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# AN EXPLORATION OF THE PHYSICAL QUALITIES THAT MOST AFFECT THE NUMBER OF BIDS RECEIVED BY WILD HORSES PLACED IN BLM'S INTERNET AUCTIONS

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by

Robert Summers

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RESEARCH PAPER APPROVAL

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TITLE: AN EXPLORATION OF THE PHYSICAL QUALITIES THAT MOST AFFECT THE NUMBER OF BIDS RECEIVED BY WILD HORSES PLACED IN BLM'S INTERNET AUCTIONS

MAJOR PROFESSOR: Dr. Ira Altman

In 1971, the United States Congress passed the Wild Free-Roaming Horse and Burro Act (WFRHBA). Under the act, the Bureau of Land Management (BLM) was entrusted with the care and management of the nation's wild horse and burro population in the western portion of the United States. Current laws allow for 22,500 wild horses and burros to live on the range, however, estimates for the FY2014 showed at least 50,000 animals living on these Herd Management Areas (HMAs) with an additional 50,000 being managed in BLM holding facilities (Elizondo, Fitzgerald, and Rucker, 2016). Potential adopters and buyers have specific criteria they look for in horses. In 2018, BLM presented their annual report to Congress, laying out four options to reduce population size, including cash incentives for buyers of wild horses. This paper is an analysis of the criteria adopters and buyers find ideal when looking to purchase wild horses through the BLM's internet auctions. By identifying the variables that buyers find desirable in wild horses, the BLM could tailor their cash incentive program toward those animals less likely to find private homes thereby reducing the number of animals being held by the BLM. This study found that saddle training, halter training, and height in hands proved to be significant in determining the number of bids buyers placed on a horse.

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# CHAPTER 1

# INTRODUCTION

*Motivation*

Since the passing of the Wild Free-Roaming Horse and Burro Act of 1971, the Bureau of Land Management (BLM) has been responsible for the management of America's wild horses and burros living on Herd Management Areas (HMAs) in several western states. The act originally limited the number of these wild animals that could live upon the land. In the decades since the passing of the act, the number of wild horses that call these ranges home have grown in excess of 80,000 animals. This has led the BLM to conduct periodic roundups to capture excess horses and burros from the lands they manage.

These animals are transferred to several short-term holding facilities where they are kept while awaiting adoption, sale, or transfer to long-term facilities where the animals will live out the remainder of their natural lives. In addition to the roundups, the BLM and others have conducted experiments in fertility control with the aim of slowing the reproduction rate seen in the wild. These fertility options have proven to be ineffective at slowing the rapid growth of herd sizes because of difficulty in tracking wild animals that have received treatment and the need for additional treatments to ensure maximum effectiveness.

*Objective*

In 2018, the BLM submitted to congress a report outlining 4 options to bring populations under control and within mandated levels. These options rely greatly on adoption and sale of excess animals held in captivity and provide cash incentives for buyers. My research seeks to identify variables that buyers find desirable, possibly leading to higher number of bids and purchase prices. Identifying these variables will allow for targeted marketing campaigns to increase awareness of these animals. Additionally, by identifying the variables and traits of wild horses buyers see as less desirable would allow the BLM to direct the cash incentives toward buyers who are willing to adopt/purchase these animals. Furthermore, results may help the BLM identify which animals to target during roundups.

*Methods*

This paper utilizes data collected from the BLM’s online adoption website for November through December 2018 and February 2019. An OLS regression analysis was performed to identify the variables most important to buyers in determining the number of bids an animal receives.

*Likely Results and Implications*

It is hypothesized that variables identified in the study by Adenkule et al. are still relevant. Variables that have the greatest impact on number of bids can be used to promote certain animals for adoption. Cash incentives included in the options presented to Congress by the BLM can be focused toward animals that are less likely to receive bids or be purchased/adopted. This would further reduce the number of animals kept in the care of the BLM allowing the BLM to better utilize its budget.

## CHAPTER 2

## REVIEW OF LITERATURE

In the article, “You Can’t Drag Them Away: An Economic Analysis of the Wild Horse and Burro Program”, issues regarding animal populations and economics expenditures, amongst other topics, are discussed (Elizondo, Fitzgerald, and Rucker, 2016). As of March 2014, the Bureau of Land Management (BLM) was holding 50,000 wild horses and burros that had gone unadopted with an additional 50,000 roaming freely on government land, which is more than legislation allows (2016). Ranchers lease government land upon which these wild horses live, however, the opportunity cost lost by these ranchers who have had to limit their herd sizes equals nearly $2,000 per horse. From 2001 through 2014, the BLM has seen the number of horses kept in long-term holding facilities increase nearly five times to nearly 50,000 in 2014. Along with the increase in horses kept, the BLM saw costs rise from $7 million in FY2000 to $71.8 million in FY2013 (2016).

