DISSERTATION

SELECTED ASPECTS OF THE ECONOMICS SURROUNDING EQUINE DISEASE

Submitted by

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ABSTRACT

SELECTED ASPECTS OF THE ECONOMICS SURROUNDING EQUINE DISEASE

The equine industry, from an economic perspective, is largely understudied with much of the existing research conducted on economic contribution studies (College of Agriculture, Food and Environment, University of Kentucky, 2013; Rephann, 2011; Conners et al., 2011; Deloitte Consulting LLP, 2005; Swinker et al., 2003) and the Thoroughbred sector of the industry (Maynard and Stoeppel, 2007; Poerwanto and Stowe, 2010; Plant and Stowe, 2013). Few studies have investigated the economic impacts of equine disease and/or equine disease outbreaks to individuals, regions, or states (USDA-APHIS-VS, 2003; Conners et al., 2011). This collection of studies aims to contribute to existing equine economic research by investigating the impacts of equine disease outbreaks in a variety of ways that complement and reinforce each component part's findings.

Equine owner's experience two major types of costs when their horse has an infectious disease: direct costs of treating the horse for the disease (e.g., veterinarian expenses) and indirect costs (e.g., lost daily use of the horse). Utilizing survey data collected nationwide, estimates of daily horse use value (DHUV), as well as, respondent preferences regarding disease treatment options was obtained. Results suggest that the average horse owner is willing to pay between $11.99 and $17.84 to reduce the number of non-use (rest) days required. Respondents showed preferences for administration of oral medications over intramuscular injection medications, all else equal, and a preference for treatments requiring fewer number of doses per day.

To expand upon the estimated DHUV, a survey of equine owners/riders/trainers, etc. provides data to estimate the lost DHUV experienced by respondents when their horse develops

a disease as it relates to equine events. Results suggest DHUV, of those surveyed, to be impacted by income level, the frequency of equine events attended by distance and whether a planned equine event is upcoming or not.

An important contribution to the previous study estimating daily use values of equids is the incorporation of a timing aspect related to equine events (i.e., length of time until a planned equine event). This generated the expected results and informed the conclusion that DHUV does vary as days until the next event decreases. As anticipated, equine owners assigned a higher daily value the use of their horse when an event was three weeks away compared to when there was no immediate event, and more specifically, the daily value increased by a difference of $4.14.

In addition to effects on the equine owners, there are economy-wide implications from equine disease outbreaks as well. As one example, equine events drive tourism for the local economies for locations where they are held, by generating revenue to multiple local industries. The economic impact from tourism activities surrounding equine events includes monies spent by event spectators, exhibitors and volunteers who reside outside the region and the “inflow of non-resident monies” used to purchase food/drink, lodging, fuel and gifts/souvenirs within the area of the event. Recent disease outbreaks in Colorado and other locations in the United States have caused equine travel restrictions, quarantines and the cancellation of equine events. Using survey data collected at a nationally attended equine event along with existing estimates of event attendee expenditures, the economic losses associated with canceled or reduced attendance at equine events are estimated. Loss estimates for the total effect from canceled or compromised attendance for this one national event range between $500,000 and $107 million depending on assumptions of the nature and severity of the outbreak.

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CHAPTER ONE - INTRODUCTION

The equine industry throughout the United States (U.S.) represents an extremely heterogeneous set of subsectors due to the vast number of breeds (over 300), as well as the variety of uses equine owners report, including; pleasure riding, trail riding, jumping, roping, dressage, barrel racing, ranch work and general value of ownership as a companion animal. Some level of horse ownership and economic activity exists in all 50 U.S. states and those stakeholders who own, manage and invest in horses have diverse backgrounds and socioeconomic status.

Estimates on the number of horses in the United States range from 3.6 million "on farms" (USDA-NASS, 2012) to 9.2 million as an estimate of all equine owned by US households and businesses (Deloitte, 2005). These estimates vary greatly with the true national equine population likely somewhere in between these estimates. What is true is that the equine industry contributes significantly to the U.S. economy. The study conducted by Deloitte LLP, commissioned by the American Horse Council in 2005, estimates the direct impacts of the equine industry to the U.S. economy at $39 billion with indirect contribution to the economy of $102 billion. The 2005 study is the only known study to estimate the economic impact of the U.S. equine industry which includes both direct and indirect impacts.

The equine industry, from an economic perspective, is largely understudied with much of the existing research conducted on economic contribution of the equine industry to a state or region (College of Agriculture, Food and Environment, University of Kentucky, 2013; Rephann, 2011; Conners et al., 2011; Deloitte Consulting LLP, 2005; Swinker et al., 2003) and the Thoroughbred industry (Maynard and Stoeppel, 2007; Poerwanto and Stowe, 2010; Plant and

Stowe, 2013). A lack of reliable data for economic descriptors of the industry contribute to the challenges in framing the role of the equine industry to the broader economy, exploring the market size available for those enterprises exploring innovations and product development that would target equine owners, and for equine economic studies as a whole. As the industry has no central data collection system, the frequent private party sales occur with little to no documentation. Overall, these challenges contribute to the lack of economic research conducted on the equine industry.

A more refined subset of equine economic research exists for equine disease. Few studies have investigated the economic impacts of equine disease and/or equine disease outbreaks to individuals, regions, or states (USDA-APHIS-VS, 2003; Conners et al., 2011). Recent disease outbreaks (equine herpesvirus in 2011 and 2012, vesicular stomatitis virus in 2014 and 2015) throughout the United States highlight the importance of investigating how industry stakeholders are affected by these outbreaks. Equine disease may impact individual equine owners/riders/trainers/caregivers, equine event management companies, equine business owners, equine service providers (veterinarians, ferries, etc.), local economies, and countless others involved directly or indirectly with the equine industry.

The collection of studies in this dissertation aims to contribute to existing equine economic research by investigating the impacts of equine disease outbreaks. Chapter 2 estimates daily horse use value, for the average survey respondent, in addition to disease treatment option preferences using a best-worst choice experiment. During a disease outbreak these use values would be lost to the individual horse owner should their horse become infected and therefore require a number of days of rest. The value an individual horse owner places on the daily use of their horse may not be static for specific segments of the larger equine industry. Equine owners who regularly compete in equine events may have variable daily use values related to the timing of a planned equine event (i.e., how much time exists until a planned equine event). Chapter 3 provides further investigation of the value of daily use using a double bounded dichotomous choice method by estimating the impacts equine event participation has on the value of daily use, in addition to understanding how daily use may vary depending on an impending equine event. Disease outbreaks can present many challenges to those involved with and/or impacted by equine events. During an outbreak, event participants may be unable or unwilling to attend an event. The absence of participants at an event creates economic loss to the local economy by way of lost tourism spending (on food, lodging, etc.) when those who do not attend reside outside of the local area. Chapter 4 estimates the lost tourism dollars to a region due to the absence of equine event participants caused by a disease outbreak. The following three essays (Chapters 2-4) explore the economic impact disease outbreaks have on individuals and local economies.

Chapter 2. Equine Daily Use Values and Owner Willingness-to-Pay for Infectious Disease Treatment Options

Few existing studies have estimated the value of daily use of an equid (USDA-APHIS-VS, 2003; Conners et al., 2011). Daily horse use value (DHUV) is defined as value to an equine owner/rider/trainer, etc. of the daily use of their horse(s) for its intended purpose (riding, showing, training, etc.). The implicit value of owning a horse, DHUV, and not just the explicit cost of horse ownership (feed, veterinary/farrier services, supplies, etc.) should be considered when a horse contracts a disease since this value is lost to the equine owner when the horse cannot be utilized for its intended purpose. Direct cost of horse ownership is sustained regardless of the use-status of the horse and therefore is still incurred when the horse is ill or injured. Use value however, is lost whenever the horse is restricted from activity.

The study presented in Chapter 2 estimates DHUV utilizing a choice experiment approach. Survey respondents are presented with a scenario in which their horse develops an infectious disease and must be treated; two treatment options and a no treatment option were presented. In addition to the primary objective of estimating DHUV, secondary objectives include estimating respondent preferences for route of drug administration and frequency of dosing of the drug. This study is the first of its kind in its attempt to assess the value equine owners place on treatment attributes, as well as the first known study to employ a choice experiment for the estimation of DHUV.

Chapter 3. Does Participation in Equine Events Impact Equine Daily Use Values?

An effort to expand on the findings described in Chapter 2 is the basis for an additional valuation analysis in Chapter 3. This targeted analysis attempts to estimate DHUV and the differential impact that demographic and competition information may have on values.
This study's objectives assume equine owners may face lost use time during a disease outbreak when their horse contracts a disease and is required rest time to recover. This lost use time for equine owners who participate in equine events, such as shows and competitions, may prohibit training/riding sessions necessary to prepare for these events. To estimate the loss of that training/riding time or lost DHUV, a survey is administered to Arabian Horse Association email listserv members.

Chapter 3 takes the estimation of daily use values a step further by providing a temporal component to an owner's willingness-to-pay to reduce rest days required when a horse develops an infectious disease. This analysis provides survey respondents the opportunity to respond with their willingness-to-pay in order to reduce the number of rest days under two different hypothetical situations; both when there was no plan to attend an equine event, and, when there was an upcoming equine event. By collecting responses to these questions, DHUV is evaluated for two different temporal situations as it is anticipated that respondents who regularly attend equine events have different DHUV when the dates of an event are upcoming compared to when they are not. More specifically, it is expected that DHUV and time until an event have an inverse relationship.

Chapter 4. Estimating the Potential Economic Loss to Local Economies When Equine Disease Outbreaks Impact Equine Events

Another important aspect of equine disease outbreaks is the economic impact to broader economic sectors related to disruptions to equine events. Events such as horse shows or competitions bring tourism monies to the local economies where the event takes place, in the form of expenditures for food/beverages, lodging, entertainment, etc. by attendees. Outbreaks can cause travel restrictions and/or quarantine requirements, both of which may result in equine events either experiencing reduced attendance from participants or, if severe enough, full cancellation of the event. Local economies will likely experience economic loss when an event is cancelled or attendance is reduced given the curtailed tourism dollars that would have otherwise be spent in that area.

Analysis in Chapter 4 estimates the economic loss experienced by a region, caused by two possible scenarios; the compromised attendance at an equine event or the full cancellation of the event. Impact analysis for planning (IMPLAN), customized with primary data to more accurately reflect the specific situation, is used to analyze the losses experienced by a defined study region. Specifically, primary data on the attendees' (exhibitors and spectator) spending is utilized for the various industries to estimate the losses experienced due to a cancelled event. Sensitivity analysis is also performed to give greater context to the range of impacts the region would experience due to compromised attendance. To augment the generalizability of the study, the procedures one could utilize to provide customizable results for equine events which may differ in the number of attendees are provided as a summary of this work.

Each of these three chapters contributes to existing equine economic studies with an emphasis on equine disease economic research as stand-alone studies. However, it is also the intention of this work to show the complementarity of the findings from each piece of research, so that a systematic look at the economics of equine disease outbreaks could begin to be framed. Equine industry personnel can benefit from these studies by gaining a more in depth and explicit understanding of the economic impact of disease outbreaks. This information can be used to justify disease spread mitigation strategies, motivate biosecurity practices, further research and product development, and more generally, inform industry stakeholders.

REFERENCES

Deloitte Consulting, LLP. 2005. National Economic Impact of the U.S. Horse Industry. American Horse Council Foundation. Available at: http://www.horsecouncil.org/national-economic-impact-us-horse-industry [accessed on 9/17/2014].

College of Agriculture, Food and Environment, University of Kentucky; Kentucky Agricultural Development Fund; Kentucky Horse Council; and Ag Equine Programs, University of Kentucky. 2013. *2012 Kentucky Equine Survey*. Kentucky Equine Survey. Paper 1. Available at: http://equine.ca.uky.edu/sites/equine.ca.uky.edu/files/2012equinesurveyreportFINAL3.pdf [accessed on 7/9/2014].

Conners, S.E., L. Couetil, J.M. Furdek, and M.A. Russell. 2011. *Indiana Equine Industry Economic Impact and Health Study*. Purdue University, College of Veterinary Medicine. Available at: https://www1.maine.gov/dafs/gamingcom/docs/Indiana%20Equine%20Industry%20Econominc%20Impact%20Study,%20PC.pdf [accessed on 7/15/2014].

Maynard, L. and K.M. Stoeppel. 2007. "Hedonic Price Analysis of Thoroughbred Broodmares in Foal." *Journal of Agribusiness*. 25,2: 181-195.

Plant, E.L., and C.J. Stowe. 2013. "The Price of Disclosure in the Thoroughbred Yearling Market." *Journal of Agricultural and Applied Economics*. 45,2: 243-257.

Poerwanto, D., and C.J. Stowe. 2010. “The Relationship Between Sire Representation and Average Yearling Prices in the Thoroughbred Industry.” *Journal of Agribusiness*. 28,1: 61-74.

Rephann, T.J. 2011. *The Economic Impact of the Horse Industry in Virginia*. Weldon Cooper Center for Economic and Policy Studies Weldon Cooper Center for Public Service, University of Virginia. Available at: http://www.coopercenter.org/sites/default/files/publications/horse_study_final.pdf [accessed on 5/21/2014].

Stowe, C.J. 2012. *Results from 2012 AHP Equine Industry Survey*: *American Horse Publications*. American Horse Publications. Available at: http://www.americanhorsepubs.org/resources/ [accessed on 7/9/2014].

Swinker, A.M., P.R. Tozer, M.L. Shields, and E.R. Landis. 2003. *Pennsylvania's Equine Industry Inventory, Basic Economic and Demographic Characteristic*s. Department of Dairy and Animal Science. The Pennsylvania State University. Available at: http://extension.psu.edu/animals/equine/economic-impact-and-population-study/pa-equine-industry-inventory-basic-economic-and-demographic-characteristics [accessed on 7/9/2014].

USDA-APHIS. 2003. *Economic Impact of West Nile Virus on the Colorado and Nebraska Equine Industries: 2002*. Info Sheet. USDA-APHIS. Available at: http://www.aphis.usda.gov/animal_health/nahms/equine/downloads/wnv2002_CO_NB.pdf [accessed on 7/15/2014].

USDA-NASS. 2012. 2012 Census of Agriculture. Summary and State Data. Volume 1. Available at: https://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_1_US/usv1.pdf [accessed on 5/1/2016].

CHAPTER TWO - EQUINE DAILY USE VALUES AND OWNER WILLINGNESS-TO-PAY FOR INFECTIOUS DISEASE TREATMENT OPTIONS

Introduction

Concerns associated with equine infectious diseases have escalated in recent years. In 2011, an outbreak of equine herpesvirus-1 (EHV-1) was associated with horses having attended a National Cutting Horse Association Event in Ogden, Utah, resulted in over 90 confirmed cases of EHV-1 or equine herpesvirus myeloencephalopathy and the cancellation of many equine related events (USDA-APHIS, 2011). In 2012, another outbreak of EHV-1 occurred at Hawthorne Racetrack near Chicago, Illinois. Due to the quarantine, horses were prohibited from entering or leaving the grounds to participate in races at other tracks. Numerous states experienced an outbreak of vesicular stomatitis virus (VSV) throughout 2014 and 2015. During the 2014 outbreak, over 370 locations in Colorado were placed under quarantine after horses and cattle became infected with VSV (USDA-APHIS, 2015a). From the start of the outbreak in 2015 thru March 4, 2016, VSV was confirmed or suspected on 823 premises in eight states; Arizona, Colorado, Nebraska, New Mexico, South Dakota, Texas, Utah and Wyoming (USDA-APHIS, 2015b). Assessing the economic costs of such outbreaks is a first step in determining the optimal investment of resources in prevention and treatment efforts.

The total economic cost of a disease outbreak is the summation of many components (e.g., lost revenue from canceled equine events, cost of medical treatment, lost use of equids, etc.), but the costs borne by equine owners represents a significant share of the total, and can represent a significant burden when one considers the inherent losses associated with lost training time (Giedt, 2014). Equine owner’s experience two types of costs when their horse develops an infectious disease: 1) direct cost of treating the horse for the disease (e.g., veterinarian charges, medication expenses, implementation of biosecurity, etc.); and 2) indirect cost (e.g., lost daily use of the horse, and emotional distress of owner, etc.). Direct costs are relatively simple to calculate and the costs of disease prevention has been estimated using enterprise budgets (Isaacs et al., 2006). However, reliable measures of indirect costs are not available.

The main purpose of this study is to obtain an estimate of daily horse use value (DHUV), or, to be precise, how much horse owners are willing to pay to reduce, by a day, the length of an incapacitating respiratory disease in their horse. Secondary objectives in this study include the assessment of preferences for route of drug administration (oral or injection) and frequency of daily dosing of a drug. Additionally, horse and owner characteristics that may affect DHUV are evaluated to understand what factors may influence the DHUV.

