhfeld et al., 1994). Efficiency is often measured as D-efficiency. D-efficiency is a quantitative value of efficiency, calculated by taking the geometric mean of the eigenvalue as is explained in more depth in Kuhfeld et al. (1994). Recently, statistically efficient designs have taken priority over orthogonality. In creating statistically efficient designs, prior knowledge regarding the parameters is taken into account. These prior assumptions can be input into programs such as SAS in order to maximize the efficiency of the experiment design (Bekker-Grob et al., 2010).

While a large experiment design is more statistically efficient, it can be extremely difficult to administer large experiments. As a result, smaller experiment designs are often used for easier administration and analysis. When using a smaller experimental design, accuracy and efficiency can be obtained with proper design and a large sample size (Lusk and Norwood, 2005).

There are seven main categories of choice experiment design often used in literature: full factorial, fractional factorial, main effects with a two-way interaction, minimizing designs, bin method, random draw, and endpoints design. The full factorial design is the most orthogonal and efficient as it includes every possible combination of attributes and attribute levels. Due to administrative difficulties, the full factorial choice experiment design is rarely utilized. The fractional factorial design uses subsets

of attributes and levels derived from the full factorial design. Fractional factorial designs can account only for main effects or for main effects and interaction terms. The main effects design is the most common choice experiment design used in research of the health industry (Bekker-Grob et al., 2010). The minimizing design is also derived from the full factorial design. To create a minimizing design, the researcher randomly selects observations, and then calculates D-efficiency. This process continues until D-efficiency is maximized. The minimizing design is not often used due to limited orthogonality of attributes. The block method, also derived from the full factorial design, creates a fractional factorial choice experiment, but divides choice options into blocks from which options for choice sets are selected. This process continues until the appropriate number of choice sets are created. The random draw choice experiment design randomly draws options from the full factorial design, without replacement of those options. In the endpoints design, the only two attribute levels respondents can choose from are a high and a low value (Lusk and Norwood, 2005). Fractional factorial designs are often used in medical choice experiments. For example, a 2008 study evaluated the effect of a WTP versus willingness to accept (WTA) format of a choice experiment on the respondents' preferences. This study utilized a choice experiment using attributes and options relating to hearing aid provisions transferred from the medical to the private sector. Grutters et al. (2008) used a fractional factorial design accounting for only main effects in order to reduce the number of choice sets necessary to be efficient.

Attribute nonattendance and survey fatigue are biases that must be considered during the choice experiment design process and administration. Attribute nonattendance occurs when a survey has too many attributes, giving respondents the opportunity to ignore certain attributes when making a choice in an experiment scenario. Respondents are affected by survey fatigue when they are given too many choices and the survey is too long. Both issues lead to inaccurate and inefficient estimates. An additional bias that must be avoided when administering a choice experiment is hypothetical bias. In a hypothetical choice experiment, respondents often exhibit a higher WTP than in a real-life situation. To

avoid hypothetical bias, “cheap talk” is often utilized, providing respondents with a script informing them that they are expected to make decisions as though they are spending real money (Widmar and Ortega, 2014).

There are different methods of choice experiment and survey administration. One method that is becoming more common with developing technology is web-based distribution. The main benefit of web-based distribution is the low cost, as there are no travel or mailing costs. Additionally, web-based administration allows for larger sample sizes, faster responses, and more accurate and continuous data collection. The format of the questionnaire can also be more visually appealing for respondents, as well as include prompts and alerts if the respondents miss or incorrectly answer a question. Additional information can be provided by way of drop down boxes and graphics. Web-based questionnaires can be more easily randomized and distributed in multiple languages. For some respondents, the internet is also more convenient than in-person, phone, or mail-based surveys and choice experiments. Disadvantages associated with web-based distribution are non-response and sample base bias. Non-response bias is associated with low response rates and occurs when those who do not participate have very different preferences than those within the sample. Sample base bias is present when there is non-random exclusion from the sample. This can be a problem when the contact information for respondents comes from a particular database that does not represent the entire population that is sampled. Another potential disadvantage of web-based administration is that researchers have no control over who is actually responding to the choice experiment and if there are multiple potential respondents at a particular web address.

Another method of distributing surveys and choice experiments is by mail. Mail-based surveys can result in higher response rates and larger sample sizes (Convers et al., 2008) and can be ignored, just as emailed web-based surveys can. There are also expenses associated with mailing questionnaires and mail-based surveys are not as flexible as web-based questionnaires (Fleming and Bowden, 2009).

A third method of survey and choice experiment administration is in-person. In-person surveys have higher response rates than web-based surveys, but do not yield statistically different results than web-based surveys. In-person surveys can potentially allow for the presentation of more complex information and scenarios. When the survey is conducted in-person, the researcher can better evaluate the respondents' understanding of the questions presented. Non-response bias is also lower for in-person surveys. Conducting surveys in-person can be expensive as the result of travel costs and labor. Additionally, the results can be bias because of interviewer effects. There are also time constraints associated with in-person interviews, as interview time can affect the respondent's understanding of the scenarios and information presented (Marta-Pedroso et al., 2007).

Best-Worst Methods

Best-worst scaling methods are a type of choice experiment in which respondents are asked to choose both their most preferred and least preferred options in a choice set. Identifying a most preferred and least preferred alternative allows for a more efficient estimation of preferences than simply asking the respondents to pick their most preferred option. Best-worst methods allow researchers to ask respondents to either choose a most preferred and least preferred attribute for an option, or rank the most-preferred and least-preferred options in a list of multi-attribute options themselves. The former allows for the analysis of the importance of each attribute individually while the latter is utilized to understand how each attribute contributes to the overall utility the respondent will obtain from a particular alternative. The ranking of multi-attribute options also allows for the estimation of respondent WTP for a particular multi-attribute profile (Costanigro et al., 2014).

METHODOLOGY

Random Utility Theory

According to economic theory, decision makers are rational (Cascetta, 2001). For this analysis, a choice experiment based on random utility theory was used to test if horse owners are rational decision makers regarding treatment versus euthanasia for a specific equine disease. Random utility theory states that an individual decision maker (*i*) has an exclusive set of *j* choice alternatives (*j*) to make a decision. Choice sets (D), are a set of *j* choice alternatives from which the decision maker has to choose and may vary between decision makers. The choice set given to an individual decision maker is denoted as D^i. Random utility theory also states that each alternative is assigned a perceived utility (U_j^i) by the decision maker and each decision maker chooses the option with the highest perceived utility. The perceived utility of the option is the result of a combination of measurable attributes and is represented as $U_j^i = U^i(X_j^i)$, where X_j^i represents the vector of attributes associated with each choice alternative, *j*, that the individual decision maker, *i*, chooses from. The perceived utility value of each choice option is not known by the researcher and thus must be represented by a random variable. The overall probability that one choice alternative will be chosen over another can be represented as:

$$P^i(j/D^i) = Pr\,[U_{j1}{}^i > U_{j2}{}^i \; \forall j_2 \neq j_1 \,,\, j_1 \in D^i] \qquad (1)$$

Where j_1 and j_2 are representative of an alternative (j_1) being ranked over a different alternative (j_2). The individual decision maker's utility is the sum of the expected utility for alternative *j* (V_j^i) and the random residual (ε_j^i). The random residual accounts for the uncertainty in the choice model. Perceived utility for alternative j_1 is shown as:

$$U_j^i = V_j^i + \varepsilon_j^i \qquad (2)$$

Where $V_j^i = E\,[U_j^i]$ $\sigma^2_{i,j} = Var\,[U_j^i]$

And $E[V_j^i] = V_j^i$ $\quad$ $Var[V_j^i] = 0$

$E[\varepsilon_j^i] = 0$ $\quad$ $Var[\varepsilon_j^i] = \sigma^2_{i,j}$

Combining equations 1 and 2 yields:

$$P^i(j_1/D^i) = Pr[V_{j1}^i - V_{j2}^i > \varepsilon_{j1}^i - \varepsilon_{j2}^i \; \forall j2 \neq j_1, j_1 \in D^i] \quad (3)$$

Equation 3 shows that probability of a particular choice is a function of the utilities of all available choices, as well as the probability law of random residuals (Cascetta, 2001). That is, when a decision maker makes a particular choice, they are taking into account the perceived utility from each alternative with which they are presented.

Choice Experiment Design

A fractional factorial experiment design was implemented to better understand how horse owners make decisions about treating their sick or injured horse.[2] The fractional factorial design was derived from a full factorial design and was an efficient main effects design. The full factorial design, and subsequent fractional factorial choice experiment were created using SAS (Kuhfeld et al., 1994).

As main effects fractional factorial designs can be unrealistic to administer due to the number of possible choice sets, the "block" method was used to reduce the number of choice sets in this choice experiment (Costanigro et al., 2013). That is, SAS generated two blocks, each with eight choice sets (SAS 9.3). In the case of this survey, each choice set constituted its own question. One choice set within each block had an obviously dominant choice alternative; therefore that choice set was dropped from each block because it would not provide any information about the respondents' decision-making behavior. Fourteen different choice sets remained, divided into two blocks of seven. Within each block, there

[2] The difficulty in administration associated with a full factorial design can lead to difficult analysis and biases including attribute non-attendance bias and survey fatigue. For these reasons, a fractional factorial experiment design was used instead of a full factorial design.

were three varying levels of the price, success rate, and recovery period attributes for each treatment option.

Euthanasia only had one attribute, price, which remained constant across all choice sets and blocks. Each respondent was responsible for answering questions in one block and the blocks were distributed randomly to the respondents. Respondents were asked to rank the most preferred and least preferred of the three alternatives they were presented with in each of the seven choice sets within their block.

This choice experiment was designed based on the perceived utility equation, represented by equation 4:

$$V^i = \beta_{0_\varepsilon}\delta_\varepsilon + \beta_1 P_J + (\beta_2 R_J * \lambda_t) + (\beta_3 S_J * \lambda_t) + \varepsilon\,, \tag{4}$$

where δ_ε is the dummy variable associated with the ranking of euthanasia as the most preferred or least preferred option. In equation 4, P_J is the price of the chosen alternative, R_j is the recovery period of the ranked treatment alternative, S_j is the success rate associated with the ranked treatment alternative, and λ_t is the dummy variable associated with the ranking of a treatment as the most preferred or least preferred option. All betas (β) represent estimated variable coefficients. The perceived utility function noted in equation 4 can be into two separate functions:

$$\lambda_t = 1 \rightarrow V^i = \beta_1 P_J + \beta_2 R_J + \beta_3 S_J + \varepsilon \tag{5}$$

$$\delta_\varepsilon = 1 \rightarrow V^i = \beta_0 \delta_\varepsilon + \beta_1 P_J \tag{6}$$

In equation 5, either Treatment A or the Treatment B was assigned a rank by the decision maker as either the most preferred or least preferred option, taking into account the alternative's price, recovery period, and success rate. In equation 6, Euthanasia was given a most preferred or least preferred rank by the decision maker. As Euthanasia did not have a recovery period or success rate, neither attribute

contributed to the utility obtained by the respondent when choosing that alternative. The dummy variable δ_{ε} is equal to one when the respondent chooses Euthanasia as the most or least preferred alternative, and changes the intercept from zero, which is the intercept associated with choosing a Treatment option.

Rank Ordered Logit Model

The Rank Order Logit (ROL) model is utilized when determining consumer preferences over a discrete set of alternatives and are employed when analyzing survey data. The ROL model is often used to analyze rank-ordered preference data (Fok et al., 2010) from surveys which ask individuals to rank a variety of choices, as opposed to only choosing a most preferred option. ROL models allow for more efficient estimation of the choice parameters since it accounts for all rankings as opposed to one preference. By analyzing the full ranking of the choice alternatives, respondent preferences are more efficient to estimate.