Using data gathered from several sources, including the American Horse Council (AHC), “The Unintended Consequence of a Ban on the Humane Slaughter (Processing) of Horses in the United States” identifies several side effects associated with banning the slaughter of horses for human consumption. These side effects include large numbers of abandoned horses, overcrowded rescues, and growing cost of care for unwanted horses (Ahern et al., 2006). In 2005, AHC estimated that 9.2 million horses lived in the United States (2005). Animal control facilities are called upon to take in many of these abandoned and neglected horses, despite lacking adequate facilities, funding, and personnel to care for these animals (Ahern et al., 2006). Maintenance costs are expected to be between $152 and $222 million dollars annually for unwanted horses (North et al., 2005). A ban on horse slaughter has had substantial economic impacts on owners, rescues, and government agencies as well as posing severe risks to the welfare of the animals.

“Wild Horse Demography: Implications for Sustainable Management Within Economic Constraints” addresses population growth, regulations, and management through a variety of methods including contraception and legal policies. In 2013, the National Research Council released long-term forecasts estimating population increases associated with 15% and 20% growth rates for years 2017 through 2026 with respect to the Herd Management Areas. These projections indicated that populations would grow from 60,000 in 2017 to 211,000 and 309,000 in 2026 for 15% and 20% growth rates respectively (Garrott, 2018). Natural controls exist, such as droughts that have occurred in Nevada the last 17 years (Garrott, 2018). According to Garrott, the most effective method for population control is the regulated gathering and removal of certain horses from HMAs (2018). Garrott (1991) and Hone (1992) concluded that contraception is highly successful at limiting population growth but does nothing to reduce population size. Garrott concluded that administrative and congressional limitations placed on the destruction of healthy wild horses shows the value society places on these animals and therefore it is unlikely that changes to policies related to slaughter are likely to occur (2018).

“An Economic Analysis of Alternative Fertility Control and Associated Management Techniques for Three BLM Wild Horse Herds” evaluated several strategies to control wild horse populations using cost projection models. The U.S. Geological Survey (USGS) identified several questions that arose from their analysis. “How often should horses be removed and/or treated with contraceptives? What sex and age horses are best to remove and/or treat with contraceptives? What other findings may be inferred from examination of simulation results (e.g., benefit:cost ratios for gather efficiency, general behavior of the HMA models)? Do the answers to the aforementioned questions depend strongly on the characteristics of individual herds or their locale?" (Bartholow, 2004). To answer these questions the authors used a baseline of the current policies concerning gathers, an alternative baseline that adjusts for new guidelines about horse ages and what category they fall into, an alternate gather period adjusted for the years between gathers, a scenario looking at length of time for contraception used, male-to-female gender ratio during gathers, gather efficiencies, and a combination of the previously listed factors (Bartholow, 2004). Bartholow used information from three HMAs in Idaho, Wyoming, and Colorado. To compile, analyze, and apply a dollar estimate to the cost projection model, the data for each HMA was entered into a Jenkins Model and estimated for each scenario. Bartholow's results showed that a gather cycle of 4 years without the use of contraception proved ideal while waiting longer to perform a gather resulted in higher annual costs (2004). Additionally, the use of contraception, whether of 2-year or 3-year duration, was shown to save an average of $15,000 annually in management costs, likely declining to roughly 70% of the baseline.

The purpose of the paper, "Research and Field Applications of Contraceptives in White-Tailed Deer, Feral Horses, and Mountain Goats", was to review the uses and effectiveness of select forms of contraceptives used to control wildlife populations of white-tail deer, feral horses, and mountain goats. Several methods of delivery were tested for effectiveness, longevity, ease of application, economic and environmental impact, and practicality and feasibility. Warren et al. (1993) report that prior to the passing of the Wild Free-Roaming Horse and Burro Act in 1971, local citizens actively engaged in the capture of wild horses for use in rodeos, slaughter for pet food, and other physical work. The act required the federal government to control the wild horse population and at great cost, more than $5 million in 1985 (Warren et al., 1993). The authors reviewed prior research using different applications of contraceptives, such as a microencapsulated form of testosterone propionate (MTP) used on stallions, estradiol, progesterone, ethinylestradiol, and norethisterone on wild mares, and other immunocontraceptives. Early tests of MTP saw a reduction in fertility rates by nearly 50% but required yearly treatments to remain effective and would have little impact on bands with multiple stallions (Warren et al., 1993).[1] Warren et al. (1993) reported that ethinylestradiol was the most effective contraceptive tested with fertility rates dropping 88% over a 3-year period.