This research is unique as it is the first known study to assess the valuation of disease treatment options of equids. Additionally, to the best of our knowledge this is the first research using a choice experiment method to estimate the indirect cost of equine disease that is perceived by equine owners. We expect that our results will be useful in assessing the cost of disease outbreaks, as well as providing information useful for field veterinarians prescribing treatments for equids and companies developing and marketing new treatment options.

Background

The equine industry remains largely unstudied from an economic perspective, in part due to the lack of reliable economic data for the equine industry. The industry is extremely heterogeneous (i.e., over 300 horse breeds with many different types of uses), with few accessible data collection systems recording purchases and sales of horses and scarce private records available. Most existing economic research focuses on the Thoroughbred racing industry (Maynard and Stoeppel, 2007; Poerwanto and Stowe, 2010; Plant and Stowe, 2013) and industry economic impact studies (College of Agriculture, Food and Environment, University of Kentucky, 2013; Rephann, 2011; Conners et al., 2011; Deloitte Consulting LLP, 2005; Swinker et al., 2003). Economic equine disease research is sparse and is mostly confined to reporting of economic impacts of particular diseases to an individual horse owner, region or state (USDA-APHIS-VS, 2003; Conners et al., 2011) with little generalizable to the broader sector.

Conners et al. (2011) reported owner estimated cost of lost use as the value of daily use plus the cost to treat an affliction (illness or injury). However, the authors report an estimate of the sum of daily use and cost of treatment without discussing how daily use values were calculated or could be recovered. In an economic impact assessment of a West Nile Virus outbreak in horses (USDA-APHIS, 2003), the USDA estimated the value of daily use as the average sale value of an equid divided by the number of days of life expectancy adjusted to current dollars and the weighted average cost of maintaining an equid during the period of lost use. This provides an estimate of DHUV based on market data, yet it does not include the indirect costs associated with the increased time spent taking care of sick animals, the emotional distress that often comes with it, or value of use and how it may relate to the timing and extent of the disease. Moreover, these studies do not tell us how DHUV varies depending on horse and owner characteristics.

The research presented here offers another method for estimating daily use values of equine owners which includes the value of reducing emotional distress to the equine owner and time spent caring for the sick horse, as well as the relative importance of treatment method attributes through choice-based modeling. Additionally, in this paper we investigate whether DHUV is dependent on the horse's market value and type of use (i.e., competitive). All of these factors allow one to start disentangling how heterogeneous aspects of the industry and its stakeholders may influence the true economic implications of disease outbreaks.

Methods

To estimate an average daily value for lost horse use and assess preferences for methods of disease treatment, we designed and administered a best-worst choice experiment (Marley and Louviere, 2005). Although many non-market valuation studies have used similar methods, few have been conducted in the equine industry, and none focus on estimating the indirect costs of equine infectious disease. For example, one study investigated which trail characteristics matter most for recreational riders in Kentucky (Hu, Pelton and Pagoulatos, 2012). Tienhaara et al. (2014) used a choice experiment to examine riding lesson preferences and the attributes that contribute to respondent choices.

The first step in designing a choice experiment is the selection of the attributes describing the options presented in each choice scenario. This process implies balancing the need for including the most relevant and realistic descriptors with the number of choices participants will have to make. In this study, four attributes are considered (see Table 2.1): the number of days of forced rest; the out of pocket expenses incurred for treating the disease; the route of drug administration (oral vs. injection); and daily frequency of administration.

Cost of medication and the number of rest days are included to induce participants to make choices involving trade-offs between reducing the number of days of lost horse use (rest days) and treatment cost. That is, horse owners with low DHUV might be less willing to incur significant costs to reduce the length of treatment or rest and vice versa. We also anticipate that respondents might have preferences regarding the route of drug administration (oral vs. injection) and the number of doses the drug is to be administered (with fewer doses per day generally preferred). Administering injectable medications might be intimidating for some owners, but oral treatments often require more frequent and/or more treatments per day, implying that administration route and number of doses could not vary independently in the experimental design (De Bekker-Grob et al., 2010). When assigning the number of daily doses, existing equine medication dosing recommendations were consulted. Dosing recommendations for trimethoprim sulfa, a commonly used medication to treat infectious upper respiratory disease in horses, include oral administration one to two times per day (Davidson and Plumb, 2003). By selecting daily dosing requirements of 1, 2, or 3 times per day, we attempt to balance representative dosing practices while inducing trade off decisions by survey respondents.

To embed these real world constraints into our survey, a labeled experimental design is devised where participants selected their best and worst option between three alternatives: an oral medication, an injectable drug, and a "no treatment" option (De Bekker-Grob et al., 2010). Including this "opt out" creates a more realistic market situation for the horse owner as they can always choose not to treat their horse (Carson et al., 1994), while the best-worst (rather than single choice) approach allows recovering preferences' for treatment options even when the *No Treatment* option is chosen as best (Holmes and Adamowicz, 2003).

The two attributes, *cost* (three levels: \$23, \$45 and \$70) and *rest* (three levels: 3, 7 and 10 days), varied independently according to an orthogonal fractional factorial design which resulted in a total of nine choice sets.[1] Variation in the number of doses is tied to the choice of

[1] Fractional designs are obtained by selecting a subset of choice sets from a full factorial design and still retain orthogonality of the design, in order to reduce the cognitive burden on respondents (Holmes and Adamowicz, 2003).

administration route and is introduced by means of a blocking strategy: participants are randomly assigned to one of three blocks where the oral medication had to be administered either 1, 2, or 3 times per day (depending on the block), while the intramuscular injected drug is always restricted to once per day. The *No Treatment* option remained unchanged across choice sets, with no out of pocket expense ($0) and the longest period of rest days (14). Table 2.1 describes the attributes for each treatment option, their levels, and frequency of treatment for each route of drug administration.

Each of the nine choice sets asks survey respondents to indicate the choice that they "Most Prefer" and "Least Prefer" (Louviere and Woodworth, 1990), thereby generating a ranking of the alternatives in each choice set. Figure 2.1 displays a screen shot of a choice set as seen by survey respondents. The survey instrument used is an online survey and the software used for development and collection of responses is Qualtrics (2013). An electronic survey link with an introduction letter was sent out by email to the American Quarter Horse Association (with a request that it be sent to all members), an equine industry internship organization, postings on horse industry websites (e.g., TheHorse.com) and through social media outlets. The survey was disseminated on October 20, 2014 and the survey link was open for four weeks.

Econometric Methods

The random utility model provides a framework to analyze how agents make choices between alternatives options (McFadden, 1974). It is assumed the utility received by the respondent *i* from choosing option *j* can be represented as:

In our case, the number of choice sets required was reduced from 81 (3^2 x 3^2) to a more reasonable nine. The design is generated using the software Ngene, distributed by ChoiceMetrics (2012).

$$U_{ij} = x_{ij}'\beta + \varepsilon_{ij} \tag{2.1}$$

where:

U = utility respondent *i* obtains from option *j*,
x = *n x k* matrix of attributes and characteristics (*cost*, *rest*, and *dose*),
β = *k x1* vector of unknown parameters to be estimated, and
ε = stochastic error term.

Our model assumes that the utility of each alternative option depends on the attributes included in the experimental design (x_{ij}), plus a subject-specific error term representing factors unobserved by the researcher. The empirical interest lies in estimating the parameters of the model (*β*) which link variation in attributes and attribute levels with the desirability of an option, as revealed by a participant's "Most Preferred" and "Least Preferred" alternatives.

Rank Ordered Logit

Best-worst choices provide subject-specific rankings of the utilities associated with the alternatives in each choice set. For example, if option B (out of A, B, and C) is selected as the most preferred and C is selected as the least preferred, it follows the inequalities $U_B > U_A > U_C$ hold. The rank ordered logit model uses the implied rankings (B=1, A=2 and C=3) as the dependent variable and regresses them on the attributes and attribute levels selected as the model's independent variables (Beggs, Cardell and Hausman, 1981). The assumption that the error term (ε_{ij}) is independently and identically distributed drawing from the extreme value distribution allows representing the probability of observing a given ordinal ranking in the "exploded logit" form (Beggs, Cardell and Hausman, 1981):

$$\text{Prob(A=2,B=1,C=3)} = \frac{\exp(x_{ij=2}'\beta)}{\sum_{j=1,2,3}^{n}\exp(x_{ij}'\beta)} * \frac{\exp(x_{ij=1}'\beta)}{\sum_{j=1,3}^{n}\exp(x_{ij}'\beta)}. \qquad (2.2)$$

From this expression, the likelihood function can be derived and the model parameters can be estimated.

Econometric Models and Willingness-To-Pay Estimates

Parameterizing the utility the horse owner enjoys from choice *j* (treatment method) as a linear function of the attributes and levels associated with that choice as presented in equation (2.3):

$$x_j'\beta = \beta_j + \beta_1 * (Cost) + \beta_2 * (Rest) + \beta_3 * (Dose). \qquad (2.3)$$

where: *Cost* = the out of pocket expense of the drug ($),

Rest = the number of days the horse will be restricted from exercise or use, and

Dose = the number of doses of drug per day that must be administered.

The coefficient associated with each of the attributes provides an estimate of its marginal utility, while the alternative-specific intercept, β_j, captures the difference in utility between the oral and intravenous administration options, holding other factors constant. Using estimated model parameters from the equations above, the average willingness-to-pay (WTP) values for *Dose* and *Rest* can be calculated using equation[2] (2.4):

$$\text{WTP}_k = -(\beta_k / \beta_1) \qquad (2.4)$$

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[2] The explanatory variables were coded as levels for estimation purposes (i.e., 1, 2, 3 representing 3,7 and 10 days of rest, or $23,$ 45 and $70 out of pocket cost, respectively). Thus, daily use value can be obtained from parameter estimates as $\text{WTP}_{use} = -(\beta_2 / \beta_1)\frac{\$23}{3.5}$. The multiplication by $23 follows from the fact that each unitary increase in *COST* corresponds to an average increase of $23 while 3.5 is the average increase in days of rest across levels.

While the model presented in equation (2.3) allows estimation of an average DHUV across the whole sample, another objective of this study is to assess how horse or owner characteristics impact the DHUV. In particular, we are interested in determining how a horse's market value affects DHUV. Two proxy variables are used that likely correlate with a horse's market value: whether a horse is insured[3] or if it is used in competitive events.[4] The proxy for value of the horse, a binary variable indicating whether or not the horse is insured, is introduced in the model as an interaction term as follows (equation 2.5):[5]

$$x_j{}'\beta = \beta_0 + \beta_1 * (Cost) + \beta_2 * (Rest) + \beta_3 * (Dose) + \beta_4 * (Rest * Insured). \qquad (2.5)$$

Estimation of equation 2.5 allows for a simple test of the hypothesis to be run to determine if insured horses have different daily use values to their owners than uninsured horses, in the form of the null hypothesis, H_0: $\beta_4 = 0$. If this interaction term is found to be significantly different from zero, WTP for an insured horse's daily use can be calculated using equation (2.6):

$$\text{WTP} = -\frac{(\beta_3 + \beta_4)}{\beta_1}. \qquad (2.6)$$

where: k = 2 (*Rest)*, 3 (*Dose)*, or 4 (interaction of *Rest* and *Insurance*). β_1 is the estimated cost coefficient.

[3] The logic for using insurance status as a proxy for value is simple: higher value horses are more likely to be insured. The type of insurance (mortality, major medical, fertility, etc.) was not specified in the survey, respondents were only asked to report if their horse was insured or not.
[4] To investigate the impact of a horse competing in sanctioned or rated shows has on the owner's WTP in order to reduce number of lost use days, an interaction term was included to the original model; however, the interaction term was not significant.
[5] The effect of demographics and other respondent-specific information not varying across alternatives cannot be estimated in the rank ordered logit model directly, and need to be introduced as interaction terms. For example, interacting *Rest* with *Insured* status will show the impact on rest days between insured and uninsured horses.

Results

Table 2.2 lists the summary statistics for survey respondent demographics and horse ownership. All of the respondents' summary statistics information were similar to the most recent industry survey conducted by American Horse Publications (Stowe, 2012). Of the 361 completed surveys, 337 (93%) respondents reported their involvement with horses as an owner/rider/trainer of horses used for recreation, pleasure, trail riding, lessons or schooling, showing or competition or farm and ranch work. The remaining 4% and 3% of respondents identified themselves and their role with horses as a breeder or involved in racing, respectively. The average age of respondents was 43 years old and 94% of the respondents were female. The majority of respondents reported having completed college, having obtained a professional or graduate degree (67%), and 45% reported annual household income greater than $75,000.

Owners were asked about the number of days in a typical week they ride their horse and to rank the average level of exercise of those rides. The average number of riding days per week was 3.66 with the majority (71%) reporting light to moderate level of exercise for their horse(s). Most respondents (82%) reported owning between one and five horses and 58% report caring for or training horses for others. Horse owners also reported on the number of horse shows they typically participate in each year. Unrated or schooling shows often require no membership or other qualifications to attend and typically cost less in entry fees. Forty-five percent of owners reported they attended one or more unrated or schooling shows per year. An often larger financial burden, rated/breed/organization/United States Equestrian Federation (USEF) sanctioned shows, require some sort of paid membership or qualifications in order to attend. Only 29% of the respondents indicated they attended one or more rated/breed organization or USEF sanction show per year. Of the respondents, 23% had insured their horses.

Each choice set asked respondents to select between two treatment options with the drug administered either by oral or intramuscular injection route. Since it is important to understand the comfort level each respondent had with administering various treatments, owners were asked to indicate their level of comfort with administering intramuscular and intravenous injections from a Likert scale: with 1 indicating the lowest comfort level and 5 indicating the highest comfort level. The average comfort level of respondents with administering intramuscular injections was 4.18 and the average comfort level for administering intravenous injections was 2.75. Respondents were also asked about their horses' reaction to receiving injections: with 1 being not very good and 5 being very good. The average horse reaction to injections was 4.04. Seventy percent of respondents reported administering most of the medications given to their horses, while 25% reporting a veterinarian administered most of the medications given to their horses.

Parameter estimates, robust standard errors and confidence intervals for the full, aggregated model (equation 2.3) are reported in Table 3. All estimates are significant at the 5% level, indicating the attributes selected did influence participants' choices (Table 2.3). For interpretation, positive coefficients imply that the presence of an attribute *lowers* the ranking of an alternative (e.g., from 1 to 2) which signifies a decrease in utility. Thus, the positive signs for *Cost*, *Rest* and *Dose* entail that increasing out of pocket treatment expenses, larger number of doses of the drug administered per day and a higher number of rest days make an alternative less desirable. The negative signs for *Injection* and *Oral* estimates suggest, on average and within the attribute levels considered, either treatment option is preferred over the no treatment alternative. At parity of dosage, however, an oral route of treatment is preferred to a drug given by injection, as implied by the greater magnitude of the coefficient on *Oral*. Based on these estimates and the calculation detailed in equation 2.4, the average WTP for a reduction in the number of required days of rest is $13.42 per day. In other words, survey respondents place a value of $13.42 per day for being able to use their horse (Table 2.3). Caution should be taken in interpreting this estimate, as this value represents only the DHUV and not an owner's WTP for treatment, which may shorten disease by several days.

The estimated WTP for a reduction in the number of times per day an oral medication must be administered is $27.54 per dose (Table 2.3). This value is rather large compared to our estimate of DHUV, but the estimate should be put in the appropriate context. First, a unitary increase in frequency of daily dosing may amount to a significant number of extra doses over the course of the treatment. Second, we have found that the vast majority of survey respondents administer medication to their horses. Thus, the large value placed on a lower number of doses per day reflects the value the respondent put on their time.

As it was mentioned earlier, both the oral and injectable route of administration options were preferred to the *No Treatment* choice (Table 2.3). A larger negative parameter estimate on *Oral* route of administration suggests that the horse owner prefers this route of administration to injection. However, the preference for oral route quickly decreases its appeal as frequency of daily dosage increases as signaled by the break-even number of doses of 2.16 per day (i.e., respondents would be willing to switch to injection medication if the number of oral doses required is more than twice per day).

Parameter estimates for the model investigating potential differences between WTP to reduce rest days between respondents with insured versus uninsured horses (equation 2.5) are described in Table 2.4. There is a positive and significant interaction term suggesting that WTP for daily use differs depending on whether the horse is insured ($17.84) or not ($11.99). It is interesting to contrast the lost use value calculated by USDA-APHIS (2003) at $8.63 per day in 2003 while we found DHUV ranging between $11.99 and $17.84 in this study conducted in 2014. Differences between values may be partially explained by the complexity of the estimation methods used and inflation. The value found in the previous study does not capture the value horse owners place on avoiding the discomfort they feel when their horse is sick, whereas our results intended to include the emotional distress the horse owner wishes to avoid as well as their desire to reduce the amount of time spent per day treating the animal.