The choice alternatives respondents were presented with were identified as *j*= 1, …, *J*, where *J* was the total number of alternatives. In the case of the survey for this research, *J*=3 and the alternatives presented were Treatment A, Treatment B, and Euthanasia. The utility of the individual respondents *i*= 1, …, *N* were denoted as U_1^i, …, U_j^i. Respondents chose a most and least preferred choice alternative, denoted as y_j^i =1 and y_j^i, respectively. The information derived from the most preferred implied that $U_j^i \geq \max\{U_1^i, \ldots, U_j^i\}$. This was interpreted as the utility respondent *i* received from alternative *j* is greater than the maximum utility gained from each of the other alternatives. It was assumed that respondents made deterministic choices when taking the survey and therefore knew the utility they would potentially receive from each option. Through the perception of these utility values, the respondents were able to rank the different alternatives. The individual respondents were aware of the utility they would receive from an alternative, but researchers cannot measure this value. Therefore, stochastic models were utilized to estimate individuals' utilities.

When it is assumed that all ε_j^i terms are independent and are distributed along a type 1 extreme value distribution, the foundation is laid for a multinomial logit (MNL) model. Each choice classification (i.e. most preferred or least preferred) within an individual choice set is its own MNL model, and each of these is combined to create the ROL model. Equation 7 is the MNL model expression that represents the probability that an individual *i* most prefers alternative *j* within a certain choice set (Starkweather and Moske, 2011). As the MNL is the basis of the ROL model, equation 7 serves as the foundation for the ROL ranking probability equation that will be discussed in the following paragraph:

$$\Pr\left[y_j^i = 1;\ \beta\right] = \Pr[\ U_j^i \geq \max\{U_1^i, \dots, U_j^i\}] = \frac{\exp(V_j^i)}{\sum_{i=1}^{J} \exp(V_l^i)} \tag{7}$$

where $\beta = \{\beta_1, \dots, \beta_J - 1\}$ and $\beta_J = 0$ for identification.

A simple MNL model can provide parameters estimates for individuals' preferences, combining the MNL models for the rankings of each alternative provide improved efficiency of these parameter estimates. While the data collected from a MNL model is enough to estimate parameters, efficiency can be improved by ranking the alternatives. Thus the rank given to the alternatives by the respondents is denoted as the vector $y^i = (y_1^i, \dots, y_j^i)$. In equation 7, y_j^i represents the rank that individual *i* gives to alternative *j*. The rank vector can be written as $r^i = (r_1^i, \dots, r_j^i)'$, where r_j^i is the alternative that received rank *j* by the respondent *i.* Therefore $y_k^i = j$ and $r_j^i = k$, where *k* represents the alternatives a respondent assigns rank *j.* Due to the assumption that the respondents were aware of all utility values they could potentially receive from each presented alternative, respondents were able to easily provide rankings for each alternative within a choice set. Subsequently, the ranked preferences were deterministic from the respondent's perspective. The result of these assumptions about utility mean that the probability of the researcher observing ranking r^i for a particular respondent is:

$$\Pr\left[r^i; \beta\right] = \Pr[U_{r_1^i}^i > U_{r_2^i}^i > \cdots > U_{r_j^i}^i = \prod_{j=1}^{J-1} \frac{\exp(V_{r_j^i}^i)}{\sum_{l=j}^{J} \exp(V_{r_l^i}^i)} \tag{8}$$

The ROL model is comprised of an MNL model for the most preferred alternative, an MNL model for how the second-most preferred alternative ranks over all other alternatives except for the most preferred, and so on. (Equation 8) The assumption that the ROL model consists of a series of MNL models holds due to the independence of irrelevant alternatives (IIA) property associated with MNL models (Beggs et al., 1981, for explanation). As a result, researchers do not have to assume that respondents make these decisions in this particular order, but equation 8, the ROL equation, implies that the results can be analyzed as if the decisions were made in that particular order. (Fok et al., 2010)

An extension of this model allows respondents to rank the most preferred option, but also identify a least preferred alternative. This process allows for increased efficiency of the estimates relative to the MNL model due to the additional information from the lower ranks. The most preferred and least preferred segments can be denoted by two indices (*k, l*), where *k* represents the number of most preferred alternatives (e.g. Treatment A, Treatment B. or Euthanasia) and *l* represents the number of least preferred alternatives that are ranked correctly. When *l* = 1, the lowest ranked option is consistent with the random utility model. We assume this case throughout this paper. The two preference combinations (*J* − 2, 1) and (*J* − 1, 1) are not included in analysis as they imply that every choice option can be given a rank. Respondents of this type are classified with the notation (*J* − 1, 0). Therefore, *J* − 2 latent classes are added to the model where *l* = 1 and *k* ranges from 0 to *J* − 3. In the context of this research, *l*=1 and *k*= *J*-2. The probabilities of observing particular ranks when *l*=1 are represented by:

$$\Pr[y_i, |(k,l);\beta] = \Pr[y_i|k;\ \beta]\,(J-k) \tag{9}$$

for *k* = 0, …, *J* – 3, where *m* is the last alternative the respondent ranks. The derivation of the probability that alternative r_j^i is the least preferred alternative in a set of alternatives (*k+1, k+2,…, J*) $\Pr[U_{r_j^i} \leq$

$U^{i}_{r^{i}_{m}} \forall m > k;\ \beta]$ can be found in Appendix 2. (Equation 9) Because of the IIA property of the MNL model that was discussed previously, the probability expressed in equation 9 is determined to be independent of the *k* most-preferred choice alternatives. The factor (*J* − *k*) is included in the above equation as the amount of least preferred item combinations of the (*J* − *k*) is decreased by (*J* − *k*) as the least preferred item is now known. (Fok et al., 2010)

In the case of this research, the rank, y^{i}_{j}=1 when the respondent (*i*) prefers alternative *j* the most and y^{i}_{j}=3 when the respondent prefers alternative *j* the least. Since *k* denotes the number of most preferred alternatives and *l* represents the number of least preferred alternatives, both values are equal to one because respondents were only asked to rank one most preferred option and one least preferred option. The coefficients for the attribute variables are denoted as β. Therefore, equation 9 states that the probability of the least preferred ranking (y_{ij} =3) is the probability that the utility gained from the least preferred alternative ($U^{i}_{r^{i}_{j}}$) is less than or equal to that of the final ranked alternative ($U^{i}_{r^{i}_{m}}$).

Willingness-to-Pay (WTP)

A respondent's WTP for a particular attribute is calculated using the coefficients derived from the ROL model. For example, the respondents' WTP for attribute π is calculated as the following:

$$WTP_{\pi} = -\left(\frac{\beta_{\pi}}{\beta_{\rho}}\right), \tag{10}$$

where $\pi = attribute\ \pi$ and $\rho = attribute\ \rho$, generally the price attribute coefficient. In the case of the present research, π can represent either the recovery period or the success rate associated with a treatment, depending on the attribute for which WTP is being calculated.

DATA

Survey Design

A choice experiment was designed to collect data for the analysis of the factors that influence a horse owner's decision to euthanize a horse with obstruction colic. This disease has the potential to be life threatening for a horse. In the context of this research, obstruction colic is used as examples of a disease that must be treated, as it is widely understood across the equestrian population that severe colic, such as obstruction colic, requires some form of veterinary treatment (Scantlebury et al., 2014). Before answering the choice experiment questions, respondents were asked a series of questions regarding their demographics and experiences with horses.

Survey respondent demographic data was collected in conjunction with the choice experiment survey. Respondents were asked to identify their primary discipline and disclose whether they compete within that discipline. They were then asked to identify the breed(s) and number of horses they currently own. Respondents answered questions about how long they had been horse owners, how they characterize their relationship with their horse(s), and the average amount of time spent with their horses weekly. Respondents indicated if they had purchased equine insurance in the past year and, if so, what type. Finally, the survey asked respondents personal demographic questions including their age, gender, level of education, average annual household income, and how many children they had. The last question respondents answered before answering the choice experiment questions required respondents to identify one horse for which to answer the questions and provide that horse's age. The age of horse serves as a proxy for the value of the horse as the two measures are highly correlated.

As previously discussed, the choice experiment questions were randomly distributed to respondents in two blocks. Respondents had three choice alternatives from which to choose: Treatment A, Treatment B, or Euthanasia. There were three attributes for the two treatment options and one

attribute for Euthanasia. The attributes that varied in value within each choice set were the price, recovery time, and success rate of each treatment. There were three value levels for each attribute for each treatment. The varying levels for the price of Treatment A and Treatment B were $2,000, $6,000, and $10,000. Both Treatment A and Treatment B's price attributes varied between these three values. The recovery periods for both Treatment A and Treatment B were one week, 12.5 weeks, and 24 weeks with three success rates of 70%, 85%, and 100% recovery. The price for Euthanasia remained constant at $400 across all choice sets and blocks. All attribute levels were derived from price, recovery period, and success rate ranges for obstruction colic treatments performed by the Colorado State University Veterinary Teaching Hospital (Personal Communication).

Variable Definitions

Table 1 presents the variables used in the regression models estimated. In the table, each variable is assigned a variable symbol, definition, and the expected sign on the estimated regression model. The four primary variables used in the ROL model regression that include the demographic interaction terms are the price, recovery period, and success rate of treatment options, and the euthanasia dummy variable (equation 4). The first three variables are the attribute variables associated with each treatment alternative. The euthanasia dummy variable represents when a respondent ranks the euthanasia alternative. The treatment dummy variable is representative of the respondent assigning either Treatment A or Treatment B a rank. Demographic variables themselves cannot directly affect the ranking of an alternative within a ROL model because they only affect how respondents react to the varying attributes of choice alternative. Therefore, an interaction term was generation for each attribute variable. These interactions represent the way in which a particular demographic affects a respondent's reaction to a change in price, recovery period, or success rate.