"When, Where and for What Wildlife Species Will Contraception Be a Useful Management Approach", prepared for the USDA National Wildlife Research Center, further examines the various uses of contraception to control wildlife populations. Fagerstone et al. (2006) pointed out that techniques for population control have been slow to be implemented despite strong public demand. One method of contraception is the use of PZP to either block sperm from penetrating the zone pellucida (ZP) layer of a mammalian egg or prevent the egg from reaching maturation (Fagerstone et al. 2006). Porcine zona pellucida (PZP) vaccines have resulted in reductions in pregnancy among a variety of species, including wild horses, after an initial and second booster injection (Fagerstone et al. 2006). Gonadotrophin Releasing Hormones (GnRH) have shown similar results as PZP, however, where PZP is only effective in females while GnRH is equally effective in both sexes (Fagerstone et al., 2006). Fagerstone et al. (2006) note that GnRH lasts for 1 to 2 years without the need for a booster and saw a reversal in infertility over time. They concluded that fertility control of white-tail deer and wild horses through various contraceptive means is not a suitable method for population control based upon

[1] Feral, or wild, horse herds consist of several smaller bands.

the relatively long lifespans of these animals even though the public sees this as a more desirable management tool than other options such as slaughter (Fagerstone et al., 2006).

"Reimmunization Increases Contraceptive Effectiveness of Gonadotropin-Releasing Hormone Vaccine (GonaCon-Eguine) in Free-Ranging Horses (Equus caballus): Limitations and Side Effects" provides an updated report on the use of contraceptives as a method to control free-ranging horse population levels. During a time frame from 2009 to 2017, Baker et al. (2018) determined the long-term effectiveness of GnRH vaccine (GonaCon-Equine). During an initial roundup in 2009, 57 mares were randomly selected from the horse population gathered on the South Unit of Theodore Roosevelt National Park in southwestern North Dakota (Baker et al., 2018). This random sample was broken into a treatment group of 29 mares and a control group of 28 mares that were involved in a second roundup in 2013 and received follow-up injections of the GnRH vaccine and a saline solution (Baker et al., 2018). To determine vaccine effectiveness (VE), researchers set vaccine effectiveness equal to relative risk reduction (RRR) in medical statistics and calculated the results from the risk ratio (RR=F_Trt/F_Con ) where FTrt = the foaling population of treated mares and FCon = the foaling population of control mares where VE=1-RR (Baker et al., 2018). Researchers utilized mixed-effects linear regression to look at risk ratio analysis among reproduction rates and behavioral changes, as well as descriptive statistics to determine physiological differences, all conducted at a confidence interval of 95%. The research resulted in the development of two treatment groups with relatively homogenous groupings (Baker et al., 2018). Baker et al. (2018) concluded that GnRH vaccine was safe to be used on pregnant mares and neonates with no adverse side effects on behavior and reached full effectiveness with subsequent injections, further validating previous research.

Paul M. Jakus (2018) reviewed previous research to determine the benefits and costs of the BLM's Wild Horse and Burro Program. The review looked at a Benefit Cost Analysis to evaluate the economic aspects of different policies in terms of net benefits (Jakus, 2018). Jakus referred to a BCA model purposed by William F. Hyde in 1978 where Net Benefits (NB) is set equal to Total Benefits minus Total Costs where Total Benefits were use values (UV) of Appropriate Management Levels (AML) plus nonuse values (NUV) of AML plus adoption/sales values (ASV) of AML and Total Costs were program costs (PC) of AML plus opportunity costs (OC) of AML plus ecological costs (EC) of AML (2018). Hyde's (1978) analysis was used to determine optimal program scale for each HMA since costs associated with management of these areas would vary based upon geographic location (Jakus, 2018)

Jakus adjusted all monetary figures to 2017 dollars (2018). Adjusting figures to a 2017-dollar value showed that for FY1998 the WHB program budget was $21.5 million likely increasing to nearly $80 million in FY2016, a compounded annual rate of growth of 7.5%. The growth rate of BLM's budget, however, has not increased at a rate needed to match increasing costs in order to maintain wild horse and burro populations at appropriate levels for their home ranges (2018). Gather costs averaged $782.71 per animal gathered between FY2011 and FY2016, a total cost of just under $28.1 million (Jakus, 2018). During this same period, total expenditures for off-range short-term and long-term holding areas averaged $2.85 per day per animal, a total expense of $291.5 million with higher averages for short-term facilities of between $4.05 and $7.02 per day while long-term facilities averaged from $1.45 and $1.62 per day (Jakus 2018). Jakus also notes that the adoption/sale costs per animal averaged $2,153 (2018). Opportunity costs for FY2005 were estimated to be $7.1 million, adjusted to 2017 dollars, measured as foregone value of hunting and lost profits from cattle ranching (Jakus, 2018). More wild horses and burros on the range resulted in decreased numbers of hunted animals and higher average and marginal opportunity costs (Jakus, 2018).