Implications

Equine disease outbreaks can occur quickly and prove costly to owners and the industry (Conners et al., 2011). Veterinary practitioners advise their clients on the prevention of such diseases and provide treatment options once a horse is sick. Equine pharmaceutical companies develop and market options to prevent and treat equine diseases, but may be lacking some of the market information needed to develop and market effective management strategies.

A major contribution of this study is the estimation of how much horse owners surveyed are willing to pay to avert one day of lost use of their horse due to a respiratory illness. Daily use calculations have been estimated in previous research (Conners et al., 2011; USDA-APHIS-VS, 2003), but differences with the current study exist. Conners et al. (2011) report a total value that includes both daily use values and the cost of treatment, which prevents the explicit reporting of daily use values. Unlike DHUV, treatment costs are relatively simple to calculate, but they often vary depending on the disease. Therefore, an estimate of the DHUV independent of treatment costs provides information that could be used to estimate the economic implications from a wider range of equine disease situations.

Daily use values estimated by USDA-APHIS in 2003 (USDA-APHIS, 2003) are likely outdated and were obtained using average market values of the equids on operations that met the USDA's definition of a farm. While the use of real market data (as opposed to hypothetical choices) is an advantage of the USDA-APHIS study, the choice experiment setting allowed for more detailed exploration of various factors that may affect WTP for treatment. In this study, we investigated how daily use value may depend on the characteristics of a horse including its specific use.

A secondary, yet relevant, contribution of this study is the assessment of how willingness-to-pay for treatment of respiratory disease in horses changes depending on the type of treatment. We found that respondents had strong preferences for oral administration over intramuscular injection of a drug, yet the preference waned if the oral treatment necessitated more frequent daily dosing than the intramuscular drug. Veterinarians can use this information to suggest treatment options that provide fewer doses per day where possible, even if this route of administration is intramuscular injection instead of oral. This information can also be used to develop new products and to support the marketing efforts (including pricing) for existing ones. For example, promotional efforts for specific products may be targeted to those in the equine industry with higher daily horse use values (e.g., higher value horses). As for product development, we found that single-dose per day oral medication was the most preferred treatment option, but injectable drug administered once per day could be a valued substitute for drug that require multiple doses per day.

Future research should investigate how those in the equine industry value attributes in the treatment of other types of disease, especially those which require longer recovery periods. This study investigates some possible attributes of treatment options, but future research may explore preferences for other product characteristics such as drugs requiring fewer daily doses, those that return a horse to work faster than others or oral route of administration versus by injection.

In the current study, we found average use values are influenced by insured status of the horse, but not by within which level of competition that horse participates. The unexpected result that level of competition did not influence the average DHUV may be explained by the fact that all of the respondents who indicated they participated in at least one competition per year were already delineated since they were considered "competitive". It is expected that the type of competition (i.e., sanctioned shows, rated shows, etc.) and frequency of competition would have a positive impact on use values. Investigation into the frequency of competition on value assigned to DHUV is not possible due to too few available observations, but further research investigating frequency of competition may provide valuable information. This information would benefit veterinarians, industry and, in the end, consumers when provided with treatment methods or therapies that best suit their preferences.

Table 2.1. Disease Treatment Attributes by Level and Survey Block

Attribute	**Level 1**	**Level 2**	**Level 3**
Rest days required (*Rest*)[a]	3	7	10
Out of Pocket Expense to the Owner (*Cost*)	23	45	70
Frequency of Daily Administration (*Dose*)	**Block 1**	**Block 2**	**Block 3**
Oral Administration	1	2	3
Injectable Drug	1	1	1

[a]*One rest day equates to one day of lost use*

Table 2.2. Summary Statistics for Respondents (n=362)

Variable Definition	Mean (St. Dev.)	% Frequency
Gender		
1 = Female; 0 = Male	0.94 (0.23)	
Age in years	43.01 (13.55)	
Annual Household Income: Percent by range of gross income		
1=Less than $25,000		12%
2=$25,000-$50,000		21%
3=$50,001-$75,000		22%
4=$75,001-$125,000		25%
5=More than $125,000		20%
Education: Percent by highest level completed		
1=Some high school		1%
2=High school		7%
3=Some college		25%
4=College		42%
5=Graduate school		18%
6=Professional degree		7%
Insured Status, Horse Care and Use		
Insured (1 = Yes; 0 = No)	0.23 (0.42)	
Comfort level (IM)[a]	4.18 (1.26)	
Comfort level (IV)[a]	2.75 (1.60)	
Horse reaction to an injection[b]	4.04 (1.01)	
Number of days ridden per week	3.66 (1.77)	
Level of Horse's Exercise[c]		
1=Light		29%
2=Moderate		42%
3=Heavy		21%
4=Very Heavy		3%
5=N/A		4%
Horses Owned [Trained]		
1=None		3% [42%]
2=1 horse		28% [10%]
3=2-5 horses		54% [29%]
4=6-10 horses		9% [9%]
5=10+ horses		7% [10%]

a How comfortable respondent is with administering intramuscular (IM) or intravenous (IV) injections to their horse: 1:Not at all; 2: Not very; 3: Neutral; 4: Somewhat; 5:Very.
b How difficult the horse is when giving injections: 1: Highly difficult; 2: Somewhat difficult; 3: Neutral; 4: Fairly easy; 5: Very easy.
c Light: 1 to 3 hour/week mostly walking and trotting. Moderate: 3-5 hours/week mostly trotting with some walking, cantering and possibly jumping. Heavy: 4-5 hours/week of trotting, cantering, galloping, jumping or ranch work. Very Heavy: racehorses and horses at elite levels of competition. N/A: not applicable.

Table 2.3. Rank-Ordered Logit Parameter Estimates and Willingness to Pay Estimates[a]

Choice	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf. Interval]		WTP ($)
Cost	0.142	0.011	13.13	0.000	0.121	0.164	-
Dose	0.170	0.059	2.89	0.004	0.055	0.286	-27.54
Rest	0.290	0.013	22.93	0.000	0.265	0.315	-13.42
Injection	-1.166	0.124	-9.41	0.000	-1.408	-0.923	-
Oral	-1.363	0.154	-8.83	0.000	-1.665	-1.060	-
n=9773 (362 groups)							

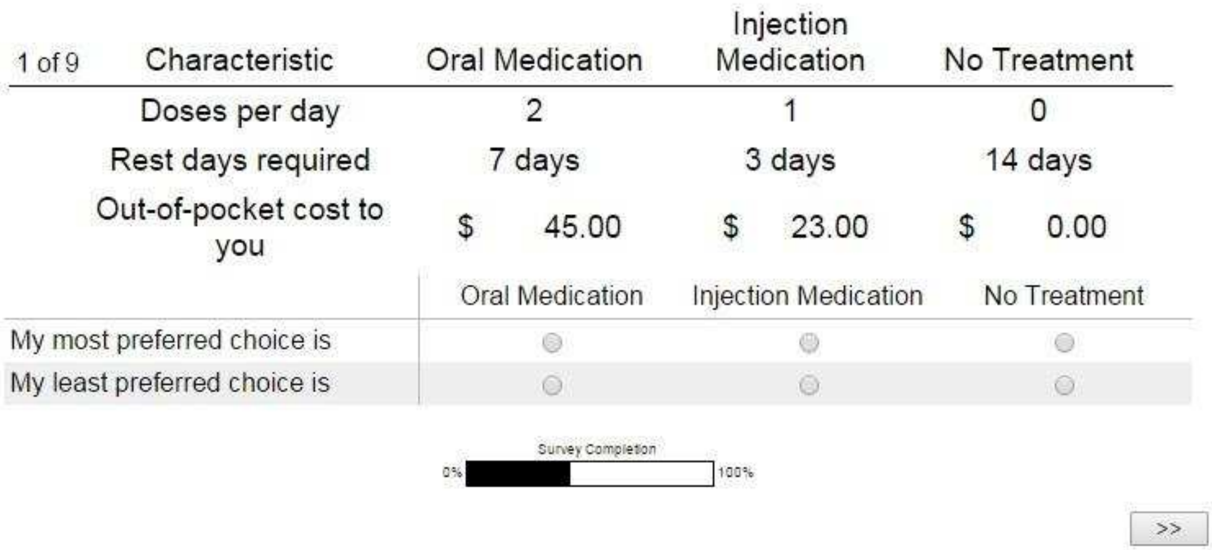
[a] Estimates are from Equation 2.3.

Table 2.4. Rank-Ordered Logit Parameter Estimates and Willingness to Pay Estimates[a] Including Interaction of Horse's Insured Status With Amount of Rest Required

Choice	Coef.	Robust Std. Err.	z	P>|z|
Cost	0.142	0.011	13.09	0
Dose	0.169	0.059	2.87	0.004
Rest	0.26	0.02	12.97	0
Rest*Ins[b]	0.127	0.068	1.86	0.062
Injection	-1.171	0.124	-9.46	0
Oral	-1.367	0.155	-8.84	0
n=9773 (362 Groups)				

WTP		
	Insured	**Not insured**
Rest	($17.84)	($11.99)

[a] WTP to reduce rest days for owners with insured ($17.84) and not insured ($11.99) horses
[b]Interaction of insured status *(Ins)* with *Rest*



1 of 9	Characteristic	Oral Medication	Injection Medication	No Treatment
	Doses per day	2	1	0
	Rest days required	7 days	3 days	14 days
	Out-of-pocket cost to you	$ 45.00	$ 23.00	$ 0.00

	Oral Medication	Injection Medication	No Treatment
My most preferred choice is			
My least preferred choice is			

Survey Completion

0% 100%

>>

Figure 2.1 Example Choice Experiment Question used to Estimate Value of Daily Use, Route, and Frequency of Drug Administration to Horse Owners

REFERENCES

Beggs, S., S. Cardell, and J. Hausman. 1981. "Assessing the Potential Demand for Electric Cars." *Journal of Econometrics* 17,1: 1-19.

Carson, R., J. Louviere, D. Anderson, P. Arabie, D. Bunch, D. Hensher, R. Johnson, W. Kuhfeld, D. Steinberg, J. Swait, H. Timmermans, and J. Wiley. 1994. "Experimental Analysis of Choice." *Marketing Letters* 5:4: 351-368.

ChoiceMetrics. 2012. Ngene 1.1.1 User Manual and Reference Guide, Australia. Available at: file:///C:/Users/mlkible/Downloads/NgeneManual112.pdf

College of Agriculture, Food and Environment, University of Kentucky; Kentucky Agricultural Development Fund; Kentucky Horse Council; and Ag Equine Programs, University of Kentucky. 2013. *2012 Kentucky Equine Survey*. Kentucky Equine Survey. Paper 1. Available at: http://equine.ca.uky.edu/sites/equine.ca.uky.edu/files/2012equinesurveyreportFINAL3.pdf [accessed on 7/9/2014].

Conners, S.E., L. Couetil, J.M. Furdek, and M.A. Russell. 2011. *Indiana Equine Industry Economic Impact and Health Study*. Purdue University, College of Veterinary Medicine. Available at: https://www1.maine.gov/dafs/gamingcom/docs/Indiana%20Equine%20Industry%20Econominc%20Impact%20Study,%20PC.pdf [accessed on 7/15/2014].

Davidson, E.J., and D.C. Plumb. 2003. Veterinary Drug Handbook: Client Information Edition. Iowa State Press. 3rd Edition.

De Bekker-Grob, E.W., L. Hol, B. Donkers, L. van Dam, J.F. Habbema, M.E. van Leerdam, E.J. Kuipers, M. L. Essink-Bot, and E.W. Steyerberg. "Labeled versus Unlabeled Discrete Choice Experiments in Health Economics: An Application to Colorectal Cancer Screening." *Value in Health* 13, no. 2 (March 2010): 315–23.

Deloitte Consulting, LLP. 2005. National Economic Impact of the U.S. Horse Industry. American Horse Council Foundation. Available at: http://www.horsecouncil.org/national-economic-impact-us-horse-industry [accessed on 9/17/2014].

Giedt, E.J. 2014. Respiratory Diseases in Horses: What You Can Do to Prevent Them. Oklahoma Cooperative Extension Service. Oklahoma State University. Available at: http://pods.dasnr.okstate.edu/docushare/dsweb/Get/Document-2091/VTMD-9120web2014.pdf [accessed on 12/16/15].

Holmes, T., and W. Adamowicz. 2003. *Attribute-based methods*. In: A Primer on Nonmarket Valuation. Champ, P., K. Boyle, and T. Brown (eds). Boston: Kluwer Academic. Series: The Economics of Non-Market Goods and Resources. Vol 3, Series ed.: Bateman, I., Chapter 6.

Hu, W., M. Pelton, and A. Pagoulatos. 2012. *Rider Preferences and Economic Values for Equestrian Trails.* Selected poster for presentation, Agricultural & Applied Economics Association. Seattle, WA.

Issacs, S., R. Nagy, S. Goode, K. Burdine, and D. Trimble. 2006. Equine Enterprise Budgets. University of Kentucky Cooperative Extension Service. University of Kentucky. Available at: https://www.uky.edu/Ag/AgEcon/pubs/ext2006-03.xls [accessed on 9/1/15].

Louviere, J., and G. Woodworth. 1990. *Best-worst scaling: A model for largest difference judgments*. Working paper, Faculty of Business, University of Alberta.

Marley, A.A.J., and J.J. Louviere. 2005. "Some Probabilistic Models of Best, Worst, and Best-Worst Choices." *Journal of Mathematical Psychology* 49 (6): 464–80.

Maynard, L., and K.M. Stoeppel. 2007. "Hedonic Price Analysis of Thoroughbred Broodmares in Foal." *Journal of Agribusiness*. 25,2: 181-195.

McFadden, D. 1974. *Conditional logit analysis of qualitative choice behavior*. In: Zarembka, P. (Ed.), Frontiers in Econometrics. Academic Press, New York, pp. 105–142.

Plant, E.L., and C.J. Stowe. 2013. "The Price of Disclosure in the Thoroughbred Yearling Market." *Journal of Agricultural and Applied Economics*. 45,2: 243-257.

Poerwanto, D., and C.J. Stowe. 2010. "The Relationship Between Sire Representation and Average Yearling Prices in the Thoroughbred Industry." *Journal of Agribusiness*. 28,1: 61-74.

Qualtrics. 2013. Qualtrics Research Suite. Version 61214 Provo, Utah, USA.

Rephann, T.J. 2011. *The Economic Impact of the Horse Industry in Virginia*. Weldon Cooper Center for Economic and Policy Studies Weldon Cooper Center for Public Service, University of Virginia. Available at: http://www.coopercenter.org/sites/default/files/publications/horse_study_final.pdf [accessed on 5/21/2014].

Stowe, C.J. 2012. *Results from 2012 AHP Equine Industry Survey*: *American Horse Publications*. American Horse Publications. Available at: http://www.americanhorsepubs.org/resources/ [accessed on 7/9/2014].

Swinker, A.M., P.R. Tozer, M.L. Shields, and E.R. Landis. 2003. *Pennsylvania's Equine Industry Inventory, Basic Economic and Demographic Characteristic*s. Department of Dairy and Animal Science. The Pennsylvania State University. Available at: http://extension.psu.edu/animals/equine/economic-impact-and-population-study/pa-equine-industry-inventory-basic-economic-and-demographic-characteristics [accessed on 7/9/2014].

Tienhaara, A., E. Pouta, L.C. Kolstrup, S. Pinzke, L. Janmere, and M. Jarvinen. 2014. *Consumer preferences for riding lessons in Finland, Sweden and Latvia*. Paper prepared for presentation at the EAAE 2014 Congress.

USDA-APHIS. 2011. *Equine Herpesvirus (EHV-1) Final Situation Report*. Available at: https://ahdc.vet.cornell.edu/docs/EHV_Situation_Report_060811_FINAL.pdf [accessed on 7/23/2014].

USDA-APHIS. 2015a. *Vesicular Stomatitis 2014 Situation Report*. Available at: http://www.aphis.usda.gov/animal_health/downloads/animal_diseases/vsv/Sitrep_013015.pdf [accessed on 12/15/2014].

USDA-APHIS. 2015b. *Vesicular Stomatitis 2015 Situation Report*. Available at: https://www.aphis.usda.gov/animal_health/downloads/animal_diseases/vsv/Sitrep_012216.pdf [accessed on 3/2/2016].

USDA-APHIS. 2003. *Economic Impact of West Nile Virus on the Colorado and Nebraska Equine Industries: 2002*. Info Sheet. USDA-APHIS. Available at: http://www.aphis.usda.gov/animal_health/nahms/equine/downloads/wnv2002_CO_NB.pdf [accessed on 7/15/2014].