Table 1: Variable Names and Definitions

Variable Name	Variable symbol	Variable Description	Expected Sign
Attribute			
Price	price	price of treatment or euthanasia	+
Recovery Period	rec	the period until full recovery for treatment	+
Success Rate	succ	the rate of full success for a treatment (return to full use)	-
Euthanasia	euth	= 1 if dummy variable is chosen, 0 otherwise	+
Demographic Variable Interactions with Attributes			
Compete	comp	dummy variable compete variable = 1 if yes, 0 otherwise, used only in interaction terms, not assessed on its own.	n/a
Compete Interacted with Price	compprice	how competing affects respondent's reaction to price change	+
Compete Interacted with Recovery Period	comprec	how competing affects respondent's reaction to change in recovery period	-
Compete Interacted with Success Rate	compsucc	how competing affects respondent's reaction to change in success rate	-
Age of Horse Interacted with Price	agehprice	the age of the horse respondent references for choice experiment questions, how age of horse affects respondent's reaction to change price	quadratic
Age of Horse Interacted with recovery period	agehrec	the age of the horse respondent references for choice experiment questions, how age of horse affects respondent's reaction to change in recovery period	+
Age of Horse Interacted with success rate	agehsucc	the age of the horse respondent references for choice experiment questions, how age of horse affects respondent's reaction to change in success rate	-
Pet Relationship with Horse Interacted with Price	relatepetprice	relatepet=1 if pet relationship with horse, 0 otherwise, how pet relationship affects respondent's reaction to change price	+

Table 1 Continued

Pet Relationship with Horse Interacted with Recovery Period	relatepetrec	relatepet=1 if pet relationship with horse, 0 otherwise, how pet relationship affects respondent's reaction to change in recovery period	+
Pet Relationship with Horse Interacted with Success Rate	relatepetsucc	relatepet=1 if pet relationship with horse, 0 otherwise, how pet relationship affects respondent's reaction to change in success rate	-
Competition Partner Relationship with Horse Interacted with Price	relatecompprice	relatecomp=1 if competition partner relationship with horse, 0 otherwise, how competition partner relationship affects respondent's reaction to change price	+
Competition Partner Relationship with Horse Interacted with Recovery Period	relatecomprec	relatecomp=1 if competition partner relationship with horse, 0 otherwise, how competition partner relationship affects respondent's reaction to change in recovery period	+
Competition Partner Relationship with Horse Interacted with Success Rate	relatecompsucc	relatecomp=1 if competition partner relationship with horse, 0 otherwise, how competition partner relationship affects respondent's reaction to change in success rate	-
Children Interacted with Price	childprice	child =1 if respondent has children, 0 otherwise, how having children affects respondent's reaction to change price	+
Children Interacted with Recovery Period	childrec	child =1 if respondent has children, 0 otherwise, how having children affects respondent's reaction to change in recovery period	+
Children Interacted with Success Rate	childsucc	child =1 if respondent has children, 0 otherwise, how having children affects respondent's reaction to change in success rate	-
Income Interacted with Price	incprice	A continuous variable for average annual household income, how household income affects respondent's reaction to change price	+
Income Interacted with Recovery Period	increc	A continuous variable for average annual household income, how household income affects respondent's reaction to change in recovery period	+

Table 1 Continued

Income Interacted with Success Rate	incsucc	A continuous variable for average annual household income, how household income affects respondent's reaction to change in success rate	-

In this survey, a rank of one represents the most preferred option and a rank of three the least preferred option. Thus, a positive coefficient implies that as the variable increases in value, it becomes less preferred. A negative coefficient means that as a variable increases in value, it becomes more preferred. Demographic interactions with price or recovery period have that positive coefficients mean that respondents within that demographic are more sensitive to changes in price or recovery period. This is because the price and recovery period attributes have a negative relationship with the perceived utility of a choice alternative. Inversely, a negative coefficient on a demographic interaction with price or recovery implies that the perceived utility of the respondent in that demographic is not as sensitive changes in price or recovery period a respondent outside that demographic. The opposite is true for the success rate attribute. A negative coefficient for a demographic interaction with success rate means that a respondent's perceived utility increases less given an increase in success rate if they are in that demographic relative to respondents that are not in that demographic. A positive coefficient for a demographic interaction with success rate means that the respondent within that demographic is more sensitive to changes in success rate than a respondent that is not in demographic.

Survey and Choice Experiment Distribution

The survey, including the choice experiment questions, was distributed to Colorado horse owners over the age of 18 through a variety of equine associations, a Colorado-specific equine social media page, and personal communication. In all, 20 Colorado equine associations were contacted with a request to distribute the survey via email to their membership. This helped ensure the anonymity of personal information of the survey respondents. Of the 20 associations that were contacted, six agreed

to distribute the survey to their members via email. These six associations provided 217 responses. The survey was also distributed via a Colorado equine social media page. The survey was listed on the page with an urgent request that only current Colorado horse owners over the age of 18 respond to the survey. Additionally, the survey was distributed via email, phone, and in-person interactions throughout a personal network of Colorado horse owners. The social media and personal networking produced 233 additional respondents. The survey was first distributed on May 26, 2017, and it remained open until July 2, 2017.

Respondent Demographic Summary Statistics

All survey respondents were over the age of 18 and residents of Colorado. The survey had a total of 450 respondents from six Colorado equine associations, as well as social media and personal networking. This sample of Colorado horse owners, the state with the 10th-highest horse population (Kilby, 2007), is a fraction of the nation's horse owning population. Demographic statistics would be expected to change from one region to another. It should be noted that horse owners are a unique population in that it is difficult to describe an "average" horse owner, as there is a lot of variation among members of the equestrian community.

Of the 422 respondents who provided their age, 23.2% were between 18 and 25 years old. The next largest age group of respondents was between 56 and 65 years old, making up 22.7% of sample. Table 2 shows that the majority of Colorado respondents (52.9%) were between the ages of 18 and 45. Only 6.2% of the horse owners were over the age of 65. Horse owners over the age of 76 were the smallest group with only 0.7% of respondents. There is a potential bias as a result of the survey distribution method, as it was distributed via email and social media. Access to and use of these tools is more prevalent with younger individuals, and less so in older populations. One survey performed by horseproperties.net found that the highest portion of the horse owners that responded to their particular survey were between the ages of 45 and 59 (Horse Properties, 2017). While this is not

necessarily true for the entirety of the U.S. horse owner population, it provides another estimate to which the present sample of horse owners can be compared. The results from the present survey are relatively consistent with the results from the Horse Properties survey, as the age groups that cover the 45 to 59 age range were some of the largest in the present survey.

Table 2: Age of Colorado Horse Owners

Owner Age Range	**Number of Respondents**	**Percent of Total (%)**
18-25 years	98	23.2
26-35 years	64	15.2
36-45 years	61	14.5
46-55 years	77	18.2
56-65 years	96	22.7
66-75 years	23	5.5
76+ years	3	0.7
Total	422	100

The majority (87.9%) of survey respondents were female (Table 3). While the domestic equine industry has traditionally been a male dominated industry, recent years have seen it transition to be predominantly female (Robinson, 2010). As this survey was a sample of Colorado horse owners, and thus a small sample of the US horse owner population, it was expected that a high percentage of respondents to this survey would be female.

Table 3: Gender of Colorado Horse Owners

Gender	**Number of Respondents**	**Percent of Total (%)**
Male	51	12.1
Female	370	87.9
Total	421	100

Household income was expected to affect the decision to treat sick or injured horses. In the survey by horseproperties.net, 45% of the respondents reported having average annual incomes

between $25,000 and $75,000, which is considered a “middle class” income. In comparison to the survey from Horse Properties, only 37.3% of respondents from the present survey reported their households making between $25,000 and $75,000 on average, annually. Of the 413 respondents who answered the annual household income question in the present survey, 33.4% reported an average annual household income of greater than $100,000. The next largest income group, 19.4% of respondents, had an average household income of between $50,000 and $74,999. Table 4 shows that 28.8% of respondents had annual household incomes of less than $50,000. These statistics support the assumption that the majority of horse owners have relatively high levels of income, as 51.8% of respondents made over $75,000 annually. This suggests that over 51.8% of respondents to the present survey have an “upper class” income level, as $75,000 is considered the high end of the “middle class” income range. These results further suggest that the respondents in the higher income categories have more disposable income to spend on veterinary care for their horse(s).

Table 4: Annual Household Income of Colorado Horse Owners

Average Annual Household Income	**Number of Respondents**	**Percent of Total (%)**
<$24,999	45	10.9
$25,000-$49,999	74	17.9
$50,000-$74,999	80	19.4
$75,000-$99,999	76	18.4
>$100,000	138	33.4
Total	413	100

While education level is often associated with average annual income, an individual’s education level may also influence their decision-making process. The largest portion of the 422 respondents that answered this question had bachelor’s degrees (50%).The next largest group of respondents, 32.7%, had earned high school diplomas or their GED. Very few respondents held graduate (14.2%) or professional degrees (3.1%).

Table 5: Education Levels of Colorado Horse Owners

Education Level	Number of Respondents	Percent of Total (%)
High School Diploma/GED	138	32.7
Bachelor's Degree	211	50.0
Graduate Degree	60	14.2
Professional Degree	13	3.1
Total	422	100

Literature has suggested that households with children have to make financial decisions such as treating a sick horse with their children's needs in mind (Brockman et al., 2006). Past research shows that when animal owners have to make veterinary purchases, they make mental budgets and are less likely to choose to purchase veterinary procedures if they have children (Brockman et al., 2006). Table 6 presents the statistics for the 421 respondents that disclosed the number of children in their household. Of these respondents, 47.5% did not have children. The next largest group of respondents (38.5%) reported one to two children in their households, while only 11.9% and 2.1% of respondents reported having three to four and five or more children, respectively. The low numbers of children could be the result of the large number of young respondents.

Table 6: Number of Children in Colorado Horse-Owning Households

Number of Children in Household	Number of Respondents	Percent of Total (%)
0 children	200	47.5
1-2 children	162	38.5
3-4 children	50	11.9
5+ children	9	2.1
Total	421	100

The majority of respondents (64.8%) owned between one and four horses (Table 7). The two respondents who reported owning zero horses were removed from the survey, as this survey was solely for people owning one or more horses. The second largest group of horse owners reported owning between five and eight horses, making up 20.3% of respondents. Only 4.7% of respondents reported owning between nine and eleven horses while 9.7% of respondents reported owning twelve or more

horses. Horse ownership tends to have limiting factors such as capital and land, accounting for the majority of owners having smaller numbers of horses.

Table 7: Number of Horses Owned by Colorado Horse Owners

Number of Horses Owned	Number of Respondents	Percent of Total (%)
0 Horses	2	0.5
1-4 Horses	274	64.8
5-8 Horses	86	20.3
9-11 Horses	20	4.7
12+ Horses	41	9.7
Total	423	100

Literature suggests that the human-equine bond has evolved to be more emotional in recent years (Endenburg, 1999). The emotional connection to their horses is expected to have an impact on owners' veterinary spending choices. Table 8 shows the majority of survey respondents (60.2%) considered their horses to be competition partners, as opposed to the 34.4% that considered their horses to be companion animals or pets. The smallest number of respondents (5.4%) reported their relationships with their horses to be that of a property or a tool.

Table 8: Colorado Horse Owners' Relationship with Horse

Relationship With Horse	Number of Respondents	Percent of Total (%)
Property/Tool	23	5.4
Competition Partner	254	60.2
Pet/Companion Animal	145	34.4
Total	422	100

It was hypothesized that people with more experience owning horses make decisions differently than those that are new to horse ownership. As seen in Table 9, only 1.0% of the 423 respondents had owned horses for less than a year. Respondents who had owned horses between one and five years, and six and ten years make up 9.7% and 9.9% of the sample, respectively. A large majority of respondents, 79.4%, reported being horse owners for over eleven years.

Table 9: Length of Time Respondent Has Owned Horses

Length of Time Owning Horse	Number of Respondents	Percent of Total (%)
<1 year	4	1.0
1-5 years	41	9.7
6-10 years	42	9.9
11+ years	336	79.4
Total	423	100

Another factor that may affect a respondent's reaction to changes in price, recovery period, and success rate of a treatment is their equine discipline. Although there are equine disciplines other than English and Western, far less of the equestrian population associates with the other disciplines. As a result, all other equine disciplines were categorized as "Other". Only 4.5% of survey respondents reported participating in a discipline in the "Other" category (Table 10). A large majority of survey respondents categorized themselves as "Western" equestrians, making up 77.1% of respondents. The other 18.4% of respondents were classified as "English" equestrians. These statistics were expected, as respondents were Colorado horse owners where the Western discipline is more popular than English or other disciplines.

Table 10: Riding Discipline of Colorado Horse Owners

Discipline	Number of Respondents	Percent of Total (%)
English	78	18.4
Western	327	77.1
Other	19	4.5
Total	424	100

While all riders associate with a predominant discipline, not all compete within that discipline. There were more respondents that report competing within their categorized discipline than considered their horse a "competition partner". Of the 422 respondents that answered the competition question, 74.4% reported competing within their discipline. The other 25.6% of respondents said they do not

compete. There are various levels of competition in which horse owners can compete, from beginner shows to professional shows, but those discrepancies were not accounted for in this survey (Table 11).