Data was also collected regarding animals adopted/sold by the BLM, determining what characteristics potential buyers/adopters sought in wild horses and burros (Jakus, 2018). Larger horses and younger horses were preferred over smaller and older horses, as were certain colors and markings and level of training before adoption/sale (Jakus, 2018). Average adoption fees collected were $191.86 while average fees for those sold was only $19.60; additional fees ranged from $12 to $112 depending on coloring and other premiums for different markings while defects reduced adoption fees by about $26 (2018). Fees have dropped nearly $20 since the horse slaughter ban went into effect in 2007 (Jakus, 2018).

Authors of "A Hedonic Price Analysis of Internet Auctions for the BLM's Wild Horses and Burros" performed three different Hedonic Regressions to identify the characteristics that were important to buyers of wild horses and burros through the BLM to determine which animals were more desirable to capture during BLM roundups from the range (Adenkule, Saghian, Stowe, and Markus, 2014). Adekunle et al. looked at BLM data from November 2012 through February 2013. They began with a sample size of 153 animals before adjusting their sample size to 93 animals to remove those that had missing data because of having no bids placed. This adjusted sample size also had missing data for height and age for some animals (2014, p.7). Variables used to determine desirability included: location of capture, sale locations, colors, gender, level and type of training, length of holding, winning bid prices, and number of bids; some of these variables were assigned dummy values of 1 or 0 to identify gender, buyers closeness to sale site, and color, amongst others (2014, p.7-9). After estimating three separate models, results showed that the variables for colored, halter training, mares, pinto, bidder closeness, capture on the range, stallion, and length of time at the holding facility were highly significant variables at both the 5% and 1% levels and had the biggest impact on raising auction prices paid for wild horses and burros while saddle training lowered bid prices as did being born in holding facilities. Adenkule et al. (2014) recommended that the BLM promote these favorable characteristics through marketing directed toward buyers located in the states where the animals are being held. The authors also suggested that another model to use is a Tobit Model because it works well when dealing with missing data observations (2014, p.23).

In their Report to Congress, the Bureau of Land Management (BLM) proposed four separate options to reduce wild horse and burro populations on and off the range (2018). The options to achieve national Appropriate Management Levels (AML) in priority Herd Management Areas (HMAs) would utilize "an intensive gather and removal program" to lower on-range herd levels while those returned to the range would undergo methods to facilitate either permanent or semi-permanent infertility and sterilization (2018, p.13-14) with the exception that animals not adopted or sold would remain under BLM control until natural death (2018, p.15-16). Additionally, an incentive program would be established to encourage adoption or purchase of off-range animals (2018, p.16-17). All options would focus on intensive gathers and promote the adoption and/or sale of horses and burros in off-range facilities to private owners and international buyers for various uses, those "not placed in private care would be sold without limitation or euthanized" (2018, p.17-18). BLM concludes that each of these options would require "the help of all stakeholders…to solve the wild horse and burro overpopulation challenge" (2018, p.18).

## CHAPTER 3

## BLM's OPTIONS

Since the passing of the Wild Free-Roaming Horses and Burros Act of 1971, the Bureau of Land Management has been tasked with the care and maintenance of wild horses and burros that live upon roughly 27 million acres of public lands in the American West across a number of Herd Management Areas (HMAs) (Adenkule, Saghian, Stowe, and Markus, 2014; U.S. Department of the Interior, Bureau of Land Management, 2018). The BLM utilized rangeland management principles to determine an Appropriate Management Level (AML) of just under 27,000 wild horses and burros as being sustainable across 10 states, however, current estimates as of 2017, put the number of wild horses and burros at over 80,000 on public land (U.S. Department of the Interior, Bureau of Land Management, 2018).

Escalating numbers of wild horses and burros is putting pressure on the forage and water resources these animals rely upon; this in turn potentially leads to starvation and death of these animals (U.S. Department of the Interior, Bureau of Land Management 2018). The BLM points out that diminishing food and water sources leads wild horses and burros to move onto private lands or along public roadways which threatens not only the safety of the animals but also the public in general (U.S. Department of the Interior, Bureau of Land Management 2018). The increasing size of herds and overcrowding of public lands has also driven out native animal species such as deer, elk, and bighorn sheep (U.S. Department of the Interior, Bureau of Land Management 2018). To return herd sizes to AML, the Bureau of Land Management presented a report to congress in March 2018 detailing four options to reduce the size of herds on HMAs.