CHAPTER THREE - DOES PARTICIPATION IN EQUINE EVENTS IMPACT EQUINE DAILY USE VALUES?

Introduction

The most recent estimates for the economic impact of the equine industry within the United States is $102 billion in total spending and nearly 9.2 million horses throughout the country based on research from the American Horse Council (Deloitte, 2005). Within the larger equine industry, there is a segment of equine owners, trainers, and/or riders that represent a relatively important economic driver for the industry and can be delineated as those who participate in competitive equine events such as horse shows or racing. The competitive sector of the equine industry has been estimated to account for $28.8 billion in total economic impact in the United States (Deloitte, 2005). The 2005 National Animal Health Monitoring System (NAHMS) Equine study reported 9.6% of all reporting equine operations indicate the primary use of equids at their facility to be for show/competition (USDA-APHIS-NAHMS, 2005).

Competitors may spend a considerable amount of resources training and preparing (keeping membership status up to date, registering/sending in entry fees, booking hotel rooms, etc.) to compete in these events, and similarly, their expenditures at events would likely be larger than the average horse owner as well. The number of horse shows and events that each competitor attends and/or participates in a given year varies, but a recent study conducted on the U.S. equine industry found 95% of respondents expect to attend the same number or more events in 2016 compared to the number of events they competed in or attended in 2015 (American Horse Publications, 2015). A 2012 equine industry survey found the average number of competitions that survey respondents expected to attend in 2012 was 5.36 events (American

Horse Publications, 2012). Of those surveyed, 33% reported the expected number of competitions attended in 2012 to be more than the number of competitions attended in 2011 (American Horse Publications, 2012).

Distance traveled to an equine event can also represent a large amount of preparation time and resources. Equine exhibitors often travel greater distances from their residence because they are seeking out prestigious events (regional and/or national events such as championships) or more challenging competition (opponents). The 2005 NAHMS Equine study reported 66.4% of equine operations whose primary use of equids was competition/showing also reported the horse traveled greater than 99 miles from the home operation at least once with the majority of responding between 100 and 499 miles (USDA-APHIS-NAHMS, 2005). Of all reporting operations, 36.6% report no transport of equine.

Each competition represents the effort (in time and resources) put forth by the equine owner in the months, weeks and days leading up to the event. Horse owners/trainers/riders, hereinafter known simply as “owners”, inherently place value on the preparation for each event, henceforth referred to as *use value*. In fact, these use values may be estimated on a daily basis, termed *daily use value*. Daily use value is the value a horse owner places on the daily use of their horse for its intended purpose (pleasure riding, horse showing, etc.) and for equine competitors that purpose is, at least in part, for competition.

Multiple disease outbreaks have occurred throughout the United States over the past few years. In 2011, an outbreak of equine herpesvirus-1 (EHV-1) among horses that had competed in a National Cutting Horse Association event held in Ogden, Utah, resulted in over 90 confirmed cases of equine herpesvirus-1 (EHV-1) and the cancellation of many equine related events (USDA-APHIS-EHV-1, 2011). In 2012, another outbreak of EHV-1 occurred at

Hawthorne Racetrack near Chicago, Illinois. A 2015 disease outbreak of vesicular stomatitis virus (VSV) in horses and cattle throughout eight U.S. states with 823 premises quarantined (USDA-APHIS-VS, 2015). Equine diseases present a direct financial burden on horse owners and caregivers due to the cost of treatment and time spent caring for the sick horse. When a horse develops an infectious disease such as VSV or EHV-1, the horse requires rest from all exercise, including riding and training for competitions. If the infected horse is being used for competition purposes, the owner would also experience an indirect loss in the daily use value for each day the horse could not be ridden. Any time a disruption in the preparation for a competition occurs, owners potentially incur this more subtle financial burden of indirect costs associated with lost training time or lost *daily horse use value* (DHUV).

The main objective of this study is to investigate DHUV of equine owners when their horse has contracted a disease with a focus on equine owners who attend and/or participate in equine events (competitions such as shows, etc.). Specific demographic and competition level information are used to determine influences on those DHUV in order to provide information on how daily use value varies. Additionally, differences in DHUV due to time-varying aspects (e.g., training/preparation/riding time becomes more valuable as time until the event decreases) related to an approaching competition are estimated as it is expected that the value of daily use may be different when an equine owner has an upcoming event planned compared to when they do not.

Equine industry personnel and participants stand to benefit from this study. Results from this study provide a time-varying value for the daily use of an equid. Few existing studies have investigated the daily use of an equid and no known study has investigated the time-varying aspect of those values. Equine pharmaceutical companies develop and produce medication for the treatment of equine diseases. The results of this study can be used to direct research and marketing efforts towards consumers within the equine industry who may have higher daily use values for their horses when compared to the average daily use values of equine owners in the equine industry in general. Consumers (equine owners) who have higher daily use values are likely interested in treatment options which will return a horse to regular training or competition in a shorter time over the alternatives.

While the desire to select a treatment option with specific attributes (route of administration, number of daily doses, etc.) may be known to the equine owner, the explicit estimation of the value of those attributes may help provide information to practicing veterinarians and product development firms. Kibler et al. (2106a) investigated medication attribute preferences (including the estimation of daily use values) of equine owners, but this study expands on those results by providing further analysis on the time-varying aspect of daily use values for equine event participants. While equine owners, practicing veterinarians, and pharmaceutical companies may implicitly understand the desire to return a horse to work faster (where possible), no existing study has attempted to estimate the actual value to owners.

Methods and Data

This study explores the value of lost daily use of their horse to equine owners, defined here as lost use (preparation and training) time to participants/competitors who regularly train for and compete in equine events. Disruptions in training due to equine infectious diseases can cause multiple days of lost training time, and potentially, regression in the animal's progress to preparation for competitions. Disease outbreaks may result in compounding losses if a participant's horse develops a disease that prevents them from attending a competition where they might have qualified for a subsequent equine competition such as a regional/national competition or year-end awards; thus, the participant may have a positive DHUV.

Equine Daily Use Survey

To estimate DHUV an online survey was developed and administered using the on-line survey software, Qualtrics (2016). A notice about the option to participate in the survey was sent to members of the Arabian Horse Association (AHA) email listserv that consists of 19,799 subscribers. There were 2,275 undeliverable email addresses. A total of 4,320 opened the email containing the survey link and 560 opened the survey link. The email about the survey was sent on February 24, 2016 and remained open for four weeks.

Survey respondents were asked to provide demographic information including their age, household income level, education level, type of involvement they had with horses, etc. (Table 3.1). Many members of the AHA participate in sanctioned shows governed by the organization with the hopes of qualifying for the U.S. Nationals Arabian and Half-Arabian Championship Horse Show. Respondents also provided information on how many horse shows they attended during 2015 and what percent of those shows were in three different distance ranges from their residence. The distance categories included the number of horse shows/competitions attended that were less than 75 miles, greater than 75 but less than or equal to 250 miles, and greater than 250 miles from the respondents' residence. Distance categories were selected to reflect differences in time and money spent attending and/or preparing for the show/competition. It is expected that use values would differ when an owner has been planning to travel a greater distance to compete compared to events that are closer to their residence as those travel costs indicate the relative importance and value place on events.

In addition to demographic and horse use information, this study framed an elicitation approach, double bounded dichotomous choice (DBDC), that is used to estimate DHUV. Dichotomous choice questions, first introduced by Bishop and Heberlein (1979), ask survey respondents, “are you willing to pay $x.xx” for the use of some good. This type of question can be considered the first round of an iterative-bidding question (Boyle, 2003), and becomes double bounded when a second round question is asked based on the first round response given by the survey participant. That is, when respondents answer, “yes” (“no”) to the first round question of willingness-to-pay (WTP), they are asked a similar question where the value has been increased (decreased) from the initial bid amount (Hanemann, Loomis, and Kanninen, 1991).

Preceding the initial (or first round) WTP question is a hypothetical situation that survey respondents are to consider in answering each WTP question. To imitate a real life situation where illness would cause a disruption in preparation training, the hypothetical situation given is as follows:

> *We would like you to consider the value you place on the use of your horse. Use is broadly defined as riding, showing, training, etc. or anything that describes the intended purpose for which you own and interact with your horse. In a hypothetical situation where your horse faced a chance of contracting a disease (with syndromes including, nasal discharge, fever, cough and occasional fluid swelling in the limbs or abdomen), what would you be willing to pay to reduce the number of rest (stall rest) days required until your horse is permitted to return to its primary use? For example, if your horse was prescribed 14 rest days, or more, by your veterinarian and you could purchase a medication that would reduce those rest days, what is your economic value for that remediation, or in this case, what would you be willing to pay for that medication on a daily basis? (Assume this hypothetical medication does not have any known adverse side effects to your horse and does effectively reduce rest days.)*

Once the above scenario is provided to the respondents, they are then asked the following first round question:

> *If your horse contracted the disease 21 days (three weeks) before a show, such as the U.S. National Arab/Half-Arab Championship show, would you pay $17.50 per*

> *day to reduce the number of rest days for your horse assuming he/she could then return to regular use (i.e., riding, training, showing, etc.)?*

A second round question for WTP is presented to the survey respondent based on their answer "yes" or "no" to the first round WTP question. An answer of "yes" ("no") to the first round question would yield a random number from the interval [$18, $28] or [$9, $17] if the answer to the first round question was "no".

A key objective of this study is to evaluate our hypothesis about daily use values among the competitive equine sector; that the closer the onslaught of the horse's disease is to the event or competition, it may result in even greater DHUV. To investigate this premise, the respondents are also asked how their DHUV changes if *no* equine competition is approaching. A second set of DBDC questions are asked to survey respondents with a small change to the hypothetical scenario; if the horse contracted the disease with *no* approaching horse show, "would you pay $17.50 per day to reduce the number of rest days for your horse…" A second round question based on the response to the first round question is asked, just as was the case with the first set of DBDC questions. By asking respondents their WTP under two scenarios with different timing aspects related to competitive equine events, we can test our hypothesis of DHUV varying in relation to timing of the onset of disease and the next event. More specifically, we attempt to estimate how DHUV varies based on the time-varying importance of use (training) owners have for their horse.

There are four possible outcomes to the first and second round questions: yes/yes; yes/no; no/yes; or no/no. The response given by the first round question indicates whether a respondent's WTP value is above or below $17.50 while responses to the second round question helps refine where the respondent's true WTP to reduce rest days lies. The starting WTP value of $17.50 is based on empirical valuation from a previous analysis of equine industry stakeholders in the previous chapter (Kibler et al., 2016a). While use values found in Kibler et al. (2016a) for competitive riders were not explicitly determined, daily horse use value of survey respondents who had insured horses was found to be \$17.84. We expect that this use value is more reflective of the use values among owners who might participate in equine events, compared to use values estimated for owners with non-insured horses (\$11.99) or the more generalized use values estimated for the average horse owner within the sample (\$13.42).

Econometric Model

This study estimates the DHUV using three models for both timing scenarios (when an equine event is approaching and when it is not). The three models used include: 1) maximum likelihood estimates for interval regression; 2) ordered probit model; and 3) ordered logit model. Individual survey responses for WTP are used to construct intervals with the upper and lower known bounds where true WTP lies. These intervals are used for maximum likelihood estimation of the interval regression. The specification of the interval regression for WTP to reduce rest days are given by equation 3.1 with the interval boundaries given by equation 3.2 (McFadden, 1974):

$$y_i^* = x_i'\beta + u_i \tag{3.1}$$

$$\Pr[a_z \le y^* \le a_{z+1}] = \Pr[y^* \le a_{z+1}] = F^*(a_{z+1}) - F^*(a_z)\,. \tag{3.2}$$

An individual's true WTP, known only to them, is represented by y_i^* which is located within (z+1) and one of four possible intervals: ($-\infty$, a_1), (a_1, a_2), (a_3, a_4), (a_z, ∞). WTP is a linear function of x_i which is a vector of explanatory variables, β is a vector of parameter estimates, and an error term, u_i. When a respondent answers "yes" to the first round WTP question (y_i=1), it is assumed their WTP value is greater than \$17.50. The estimation follows a structure similar to the probit model where we estimate the probability of observing a "yes" response (Lopez-Feldman, 2012). The possible intervals y_i^* is located in this study are:

$$0 \le y^* \le 17,\ 9 \le y^* \le 17,\ 17.5 \le y^* \le 28,\ and\ 18 \le y^* \le \infty\ . \tag{3.3}$$

The WTP to reduce rest days can be calculated with the empirical specification (Yang et al., 2012) from equation (3.1):

$$WTP = y^* = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_{14} x_{14} + \varepsilon \tag{3.4}$$

where WTP (dependent variable) is explained using 14 independent variables (x_i's) and β_i are the parameters being estimated. The estimated ordered probit and ordered logit models are similar to equation 3.1, but with categorical dependent variables given in equations 3.5 and 3.6:

$$y_i^* = z,\ if\ \ a_{z-1} < y_i^* < a_z,\ and\ a_0 = -\infty,\ a_n = \infty \tag{3.5}$$

$$\Pr[y_i = z] = \Pr[a_{z-1} < y_i^* \le a_z] = F(a_z - x_i'\beta) - F(a_{z-1} - x_i'\beta)\ . \tag{3.6}$$

u_i (equation 3.1) is a logistic cdf in the ordered logit model: $F(p)=e/(1+e^p)$. F is the standard normal cdf for the ordered probit model.

Results

Explanatory variables used in estimation included demographic information including respondents' age, highest education level completed, and household income. These explanatory variables, descriptions and summary statistics are reported in Table 3.1. Of the respondents, 91% were female with a majority (79%) between the ages of 25 and 64 years. Most respondents had some college education to a higher level of education completed (91%) while nearly 63% had total household income greater than $75,000 per year. The average number of shows attended in 2015 were 1.9, 1.5 and 1 for three distance categories of 75 miles or less, 75 ≥ 250 miles, and greater than 250 miles from their residence, respectively. These summary statistics are comparable to the 2012 equine industry survey conducted by American Horse Publications (2012) with 91% of the respondents being female, 81% between the ages of 25-64, and 50% having an annual household income of $75,000 or greater.

The four possible intervals determined by the participants' yes/no responses to the two rounds of WTP questions are listed in Table 3.2. Survey respondents were presented with two sets of WTP questions with one variation to evaluate the time-varying nature of DHUV. In the first set of WTP questions, respondents were asked to consider their WTP to reduce rest days when they had a horse show occurring in 21 days. The second set of WTP questions was identical to the first set, except respondents were told there was no plan to attend a show. As expected, the percentage of survey respondents in each WTP interval is impacted by the timing of an approaching show (Table 3.2). When respondents were told attending a show was planned, over 49% of respondents answered "yes, yes" to the WTP questions placing them in the highest WTP category. However, when there was no plan to attend a show, over 42% responded "no, no" and fall into the lowest WTP interval, indicating that the timing of the horse developing a disease does have an impact on owner WTP in order to reduce rest days.

For this analysis, the dependent variable is in the form of an interval representing a range within which the respondent's true WTP lies. These values were determined from responses to the two willingness-to-pay questions presented to each respondent, and as discussed previously, was informed by a complementary analysis of a different sample of respondents within the same research project (Kibler et al., 2016a). Thus, this analysis clarifies how representative that estimate is of a broader set of participants in the equine industry (if use values are found to reflect this estimate). For respondents who answered "yes" ("no") to the first WTP question, they were presented a second similar question with a value larger (smaller) than $17.50. Several estimation methods were considered, and this approach was chosen based on the available data and the nature of the empirical question.

Respondent WTP to reduce rest days

Maximum likelihood estimation for an interval regression was used to estimate DHUV of survey respondents. Ordered probit and ordered logit models were also estimated for respondent DHUV and results are listed in Table 3.3. Dependent variables for the ordered probit/logit models were categorical representing each WTP interval (1-“no, no”; 2-“no, yes”; 3-“yes, no”; 4-“yes, yes”). All three models are consistent in the sign of the coefficient (with the exception of the education variable in the ordered logit model) and are similar in significance. The significant variables across all four models are *income2* and *income4-income8,* as well as, *distance3* and *show*. The constant terms are significant in the interval regression model.

Coefficients for the interval regression are interpreted as the increase (decrease) the explanatory variable contributes to respondents’ WTP. Respondents’ age and annual income were included as binary variables for each category respondents reported. For example, *income8* indicates an increase in WTP of $3.34 per day for respondents who reported an annual household income of greater than $150,000 compared to the lowest income level (<$20,000), ceteris paribus. Categorical variables are interpreted as the impact to DHUV by the amount of the coefficient multiplied by the number of the category (i.e., a respondent with a Bachelor’s degree has $1.22 (4*0.304) higher than a respondent with different education level, all else equal). It should be noted that ordered probit and ordered logit coefficients do not directly represent monetary values and provide less information compared with the interval regression coefficients unless interpreted in the context of marginal effects at some point on their distribution underlying these models. Results from the ordered probit and ordered logit models are included for comparison to the interval regression of the estimated coefficients and estimated signs.