Table 11: Number of Respondents that Compete within their Discipline

Compete	Number of Respondents	Percent of Total (%)
Yes	314	74.4
No	108	25.6
Total	422	100

Horse owners spend varying amounts of time with their horse(s) each week. Those who compete at higher levels, or at all, were hypothesized to spend more time with their horse(s) than those that ride for pleasure (Table 12). The majority of respondents (65.2%) reported spending more than eight hours per week with their horse(s), which follows as the majority of respondents reported competing with their horses. The next largest group of respondents (27.2%), reported spending between four and seven hours per week with their horse(s) Only 7.6% of the respondents who answered this question reported spending between one and three hours per week with their horse(s). Zero respondents reported not spending any time with their horse(s) each week.

Table 12: Number of Hours per Week Respondents Spend with Horses

Hours/Week Spent With Horse	Number of Respondents	Percent of Total (%)
0 hours	0	0
1-3 hours	32	7.6
4-7 hours	115	27.2
8+ hours	276	65.2
Total	423	100

Just as pet owners can purchase insurance for their companion animals, horse owners can purchase insurance to cover treatment for a variety of conditions, equestrian liability, and even death. Having equine insurance allows owners to purchase treatments for covered conditions that they otherwise could not afford. Of the 423 respondents that completed this question, only 31.7% reported purchasing some form of equine insurance in the past year (Table 13).

Table 13: Number of Respondents that Purchased Equine Insurance

Purchased Equine Insurance	Number of Respondents	Percent of Total (%)
Yes	134	31.7
No	289	68.3
Total	423	100

Choice Experiment Summary Statistics

While the demographic information associated with the respondents are important, it is also imperative to understand how respondents behave in market situations simulated by choice experiment questions. The statistics of how various alternatives were ranked, as well as how often particular attribute levels were ranked as most and least preferred, provide additional information to the results of the rank ordered logit model. Respondents provided rankings for the three alternatives in each of the seven choice sets with which they were presented. Each ranking was its own response. The total number of responses reported in each table was the total number of rankings associated with the alternative or the attribute in the table.

Euthanasia was most commonly ranked as the least preferred option, with just under two-thirds of the total euthanasia rankings being assigned the least preferred rank (Table 14). The number of times euthanasia was ranked as most preferred, or left as the "indifferent" option were similar, with the number of most preferred rankings being only 0.4% more than the number left as indifferent. This suggests that respondents would prefer to purchase some form of treatment for their sick horse before resorting to the euthanasia option.

Table 14: Ranking Statistics of Euthanasia Alternative

Rank	Number of Rankings	Percent of Rankings (%)
1 (Most Preferred)	425	17.12
2	415	16.72
3 (Least Preferred)	1642	66.16
Total	2482	100

As was expected, the different prices of treatments were correlated with how an alternative was ranked by a respondent (Table 15). Treatments with a price of $2000, the lowest level, were ranked as a most preferred option more than 67% of the time, and were only ranked as a least preferred option about five percent of the time. Treatment alternatives with a price of $6,000 were left as the neutral option over 50% of the time and were ranked as a most preferred option just over 36% of them time. This suggests a respondent's utility is less affected by the mid-level price than by the lowest price level. Treatment alternatives with a price of $10,000 were least often (20%) ranked as a most preferred option. More commonly, alternatives with a price of $10,000 were ranked second, which demonstrates the high-level price for an alternative is less influential on a respondent's utility than was hypothesized (Table 15).The frequency with which the highest price alternatives were ranked second suggests that respondents are not as sensitive to the price of a treatment as was originally hypothesized.

T*able 15: Ranking Percent of Different Prices of Treatments*

	Price of Treatment		
Rank	**$2000**	**$6000**	**$10000**
	Percent (%) of Responses		
1 (Most Preferred)	67.40	36.54	19.85
2	27.74	51.05	44.02
3 (Least Preferred)	4.86	12.41	36.13
Total	100	100	100

It was hypothesized that recovery time period would have the smallest effect on how treatments were ranked (Table 16). The majority (51.85%) of alternatives with a recovery period of one week were ranked as the neutral option. The largest percentage of alternatives with recovery periods of 12.5 weeks and 24 weeks (48.15% and 47.49%, respectively) were ranked as most preferred options. A longer recovery period does not necessarily correlate with a variation in price, but simply more time and energy spent caring for the recovering horse, so it does not follow the hypothesis that a longer recovery period would result in a less preferred option. Alternatives with recovery periods of 12.5 weeks and 24 weeks were ranked as the least preferred options 16.66% and 13.84% of the time, respectively. This

information suggests that recovery period did not necessarily influence the utility a decision maker receives from choosing a treatment alternative, and that alternative rankings are more strongly influenced by other attributes.

Table 16: Ranking Percent of Different Recovery Periods for Treatments

	Recovery Period of Treatment		
Rank	**1 week**	**12.5 weeks**	**24 weeks**
	Percent (%) of Responses		
1 (Most Preferred)	25.14	48.15	47.49
2	51.85	35.19	38.67
3 (Least Preferred)	23.01	16.66	13.84
Total	100	100	100

Treatment success rate was expected to be an influential factor in a respondent's decision, as it determines the probability a horse will fully recover from a treatment. Alternatives with a 70% and 85% success rates were ranked as the neutral option 48.53% and 68% of the time, respectively (Table 17). This result was expected for alternatives with 85% success rates, as it is the mid-level success rate, but was unexpected for the alternatives with 70% success rates, as it is the lowest level of the success rate attribute. It was expected that alternatives with the lowest success rate would be ranked as a least preferred option more often than not. The highest percentage of alternatives with a 100% success rate (49.27%) were ranked as most preferred. This was expected as a 100% means that the sick horse is guaranteed to make a complete recovery after treatment. The fact that less than half of the alternatives with a 100% success rate were ranked as the most preferred option supports the hypothesis that the other attributes also influence a respondent's decision making.

Table 17: Ranking Percent of Different Success Rates for Treatments

	Success Rate of Treatment		
Rank	**70%**	**85%**	**100%**
	Percent (%) of Responses		
1 (Most Preferred)	36.57	14.45	49.27
2	48.53	68.79	30.98
3 (Least Preferred)	14.90	16.76	19.75
Total	100	100	100

It was hypothesized that income would have an effect on how respondents ranked certain alternatives. It was assumed that those with higher income levels would be willing to pay more for treatment, and thus would be less likely to rank Euthanasia as the most preferred option. Table 18 shows that those who ranked Euthanasia as the most preferred option most commonly (58.55%) had average household incomes of under $75,000 annually. Conversely, euthanasia was ranked as a least preferred option most commonly (54.08%) by those with average annual household incomes greater than or equal to $75,000.

Table 18: Income and Ranking of Euthanasia

		Euthanasia	
Income	**Most Preferred**	**Indifferent**	**Least Preferred**
		Percent (%) of Responses	
<$24,999	11.33	14.77	10.57
$25,000-$49,999	26.02	15.01	17.46
$50,000-$74,999	21.20	18.41	17.89
$75,000-$99,999	17.59	17.43	18.68
>$100,000	23.86	34.38	35.40
Total	100	100	100

Due to the increasing emotional connection between humans and their horses in recent years, it was expected that a respondent's relationship with their horse would have an impact on how they respondent to different alternatives. As shown in Table 19, those who classified their relationship as "property or tool" had a relatively even distribution of how they ranked euthanasia. Expectedly, those, those that classified their relationship with their horse as either a "competition partner" or a "pet or companion animal" most frequently ranked euthanasia as the least preferred option (71.94% and 60.81%, respectively). Unexpectedly, those who classified their relationship with their horse as a "pet or companion animal" more frequently ranked euthanasia as most preferred (21.73%) than left as the middle option (17.46%).

Table 19: Relationship with Horse and Ranking of Euthanasia

		Euthanasia	
Ranking	**Tool/Property**	**Competition Partner**	**Pet/Companion Animal**
		Percent (%) of Responses	
Most Preferred	30.50	13.24	21.73
Indifferent	33.33	14.82	17.46
Least Preferred	36.17	71.94	60.81
Total	100	100	100

Table 20 shows the ranking of treatment success rates given different income levels. Unexpectedly, the 70% success rate was not ranked as least preferred most often at any income level. At the lowest income level, less than $24,999 annually, the 70% success rate was ranked as the most preferred option (43.88%) more than any other ranking. At all other income levels, it was most commonly left as the indifferent option. At all income levels, the 100% success rate was most commonly ranked as the most preferred option. The most notable difference in ranking of the of the 100% success rate is at the highest income level of over $100,000. At this income level, 56.73% of the rankings of 100% success rate were most preferred, more than in any other income group.

Table 20: Income with Success Rate of Treatments

	Income Levels														
Rankings of Alternative	<$24,999			$25,000-$49,999			$50,000-$74,999			$75,000-$99,999			>$100,000		
	Success Rate			Success Rate			Success Rate			Success Rate			Success Rate		
	0.7	0.85	1.00	0.7	0.85	1.0	0.7	0.85	1.0	0.7	0.85	1.0	0.7	0.85	1.0
Most Preferred	43.88	14.29	43.06	39.86	13.33	38.94	36.45	10.17	47.86	36.08	9.84	51.12	32.53	19.40	56.73
Indifferent	39.66	61.90	34.16	46.15	71.11	36.87	49.76	62.71	30.79	49.23	75.41	29.91	52.04	68.66	27.53
Least Preferred	16.46	23.81	22.78	13.99	15.56	24.19	13.79	27.12	21.35	14.69	14.75	18.97	15.43	11.94	15.73
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

The attribute summary statistics support the theory that each treatment attribute had an effect on a respondent's decision-making process. That is, no single attribute was solely influential on a horse owner's treatment choice. A ROL regression was utilized to better understand how the treatment attributes affect the respondents' choice ranking decisions and will be discussed in the following section.

RESULTS AND DISCUSSION

Initial Regression Results and WTP Estimates

In order to estimate respondents' WTP for treatment attributes (equation 10), a ROL regression was implemented with the treatment attribute variables as the independent variables. The dependent variable was the ranking assigned to the alternatives chosen by the respondents, which ranged from one (most preferred) to three (least preferred). The independent variables in the initial regression were price, recovery period, success rate, and a euthanasia dummy variable. The results for the base ROL regression are presented in Table 21. The signs on the coefficients were as expected. The price and recovery period coefficients were positive and the success rate coefficient was negative. The positive coefficient associated with the price attribute suggests that as price of a treatment increased by increments of $4,000, the utility a respondent received from that treatment decreased, causing the alternative to become less preferred. The positive coefficient for the recovery period attribute suggests that as the length of recovery time for a treatment increased by increments of 11 and a half weeks, the alternative became less preferred. Decreased utility from an alternative means that alternative became less preferred and the rank value increased from one towards three. The opposite holds for the success rate of a treatment option. As the success rate increased by intervals of 15 percent for a particular treatment alternative, the utility gained from selecting that alternative also increased. The increase in utility a respondent received as success rate increased caused the respondent to give the alternative a more preferred ranking. Euthanasia was the option that was expected to provide the respondents with the lowest utility. The coefficient on the dummy variable for choosing euthanasia is positive, suggesting that choosing euthanasia led to a decrease in a respondent's utility.