The report to congress contained the following: Option I is designed to reach AML in 8 years and decrease off-range holding costs; Option II would attain AML in 10 years and require increased program funding; Option III would reach AML in 6 years and create an incentive program to adopt wild horses; and Option IV would see AML reached after 12 years while also utilizing an incentive program for adoption and increasing permanent sterilization treatments (U.S. Department of the Interior, Bureau of Land Management 2018). Each option would require an initial increase in the BLM's annual budget until AML is achieved. Once AML is achieved, BLM's budget would be reduced (U.S. Department of the Interior, Bureau of Land Management 2018).

For the purpose of this paper, the focus is on Options III and IV, specifically, the creation and utilization of cash incentives in order to encourage adoption. The reason for focusing on these two incentive programs is for directed marketing, focused gathers, and incentives to be used to find buyers for animals that are otherwise less likely to find homes during online auctions and sales events.

Option III states that "within priority HMAs (about 115 of the 177 HMAs, or about two-thirds of the total)" would return to AML by 2021 with the remaining HMAs achieving AML by 2024 (U.S. Department of the Interior, Bureau of Land Management, 2018, p.16). However, achieving these results would be costly because more intensive roundups would have to be undertaken in order to significantly reduce the on-range animal population (U.S. Department of the Interior, Bureau of Land Management 2018). Maintaining AML would require the implementation of "permanent sterilization throughout the 6 years to help control population growth and maintain AML once achieved" (U.S. Department of the Interior, Bureau of Land Management 2018, p.16). Additionally, Option III would allow for international sale of gathered animals to foreign countries to be used for farming operations, police operations, and other potential uses (U.S. Department of the Interior, Bureau of Land Management 2018).

Finally, the creation of a cash incentive program to entice potential buyers to purchase animals with additional funding to care for these animals could be beneficial, especially if the incentives were specifically geared toward certain animals. While a cash incentive itself could be enough to attract more bidders, focusing incentives toward the animals less likely to find homes could lead to more animals finding homes rather than just those that are already deemed desirable. Currently, the proposal would allocate “$1,000 per animal” purchased (U.S. Department of the Interior, Bureau of Land Management 2018, p.16); however, a multitiered incentive program with higher payments going toward the animals considered less desirable and lower payments for animals that are most desirable would likely result in more animals finding homes outside of short-term holding facilities where cost for the care of one animal can reach “$1,000 after only 200 days in captivity” and “cost the taxpayers nearly $46,000” over the length of the same animal’s lifespan (U.S. Department of the Interior, Bureau of Land Management, 2018, p.16).[2]

Option IV, taking 12 years to reach desired AML, relies on the same requirements to achieve AML as Option III with only one significant difference. Option IV would focus primarily on the use of permanent sterilization during the first half of the program, reducing the breeding population of herds to about 20 percent of animals currently living on the range (U.S. Department of the Interior, Bureau of Land Management, 2018, p.17). During the first half of Option IV, the BLM would actively pursue “fertility control treatment research” to identify “reliable options for long-lasting, easily administered vaccines” to reduce animal fertility rates (U.S. Department of the Interior, Bureau of Land Management, 2018, p.17). The goal of

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[2] As of March 20, 2019, several news agencies have reported that the BLM has begun its $1,000 per animal cash incentive program for buyers of wild horses.

researching effective fertility control vaccines is to limit the use of “permanent sterilization” (U.S. Department of the Interior, Bureau of Land Management, 2018, p.17).

# CHAPTER 4

## ECONOMICS

Since the beginning of the Wild Free-Roaming Horse and Burro Act of 1971, the BLM has faced a variety of challenges maintaining AML. Many of these problems have severe economic consequences. For the time period FY12 thru FY17, the BLM saw their budget increase from just under $75 billion in FY12 to over $80.5 billion in FY17. However, in FY18, the BLM saw their budget decrease to $75 billion. BLM's own figures show that during FY13, FY17, and FY18 total expenditures exceed total appropriations with off-range holding costs accounting for between 58 and 66% of spending each year (https://www.blm.gov/programs/wild-horse-and-burro/about-the-program/program-data).

According to Elizondo, Fitzgerald, and Rucker (2016), a 2008 GAO report "found that the average daily costs of short- and long-term holding per head were $5.08 and $1.27" respectively (p.1). This averages out to $1,854.20 per animal per year in short-term holding facilities and $463.55 per animal per year in long-term holding facilities. As of January 2018, the BLM estimates that 50,935 animals were being held in off-range facilities (https://www.blm.gov/programs/wild-horse-and-burro/about-the-program/program-data). Taking average per year holding costs and multiplying that number by the number of animals being held off-range equates to between $23.61 million and $94.45 million in FY08 dollars per year in holding costs alone.[3] It should be noted that Jakus (2018) reported that average costs of off-range holding has fluctuated across reporting agencies and years (p.61).