Results of the three models indicate that various levels of annual household income and respondent's age impact a respondent's DHUV. Significant results for distance categories indicate that, as the number of shows the respondent attended were in the longest distance categories, the higher the DHUV. In other words, distance willing to travel to events may be an indicator of the inherent value placed on the competitive equine use by the owner. When the magnitude of the coefficients is compared between the two longest distance categories, the higher the number of shows attended at greater than 250 miles away from the respondent's residence, the larger the impact on DHUV ($0.19 per day for each additional show attended more than 250 miles away, all else equal). All but one income coefficient (*income3*) was significant at either the 10%, 5%, or 1% level where respondents who reported household income levels between $20,000-$30,000 (*income2*) and household income greater than $45,000 (*income4* – *income8*) had an average WTP of $2.64 per day higher than respondents who reported annual household income levels *income1*, all else equal. The estimate for *income8* was significant at the 1% level and provided the highest increase to DHUV ($3.34) compared to all other household income categories. This income category represents approximately 18% of the survey population. The second highest income category for WTP to reduce rest days was income5 ($3.17), all else equal. Findings for WTP to reduce rest days contradicts our expectations since WTP does not linearly increase as income level increases.

To estimate the difference between the DHUV an equine owner places on the use of their horse when they have an event/show upcoming or when they do not, a dummy variable was used to indicate the different DBDC scenarios. The independent variable, *event*, is a binary variable indicating whether the scenario given indicated an event was not approaching (*event*=0) and when an event was 21 days away when the horse contracted the disease (*event*=1). The coefficient, event, was significant at the 1% level indicating that survey respondents were WTP $4.14 more per day to reduce days of rest required of their horse when an equine event was approaching in 21 days. This result supports our hypothesis that DHUV is time-varying for equine owners as it relates to scheduled periods of increase use (i.e., equine events).

Predicted lost daily use values

Coefficients from the interval regression were used to calculate DHUV based on specific demographics. Using those demographics, four scenarios calculating different levels of DHUV are listed in Table 3.4. Scenario A represents survey respondents with the most frequent demographic characteristics from the survey population; between the ages of 45-64 years old, who attended graduate school, with a household income between $90,000 and $150,000, and attends five equine events a year. Scenario B represents survey respondents in the second most frequent demographic categories within the survey population who were between the ages of 25-44, who attended some college, with a household income greater than $150,000 and attended five events a year. Scenario C is used to calculate DHUV utilizing the third most frequent demographic categories by describing a respondent 65 or older, who holds a Bachelor's degree, with an annual household income between $75,001 and $90,000, and annually attends twice as many equine events in each distance category than the individuals represented in scenarios A and B. Scenario D likely represents equine owners who may be attending college and still living with their parents. It is unlikely that a respondent in this age category would earn greater than

$150,000 on their own, but rather reported their household, including parents' income, in their response.

Daily horse use values vary under scenarios A-D by $3.37 per day when an equine event is approaching or when no equine event is approaching. Since equine owners may spend significant resources to prepare for and attend equine events, an inverse relationship between DHUV and time until an equine event was anticipated. Results indicate an increase of $4.14 in DHUV among survey respondents when and equine event is approaching indicating the existence of time-varying use value differences. Each scenario includes the number of annual equine events the person represented attends or plans to attend each year. The impact of a single planned equine event is minimal for each of the three distance categories at $0.01 when a respondent travels less than 75 miles from their residence, $0.14 when traveling between 75 and 250 miles from a respondent's residence, and $0.19 per day when a respondent travels more than 250 miles from their residence for an equine event.

For comparison, results indicate that someone who attends 18 events a year; 10 events less than 75 miles from their residence, four events between 75-250 miles of their residence, and four events farther than 250 miles from their residence would have $1.45 higher daily use values over someone show does not attend any equine events. This example helps put the impact of individual shows into context since to achieve a use value difference as large as $1.45 per day, a survey respondent must attend 18 events, a number significantly larger than the average number of shows reported among survey respondents (4.6) and the average number of equine events attended in the 2012 U.S. equine industry survey conducted by American Horse Publications (5.4).

Discussion

Respondents from an equine industry report indicate attending, on average, just over five equine events annually (American Horse Publications, 2015). Events vary in distance from the attendee's residence, length of the event, and monetary cost to attend the event. Equine competitors may commit many hours of preparation for these events over a year in preparation for year-end awards or competitions. Disease outbreaks may cause disruptions to these preparations and indirectly impose a cost on the competitors' individually assigned daily use value they place on their horse for these events.

Results from this study support the hypothesis that willingness-to-pay (WTP) for daily equine use is higher for horses involved in competitions compared to those that are not. WTP to reduce rest days when a show was approaching was found to increase with respondent income level and by the number of competitions attended that were over 250 miles from the respondent's residence. Findings support the hypothesis that daily horse use value (DHUV) changes depending on an impending competition since the independent binary variable for an upcoming event indicated an increase of $4.14 per day.

Results of this study can assist in the decision making process for those who prescribe disease treatments for the horse, as well as, pharmaceutical company personnel involved in product promotion and development. Where possible, these results support that practicing veterinarians may suggest treatment options that will return the horse to work faster, even if the cost of the medication is higher, if the horse is to attend a competition in the near future. Pharmaceutical companies may use this information to further product development for medications that can reduce the amount of rest days required for competition horses. Company marketing personnel may use the results of this study to promote existing products which return a horse to work faster than other medications (even at a higher cost), particularly targeting equine competitors with higher use values.

This study is one of the only known studies to investigate use values of horses to their owners. Existing studies have either not found differences in WTP to reduce rest days for equine competitors (Kibler et al., 2016a) or have not included key variables related to competitive use in the models underlying their estimation (APHIS-VS, 2003). Additionally, past literature has not examined variances in WTP due to timing of equine events. Further investigation into the timing of competitions and its impact on daily use is needed and could better refine WTP values (e.g., randomizing starting WTP values presented to survey respondents to discourage or control for anchoring on initial WTP values).

Few studies have conducted economic analysis of equine disease outbreaks, and existing work has investigated disease treatment attributes and use values (Kibler et al., 2016a), economic loss from canceled equine events (Kibler, Thilmany and Pendell, 2016b), and equine enterprise budgets (Issacs et al., 2006). Disease outbreaks have plagued the equine industry with increasing awareness in recent years. The current study provides evidence to support the assumed economic losses that equine industry participants experience when a disease outbreak occurs, preventing the use of their horse for equine events/shows and how the value of use increases when time until an event diminishes. In addition to the losses experienced by local economies from disease outbreaks (Kibler, Thilmany and Pendell, 2016b), equine owners face the explicit financial losses from treating diseased animals, as well as the implicit DHUV experienced when the horse cannot be used. Results from the current study provide estimates that can be used to evaluate the cumulative losses experienced by equine owners which may provide motivation to increase biosecurity and disease management practices, thereby informing many facets of the broader equine industry.

Table 3.1. Summary Statistics

Variable	Variable Description	Mean (St. Dev.)	Min	Max	Percent Frequency
female	=1 if respondent is a female				91.06%
	Respondent age				
age1	=1 if 18-24 years old				2.65%
age2	=1 if 25-44 years old				23.51%
age3	=1 if 45-64 years old				55.96%
age4	=1 if 65+ years old				17.88%
edu	Respondent education level				
	=1 if "Some high school or less"				0.66%
	=2 if "High school graduate"				7.95%
	=3 if "Some College or trade school"				30.13%
	=4 if "Bachelor's degree"				25.17%
	=5 if "Some graduate school or graduate degree"				36.09%
	Respondent household income (HHI)				
income1	=1 if HHI* is <$20,000				3.20%
income2	=1 if HHI is between $20,000-$30,000				5.34%
income3	=1 if HHI is between $30,001-$45,000				6.05%
income4	=1 if HHI is between $45,001-$60,000				11.74%
income5	=1 if HHI is between $60,001-$75,000				9.96%
income6	=1 if HHI is between $75,001-$90,000				16.73%
income7	=1 if HHI is between $90,001-$150,000				28.83%
income8	=1 if HHI is >$150,000				18.15%
	Respondent distance traveled				
distance1	Number of shows attended within 0-75 miles	1.940 (2.906)	0	23.75*	
distance2	Number of shows attended within 75-250 miles	1.580 (2.484)	0	18	
distance3	Number of shows attended more than 250 miles	1.041 (2.512)	0	27	

**The number of shows in each distance range was calculated by multiplying the total shows attended by the percent of shows attended in each distance category given.*

Table 3.2. Willingness-To-Pay Intervals and Percent of Survey Respondents Reported In Each Interval

Response Sequence	WTP Interval	% of sample (approaching show)	% of sample (no approaching show)
Yes, Yes	[$18.00, +∞]	49.3%	21.2%
Yes, No	[$17.50, $28.00]	23.8%	13.9%
No, Yes	[$9.00, $17.00]	8.6%	22.5%
No, No	[$0.00, $17.00]	18.2%	42.4%

Table 3.3. Regression Results†: Interval Regression, Ordered Probit, and Ordered Logit

Variable	Interval Coefficients	Ordered Probit Coefficients	Ordered Logit Coefficients
age2	-2.205	-0.759**	-1.203**
	(1.517)	(0.335)	(0.544)
age3	-1.843	-0.739**	-1.172**
	(1.482)	(0.328)	(0.534)
age4	-2.529	-0.980***	-1.569***
	(1.546)	(0.342)	(0.559)
edu	-0.007	-0.000	0.011
	(0.227)	(0.049)	(0.081)
income2	2.230*	0.633**	1.045**
	(1.235)	(0.274)	(0.455)
income3	1.496	0.217	0.382
	(1.152)	(0.258)	(0.429)
income4	2.497***	0.587***	0.963***
	(0.956)	(0.210)	(0.348)
income5	3.170***	0.724***	1.209***
	(1.013)	(0.220)	(0.364)
income6	2.286**	0.641***	1.096***
	(0.901)	(0.199)	(0.333)
income7	2.306***	0.599***	0.985***
	(0.845)	(0.185)	(0.308)
income8	3.343***	0.719***	1.185***
	(0.913)	(0.198)	(0.329)
distance1	0.011	-0.002	-0.002
	(0.073)	(0.016)	(0.028)
distance2	0.142	0.030	0.050*
	(0.087)	(0.019)	(0.030)
distance3	0.193**	0.056***	0.093***
	(0.093)	(0.020)	(0.034)
event	4.141***	0.843***	1.416***
	(0.469)	(0.094)	(0.160)
constant	15.196***		
	(1.690)		
N	600	600	600
Log pseudo-likelihood	-405.300	-739.357	-738.712
Wald chi2	123.61	120.29	121.58
Pseudo R^2		0.075	0.076

, **, and * denote 10%, 5% and 1% significance*
†Standard Errors are listed in parentheses

Table 3.4. Predicted Lost Daily Use Value (DHUV) Under Interval Regression

Demographic	Scenario A	Scenario B	Scenario C	Scenario D
Age Range	45-64	25-44	65+	18-24
Education	Graduate School	Some College	Bachelor's Degree	Some College
Income Range	$90,001-$150k	>$150k	$75,001-$90k	>$150k
Number of Shows less than 75 miles	2	2	4	1
Number of shows between 75-250 miles	2	2	4	4
Number of shows more than 250 miles	1	1	2	1
Calculated DHUV with no approaching show/event	$18.11	$16.81	$15.92	$19.29
Calculated DHUV with an approaching show/event	$22.25	$20.95	$20.06	$23.43

REFERENCES

American Horse Publications. 2012. 2012 AHP Equine Industry Survey. Kentucky Equine Research, Merck Animal Health and Pfizer Animal Health. Available at: http://www.americanhorsepubs.org/equine-survey/2012-equine-survey/ [accessed on 1/15/2016].

American Horse Publications. 2015. *2015 AHP Equine Industry Survey*. Zoetis. Available at: http://www.americanhorsepubs.org/equine-survey/2015-equine-survey/ [accessed on 1/15/2016].

Bishop, R.C., and T.A. Heberlein. 1979. *Measuring Values of Extra-Market Goods: Are Indirect Measures Biased?* American Journal of Agricultural Economics 61(5):926-930. Available at: http://www.udel.edu/johnmack/frec343/bishop_and_heberlein.pdf [accessed on 1/12/2016].

Boyle, K.B. 2003. *Contingent Valuation in Practice*, in: P. Champ, K. J. Boyle, and T. C. Brown. A Primer on Nonmarket Valuation. Kluwer academic Publishers. Available at: http://www.jstor.org/stable/1242453?seq=1#page_scan_tab_contents [accessed on 1/25/2016].

Deloitte Consulting, LLP. 2005. *National Economic Impact of the U.S. Horse Industry*. American Horse Council Foundation. Available at: http://www.horsecouncil.org/national-economic-impact-us-horse-industry [accessed on 9/17/2015].

Hanemann, W.M., J. Loomis, and B. Kanninen. 1991. *Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation.* American Journal of Agricultural Economics 73(1):1255-1263. Available at: http://www.jstor.org/stable/1242453?seq=1#page_scan_tab_contents [accessed on 1/24/2016].

Issacs, S., R. Nagy, S. Goode, K. Burdine, and D. Trimble. 2006. Equine Enterprise Budgets. University of Kentucky Cooperative Extension Service. University of Kentucky. Available at: https://www.uky.edu/Ag/AgEcon/pubs/ext2006-03.xls [accessed on 3/1/16].

Jeffcoat, C., A.F. Davis, and W. Hu. 2012. *Willingness to Pay for Broadband Access by Kentucky Farmers*. Journal of Agricultural and Applied Economics 44(3):323-334. Available at: http://ageconsearch.umn.edu/bitstream/130268/2/jaae443ip4.pdf [accessed on 4/1/2016].

Kibler, M.L., D.L. Pendell, M. Costanigro, and J. Traub-Dargatz. 2016. *Equine Daily Use Values and Owner Willingness to Pay for Infectious Disease Treatment Options*. Working Paper.

Kibler, M.L., D. Thilmany, and D.L. Pendell. 2016. *Estimating the Potential Economic Loss to Local Economies When Equine Disease Outbreaks Impact Equine Events*. Working Paper.

Lopez-Feldman, A. 2012. *Introduction to contingent valuation using Stata*. Centro de Investigacion y Doncencia Economicas. Munich Personal RePEc Archive. No. 41018. Available at: https://mpra.ub.uni-muenchen.de/41018/2/intro_CV.pdf [accessed on 1/10/2016].

McFadden, D. 1974. *Conditional logit analysis of qualitative choice behavior*. In: Zarembka, P. (Ed.), Frontiers in Econometrics. Academic Press, New York, pp. 105–142.

Qualtrics. 2016. Qualtrics Research Suite. Version 61214 Provo, Utah, USA.

USDA-APHIS-EHV-1, Surveillance, Preparedness and Response Services. 2011. *Equine Herpesvirus (EHV-1) Final Situation Report*. Available at: https://ahdc.vet.cornell.edu/docs/EHV_Situation_Report_060811_FINAL.pdf [accessed on 7/23/2014].

USDA-APHIS-NAHMS, Equine. 2005. *Part 1: Baseline Reference of Equine Health and Management, 2005*. Available at: https://www.aphis.usda.gov/animal_health/nahms/equine/downloads/equine05/Equine05_dr_PartI.pdf [accessed on 6/25/2016].

USDA-APHIS-VS, Surveillance, Preparedness and Response Services. 2015b. Vesicular Stomatitis 2015 Situation Report. Available at: https://www.aphis.usda.gov/animal_health/downloads/animal_diseases/vsv/Sitrep_120915.pdf [accessed on 12/2/2015].

USDA-APHIS. 2003. *Economic Impact of West Nile Virus on the Colorado and Nebraska Equine Industries: 2002*. Info Sheet. USDA-APHIS. Available at: http://www.aphis.usda.gov/animal_health/nahms/equine/downloads/wnv2002_CO_NB.pdf [accessed on 7/15/2014].

Yang, S., W. Hu, M. Mupandawana, and Y. Liu. 2012. *Consumer Willingness to Pay for Fair Trade Coffee: A Chinese Case Study*. Journal of Agricultural and Applied Economics 44(1):21-34. Available at: http://ageconsearch.umn.edu/bitstream/120449/2/jaae419.pdf [accessed on 4/1/2016].