Table 21: ROLM with Attribute Variables and Euthanasia Dummy Variable[3]

Variable	Coefficient	Sig.	Std. Error	p-value	95% Confidence Interval	
Price	0.0002	***	7.95xe-06	0.00	2.09xe-04	2.40xe-05
Recovery Period	0.0089	***	0.0024	0.00	0.0042	0.0137
Success Rate	-2.4532	***	0.1512	0.00	-2.7495	-2.1568
Euthanasia	0.5868	***	0.1223	0.00	0.3470	0.8266

Significance at the 1% (***), 5% (**), and 10% (*) level.

All variable coefficients in the initial ROL regression are statistically significant at the one percent level. This indicates that price, recovery period, and success rate are all significantly influential on the utility a respondent receives from a particular alternative, and thus how they rank the alternative. The positive coefficient for the price variable indicates that as the price of the treatment increases, the rank a respondent assigns to that treatment increases towards a three, all else constant. As three is the least preferred ranking, and one is the most preferred ranking, the treatment becomes less preferred as price increases.

The coefficient for the recovery period attribute is also positive, meaning that if as recovery period for a treatment increases, the perceived utility of that treatment decreases, all else constant. A longer recovery period for a treated horse requires time, labor, and capital from the respondent, decreasing their utility. The lower utility associated with the inconvenience of a longer recovery period causes the respondent to prefer a shorter recovery period to a longer one, keeping all else constant.

The success rate attribute coefficient is the only negative coefficient in the initial ROL regression. The negative coefficient suggests that an increased success rate decreases the rank value meaning it becomes the more preferred alternative. The utility a respondent gains from a treatment with a higher

[3] A negative coefficient means that as the attribute's value decreases, the ranking becomes more preferred and vice versa. A positive coefficient means that an increase in the attribute's value leads to a less preferred alternative.

success rate is greater than from a treatment with a lower success rate. All else constant, a treatment with a higher success rate is ranked as a more preferred option than a treatment with a lower success rate.

The euthanasia coefficient is positive and statistically significant, which indicates it is associated with lower rankings (i.e. higher rank values). Euthanasia was selected as the least preferred option approximately 66% of the time. This supports the hypothesis that respondents would generally prefer to purchase treatment for their sick horse than choose the less expensive option to euthanize their horse.

The value of the coefficients associated with the price, recovery period, success rate, and the euthanasia dummy variable influence the WTP estimates, as the ROL regression coefficients are what are used to calculate the WTP estimates. As a result, the estimates from Table 21 are used to estimate WTP for each of the variables. The coefficient estimate for the price attribute variable is the denominator in the WTP equation and the numerator is the attribute for which the WTP is being estimated, as see in equation 11. Specifically, WTP estimates are calculated as:

$$WTP^{attribute} = -(\frac{\beta_{attribute}}{\beta_{price}}). \quad (11)$$

This provides an estimate for how much, on average, a respondent is willing to pay for a change in attribute level, given the information presented in the choice scenarios.[4] This allows for better understanding of how horse owners react to changes in level of recovery period and success rate. The WTP estimate provides more context to the importance of the recovery period and success rate attributes, providing more insight into why respondents ranked alternatives with certain attribute levels the way they did. The WTP estimate for the euthanasia dummy variable also provides more information about the price point at which respondents are no longer willing to pay for treatment for their sick or

[4] WTP values do not necessarily reflect ability to pay and are subject to change from person to person.

injured horse. The WTP estimates can be either positive or negative. The WTP estimates are not necessarily representative of respondents' ability to pay. It was expected that the WTP for recovery period would be negative due to the assumption that respondents will prefer shorter recovery periods (i.e. $\beta_{rec}$is positive). Conversely, it was expected that the WTP for success rate would be positive, as the coefficient for success rate is negative. A high success rate improves the ranking, giving it a lower value.

Using equation 11, it was calculated that a horse owner is willing to pay $39.81 less for a treatment with a recovery period that is 11.5 weeks longer. This estimate shows that the respondents prefer treatment options with shorter recovery periods, and are willing to pay more for a shorter recovery period. The WTP estimate can also be interpreted as horse owners are willing to pay $39.81 to avoid a treatment that has a recovery period that is 11.5 weeks longer. This is consistent with the theory that a treatment with a longer recovery period is less desired by respondents than that with a shorter recovery period. The WTP estimate for recovery period provides insight into how horse owners evaluate the trade-off between the recovery period of a treatment option and the price of that treatment. The WTP estimate for recovery period can be utilized by veterinary clinics to better understand how the length of recovery period affects the desirability of a treatment option.

The WTP for a change in the treatment success rate was calculated using equation 11 as $10,912. This calculation is interpreted as the horse owners surveyed are willing to pay nearly $11,000 for a 15% higher success rate. The large WTP value for success rate highlights how respondents prioritize the success rate of a treatment over the recovery period associated with a treatment. This relationship was expected because the success rate determines if the horse will recover from a treatment, while the recovery period determines how long recovery will take. The WTP estimate for the success rate attribute is particularly useful in practice as it suggests that horse owners are much more interested in purchasing treatment options with higher success rates with a higher price than those that are less expensive with lower success rates.

Using the results in Table 21 and equation 11, the willingness to pay to euthanize a horse was calculated as -$2,610. Since the value is negative, the absolute value of this estimate is evaluated. Specifically, the average respondent in this experiment would be willing to pay $2,610.52 to avoid euthanizing their horse if it was suffering from obstruction colic, given the hypothetical scenarios presented to them. The WTP estimate for the euthanasia dummy variable provides a general value that can be utilized by veterinary practices to understand their clients' financial considerations when making veterinary care decisions for their horse. Current treatment options for obstruction colic are medical or require a combination of medical and surgical methods. Surgical treatments can become complicated and thus more expensive.

Table 22: Willingness-to-Pay Estimates

Variable	WTP Estimate ($)
Recovery Period	$39.81
Success Rate	$10,912
Euthanasia Dummy Variable	-$2,610

Regression Results with Demographic Interactions

The treatment decisions a horse owner makes are not simply a function of the treatment attributes themselves, but of the demographics of the horse owner as well. While the direct impact of demographic variables on the ranking of a particular alternative, or the WTP, could not be determined with the ROL model, their interactions with the treatment attribute variables can provide insight to the decision-making process of the respondents (Table 24). The demographic-attribute interaction terms describe how a specific demographic variable affects the way in which a respondent reacts to a change in attribute level at an individual level.

An explanation of interaction coefficient sign interpretations can be found in Table 23. A negative coefficient in the initial ROL regression suggested a decrease in the rank value given to an

alternative, but means that the alternative receives a more-preferred ranking. The opposite was true for positive coefficients in the regression. The positive coefficients on price and recovery period in the initial regression means that an increase in either attribute caused the treatment to be less preferred. In the regression that included demographic interaction terms, a negative coefficient on a price or recovery period interaction term suggests that the demographic variable in the interaction decreases the respondent's sensitivity to changes in price or recovery period. If a price or recovery period interaction coefficient is positive, this suggests that the interacted demographic has the opposite effect. Alternatively, a positive coefficient on a success rate interaction means that the interacted demographic decreases the respondents' sensitivity to changes in success rate. A negative coefficient on a success rate interaction term suggests that the demographic increases a respondent's sensitivity to changes in success rate.

Table 23: Interpretations of Table 24 Interaction Variable Coefficient Signs

Attribute with which Demographic Interacts	Sign	Interpretation
Price	Positive (+)	More sensitive to change in price
	Negative (-)	Less sensitive to change in price
Recovery Period	Positive (+)	More sensitive to change in recovery period
	Negative (-)	Less sensitive to change in recovery period
Success Rate	Positive (+)	Less sensitive to change in success rate
	Negative (-)	More sensitive to change in success rate.

Table 24: ROLM with Relevant Demographic Interaction Terms

Variable	Coefficient	Sig.	Standard Error	p-value	95% Confidence Interval	
price	0.0003	***	4.38e-05	0.000	2.61e-04	4.32e-04
rec	0.0068		0.0130	0.602	-0.0187	0.0322
succ	-2.0086	***	0.4946	0.000	-2.9780	-1.0391
euth	0.6691	***	0.1242	0.000	0.4257	0.9126
compprice	6.46e-06		2.38e-05	0.786	-4.01e-05	5.30e-05
comprec	-0.0049		0.0073	0.501	-0.0192	0.0094
compsucc	-0.1910		0.2798	0.495	-0.7395	0.3575
agehprice	-9.18e-07		1.57e-06	0.557	-3.99e-06	2.15e-06
agehrec	1.64e-05		4.81e-04	0.973	-9.27e-04	9.60e-04
agehsucc	0.1258	***	0.0183	0.000	0.0900	0.1617
relatepetprice	-7.96e-05	**	3.61e-05	0.027	-1.5e-04	-8.86e-06
relatepetrec	-0.0166		0.0107	0.122	-0.0376	0.0044
relatepetsucc	-0.9307	**	0.3824	0.015	-1.6802	-0.1811
relatecompprice	-9.94e-05	***	3.61e-05	0.006	-1.70e-04	-2.86e-05
relatecomprec	-0.0011		0.0108	0.918	-0.0223	0.0200
relatecompsucc	-1.2392	***	0.3706	0.001	-1.9655	-.5129
childprice	-1.19e-05		1.73e-05	0.494	-4.59e-05	2.21e-05
childrec	0.0032		0.0054	0.550	-0.0073	0.0137
childsucc	0.7024	***	0.2012	0.000	0.3081	1.0968
incprice	-3.75e-10		2.96e-10	0.206	-9.55e-10	2.06e-10
increc	1.21e-07		9.18e-08	0.187	-5.89e-08	3.01e-07
incsucc	-1.34e-05	***	3.38e-06	0.000	-2.00e-05	-6.74e-06

Significance at the 1% (***), 5% (**), and 10% (*) level.

Table 24 shows the results of the regression with six demographic variable interaction terms added to the original regression. With the inclusion of the interaction terms, the coefficient for the recovery period attribute loses its significance at the 1%, 5% or 10% levels. The new lack of significance for the recovery period coefficient suggests that changes in the level of recovery period significantly influence a respondent's utility only if they are part of a particular demographic. Understanding the demographic information that makes respondents more sensitive to changes in the length of recovery period will allow veterinarians to better understand how different clients make treatment decisions.

The price, success rate, and euthanasia dummy variable coefficients maintained their significance at the 1% level. Including the demographic interaction terms did not change the sign or significance of the price or success rate attribute coefficients. This suggests that, regardless of their demographics, respondents were still averse to increases in the price of a treatment option, and prefer treatment options with higher success rates. The sign of the euthanasia variable coefficient did not change with the inclusion of the demographic interaction terms. This suggests that respondents, regardless of their demographic profile, generally ranked euthanasia as a less preferred alternative. The inclusion of the demographic interaction terms provides more information about how individuals react to changes in different attribute levels. The addition of these terms also supports the theory that, universally, horse owners are sensitive to changes in the price of treatment as well as the rate of success.

Whether or not the respondent competes with their horse in shows, rodeos, or any other equestrian event did not significantly interact with price, recovery period, or success rate. However, it is included in this analysis as it was expected that those who do compete would have different reactions to attribute changes than those who do not. Removing the competition interaction terms from the regression causes the coefficients and significance of other primary variables to change in ways that are not logical with respondent behavior. This suggests that competing may be affecting respondents' decisions in a way that cannot be captured through this method of analysis.