[3] Estimates figured by multiplying long-term holding cost per animal in FY08 dollars with number of animals held off-range as of January 2018 to determine lower boundary and multiplying short-term holding cost per animal in FY08 dollars with number of animals held off-range as of January 2018 to determine upper boundary.

These costs become problematic when considering the rate at which wild horse populations increase. Based upon fifteen and twenty percent population growth estimates, Garrott (2018) projected the number of animals living on HMAs would double in size between 2021 and 2022 based on a starting point of 60,000 horses in 2017 (p.47-48). Within a decade the number of wild animals would exceed 300,000 without human intervention as wild horses have no natural predators living on HMAs capable of killing full-grown horses, aside from mountain lions which can kill young horses separated from the herd (Garrott, 2018).

# CHAPTER 5

## DATA AND METHODS

This study evaluates the BLM's internet auctions for wild horses by examining physical characteristics of wild horses that buyers find desirable. Modelling was influenced by research conducted by Adenkule et al. in 2014. Ordinary Least Squares (OLS) is used to identify the variables buyers find desirable in order to determine the number of bids placed on an animal during a BLM internet auction. A horse with mostly desirable qualities attracts a greater number of bids and higher final sale prices. A second objective is to determine the relevance of cash incentives as a method of increasing the number of bids and purchase rates. This research utilizes data extracted from BLM's internet auctions for wild horses and burros over two time periods: November through December 2018 and February 2019. Beginning with a population size of 135 observations, data observations were reduced to include only those animals which received at least one bid. Removing unsold animals produced an adjusted population size of 64 and eliminated the color *Dun* as a possible variable under the umbrella variable for *Colored*. Data from all 64 animals sold was used to estimate both OLS models.

Adenkule et al. looked at the variables for month of sale, location of capture, holding facility born horses, sale location, buyer's location, age, height, color, accessories, month captured, gender, level and type of training, length of holding, winning bid prices, and number of bids (2014). Some of these variables were assigned dummy values of 1 or 0; for example, gender, buyer's closeness to sale site, color, saddle training, and halter training (Adenkule, Saghian, Stowe, and Markus, 2014). Since Adenkule et al. performed their original study in 2014, the Bureau of Land Management has made changes to their online auction platform. These changes have eliminated the ability to determine the buyers' locations and their relative closeness to where the animals are located. This development necessitated removing these two variables from the models I estimated. The variable, "accessories", for example, blaze and stockings, was also removed from the models used for this research.

Dummy variables are used to classify *Gender, HalterTraining, SaddleTraining, Colored* (including expanded color base), and *BornOnRange*. For the variable *Gender,* 1 is used to signify *Gelding* and 0 for *Mare*.[4] For both *HalterTraining* and *SaddleTraining*, 1 signifies *yes* and 0 indicates *no*. Horses that are born on HMAs (*BornOnRange*) receive a 1 and those born in captivity take a value of 0. Animals that are any color other than *Black or Gray* are assigned a value of 1 and those that are *Black or Gray* are given a value of 0. When the variable *Colored* is expanded to include each color individually, animals are given a value of 1 if they are the specific color and take a value of 0 if they are not that individual color. *Age, HeightinHands,* and *TimeinHolding(Days)* are treated as continuous variables. A linear relationship is assumed between the independent variables and the dependent variable, *NumberofBids*.

For the variables *Age* and *TimeinHolding(Days)* it is expected that these variables will have negative signs, indicating that younger horses and those who have spent less time in holding are preferred by bidders. It is further hypothesized that animals that have been halter or saddle trained will have positive signs on their coefficients and are therefore preferred by buyers. Positive signs related to variables *HeightinHands*, *BornOnRange,* and *Colored* would point to a positive preference for animals that are taller, born in the wild, and any color other than *Black or Gray*. I also expect to see a positive sign on *Gender* based on domestic horse owners' preferences for geldings. A negative sign on the coefficient for *Gender* would signify that mares

[4] Geldings were given a value of 1 because of their desirability amongst buyers of domesticated horses.

are preferred over geldings. I do not expect *DateofSale* to have any significant affect on the number of bids.

The initial OLS regression run for the dependent variable *NumberofBids* an animal receives is: $NumberofBids = \beta_1 DateofSale + \beta_2 BornOnRange + \beta_3 Gender + \beta_4 Colored + \beta_5 HeightinHands + \beta_6 TimeinHolding(Days) + \beta_7 HalterTraining + \beta_8 SaddleTraining + \beta_9 Age + E$ (OLS Model 1). The Null Hypothesis for each independent variable is that each variable is not statistically significant from zero at the 5% significance level. For example, $H_0$: *DateofSale* is not significantly different from zero.