CHAPTER FOUR - ESTIMATING THE POTENTIAL ECONOMIC LOSS TO LOCAL ECONOMIES WHEN EQUINE DISEASE OUTBREAKS IMPACT EQUINE EVENTS

Introduction

The direct economic impact of the equine industry throughout the United States has been estimated as $39 billion annually (Deloitte, 2005). The same study found the industry employs nearly 1.4 million full-time equivalent jobs annually throughout the United States. Other existing studies have estimated the economic impact of the equine industry, as well as the number of annual jobs, by state (Conners et al., 2011; Rephann, 2001; Rutgers Equine Science Center, 2007; Swinker et al., 2003). Within the equine industry, the economic contribution of the horse show segment has been estimated at $28.8 billion (Deloitte, 2005). Equine events, such as horse shows, attract tourism to the region hosting the event when competitors/exhibitors travel from outside the area to attend the equine event.

Industries within a local economy benefit from tourism dollars brought to the area by way of purchases made by non-local individuals for items such as food/drink, lodging, gifts, entertainment, etc. Impacts generated from event-driven tourism spending have been estimated for a variety of events such as sporting events (Connaughton and Swartz, 2014; Daniels, Normal and Henry, 2004) and livestock shows (Shideler et al., 2012; Kelsey and Hoy, 2012; and Smith 2010) while only two known studies investigate the economic impact of tourism to local or state economies generated from equine events (Swanson, 2013; Adams, Binnings, and Rochette, 2012). Dixon, Henry, and Martinez (2013) find tourism spending generated a total impact of $5.2 million to the local economy from a university baseball team’s home games while a 2011 study finds the total economic impact of over $2 billion to the Charlotte metropolitan statistical area from sporting events (professional, collegiate, and other sporting events) to the to be over $2 billion (Connaughton and Swartz). Though few estimates for economic impact of equine events exist, one study finds the total economic impact of the Rolex Kentucky Three-Day Event to Lexington, Kentucky which draws over 40,000 visitors annually, to be $14.2 million (Swanson, 2013). Estimates of the individual event impacts provide greater context to the contribution the tourism industry provides local economies.

Equine events include horse shows, clinics, racing, Western performance, etc., and represent a large part of the equine industry. Equine events drive tourism activity for the local economies where the events draw monies spent by spectators, exhibitors and volunteers who reside outside the region and the "inflowing monies" are used to purchase food/drink, lodging, fuel and gifts/souvenirs within the area. A 2012 study estimated total spending by non-local visitors to the Colorado Horse Park at $15.3 million (Adams, Binnings, and Rochette). In contrast to the economic contribution of tourism dollars, a potential negative impact would be the absence of a planned, annual event that the community has grown the tourism infrastructure to accommodate in any given year (or a reduction in the anticipated number of spectators) resulting in an implicit economic loss to the local area when that tourism revenue of typical visitors is curtailed, and instead, remains as spending outside the local economy.

Recent disease outbreaks throughout the state of Colorado and other parts of the United States have caused travel restrictions, quarantines and the cancellation of equine events. Once an infectious disease outbreak becomes a big enough concern that equine events are canceled, local economies are likely to experience economic losses when participants and spectators who would have come to that location no longer do so. In short, an economic loss occurs when revenue that would otherwise flow to a region is kept from that region.

The goal of this analysis is to evaluate the economic losses associated with a range of potential economic impacts, representing the full spectrum from canceled or different levels of reduced attendance at equine events when fewer competitors attend due to fears of the outbreak. For the purpose of this study, we focus on equine show events, but the findings should be fairly generalizable to other events that may include race meets, organized trail rides, conventions, clinics or any other occasion where horses gather from different locations. Knowing the impacts from an outbreak will help industry leaders, event organizers and participants make more informed decisions on the economic implications of the investments that may be undertaken to prevent future outbreaks.

Background

The equine industry has experienced significant disease outbreaks in recent years (e.g., equine herpes virus-1 (EHV-1) in 2011 and 2012, vesicular stomatitis virus (VSV) in 2014 and 2015). Horses who attend events while infected with a disease have the potential to spread viruses rapidly via direct horse-to-horse contact or when horses come into contact with infected surfaces (Nadeau, unknown). Throughout an event, horses are typically kept in close proximity to each other often with just one incomplete wall or gate separating them. And, since many diseases, such as EHV-1, are spread via direct contact, one infected horse has the potential to transmit the disease agent to many horses. Since most events have on-site boarding, an infected horse stabled next to other horses will lead to other carriers that return home after the event, and perhaps infect, many other horses (University of California Davis, unknown). In short, these events may accelerate disease spread.

Equine event management companies have been tasked with determining how to manage large numbers of horses shipping in from many different locations. The Colorado Department of Agriculture suggests that equine events require a veterinary certificate issued within 2-5 days of arrival at an event for each horse entering the premises if there is known disease situations in the area or within a population of horses (Colorado Department of Agriculture, 2015). Horse show officials may also choose to physically inspect each animal prior to granting permission to enter the event grounds. Other protocols (e.g., monitoring horse movement, temperature logging, etc.) may be in place for the duration of the event in order to prevent as much horse-to-horse contact as possible. In fact, in response to a 2011 outbreak of EHV-1, the California Department of Food and Agriculture developed a biosecurity toolkit to aid equine event management personnel in developing strategies to prevent transmission of equine infectious diseases at an event premises. Any decision to alter protocols is costly to horse owners, event managers or both in terms of increased monetary costs and/or in time spent enacting enhanced biosecurity procedures. The administrative costs of protocols should be measured against the perceived risk and economic impacts of spread. Subsequently, if the risk associated with the disease outbreak proves too great, event management may ultimately decide to cancel the equine event altogether.

Recent equine disease outbreaks have presented challenges to competitive horse owners whose plans to attend equine events are impacted by an outbreak. Many competitive riders, trainers and owners spend significant time, money and other resources to prepare for and attend major competitions. These competitions can be held at great distances from where event participants or exhibitors reside. Moreover, the events are often the means to qualify or accumulate experience for a year-end championship competition or the year-end competitions themselves, each of which may be impacted by a disease outbreak. During an outbreak, the competitors must weigh the tradeoffs inherent in the risks involved with attending an equine event compared to the benefits of competing. Since these tradeoffs may vary by owner, some will decide to attend while others may not.

Equine events, especially large events with thousands of spectators, generate measurable tourism dollars to local economies hosting the events. Event participants and spectators from outside the local economy make purchases for food, lodging, services, fuel and souvenirs during their stay. The purchases made by these spectators would not otherwise be spent in the local economy in the absence of the event, and therefore, are considered a potential economic impact. Expenditures made by spectators who reside in the local economy are not counted as a loss since their spending would exist in that area regardless of the equine event, albeit likely spent with different establishments or sectors. Existing studies estimate the economic impacts to local economies from events such as sporting events (Crompton and Lee, 2000), livestock and farm shows (Kelsey and Hoy, 2013; Smith, 2010; and Schideler et al., 2012), 4-H youth programs (Hill and Goodwin, 2015; Harder and Hodges, 2011) and food festivals (Cela, Knowles-Lankford and Landford, 2007). Those expenditures can be a notable contribution to the local economy and certain subsectors may rely, at least somewhat, on the economic activity associated with the annual attendance the event brings. Should an equine disease outbreak result in a reduction in the anticipated attendance figures, or worse, a complete cancelation of the event, at least some share of expenditures would be lost to the local economy.

Economic activity analysis measures how expenditures from an industry, or industries, flow through a region's economy. A more specific type of economic activity analysis, *economic impact*, is defined as the net change in economic activity as a result of the introduction, or removal of, an industry, event or policy (Watson et al., 2007). In the case of canceled equine events, this can be defined as an *economic loss*. Expenditures from outside visitors within the given region that would have otherwise been there are no longer circulated within that region when an equine event is canceled.[6] In short, when spectators and event participants from outside the study region do not come to the region and/or do not make expenditures due to a canceled equine event, it is likely a measurable economic impact will occur.

Due to the interconnectedness of most industries, economic impact analysis results are multi-faceted and generally placed into three categories: 1) direct impacts; 2) indirect impacts; and 3) induced impacts. *Direct* impacts are those expenditures made by the industry. *Direct* impacts would include expenditures by the show/event management company for the event venue (show facility) and purchases by competitors/exhibitors/spectators for hotel, food and fuel within the area. *Indirect* impacts are the expenditures or purchases by the businesses that make up the recipients of the direct impacts. These impacts include bedding, feed and other supplies purchased by the event management companies or food and beverage purchases by the food vendors to sell at the show or event. Finally, the *induced* impacts are the spending by employees of those companies who received direct impacts. *Induced* impacts are the purchases of event management employees, restaurant and hotel workers and gas station employees by spending of the income generated from the *direct* impact expenditures. For example, these expenditures may include common daily household expenditures such as food, furniture, gas, etc.

For this study, economic losses associated with canceled or reduced attendance at equine events is to be evaluated. To date, the authors are unaware of another existing study examining economic loss due to equine disease outbreaks, with most studies evaluating the contributions of the equine industry to the local/regional economy. One recent report estimates the economic

[6] Analysis does not include those spectators and participants who live inside the study area.

impact of an equine event to Lexington, Kentucky (Swanson, 2013) and another study outlines the economic impact of the Colorado Horse Park to Douglas and Elbert counties in Colorado (Adams, Binnings and Rochette, 2012).

Methods

To estimate the economic loss associated with one particular event with a national draw as an example of the impacts that result from canceled equine events, intercept surveys were administered with spectators and competitors/exhibitors attending the National Western Stock Show in Denver, Colorado in 2014. Data collected included various expenditure information as well as information regarding length of stay, mode of transportation, and number of people in the group traveling to the event, along with demographic/household information.

A simplified model tracking the tourism dollar through the local economy is presented in Figure 4.1. Estimating the economic loss from the equine event includes tracking expenditures made by tourists as a direct result of the event through the local economy. This is done by considering the three impacts discussed above: 1) direct; 2) indirect; and 3) induced. The direct impacts are the tourism dollars that enter the local area by way of event spectator/exhibitor expenditures on restaurants, hotels and other purchases while attending an equine event. Backward linkages are then made for those tourism dollars when indirect impacts are considered, which include the purchase of goods and services by the business establishments receiving spectator/exhibitor expenditures (i.e., the local restaurant's wholesale purchases of food and drink items). Finally, the induced impacts include the household purchases made by employees of the restaurants, hotels, retail stores or other employees whose incomes are derived from tourism expenditures (e.g., a local restaurant employee purchasing furniture for their house or gasoline for their vehicle).

Estimates of economic loss to the local area are generated for two potential scenarios: 1) total cancelation of the equine event; and 2) reduced attendance at the event. Impact analysis for planning (IMPLAN) software is used to develop economic loss estimates. The methods used for this analysis can be adapted to simulate other equine events across the country and of various magnitudes or wherever differences between equine events may exist.

Results

The National Western Stock Show (NWSS) occurs annually each January in Denver, Colorado. This two-week long event draws more than 600,000 spectators who come to shop the trade fair, view the numerous types of livestock on exhibit and to watch rodeos, horse shows and/or other spectator events. Because of its national prestige, hundreds of equestrians come to the National Western Complex to compete in the seven horse shows and rodeo performances held throughout the event. These exhibitors come from within Colorado, as well as from other states and occasionally from outside the United States, to compete. While at NWSS, they create economic activity as they stay in hotels, eat at local restaurant establishments, shop at local retail stores and at the trade fair, use veterinarian and farrier services while at NWSS and pay entry fees to compete at the NWSS.

Forty-eight surveys in all were collected from event spectators, exhibitors, vendors and volunteers attending NWSS. Results from the survey were used to estimate representative, per person expenditures in different stakeholder categories. These per person amounts were then aggregated to represent the event's entire economic activity in the input-output model. The survey provided perspective from several representative stakeholder groups including those attending the event such as spectators and competitors/exhibitors, as well as the family, friends or other personnel accompanying participants of the event.

Table 4.1 provides summary statistics for demographic and travel party information from the survey respondents. A majority of respondents were women (77%) between the ages of 25 and 64 with at least some college education[7]. Local residents accounted for 71% of survey respondents and 86% indicated that the NWSS was the primary reason for visiting the Denver area. Table 4.2 lists average, minimum and maximum values for the number of people in the respondent's group at NWSS, number of days attending NWSS, number of days in the local area (non-local residents only), how many other events similar to NWSS they generally attended per year and how many of the past 10 years that person had attended the NWSS. Survey respondents were asked to estimate the amount they would spend during their entire stay at stock show in a number of categories (Table 4.3).

Of those surveyed, 73% were there as spectators, 21% were riders, owners, trainers, or exhibitors, 4% were volunteers and one person surveyed was a vendor[8]. Those who were at the stock show as exhibitors were asked to estimate the expenditures associated with the livestock they brought to NWSS in a number of categories. Table 4.4 reports average, minimum and maximum values in each of those categories.

Another important perspective and set of estimates was provided by the show/event organizers or management companies producing the event. Phone and email interviews with

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[7] Age and income range category by percentage of respondents were similar to findings of Diehl and Johnson (2014) who produced a statistical demographic report for NWSS in 2014; 92% of respondents were between 18-64 years of age and 88% had an annual household income <$150,000. Our survey found 89% of respondents were between18-64 years of age and 91% had an annual household income <$150,000.

[8] Of the 640,022 person days reported by NWSS for 2014, we estimate that approximately 66% were spectators, 33% were exhibitors, and less than 1% were volunteers or vendors.

event management helped to provide more population-wide information on attendees. Using the attendee surveys, management interviews and information compiled from other studies, we estimate the complete economic impact of tourism dollars brought to the Denver Metropolitan area as a result of (NWSS) events by determining the number of person-days for each type of attendee, as well as daily per-attendee spending. After per-person spending was calculated, the appropriate IMPLAN industries were adjusted (or shocked) by this amount. Results from this study depict the economic impacts from NWSS; however, customization of the model to reflect other equine events is possible using the following steps.

Data collection for estimation of tourism impacts from an event is often done through the use of surveys. In a similar fashion, the survey for this study aimed to account for as many expenditure categories as possible while also collecting information regarding size of the group traveling to the event, number of days attending the event and whether the respondent was a local resident or not. For spectators, vendors and exhibitors (livestock and equine), information was collected for total travel party expenditures on lodging, food and drink, fuel purchases within the region, and gift/souvenirs/clothing purchases.[9] In addition to those expenditures, information on the expenditures for show/entry fees, veterinarian and farrier services, as well as feed and bedding were collected while interviewing exhibitors. IMPLAN sector numbers, including descriptions, are provided in Table 4.5. The direct spending in each category was used in the IMPLAN model to measure the full impact of loss from the cancellation of NWSS.

Average daily expenditures were compiled for attendees belonging to four categories of stakeholders including: 1) spectator; 2) livestock exhibitor; 3) equine exhibitor; and 4) vendor using intercept surveys conducted at NWSS, as well as, data from other studies on similar equine

[9] An "Other" category was listed in the survey to capture all other spending than the options listed.

related events. Data from more attendee categories could be used when data are available, such as officials, volunteers, or sponsors (Swanson, 2013). Once average daily expenditures in the selected categories are known for each designation of attendee, total event spending can be calculated. Spending per attendee group was calculated for each appropriate IMPLAN industry where that spending occurred by multiplying average spending to the number of estimated person-days for that group (i.e., daily average spending on food for spectators multiplied by the total number of spectator person-days).

After total spending per type of attendee was calculated, spending for each IMPLAN industry across all attendees was summed to generate total spending for NWSS attendees. The generated spending amounts per industry were then incorporated into a customized sector in the IMPLAN model to generate economic losses suffered from complete cancellation of NWSS due to the direct, indirect and induced impacts. Due to low survey response for the NWSS expenditure survey, findings from existing studies were also consulted and used to adapt our primary data throughout the analysis for average spending in each category. Sensitivity analysis was conducted to determine possible ranges of economic loss. That is, we estimate two different scenarios predicting total economic loss from cancelling NWSS, one with more conservative spending totals than the other.

Local residents are considered those individuals who reside within the study area (defined below). Their expenditures should not be included in economic loss estimation since their dollars are not necessarily lost to the local economy, but instead, likely transferred to other sectors. A cancellation of an event (such as NWSS) would mean that tourism dollars from non-local residents will no longer exist in the region; however, local residents would likely still make purchases within the study region regardless of attending the event or not. Therefore, local resident expenditures are not included in the estimation of economic loss.

Knowing the total attendance for the equine event allows us to aggregate up using the total number of person-days. In 2014, total attendance at NWSS was 640,022 person-days (nationalwestern.com). As previously explained, local resident person-days should be removed from the total number of person-days since their expenditures would not be removed from the area due to the cancellation of NWSS. According to event management personnel at NWSS, 17% of attendees are from outside the state of Colorado while 32% of attendees are from outside the Denver metropolitan area, but still within Colorado.