Survey respondents were asked to identify the age of the horse for which they were making treatment decisions in the choice experiment section of the survey. While the age of the horse did not significantly affect how respondents reacted to price changes or changes in recovery period, it did significantly interact with success rates. The positive coefficient for the interaction between the age of horse and the success rate variable was unexpected. It is possible this indicates the importance of diminishing treatment success rates as the age of horse increases. The positive sign is possibly the result

of the linear nature of the age of horse variable. A different functional form could produce the more expected sign for the age of horse interaction with success rate. However, the positive sign for this interaction coefficient would also explain the insignificance of the coefficients for the age of horse interactions with price and recovery period.

The pet classification of the respondent's relationship with their horse results in the respondent becoming less sensitive to price changes for the treatment, as shown by the negative coefficient associated with that interaction. The negative coefficient on this interaction means that a respondent's utility is affected less by a price change if they consider their horse to be a pet. This supports the hypothesis that those with a more emotional attachment to their horse would be less sensitive to price changes for treatment since they classify their horse as a pet. The same hypothesis holds for those who consider their horses to be competition partners, though to a slightly greater extent. This could be because, while the pet relationship provides a more emotional connection, a competition horse provides a source of income for the owner. Respondents who consider their horse as pets or competition partners are less sensitive to changes in price and recovery period, but more sensitive to changes in success rate. This implies that success rate is the most important attribute to those who consider their horses to be competition partners and pets.

The child variable, a dummy variable that is equal to one if the respondent has children and zero otherwise, was also interacted with the attribute variables. This interaction was studied because of previous research that suggested animal owners with children mentally budget differently than those without, especially when considering veterinary expenses. The interaction between the child dummy variable and the success rate variable had a positive and significant coefficient. This result implies that those who have children are less concerned with the success rate of their horse's treatment when compared to their childless counterparts. The reason for this could be due to the fact that these households have other priorities, such as their children, and have to budget their time, money, and

attention in a way that horse owners without children do not. It was expected that respondents with children would be more sensitive to price changes (Brockman, 2006), but this was not found to be statistically significant. Horse owners with children were hypothesized to be influenced by longer recovery periods as their time is more constrained compared to horse owners without children. But again, this interaction was not found to be statistically significant. These results do not support the Brockman (2006) research discussed in the literature review that respondents with children, who mentally budget differently than those without, are more sensitive to changes in price, recovery period, and success rate. This may be due to the fact that 47.5% of our sample indicated they did not have children.

The only income interaction coefficient that was found to be statistically significant was between income and success rate. The coefficient associated with this interaction was negative, suggesting that a respondent becomes more sensitive to changes in the success rate of a treatment as his or her income increases. While veterinarians have limited control over the success rate of a treatment, they can use this information when suggesting treatments to their clients, as they can better understand how clients of different income levels prioritize the success rate in their decision-making process. The coefficient for the income-price interaction had the expected negative sign, but not statistically significant. The lack of statistical significance for this interaction means that a horse owner's income does not significantly influence their sensitivity to changes in the price of a treatment. It was expected that income would reduce the impact an increase in price would have on how a respondent ranked a particular alternative, as those with more disposable income tend to be less concerned with the price of goods and services. This theory was not supported by the results in Table 24.

CONCLUSION

Colorado is home to over 100,000 residents involved in the equine industry and has the 10th largest equine population in the United States. Over 50% of these individuals are horse owners, contributing in a variety of ways to Colorado's economy. The Colorado equine industry contributes $1.6 billion annually to Colorado's economy as a result of feed purchases, horse show entries, public land use fees, and other equine-related transactions. A portion of this economic contribution of the equine industry in Colorado is veterinary spending. Colorado is a good sample state in which to perform research on horse owner veterinary treatment decisions because it has a prominent equestrian community.

Horse owners are sometimes faced with the difficult decision of whether to treat or euthanize their sick or injured horse(s). As horse owners have developed increasingly emotional relationships with their horses in more recent decades, this decision has become increasingly difficult and is influenced by a multitude of emotional and objective factors. The owner's decision to euthanize can also have an effect on the welfare of the veterinarian performing the euthanasia. It has been shown that the responsibility of performing euthanasia procedures is related to decreased job satisfaction, increased rates of depression, increased rates of suicide, and other welfare issues within the veterinary profession (Woods et. al, 2010). Another potential problem associated with the euthanasia of clients' horses is the loss of potential future revenues for veterinarians. When veterinarians euthanize a patient, they could lose all future revenues from vaccinations, maintenance care, and emergency care for that horse. This could add up to thousands of dollars in missed revenues for each euthanized horse, depending on the horse's age and the frequency of veterinary visits.

The main objective of this research was to understand what influences a horse owner's decision to treat or euthanize their sick or injured horse. Another objective of this paper was to calculate the

treatment price point at which the average horse owner chooses euthanasia over treatment for their sick or injured horse. These objectives were assessed by distributing a survey that included a choice experiment and questions related to demographics to a sample of the Colorado horse owner population. The choice experiment included seven scenarios where respondents were asked to rank Treatment A, Treatment B, and Euthanasia for their horse with hypothetical obstruction colic. Treatment A and Treatment B varied in price, length of recovery period, and success rate and Euthanasia had a constant price across all alternatives. This survey had 450 respondents with a variety of ages, equine experiences, and socioeconomic backgrounds.

When not including the demographic interaction variables, all attribute variables were statistically significant, as was the euthanasia choice dummy variable. The price and recovery period attribute coefficients were both positive indicating that as price or recovery period increased, the rank value also increased. As a higher rank value meant a lower preference (i.e. a rank of three was the least preferred option while a rank of one was the most preferred option) these results show that as price or recovery period for an alternative increased, respondents were less likely to rank the alternative as a more preferred option. The success rate coefficient was negative, meaning that as success rate for an alternative increased, respondents were more likely to rank that alternative as a more preferred option. The euthanasia dummy variable coefficient was positive. This meant that when the euthanasia variable was ranked, it was given a higher rank value, and was thus a less preferred option. All of these results support the hypotheses that as price or recovery period increased, respondents were less attracted to that alternative. These results also support the hypothesis that a higher success rate increases the chance an alternative will be ranked as a more preferred option. As expected, when the euthanasia alternative was ranked, it was ranked as a less preferred option.

Using the results from the initial regression (Table 21), it was determined that respondents were willing to pay more for a shorter recovery period and a higher success rate (Table 22). The difference

between these values was immense. The WTP estimate for an 11.5 week shorter recovery period was calculated to be $39.81 while the WTP value for a 15% higher success rate was calculated at $10,912. Results also show that respondents would be willing to pay $2,610 to avoid euthanizing their sick horse.. These calculated estimates reflect survey respondent behavior given the hypothetical circumstances presented to them in the choice experiment. This analysis demonstrates that horse owners are most concerned with the success rate of a treatment, and less concerned with recovery period and price. The results also suggest that, while the average respondent willing to pay over $2,000 to avoid euthanizing their horse given the presented hypothetical scenarios, they are willing to pay more for a treatment with a high, if not guaranteed, success rate.

When the demographic interaction variables were included in the regression, the recovery period variable became statistically insignificant. Whether or not the respondent competed had no statistically significant interactions with any of the attributes, which was unexpected. The age of the horse interacted with the success rate of the treatment was statistically significant at the one percent level and positive, suggesting as the age of the sick horse increases, success rate becomes more influential on the respondent's decision. Respondents that considered their horses to be competition partners, as opposed to tools or pets, were statistically less sensitive to changes in the price of a treatment. Respondents that considered their horses to be pets or companion animals were statistically more sensitive to changes in the success rate of a treatment. This suggests that these respondents are willing to pay more for a treatment if it has a higher success rate. Respondents with children were only statistically influenced by changes in the success rate of a treatment, being more sensitive to changes in the success rate attribute than their childless counterparts. Unexpectedly, the income of a respondent only statistically influenced their sensitivity to changes in success rate. The negative coefficient for the income and success rate interaction term suggests that those with higher incomes are more concerned with a treatment having a high success rate. It was expected that respondents with a higher income

would be less influenced by increases in the price of a treatment and those with lower incomes would be more influenced by increases in price, but the results unexpected suggest that income did not influence a respondent's sensitivity to price changes. These results imply that the success rate of a treatment is the most important attribute to horse owners when considering spending their disposable income on the treatment of their sick or injured horse.

The results from this research are extremely valuable to those within the veterinary profession. At a minimum, the information gleaned from the survey, choice experiment, and subsequent regressions can provide veterinarians and the veterinary industry with more information about their clients. With these results, veterinarians can better understand how and why their clients make the treatment decisions they do for their sick or injured horses. Overall, it can help the veterinary industry better understand the topics that should be emphasized to further train veterinarians as they interact with clients in a treat-or-euthanize scenario. While this particular study focused on obstruction colic in horses, the results can be used to inspire future research to assess treatment options of various horse ailments, as well as veterinary treatment in other animal industries.

REFERENCES

Bates, J. 1988. Econometric issues in stated preference analysis. Journal of Transport Economics and Policy, 59-69.

Bekker-Grob, E.W., M. Ryan, and K. Gerard. 2010. “Discrete Choice Experiments in Health Economics: A Review of the Literature.” *Health Economics.* 21 (2): 145-172.

Ben-Akiva, M., Bradley, M., Morikawa, T., Benjamin, J., Novak, T., Oppewal, H., & Rao, V. (1994). Combining revealed and stated preferences data. Marketing Letters, 5(4): 335-349.

Breidert, C., Hahsler, M., & Reutterer, T. (2006). A review of methods for measuring willingness-to-pay. Innovative Marketing, 2(4): 8-32.

Brockman, B.K., V.A. Taylor, and C.M. Brockman. 2006. “The Price of Unconditional Love: Consumer Decision Making for High-Dollar Veterinary Care.” *Journal of Business Research.* 61: 397-405.

Cascetta, E. 2001. "Random Utility Theory." *In Transportation Systems Engineering: Theory and Methods*. Vol. 29. Springer Optimization and Its Applications. Dordrecht: Kluwer Academic. pp. 89-167.

Convers, P.D., E.W. Wolfe, X. Huang, and F.L. Oswald. 2008. “Response Rates for Mixed-Mode Surveys Using Mail and Email/Web.” *American Journal of Evaluation.* 29 (1): 99-107.

Deolite. American Horse Council Foundation: The Economic Impact of the Colorado Horse Industry. 2005. Colorado Horse Industry Impact Report

Didier, Tagbata, and Sirieix Lucie. "Measuring consumers willingness to pay for organic and Fair Trade products." International Journal of Consumer Studies 32, no. 5 (August 13, 2008), 479-90.

Dransfield E., T.M. Ngapo, N.A. Nielsen, L. Bredahl, P.O. Sjödén, M. Magnusson, et al. 2005. Consumer choice and suggested price for pork as influenced by its appearance, taste and information concerning country of origin and organic pig production. Meat Science. 69: 61–70

Dyce, K. M., DVM&S, MRCVS, W. O. Sack, DVM, PhD, Dr. Med. Vet, and C. J.G. Wensing, DVM, PhD. "The Abdomen of the Horse." In Textbook of Veterinary Anatomy, 545-62. 4th ed. St. Luis, MO: Saunders Elsevier, 2010.

Endenburg, N. 2010. "Perceptions and attitudes towards horses in European societies." *Equine Veterinary Journal.* 31(28): 38-41.

Endenburg, N., J. Kirpensteijn, and N. Sanders. 1999. "Equine Euthanasia: The Veterinarian's Role in Providing Owner Support." *Anthrozoos: A Multidisciplinary Journal of the Interactions of People & Animals.* 12(3): 138-141.