The empirical model for the second OLS regression with the variable *Colored* expanded is as follows: $NumberofBids = \beta_1 BornOnRange + \beta_2 Gender + \beta_3 HeightinHands + \beta_4 TimeinHolding(Days) + \beta_5 HalterTraining + \beta_6 SaddleTraining + \beta_7 Sorrel + \beta_8 RedRoan + \beta_9 Pinto + \beta_{10} Palomino + \beta_{11} BlueRoan + \beta_{12} Black + \beta_{13} Brown + \beta_{14} Age + E$ (OLS Model 2). *DateofSale* was removed from this model to test if it was statistically. Both models are evaluated at a confidence level of 95% based on the value of $R^2$.

# CHAPTER 6

# RESULTS

Based on an $R^2$ value of .606 for model 1, the explanatory variables taken together explained slightly more than 60% of the variation in the dependent variable, *NumberofBids*. A T statistical test on the model shows that the variables *HeightinHands, HalterTraining,* and *SaddleTraining* are statistically significant at a 95% confidence level and I reject the null hypothesis that these three variables are not statistically significant.[5] However, *DateofSale, BornonRange, Gender, Colored,* and *TimeinHolding(Days)* are not significant at an alpha value of .05, or a 95% confidence level, and I fail to reject the null hypotheses that these variables are not statistically significant.

Results of OLS regression model 1 showed positive signs assigned to all variables except for *BornonRange, Age,* and *TimeinHolding(Days)*. The coefficient of age, although not statistically significant, had a negative sign in accordance with my hypothesis that horse buyers prefer younger horses. The variable, *BornonRange*, which was also not statistically significant had a negative sign on its coefficient which means, on average, horses born in captivity receive a greater number of bids compared to those born on the range. This is not in accordance with my hypothesis that a horse born on the range is more preferred to a horse born in captivity due to its "wildness." With respect to the variable *TimeinHolding*, although not statistically significant, it did have a negative sign which is in accordance with my hypothesis that horse buyers, on average, prefer horses that have spent less time in holding facilities and would therefore receive a greater number of bids. The positive signs on the remaining estimates (*Gender, Colored,*

[5] Appendix B: Table 3: NumberofBids Base Model

*HeightinHands, HalterTraining,* and *SaddleTraining*) means that, on average, horses with predominantly these qualities are more preferred by buyers than horses without these traits and would, theoretically, receive a greater number of bids compared to horses without these qualities or fewer of them.

Based on an $R^2$ value of .632 for model 2, the explanatory variables jointly explained slightly more than 63% of the variation in the dependent variable, *NumberofBids*. A T statistical test on model 2 shows the variables *HeightinHands*, *HalterTraining,* and *SaddleTraining* are once again statistically significant at a 95% confidence level and I reject the null hypothesis that these three variables are not statistically significant. However, like model 1, *DateofSale*, *BornonRange, Gender, Colored,* and *TimeinHolding(Days)* are not significant at an alpha value of .05 or a 95% confidence level, and I fail to reject the null hypothesis that these variables are not statistically significant.

Results of OLS regression model 2, like regression model 1, showed positive signs for all the variables except for *BornonRange, Age,* and *TimeinHolding(Days)*. Said differently, the variables *HalterTraining, SaddleTraining,* and *Gender* had positive signs indicating a preference for animals that are halter and/or saddle trained and are geldings (not mares or stallions).[6] With respect to color, while not statistically significant, Blue Roan horses were most preferred based on the magnitude of the variables standardized beta coefficient and its p-value. The negative signs associated with *TimeinHolding(Days)* and *Age* indicate that buyers have a preference for younger animals and animals that have been in holding facilities for fewer days. The negative sign associated with the variable *BornonRange* was unexpected, indicating that buyers preferred

[6] Appendix B: **Error! Reference source not found.**

horses born in holding facilities. The reasons for this could be because it is more likely that animals born in captivity likely received medical treatment and are less likely to be ill or injured and are more likely to be halter and saddle trained and use to interacting with people.

# CHAPTER 7

# CONCLUSION

This research had two specific goals. The first goal was to determine the desirable characteristics of wild horses that determine the number of bids placed on an animal put up for auction by the BLM. The second goal was to take those findings and apply them to improving the Bureau of Land Management's cash incentive program to increase the likelihood that animals removed from HMAs find homes in the private sector.

The number of bids an animal received were likely to be higher for geldings rather than mares or stallions. Results also suggest that bidders prefer a horse of color, primarily Blue Roan, over either Black or Gray. Saddle and halter trained horses were preferred by bidders rather than horses that have had no training and are basically "unbroke." This research also showed that buyers prefer younger, taller horses.