Before applying these percentages to total attendance to make estimates, the total number of person-days for exhibitors, vendors and volunteers must be removed. Information from NWSS staff provided total livestock numbers and entries for equine competitors. Using that information and industry standards, it was assumed that 2.5 people per horse should be used to calculate the number of exhibitor person-days. Vendor and volunteer person-days were also removed using information provided by NWSS staff and the remaining number of person-days for spectators was 413,394 days. Thus, the latter number was used to extrapolate person-days for non-Colorado and non-Denver spectators, estimated at 70,276 days and 124,018 days, respectively. Using these figures (and the number of person-days for exhibitors and vendors), and subsequently multiplying by the average daily expenditures for each category, the direct impact in each sector was estimated. Since this impact would be the amount of direct spending lost to the local area if NWSS did not occur in that given year, they were entered as negative dollar amounts.

One very important step in constructing an IMPLAN model estimating economic loss was defining the geographic study area. The larger the study area (region) selected, the higher the impacts will be. It is important to select a region that accurately depicts where the tourism dollars were spent due to the event. This step involves selecting the appropriate county(ies) where attendees of NWSS (or another equine related event) will be making purchases including meals, lodging and other expenditures. For the analysis of NWSS, the counties selected were Denver, Arapahoe, Jefferson and Adams each of which are considered part of the greater Denver Metropolitan area and also represent locations where attendees would likely book lodging, frequent restaurants and make purchases.

Cancelation of NWSS

To provide greater perspective on the potential losses that might be incurred from a cancellation of NWSS, two scenarios differing in total direct spending were run. Both Model 4.1 and Model 4.2 use additional estimates from data collected from other studies in conjunction with data collected through surveys administered at NWSS. A range of spectator and exhibitor spending was created from existing studies and NWSS surveys which was used to generate the two models. Model 4.1 uses estimates towards the lower end of the expenditure range while Model 4.2 uses estimates at the upper end of the range (e.g., per person, daily average spending for Model 4.2 is $83.83 more than estimates from Model 4.1). Estimates used for Models 4.1 and 4.2 are provided in Table 4.6. Table 4.7 reports direct, indirect, induced and total effect estimates for both Models 4.1 and 4.2 from the cancellation of NWSS. A difference of over $30 million exists between the total effect of output from Model 4.1 and Model 4.2. However, the two estimates are offered to represent the potential range of losses that could occur depending on one's assumptions of the level of the change in event attendance.

Annual events, such as NWSS, generate anticipated tourism spending for the industries described above. Through that spending, firms within those industries are able to employ local residents. When expected tourism dollars are kept from the local area, full and part time employment may be impacted. Model 4.1 indicates possible losses of over 700 jobs within the study area (over 1,200 in Model 4.2). These lost jobs come from each of the affected industries which experience the lost tourism dollars due to the full or partial cancellation of NWSS.

Compromised Attendance by Equine Competitors at NWSS

Another concern for event management companies is the reduction in attendance of exhibitors during disease outbreaks. During an outbreak, attendance of competitors/exhibitors may be compromised, either voluntarily or involuntarily. Models 4.3 and 4.4 estimate the losses that would be incurred if attendance of exhibitors at horse shows during NWSS was 50% and 25% lower than anticipated, respectively. Spending modifications for models 4.3 and 4.4 were calculated using total spending from equine exhibitors, but scaled downward by 50% and 25%, respectively, to reflect the change in attendance; hence, any specific reduction in attendance may be estimated in this manner. For the analysis, it was assumed that only the horse show attendance was impacted, with no discernible change in attendance by spectators, vendors, rodeo exhibitors, and livestock exhibitors. This assumption was made given the lack of information regarding the specific number of equids used for rodeo and livestock events during NWSS. Economic losses estimated from reduced attendance were lower than losses estimated for a full cancellation of NWSS as reported in Table 4.8. Compromised attendance of equine exhibitors by the previously mentioned 50% and 25% levels for those attending for the horse shows alone (not including other equine events such as demonstrations or rodeo events) would result in losses close to $1 million and $500,000, respectively.

Discussion

Increased awareness of disease outbreaks in recent years has caused concern for event managers. There are fears an outbreak would occur at their event with potential lost income. This analysis shows that economic losses should not only be a concern for the event managers, but also for broader local economies where these events occur. Equine events provide revenue not just to the event management companies, but also to local industries surrounding the event. The occurrence of equine disease outbreaks which impact equine events, either through complete cancellation or compromised attendance, can result in loss of the tourism dollars generated from an equine event. Events, such as NWSS, indirectly promote local industries through jobs and employee incomes.

A 2015 study of the U.S. equine industry found that 95% of survey respondents indicated they would attend the same or more equine events in the year 2016 (American Horse Publications). Even though most equine owners expected to attend the same number of competitions as in previous years according to that study, health events such as disease outbreaks have the potential to affect plans and attendance. As discussed in a recent podcast, the potential for vesicular stomatitis virus (a viral disease which infects horses and other animals) to spread to previously unaffected states throughout the United States is a real concern (theHorse.com, 2016). Previous outbreaks of VSV have caused cancellation of, and reduced attendance, at equine events throughout states with reported cases. This emerging equine disease and other types of health events can cause lost tourism dollars to local economies whenever the event's attendance is impacted, whether it is a complete cancellation or through reduced attendance.

Results from this analysis reflect potential losses from one specific event, the NWSS, but the approach used in this study could be customized to estimate losses from other equine events which differ in location, size, duration, attendance, spending, etc. It is also important to note that impact estimates will also need to account for differences that may exist in the percentage of attendees from outside the area where the event is held. Careful consideration should be taken in subsequent studies to be sure to determine the geographic scope, commonly framed as specific counties, to include within the IMPLAN model for analysis since results can be greatly impacted by the geographic choices and designation.

According to the Denver Post (Mitchell, 2016), attendance at the 2016 NWSS was the second highest on record (686,745 attendees); this following two consecutive years where outbreaks of VSV have occurred throughout the state of Colorado and other western states. Other large equine events with significant spectator attendance exist throughout the United States (e.g., All American Quarter Horse Congress) where similar patterns may have played out. This approach can be utilized to determine the economic contribution of these large events to the local economies who host them. Equine events of similar spectator attendance which are held at locations with comparable economies can expect similar results. Results for Models 4.1 and 4.2 may be divided by the number of person-days, or total attendance, to provide economic losses to the local economy on a person-day basis.

While it is important to understand the economic impacts of large equine events, smaller-scale equine events also have economic impacts to local economies. Smaller events do not generate the number of attendees, including exhibitors and non-exhibitors, as large events;

however, they occur more frequently and thus the economic contribution may be substantial. The approach used in our study can also be customized for smaller-scale events and used to determine aggregate impacts from numerous shows. Results from reduced attendance of equine competitors (Models 4.3 and 4.4) may be generalized to represent losses incurred by smaller-scale equine events since these events attract much less spectator attendance, but equine attendees likely have comparable daily expenditures. Dividing model results from Model 4.3 by the number of equine exhibitor person days (50% of the total equine exhibitor person days) generates economic loss to the local economy on a per person day basis. These person-day figures may be aggregated to estimate potential losses from consecutive or multiple disruptions to equine events at the same venue.

Exact attendee information could not be recovered for some attendee groups at NWSS (rodeo exhibitors and livestock exhibitors). Future studies would benefit from more precise estimates of number of people by attendee group and attendee expenditure categories. For example, Swanson (2013) estimated participant spending at the equine event and outside of the equine event. Knowing whether attendees made purchases in each expenditure category within the NWSS grounds or outside of the grounds in the broader Denver area would provide more precise industry impacts within IMPLAN.[10] Future studies would benefit from more precise expenditure categories where possible without inducing respondent fatigue.

[10] IMPLAN provides separate industries for full service dining, limited services dining and "All other dining". Multiple IMPLAN models were run to estimate differences in total impacts from direct spending on food and drink input into these different industries. Total impact differences were minimal when spending on food and drink was estimated for limited service dining and all other dining, 1.3% and 0.4% respectively.

Table 4.1. National Western Stock Show Survey Results: Demographic Summary Statistics (N=48)

	Category	% of Sample
Gender		
	Female	77%
Age (in years)		
	18 – 24	20%
	25 – 44	43%
	45 – 64	26%
	65 +	11%
Annual Household Income		
	<$20,000	26%
	$20,001 - $30,000	6%
	$30,001 - $45,000	4%
	$45,001 - $60,000	11%
	$60,001 - $75,000	9%
	$75,001 - $90,000	15%
	$90,001 - $150,000	21%
	>$150,000	9%
Local Resident		
	Reside Within 75 miles of Denver	71%
Reason for Visit		
	NWSS Primary Reason	86%

Table 4.2. NWSS Survey Results: Travel Information

	N	Average (Std. Dev.)	Minimum	Maximum
Number of People in Group	48	4.98 (8.90)	1	60
Days Attending	48	4.66 (4.62)	1	17
Days in Local Area	14	6.86 (5.53)	3	17
Events including NWSS*	48	4.47 (14.70)	1	100
Attendance past 10 years	48	5.48 (3.31)	0	10

**One barrel racer was surveyed who attends 100+ events each year. This is skewing the average, most people only attend NWSS or one other large event per year. The average without the outlier is 2.29.*

Table 4.3. Reported Spending by Attendees Per Group at NWSS (N=48)

	Average (Std. Dev.)	Minimum	Maximum
Food and Drink	$237.33 ($758.39)	$10	$5,000
Lodging	$217.08 ($541.68)	$0	$3,000
Entertainment	$3.96 ($16.34)	$0	$100
Gifts, Souvenirs etc.	$86.04 ($179.52)	$0	$1,000
Travel (gas, tolls, fares)	$84.44 ($166.03)	$5	$800

Table 4.4. Per Group Spending for Livestock and Equine Exhibitors

	Average (Std. Dev.)	Minimum	Maximum
Entry, registration fees	$435.00 ($395.93)	$0	$1,000
Stall or boarding	$86.67 ($133.17)	$0	$240
Feed and bedding	$131.33 ($230.82)	$0	$600
Services (vet, farrier, etc.)	$50.00 ($70.71)	$0	$100
Supplies	$200.00 ($282.84)	$0	$400

Table 4.5. IMPLAN Sectors and Sector Descriptions

Category	Description	IMPLAN Sector #
Hotel	Hotels and Motels, including casino hotels	499
Food and Drink	Full Service Restaurants	501
Fuel	Retail: Gasoline Stores	402
Gifts, Souvenirs, etc.*	Retail: Sporting goods, hobby, musical instruments and bookstores	404
Veterinarian Services	Veterinarian Services	459
Tickets and Show Fees	Promoters of performing arts and sports and agents for public figures	491
Other spending**	Retail: Building material and garden equipment and supply stores	399

****Includes purchases by spectators, exhibitors, and volunteers at NWSS and in the Denver area.***

**Includes bedding for livestock purchased by exhibitors at NWSS.*

Table 4.6. Person Days and Daily Average Spending Per Person (Model 1 and Model 2 Estimates)

Type of Attendee	Person-Days	Non-Local Person-Days	Daily Average Spending Per Person (Model 1)	Total Direct Spending (Model 1)	Daily Average Spending Per Person (Model 2)	Total Direct Spending (Model 2)
Spectators	413,394	194,294	$109.35	$21,246,048	$193.18	$37,533,714
Livestock Exhibitors	210,000	210,000	$66.83	$14,034,300	$66.83	$14,034,300
Equine Exhibitors	7,328	7,328	$130.52	$956,450	$471.09	$3,452,148
Vendors	4,560	4,560	$86.51	$394,485	$86.51	$394,485
Total	635,282	416,182	$393.21	$36,631,283	$817.61	$55,414,647

Table 4.7. Results of Model 1 and Model 2: Complete Cancellation of NWSS

Impact Type	Employment (Annual Jobs)		Labor Income (in $1,000's)		Value Added (in $1,000's)		Output (in $1,000's)	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Direct Effect	(854.2)	(537.5)	($23,078)	($14,484)	($33,102)	($21,721)	($56,396)	($37,481)
Indirect Effect	(174.6)	(122.0)	($9,801)	($6,794)	($15,182)	($10,210)	($26,857)	($18,361)
Induced Effect	(175.2)	(113.3)	($8,866)	($5,732)	($14,651)	($9,472)	($24,663)	($15,945)
Total Effect	(1,204.1)	(772.8)	($41,746)	($27,010)	($62,935)	($41,403)	($107,917)	($71,787)

Table 4.8. 50% (Model 3) and 25% (Model 4) Reduction in Equine Competitors

Impact Type	Employment (Annual Jobs)		Output (in $1,000s)	
	Model 3	Model 4	Model 3	Model 4
Direct Effect	(8.5)	(4.2)	($478)	($239)
Indirect Effect	(2.3)	(1.1)	($307)	($153)
Induced Effect	(1.5)	(0.8)	($207)	($104)
Total Effect	(12.2)	(6.1)	($992)	($496)

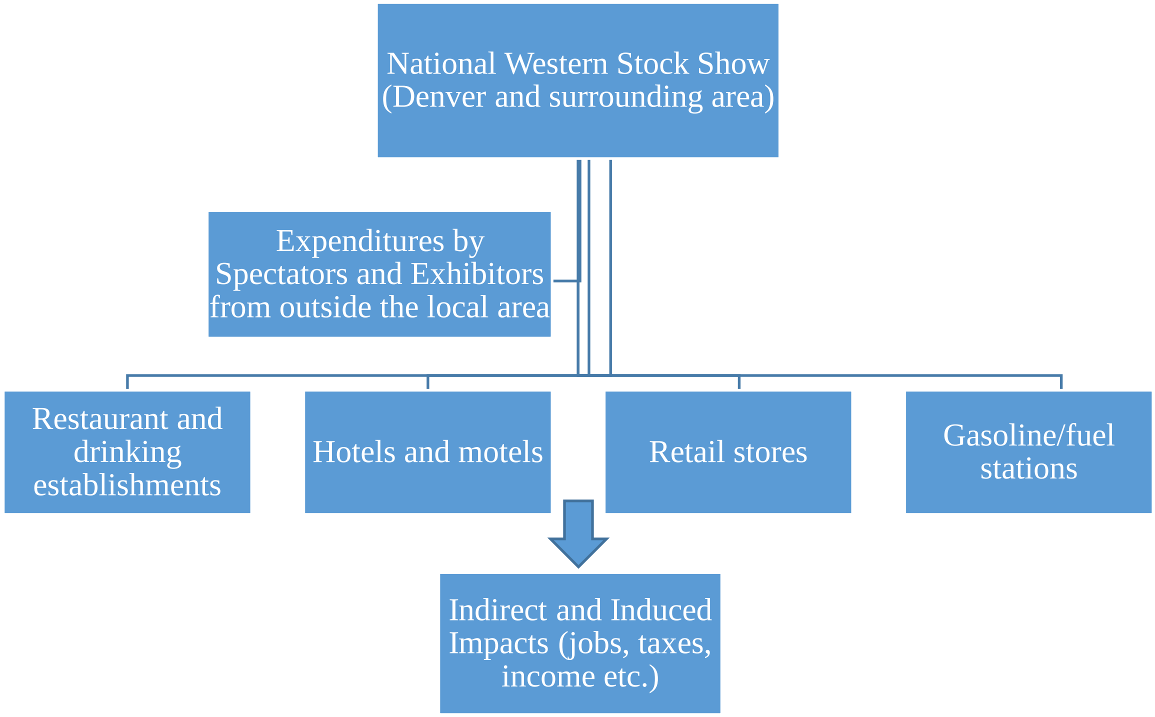

Figure 4.1. Tracking the Tourism Dollar Through the Local Economy

REFERENCES

Adams, T.H, T. Binnings, and P. Rochette. 2012. The Economic Impact of the Equine Industry in Douglas and Elbert Counties. Phase I Report Impact of Activities at the Colorado Horse Park. Summit Economics, LLC. Colorado Springs, CO. Available at: http://www.coloradohorsepark.com/sites/coloradohorsepark.com/files/page/attach/Colorado%20Horse%20Park%20Impact.pdf [accessed on 1/15/2014].

American Horse Publications. 2015. *2015 AHP Equine Industry Survey*. Zoetis. Available at: http://www.americanhorsepubs.org/equine-survey/2015-equine-survey/ [accessed on 1/15/2016].

California Department of Food and Agriculture. Biosecurity Toolkit for Equine Events. Available at: https://www.cdfa.ca.gov/ahfss/animal_health/equine_biosecurity.html [accessed on 1/5/2016].

Cela, A., J. Knowles-Lankford, and S. Lankford. 2007. *Local food festivals in Northeast Iowa communities: A visitor and economic impact study*. Managing Leisure 12, 171-186. April-July 2007. Available at: http://www.tandfonline.com/doi/abs/10.1080/13606710701339470 [accessed on 2/15/2015].