Espejel, J., C. Fandos, and C. Flavián. 2007. "The role of intrinsic and extrinsic quality attributes on consumer behaviour for traditional food products." *Managing Service Quality: An International Journal.* 17(6): 681-701.

"Euthanasia". Merriam-Webster 2017. Web. 7 Mar. 2017.

Fleming C and M. Bowden. 2009. “Web-based surveys as an alternative to traditional mail methods.” *Journal of Environmental Management.* 90: 284–292.

Fok, D., R. Paap, and B. Van Dijk. 2010. "A Rank-Ordered Logit Model With Unobserved Heterogeneity In Ranking Capabilities." *Journal of Applied Econometrics*. 27 (5): 831-46.

Freeman III, A. M., Herriges, J. A., & Kling, C. L. 2014. The measurement of environmental and resource values: theory and methods. Routledge.

Gafni, Amiram. "Willingness To Pay." PharmacoEconomics 14, no. 5 (November 1998): 465-70.

Grutters, J., A. Kessels, C. Dirkson, D. Van Helvoort-Postulart, L. Anteunis, and M. Joor. 2008. "Willingness to Accept versus Willingness to Pay in a Discrete Choice Experiment." *Value in Health.* 11 (7): 1110-1119.

Hansez, I., F. Schins, and F. Rollin. 2008. "Occupational stress, work-home interference and burnout among Belgian veterinary practitioners." *Irish Veterinary Journal*. 61 (4): 233.

Hensher, D. A., and M. Bradley. 1993. Using stated response choice data to enrich revealed preference discrete choice models. Marketing Letters, 4(2): 139-151.

Horse Properties. "Horse Industry Statistics ." HorseProperties.net. 2017. Accessed August 11, 2017.

Ireland, J. L., P. D. Clegg, C. M. Mcgowan, S. A. Mckane, and G. L. Pinchbeck. 2010. "A cross-sectional study of geriatric horses in the United Kingdom. Part 2: Health care and disease." *Equine Veterinary Journal.* 43 (1): 37-44.

Kilby, E.R. (2007). The demographics of the U.S. equine population. In D.J. Salem & A.N. Rowan (Eds.), The state of the animals 2007 (pp. 175-205). Washington, DC: Humane Society Press.

Kotchen, M.J., and S.D. Reiling. 2000. "Environmental attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species." *Ecological Economics*. 32 (1): 93-107.

Krystallis, A., and G. Chryssohoidis. 2005. Consumers' willingness to pay for organic food: Factors that affect it and variation per organic product type. *British Food Journal*, 107(5): 320-343.

Kuhfeld, W.F., R.D. Tobias, and M. Garratt. 1994. "Efficient Experimental Design with Marketing Research Applications." *Journal of Marketing Research.* 31 (4): 545-557.

Louviere, J. J. 1988. Conjoint analysis modelling of stated preferences: a review of theory, methods, recent developments and external validity. *Journal of Transport Economics and Policy*, 93-119.

Lusk, J.L., and F.B. Norwood. 2005. "Effect of Experimental Design on Choice-Based Conjoint Valuation Estimates." *American Journal of Agricultural Economics.* 87 (3): 771-785.

Marta-Pedroso, C., H. Freitas, and T. Domingos. 2007. "Testing for the survey mode effect on contingent valuation data quality: A case study of web based versus in-person interviews." *Ecological Economics.* 62 (3-4): 388-398.

Platt, B., K.Hawton, S. Simkin, and R.J. Mellanby. 2010. "Suicidal behaviour and psychosocial problems in veterinary surgeons: a systematic review." *Social Psychiatry and Psychiatric Epidemiology.* 47 (2): 223-240.

Robinson, I. H. 2010. "The human-horse relationship: how much do we know?" *Equine Veterinary Journal*. 31 (S28): 42-45.

Scantlebury C.E., E. Perkins, G.L. Pinchbeck, D.C. Archer, R.M. Christley. 2014. "Could it be colic? Horse-owner decision making and practices in response to equine colic*." BMC Veterinary Research*. 10(Suppl 1):S1

Starkweather, J., and A.K. Moske. 2011. "Multinomial Logit Regression." Unpublished, University of North Texas.

Svenson, Ola. "Process descriptions of decision making." Organizational Behavior and Human Performance 23, no. 1 (February 1979): 86-112.

Tinker, Mary K., N. A. White, P. Lessard, C. D. Thatcher, K. D. Pelzer, B. Davis, and D. K. Carmel. 1997. "Prospective study of equine colic incidence and mortality." *Equine Veterinary Journal.* 29 (6): 448-53.

Vlosky, R.P., L.K. Ozanne, and R.J. Fontenot. 1999. A conceptual model of US

consumer willingness-to-pay for environmentally certified wood products. Journal of Consumer Marketing, 16(2): 122-140

Weyenberg, S., Van, J. Sales, and G.P.J. Janssens. 2006. "Passage rate of digesta through the equine gastrointestinal tract: A review." *Livestock Science.* 99 (1): 3-12.

Widmar, N.J.O., and D.L. Ortega. 2014. "Comparing Consumer Preferences for Livestock Production Process Attributes Across Products, Species, and Modeling Methods." *Journal of Agriculture and Applied Economics.* 46 (3): 375-391.

Witte, T.K., C.J. Correia, and D. Angarano. 2012. "Experience with Euthanasia is Associated with Fearlessness about Death in Veterinary Students." *Suicide and Life-Threatening Behavior*. 43 (2): 125-138.

Wolf, C.A., J.W. Lloyde, and J.R. Black. 2008. "An Examination of US Consumer Pet-Related and Veterinary Service Expenditure, 1980-2005." *Journal of the American Veterinary Medical Association* 223 (3): 404-413.

Woods, J., J.K. Shearer, and J. Hill, 2010. "Recommended on-farm euthanasia practices." *Improving Animal Welfare: A Practical Approach*, pp.186-213.

Zoetis. 2015. "2015 AHP Equine Industry Survey." *American Horse Publications*. August.

APPENDIX A

Equine Gastrointestinal Tract

The equine gastrointestinal tract is shown in Figure 1. When a horse consumes food, it travels through the esophagus into the stomach, where it is held for two to six hours. The stomach is relatively small compared to the size of the horse. It predominantly lies on the left side of the abdomen and it protected by the rib cage. When additional food is ingested and passes into the stomach, older digesta leaves the stomach and enters the duodenum, the initial part of the small intestine (Weyenberg, 2006).

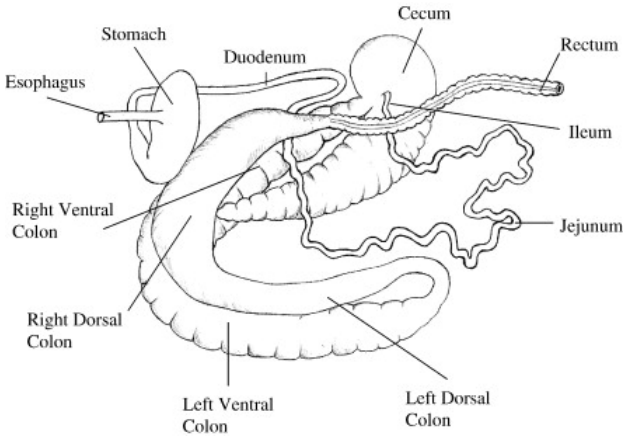

Figure 1: Equine Gastrointestinal Tract- (Weyenberg et al. 2006)

The duodenum is relatively short and remains relatively still inside of the abdomen as it is tightly tethered to adjacent organs. The partially digested feedstuffs then rapidly transfer from the duodenum into the rest of the small intestine, moving through the jejunum and the ileum. The jejunum makes up the majority of the length of the small intestine, moving digesta from the duodenum to the ileum. The ileum is very short and has a much thicker wall than the rest of the small intestine. It attaches the small intestine to the cecum at the cecal base and protrudes into the interior of the cecum (Dyce et al., 2010). The cecum is the initial part of the large intestine. It is responsible for microbial fermentation of the digesta that produces gas that is discharged into the right ventral colon at regular intervals. The cecum also contracts both upwards and downwards in order to move digesta through the ceco-colic junction

into the right ventral colon. There are three parts of the colon: ascending, transverse, and descending. The right ventral colon is the initial section of the ascending colon, followed by the ventral diaphragmatic flexure, left ventral colon, pelvic flexure, left dorsal colon, dorsal diaphragmatic flexure, and right dorsal colon. The right dorsal colon is then connected to the descending colon by the short transverse colon (Dyce et al., 2010). Digesta spends the majority of its time in the colon, moving from the right ventral colon through the left ventral colon, into the left dorsal colon and finally the right dorsal colon. After digestion in the colon is complete, digesta is finally evacuated through the rectum (Weyenberg, 2006). Many common conditions that cause colic are the result of obstructions and displacement of the large intestine (Dyce et al., 2010).

APPENDIX B

Derivation of Probability of Least Preferred Option

Below is the derivation of the probability that an alternative is ranked as the least preferred alternative in a set of J alternatives. The probability of interest is denoted as $\Pr\left[U_{ir_{ij}} \leq U_{ir_{im}} \forall m > k\right]$. The IIA property associated with logit models suggests that the probability that an alternative (r_{ij}) is ranked as least preferred is not dependent on the utilities associated with the most preferred alternatives. The below notation is the probability that alternative 1 is ranked as least preferred in a set of J alternatives, with subscript *i* removed for notational simplicity. (Fok et al., 2010)

$$
\begin{aligned}
\Pr[y_1 = J] &= \Pr\left[U_1 \leq U_j, j = 2, \dots, J\right] \\
&= \Pr\left[\varepsilon_j > V_1 - V_j + \varepsilon_1, j = 2, \dots, J\right] \\
&= \int_{-\infty}^{\infty} f(\varepsilon_1) \int_{V_1 - V_2 + \varepsilon_1}^{\infty} f(\varepsilon_2) \dots \int_{V_1 - V_J + \varepsilon_1}^{\infty} f\left(\varepsilon_J\right) d\varepsilon_J \dots d\varepsilon_2 d\varepsilon_1 \\
&= \int_{-\infty}^{\infty} f(\varepsilon_1) \int_{V_1 - V_2 + \varepsilon_1}^{\infty} f(\varepsilon_2) \dots \int_{V_1 - V_{J-1} + \varepsilon_1}^{\infty} f\left(\varepsilon_{J-1}\right) \\
&\times [1 - ecp(-e^{V_J - V_1 - \varepsilon_1})] d\varepsilon_{J-1} \dots d\varepsilon_2 d\varepsilon_1 \\
&= \int_{-\infty}^{\infty} f(\varepsilon_1) [1 - \exp(-e^{V_2 - V_1 - \varepsilon_1})] \dots [1 - \exp(-e^{V_J - V_1 - \varepsilon_1})] d\varepsilon_1
\end{aligned}
$$

APPENDIX C

Survey and Choice Experiment Block 1

Thank you for taking the time to participate in this study. Your answers will be part of a project aimed at **understanding the factors that influence a horse owner's willingness to pay for a sick or injured horse**. The disease considered in this study is **obstruction colic.**

Your participation poses no risk to you as your responses are anonymous. No personal identifiers will be collected through this research. Your answers to these questions will lead to better understanding of the veterinary care decisions of horse owners like yourself, and possibly lead to further research in this field.

It is my hope that the data collected through this survey and the subsequent analysis will provide information to veterinarians regarding how their clients make treatment decisions for their horses. Ideally, veterinarians will be able to use this new knowledge to make managerial and pricing decisions that will potentially allow for more clients to choose to treat their sick or injured horses as opposed to euthanasia.