Colorado Department of Agriculture. 2015. Vesicular Stomatitis (VS) – Positive Diagnosis in Two Colorado Counties Tips for Livestock Owners and Veterinarians. Colorado Department of Agriculture. 2 July, 2015. Available at: https://www.colorado.gov/pacific/agmain/news/722015-vesicular-stomatitis-vs-%E2%80%93-positive-diagnosis-two-colorado-counties [accessed on 8/12/2015].

Connaughton, J.E., and C. Swartz. 2014. *The Economic Impact of Sports and Sporting Events On The Charlotte Metropolitan Statistical Area (MSA) Economy*. Journal of Business & Economics Research. Volume 12:3. 215-230. Available at: http://www.cluteinstitute.com/ojs/index.php/JBER/article/viewFile/8725/8705 [accessed on 7/20/2016].

Conners, S.E., L. Couetil, J.M. Furdek, and M.A. Russell. 2011. *Indiana Equine Industry Economic Impact and Health Study*. Purdue University, College of Veterinary Medicine. Available at: https://www1.maine.gov/dafs/gamingcom/docs/Indiana%20Equine%20Industry%20Econominc%20Impact%20Study,%20PC.pdf [accessed on 2/27/2016].

Crompton, J.L., and S. Lee. 2000. *The Economic Impact of 30 Sports Tournaments, Festivals, and Spectator Events in Seven U.S. Cities*. Journal of Park and Recreation Administration. Volume 18:2. 107-126. Available at: http://js.sagamorepub.com/jpra/article/view/1606,accessed29April2012 [accessed on 9/28/2015].

Daniels, M.J., W.C. Norman, and M.S. Henry. 2004. *Estimating Income Effects of a Sport Tourism Event.* Annals of Tourism Research. Volume 31:1. 180-199. Available at: http://isiarticles.com/bundles/Article/pre/pdf/47914.pdf [accessed on 7/20/2016].

Deloitte Consulting, LLP. 2005. *National Economic Impact of the U.S. Horse Industry*. American Horse Council Foundation. Available at: http://www.horsecouncil.org/national-economic-impact-us-horse-industry [accessed on 9/17/2015].

Diehl, S. and T. Johnson. 2014. National Western Stock Show: Statistical Demographic Findings Report. BGV Marketing Services. Centennial, CO.

Dixon, A.W., M. Henry, J.M. Martinez. 2013. *Assessing the Economic Impact of Sports Tourists' Expenditures Related to a University's Baseball Season Attendance.* Journal of Issues in Intercollegiate Athletics. 96-113. Available at: http://csri-jiia.org/documents/publications/research_articles/2013/JIIA_2013_6_6_96_113_Economic_Impact.pdf [accessed on 7/20/2016].

Harder, A., and A. Hodges. 2011. *Economic Impact Analysis of 4-H Youth Livestock Projects Using IMPLAN*. Journal of Extension. Volume 49.1. Available at: http://www.joe.org/joe/2011february/tt3.php [accessed on 12/10/2015].

Hill, R., and J. Goodwin. 2015. *Using IMPLAN to Evaluate the Economic Contribution of 4-H to Colorado and Individual Counties*. Journal of Extension. Volume 53:1. Available at: http://www.joe.org/joe/2015february/a6.php [accessed on 12/14/2015].

Kelsey, T.W., and K. Hoy. 2012. The Economic Impact of the Farm Show Complex & Expo Center, Harrisburg. Agricultural Economics. Pennsylvania State University. Available at: http://aese.psu.edu/research/centers/cecd/publications/economic-impact/economic-impact-of-farm-show-complex-expo-center-harrisburg [accessed on 6/25/2015].

Mitchell, K. 2016. *2016 National Western Stock Show: 2nd highest attendance in 110-year history.* The Denver Post. Available at: http://www.denverpost.com/news/ci_29429183/national-western-2nd-highest-attendance-110-year-history [accessed on 8/27/2016].

Nadeau, J. Unknown. Equine Herpesvirus – Fact Sheet. Department of Animal Science. University of Connecticut Extension. Available at: http://animalscience.uconn.edu/extension/publications/herpesvirus.htm [accessed on 8/27/2015].

Rephann, T.J. 2011. *The Economic Impact of the Horse Industry in Virginia*. Weldon Cooper Center for Economic and Policy Studies Weldon Cooper Center for Public Service, University of Virginia. Available at: http://www.coopercenter.org/sites/default/files/publications/horse_study_final.pdf [accessed on 2/27/2016].

Rutgers Equine Science Center. 2007. *The New Jersey Equine Industry 2007: Economic Impact.* New Jersey Agricultural Experiment Station, Rutgers University. Available at: http://esc.rutgers.edu/wp-content/uploads/2014/11/2007EconomicImpact.pdf [accessed on 2/27/2016].

Shideler, D., T. Woldesenbet, V. Stanley, and J. Frye. 2012. The Economic Impact of the Muskogee Regional Junior Livestock Show on the Economy of Muskogee County, Oklahoma. Oklahoma State University Extension. Available at: http://agecon.okstate.edu/faculty/publications/4455.pdf [accessed on 7/7/2015].

Smith, B. 2010. The Economic Impact of Houston Livestock Show and Rodeo. University of Houston. Available at: https://www.rodeohouston.com/Portals/0/Downloads/AboutUs/hlsr_econ_impact_2010.pdf [accessed on 7/7/2015].

Swanson, J. 2013. Analysis of 2013 Rolex Kentucky Three-Day Event Economic Impact Survey Data. Hospitality Management and Tourism. University of Kentucky. Lexington, KY.

Swinker, A.M., P.R. Tozer, M.L. Shields, and E.R. Landis. 2003. *Pennsylvania's Equine Industry Inventory*, *Basic Economic and Demographic Characteristic*s. Department of Dairy and Animal Science. The Pennsylvania State University. Available at: http://extension.psu.edu/animals/equine/economic-impact-and-population-study/pa-equine-industry-inventory-basic-economic-and-demographic-characteristics [accessed on 2/27/2016].

theHorse.com. 2016. *Vesicular Stomatitis: An Emerging Equine Disease.* Podcast. theHorse.com. Available at: http://www.thehorse.com/ask-the-vet/37149/vesicular-stomatitis-an-emerging-equine-disease [accessed on 2/27/2016]

University of California, Davis. Unknown. Equine Herpesvirus: EHV-1 How to Handle a Sick Horse. Center for Equine Health. Davis, CA. Available at: http://www.vetmed.ucdavis.edu/ceh/resources/ehv1/ehv1_sick.cfm [accessed on 8/4/2015].

Watson, P., J. Wilson, D. Thilmany, and S. Winter. 2007. Determining Economic Contributions and Impacts: What is the difference and why do we care? Regional Analysis & Policy. 37(2):1-15. Available at: http://jrap-journal.org/pastvolumes/2000/v37/F37-2-6.pdf [accessed on 1/3/2014].

CHAPTER FIVE - CONCLUSION

Results from this collection of interrelated, yet independent studies were framed to inform and benefit numerous equine industry stakeholder groups. Research regarding the economic impacts of equine disease are timely given the reoccurrence of equine disease outbreaks in recent years. While measures and research efforts to mitigate equine diseases and subsequent outbreaks of disease are emerging, a focused understanding the economic impacts is relatively undiscovered albeit valuable to the industry. This unique view of equine disease provides additional framework to model how equine industry personnel are affected beyond the traditional perception of equine disease which often considers only the direct cost of treating the horse (i.e., veterinary expenses, drugs, biosecurity practices, etc.). These studies not only provide context to disease outbreak in the equine industry, but may also contribute to future research, animal health policy and product development efforts.

The collection of studies framed here should serve as a launching point for future research which may expand on the economic losses suffered by other industry stakeholders. These stakeholders may include event management companies who experience losses because of the long-term, fixed costs already foregone in the production of an equine event when a disease outbreak prevents equine event competitors/exhibitors from attending. Additionally, future research may consider how equine competitors value the specific biosecurity practices employed by event management or equine owner perspectives regarding disease treatment options or equine vaccines. Future research should also explore any similarities or differences between the various types of equine diseases as the attributes and impacts are not uniform across diseases. This collective work may be used to expand to other animal health and care issues beyond equine disease; for example, to investigate how equine owners are impacted by equine injuries and any relevant comparisons that may exist to equine diseases.

Equine owners experience two types of costs when their horse develops an infectious disease: the direct cost of treating the horse for the disease (e.g., veterinarian expenses); and indirect costs associated with changes in welfare of ownership (e.g., lost daily use of the horse). The objectives addressed in Chapter 2 were to estimate the lost daily use values that equine owners experience, as well as assessing preferences for disease treatment attributes. Utilizing survey data collected nationwide, daily horse use value was estimated along with respondents' preferences regarding disease treatment options. Selecting ranges for treatment attributes often requires balancing the existing equine drugs that a consumer would consider with product attributes that elicit trade-off decisions from survey respondents. This balance poses a challenge for the researcher as it is important to select product attributes and attribute levels which accurately factor into the decision making process of equine owners (by way of survey respondents) in order to estimate the relevant study objectives. When using a choice experiment stated-preference approach, careful consideration in the attribute and attribute level selection process is necessary. The researcher is granted no control when eliciting existing market data to analyze consumer valuation of products and their attributes. Applying a stated-preference approach offers an advantage over existing market data as it allows the researcher control in attribute and attribute-level selection permitting the valuation of product attributes in a way that may be impossible with market data. Choice experiments allow for the analysis of multiple attributes jointly compared to the valuation of a single attribute (either with or without) at a time as with other contingent valuation methods.

Ranges selected for treatment attributes (frequency of dose and cost of medication) were selected to be realistic and represent the scientific efficacy of existing medications while still allowing for the estimation of respondent trade-offs between oral medication and injectable drugs. That is, the attribute levels for frequency of dose and cost of medication levels were selected by researching currently available market drugs for equine respiratory infections. In some cases, level selected pushed the boundary of feasibility (e.g., dosing oral medication three times per day) to provide greater context and possible variability to better delineate respondent preferences.

Survey respondents were comprised of any equine owners, riders, trainers, caregivers, etc. who responded to a survey disseminated with the help of Zoetis, Inc., the Kentucky Equine Management Internship, theHorse.com and the social media outlet, Facebook. The average survey respondent's daily horse use value (DHUV) was estimated to be $13.42 per day (Chapter 2). This value increases to $17.84 per day for those surveyed who reported having insured horses ($11.99 for those with uninsured horses). Results also indicate a preference for oral administration of medications compared to intramuscular injection of medications, all else equal. A particularly interesting finding suggests that respondents have preferences for an injectable medication treatment when oral treatment was required more than 2.16 times per day. These results contribute to existing literature by providing an estimate for DHUV that is independent of the cost of treatment, providing generalizable takeaways for various disease situations.

The use values generated by this study are comparable and should be considered when determining the willingness to pay to return a horse to work (use) faster due to an injury which has some similarities to the need for rest and treatment of an infectious disease. An absolute direct comparison should not be assumed however, since there are also many differences between equine infectious diseases and equine injuries. Equine injuries are non-contagious and do not impact others in the industry as no horse transport is stopped. Equine injuries and infectious diseases both have the possibility of permanent damage to the horse but in different ways.

A preference towards less frequent dosing of oral medications is an important finding and valuable to product development efforts of animal pharmaceutical companies. Though the preference for oral treatment medications over injectable medication was clear, daily dose of injectable medications appears to be a reasonable option for many owners when compared to an oral medication that must be administered multiple times each day. These results originate from scenarios presented regarding treatment of respiratory disease, but may provide useful insights into equine owner preferences for treatment of a diverse set of equine diseases and/or ailments.

In an effort to expand upon the results generated in Chapter 2, a double bounded dichotomous choice (DBDC) question sequence was used to estimate lost daily use values for equine owners who attend equine events. Though this method does not allow for individual attribute preference estimation, initial values for equine owner daily use for DBDC questions were selected from a previous study (Chapter 2). Dichotomous choice methods are at risk of contributing to an anchoring effect resulting in respondents' answers to a second round questions being influenced by the value of the first round question. By expanding on prior research, Chapter 3 provides further estimation of daily use values and, with the inclusion of a second set of DBDC question sequence, give insight to the time-varying component of use values of equine owners. Dichotomous choice methods are beneficial when considering non-market products or goods for which behavior data is limited or non-existent by eliciting trade-off decisions from survey respondents. This decision process allows individuals to select a binary (yes, no) response to willingness-to-pay questions which provide them the highest level of utility. Hanemann, Loomis, and Kanninen (1984 & 1991) find that the inclusion of a second round follow-up question in addition to the first round willingness-to-pay question can improve statistical efficiency of estimated coefficients and confidence intervals.

Individuals who participate in numerous horse shows and/or competitions with their horse(s) are a specific subsector of the equine industry. The primary objective in the chapter was estimating DHUV of equine event participants/exhibitors while secondary objectives included estimating how DHUV may vary as the time until an event decreases. Data were collected from members of the Arabian Horse Association email listserv and includes equine owners, riders, trainers, caregivers, etc. who may or may not participate in equine events each year. The results indicate that the DHUVs of those surveyed are impacted by respondents' annual household income, whether an equine event is approaching or not, and the number of shows attended in various distance categories.

An important contribution to the previous study estimating daily use values of equids was integrating a timing aspect as an attribute related to equine events. The research generated expected results that lead one to conclude that DHUV does vary as time until an equine event decreases. As anticipated, those equine owners surveyed valued the use of their horse more when an equine event was three weeks away compared to when there was no plan to attend an event in the near future, and the marginal different is nearly $4.14 per day for the calculated willingness to pay. Future research could expand on this time-varying component of use value by investigating the continuum of DHUV with a greater variety of time frames relative to the participation in an equine event.

Tourism generated from equine events provides significant economic contributions to the local/surrounding areas by way of outside spending brought into the region. In particular, large equine events generate millions of dollars to local economies. Chapter 4 estimates these potential economic losses that would occur to a local economy should the event be canceled or when attendance at the event is less than anticipated. Analysis for this study was modeled based on a large regional event, the NWSS, and its equine events which in total had over 600,000 attendees in 2014. Since selection of study size within the IMPLAN software has direct impacts to the results since selecting a larger study region will generate greater results, in turn causing the impact to local industries to be diluted, model parameters were chosen carefully (Watson et al., 2007). In general, the ability to manipulate IMPLAN model results is a potential weakness of this method, highlighting the importance of careful construction of model parameters. Though challenges exist when developing an IMPLAN model, this method provides beneficial estimates for the full scope of potential losses suffered by local economies should equine events experience effects of equine disease outbreaks by including the linkages from businesses which are indirectly impacted from equine events. Estimates for complete cancellation of NWSS are generalizable for equine events of similar size and scope, while estimates for reduced attendance have implications for a broader scope of equine events including regional events with significantly less spectator attendance.

Results from an IMPLAN model indicate potential losses between $71 million and $107 million to the Denver, Colorado region should NWSS be canceled due to a disease outbreak. Sensitivity analysis indicates a potential for a $500,000 and $1 million loss in tourism dollars with 25% and 50% reduction in attendees, respectively. These results highlight the importance of understanding the economic impacts of equine disease, not only to the equine industry but also to those indirectly impacted (local economies). The methodology used to estimate the economic loss from an event are customizable. A key outcome of the study described in this thesis allows for specific estimation of tourism impacts from equine events with different parameters from the model estimated in Chapter 4.

The collection of studies presented in this dissertation expand on existing equine economic research related to use values, disease outbreaks and equine events. The results have broader implications for the equine industry if used to explain phenomenon outside of equine disease outbreaks. Use values may have larger implications and relatability beyond equine owner willingness to pay to reduce rest days due to respiratory disease. As one example lost tourism monies due to cancelled or compromised attendance at equine events provides some of the first estimates of economic contribution related equine events for their local economies with the addition of customizable results.

REFERENCES

Hanemann, W.M. 1984. "Discrete Continuous Models of Consumer Demand." Econometrica Volume 52:3. 541-61. Available at: https://www.jstor.org/stable/1913464?seq=1#page_scan_tab_contents [accessed on 7/22/2016].

Hanemann, W.M., J.B. Loomis, and B.J. Kanninen. 1991. "Statistical Efficiency of Double-Bounded Dichotomous Choice Contingent Valuation". American Journal of Agricultural Economics. Volume 73:4. 1255-63. Available at: https://www.jstor.org/stable/1242453?seq=1#page_scan_tab_contents [accessed on 7/22/2016].

Watson, P., J. Wilson, D. Thilmany, and S. Winter. 2007. "Determining Economic Contributions and Impacts: What is the difference and why do we care?" Regional Analysis & Policy. 37(2):1-15. Available at: http://jrap-journal.org/pastvolumes/2000/v37/F37-2-6.pdf [accessed on 1/3/2014].