Please click on the arrows below to continue the survey.

Before we state the survey, it is important to define a few terms that will be used throughout the survey to ensure everyone has the same background when completing the survey.

Obstruction colic occurs when a portion of the **intestine become twisted on itself**. This causes the partial or complete obstruction of blood flow that part of to the intestine. It is the usually the result of an abnormal positioning of the intestine, though it can also occur in the cecum or colon.

Symptoms include **absence of gut sounds**, **severe and continuous abdominal pain**, **pawing**, **rolling**, **lack of appetite**, **dehydration**, and **lack of bowel movements**.

While treatment for some cases of obstruction colic can occur in the field, surgery may be required in some cases. **Surgical treatments are the focus of this study.**

The price of surgical treatment can range anywhere from **$1,500 to upwards of $15,000.**

To begin this survey you will be asked to answer **demographic questions** about your horse and yourself. Please answer these questions as thoroughly and truthfully as possible, as they will help to understand the choices you make regarding the treatment for your horse. Following the demographic questions, you will be asked to answer choice scenarios regarding obstruction colic.

Please indicate below if you are a horse owner AND over the age of 18.

- O I am a horse owner AND over the age of 18.
- O I am NOT a horse owner AND over the age of 18.

With which discipline do you most associate?

- O English
- O Western
- O Other

Do you compete within your discipline?

- O Yes
- O No

Please select all breeds of horses you currently own.

- [ ] Appaloosa
- [ ] Arabian
- [ ] Draft Breed
- [ ] Gaited Breed
- [ ] Miniature Horse
- [ ] Morgan
- [ ] Mule/Donkey
- [ ] Mustang
- [ ] Other
- [ ] Paint Horse
- [ ] Pony Breed
- [ ] Quarter Horse
- [ ] Standardbred
- [ ] Thoroughbred
- [ ] Warmblood

How many horses do you own?

- O 0
- O 1-4
- O 5-8
- O 9-11
- O 12+

How long have you owned horses?

- O <1 year
- O 1-5 years
- O 6-10 years
- O 11+ years

How would you characterize your relationship with your horse?

- O Property/Tool
- O Competition Partner
- O Pet/Companion Animal

How many hours per week, on average, do you spend with your horse(s)?

- O 0 hours
- O 1-3 hours
- O 4-7 hours
- O 8+ hours

Have you purchased equine medical insurance in the past year?

- O Yes
- O No

If you have equine medical insurance, what kind of coverage do you have?

- O Major Medical
- O Surgical
- O Full Mortality
- O Limited Mortality
- O Loss of Use
- O Personal Liability

How old are you?

- O 18-25 years
- O 26-35 years
- O 36-45 years
- O 46-55 years
- O 56-65 years
- O 66-75 years
- O 76+ years

What is the highest level of education you have completed?

- O High School Diploma/GED
- O Bachelor's Degree (e.g. B.S., B.A.)
- O Graduate Degree (e.g. M.S., M.A., M.B.A, PhD)
- O Professional Degree (e.g. J.D., M.D., D.V.M.)

What is your gender?

- O Male
- O Female

How many children do you have?

- O 0
- O 1-2
- O 3-4
- O 5+

What is your average annual household income?

- O <$24,999
- O Between $25,000 and $49,999
- O Between $50,000 and $74,999
- O Between $75,000 and $99,999
- O >$100,000

You will be asked to answer several questions about your choice to purchase one of two treatment options for your horse or to euthanize after your horse hypothetically develops obstruction colic. You will be asked to choose from Treatment A, Treatment B, or Euthanize. Each treatment option will vary in price ($), recovery period (weeks), and success rate (percent chance of full recovery). Euthanasia will have a price of $400 in all choice sets.

When you make these decisions in the survey, please make each choice as true-to-life as possible, as previous studies have shown participants tend to overestimate their willingness to pay when completing surveys. Please make a choice as if you were using real money, keeping in mind your personal financial and equine situation. Your responses may prompt future research into this and related topics. All questions and scenarios in this survey refer to horses you own and care for on a regular basis.

How old is the horse you are referring to in your decisions for obstruction colic treatment?

▼ 1 ... 40

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$10,000** Recovery Period: **1 week** Success Rate: **70%**	Treatment B Cost: **$2,000** Recovery Period: **24 weeks** Success Rate: **70%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$2,000** Recovery Period: **24 weeks** Success Rate: **70%**	Treatment B Cost: **$6,000** Recovery Period: **12.5 weeks** Success Rate: **100%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$6,000** Recovery Period: **12.5 weeks** Success Rate: **100%**	Treatment B Cost: **$10,000** Recovery Period: **24 weeks** Success Rate: **100%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$10,000** Recovery Period: **24 weeks** Success Rate: **100%**	Treatment B Cost: **$6,000** Recovery Period: **24 weeks** Success Rate: **70%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$6,000** Recovery Period: **24 weeks** Success Rate: **70%**	Treatment B Cost: **$10,000** Recovery Period: **12.5 weeks** Success Rate: **70%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$2,000** Recovery Period: **12.5 weeks** Success Rate: **70%**	Treatment B Cost: **$10,000** Recovery Period: **12.5 weeks** Success Rate: **100%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$10,000** Recovery Period: **12.5 weeks** Success Rate: **100%**	Treatment B Cost: **$10,000** Recovery Period: **1 week** Success Rate: **70%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

The survey is complete. Thank you for taking the time out of your busy day to answer this survey. A summary report will be provided to your association once it is complete.

APPENDIX D

Survey and Choice Experiment Block 2

Thank you for taking the time to participate in this study. Your answers will be part of a project aimed at understanding the factors that influence a horse owner's willingness to pay for a sick or injured horse. The disease considered in this study is obstruction colic.

Your participation poses no risk to you as your responses are anonymous. No personal identifiers will be collected through this research. Your answers to these questions will lead to better understanding of the veterinary care decisions of horse owners like yourself, and possibly lead to further research in this field.

It is my hope that the data collected through this survey and the subsequent analysis will provide information to veterinarians regarding how their clients make treatment decisions for their horses. Ideally, veterinarians will be able to use this new knowledge to make managerial and pricing decisions that will potentially allow for more clients to choose to treat their sick or injured horses as opposed to euthanasia.

Please click on the arrows below to continue the survey.

Please take a moment to read the following about obstruction colic:

Obstruction colic occurs when a portion of the intestine become twisted on itself. This causes the partial or complete obstruction of blood flow that part of the intestine. It is the usually the result of an abnormal positioning of the intestine, though it can also occur in in the cecum or colon.

Symptoms include absence of gut sounds, severe and continuous abdominal pain, pawing, rolling, lack of appetite, dehydration, and lack of bowel movements.

While treatment for some cases of obstruction colic can occur in the field, surgery may be required in some cases. Surgical treatments are the focus of this study.

The price of surgical treatment can range anywhere from $1,500 to upwards of $15,000.

To begin this survey you will be asked to answer **demographic questions** about your horse and yourself. Please answer these questions as thoroughly and truthfully as possible, as they will help to understand the choices you make regarding the treatment for your horse. Following the demographic questions, you will be asked to answer choice scenarios regarding obstruction colic.

Please indicate below if you are a horse owner AND over the age of 18.

O I am a horse owner AND over the age of 18.

O I am NOT a horse owner AND over the age of 18.

With which discipline do you most associate?

O English

O Western

O Other

Do you compete within your discipline?

O Yes

O No

Please select all breeds of horses you currently own.

- [ ] Appaloosa
- [ ] Arabian
- [ ] Draft Breed
- [ ] Gaited Breed
- [ ] Miniature Horse
- [ ] Morgan
- [ ] Mule/Donkey
- [ ] Mustang
- [ ] Other
- [ ] Paint Horse
- [ ] Pony Breed
- [ ] Quarter Horse
- [ ] Standardbred
- [ ] Thoroughbred
- [ ] Warmblood

How many horses do you own?

- O 0
- O 1-4
- O 5-8
- O 9-11
- O 12+

How long have you owned horses?

- O <1 year
- O 1-5 years
- O 6-10 years
- O 11+ years

How would you characterize your relationship with your horse?

- O Property/Tool
- O Competition Partner
- O Pet/Companion Animal

How many hours per week, on average, do you spend with your horse(s)?

- O 0 hours
- O 1-3 hours
- O 4-7 hours
- O 8+ hours

Have you purchased equine medical insurance in the past year?

- O Yes
- O No

If you have equine medical insurance, what kind of coverage do you have?

- O Major Medical
- O Surgical
- O Full Mortality
- O Limited Mortality
- O Loss of Use
- O Personal Liability

How old are you?

- O 18-25 years
- O 26-35 years
- O 36-45 years
- O 46-55 years
- O 56-65 years
- O 66-75 years
- O 76+ years

What is the highest level of education you have completed?

- O High School Diploma/GED
- O Bachelor's Degree (e.g. B.S., B.A.)
- O Graduate Degree (e.g. M.S., M.A., M.B.A, PhD)
- O Professional Degree (e.g. J.D., M.D., D.V.M.)

What is your gender?

- O Male
- O Female

How many children do you have?

- O 0
- O 1-2
- O 3-4
- O 5+

What is your average annual household income?

- O <$24,999
- O Between $25,000 and $49,999
- O Between $50,000 and $74,999
- O Between $75,000 and $99,999
- O >$100,000

You will be asked to answer several questions about your choice to purchase one of two treatment options for your horse or to euthanize after your horse hypothetically develops obstruction colic. You will be asked to choose from Treatment A, Treatment B, or Euthanize. Each treatment option will vary in price ($), recovery period (weeks), and success rate (percent chance of full recovery). Euthanasia will have a price of $400 in all choice sets.

When you make these decisions in the survey, please make each choice as true-to-life as possible, as previous studies have shown participants tend to overestimate their willingness to pay when completing surveys. Please make a choice as if you were using real money, keeping in mind your personal financial and equine situation. Your responses may prompt future research into this and related topics. All questions and scenarios in this survey refer to horses you own and care for on a regular basis.

How old is the horse you are referring to in your decisions for obstruction colic treatment?

▼ 1 ... 40

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$2,000** Recovery Period: **1 week** Success Rate: **70%**	Treatment B Cost: **$10,000** Recovery Period: **1 week** Success Rate: **100%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$10,000** Recovery Period: **1 week** Success Rate: **100%**	Treatment B Cost: **$6,000** Recovery Period: **12.5 weeks** Success Rate: **70%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$6,000** Recovery Period: **12.5 weeks** Success Rate: **70%**	Treatment B Cost: **$2,000** Recovery Period: **24 weeks** Success Rate: **100%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$2,000** Recovery Period: **24 weeks** Success Rate: **100%**	Treatment B Cost: **$6,000** Recovery Period: **1 week** Success Rate: **85%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$6,000** Recovery Period: **1 week** Success Rate: **85%**	Treatment B Cost: **$6,000** Recovery Period: **24 weeks** Success Rate: **100%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$6,000** Recovery Period: **24 weeks** Success Rate: **100%**	Treatment B Cost: **$2,000** Recovery Period: **12.5 weeks** Success Rate: **100%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Please choose the option you are most likely to choose if your horse becomes ill with obstruction colic.

	Treatment A Cost: **$2,000** Recovery Period: **12.5 weeks** Success Rate: **100%**	Treatment B Cost: **$2,000** Recovery Period: **1 week** Success Rate: **70%**	Euthanasia Cost: **$400**
Most Preferred	O	O	O
Least Preferred	O	O	O

Once again, thank you for your participation in this study.