The validity of these OLS regression results come into question because of the low $R^2$ value on models 1 and 2, which indicate that other independent variables that weren't included in these models are needed to explain number of bids received by wild horses. A buyer's location and distance from where a horse is being held would likely lead to a higher $R^2$ value as would a variable for number of bidders. Additionally, it is highly probable that multicollinearity problems exist between age and the number of days an animal has been held in a facility and also between age and the height of an animal. I did not test or correct for the presence of multicollinearity. As a result of possible problems with multicollinearity, all the inferences made on all the estimates in models 1 and 2 may be statistically imprecise.

The second goal of this research was to address how the BLM can increase public adoption rates using cash incentives. To this end, the BLM needs to change certain policies as they relate to adoption and develop marketing campaigns that promote the adoption of wild horses. The BLM has begun to implement a cash incentive program to provide a nominal cash payment of $1,000 to individuals that purchase wild horses. A cash incentive program would likely require an additional increase in BLM’s annual budget if other interest groups are unable or unwilling to contribute to the program. Additionally, a cash incentive may do little or nothing to encourage the purchase of those animals that do not have the qualities buyers prefer. Instead of offering the same incentive payment across every animal available for sale, a graduated schedule based upon desirable traits might be more effective. Buyers who are interested in horses with a number of desirable traits would receive a smaller cash incentive or none at all compared to buyers interested in horses with fewer desirable characteristics. Graduated cash incentives targeted toward less desirable horses might increase the probability of these animals being purchased. Additionally, steps taken to market specific animals for sale above the base cash incentive with a bonus payment could be utilized to encourage the purchase of more animals in holding facilities. Future research that analyzes which physical characteristics of horses influence a buyer’s decision to bid for a horse needs to include the impact BLM’s cash incentive program has on number of bids and final prices. It may also be beneficial to hold a live auction once or twice a year where select animals can potentially attract higher bid prices.

# BIBLIOGRAPHY

Adenkule, O., S. Saghian, C. Stowe, and L. Markus. “A Hedonic Price Analysis of Internet Auctions for the BLM’s Wild Horses and Burros.” 2014. Annual Meeting of the Southern Agricultural Economics Association, February 1–4, Dallas, TX. Available online at http://purl.umn.edu/162469.

Ahern, James J., David P. Anderson, DeeVon Bailey, Lance A. Baker, W. Arden Colette, J. Shannon Neibergs, Michael S. North, Gary D. Potter, Carolyn L. Stull. 2006. “The Unintended Consequence of a Ban on the Humane Slaughter (Processing) of Horses in the United States.” *Animal Welfare Council, Inc*.

Baker, Dan L., Powers, Jenny, G., Ransom, Jason I., McCann, Blake E., Oehler, Michael W., Bruemmer, Jason E., et al. (2018) “Reimmunization Increases Contraceptive Effectiveness of Gonadotropin-Releasing Hormone Vaccine (GonaCon-Eguine) in Free-Ranging Horses (Equus caballus): Limitations and Side Effects”. *PloS ONE* 13(7).

Bartholow, J.M., 2004. An economic analysis of alternative fertility control and associated management techniques for three BLM wild horse herds: U.S. Geological Survey, Biological Resources Discipline, Open File Report 2004-119, 33 p.

Elizondo, Vanessa, Timothy Fitzgerald, and Randal R. Rucker. 2016. “You Can’t Drag Them Away: An Economic Analysis of the Wild Horse and Burro Program.” *Journal of Agricultural and Resource Economics* 41(1):1–24

Fagerstone, Kathleen A.; Miller, Lowell A.; Bynum, Kimberly S.; Eisemann, John D.; Yoder, Christi., “When, Where and for What Wildlife Species Will Contraception Be a Useful

Management Approach" (2006). Proc. 22nd Vertebr. Pest Conf., Univ. of Calif., Davis. 45-54.

Garrott, Robert A. 2018. "Wild Horse Demography: Implications for Sustainable Management Within Economic Constraints." *Human-Wildlife Interactions* 12(1):46–57.

Jakus, Paul M. 2018. "A Review of Economic Studies Related to the Bureau of Land Management's Wild Horse and Burro Program". *Human-Wildlife Interactions* 12(1):58-74.

U.S. Department of the Interior, Bureau of Land Management. 2018. *Report to Congress: Management Options for a Sustainable Wild Horse and Burro Program*. Washington D.C.

U.S. Department of the Interior, Bureau of Land Management. 2018. Program data. U.S. Department of the Interior, Washington, D.C., USA, https://www.blm.gov/programs/wildhorse-and-burro/about-the-program/programdata.

Warren, Robert J.; Fayrer-Hosken, Richard A.; Muller, Lisa I.; Willis, L. Paige.; and Goodloe, Robin B., "Research and Field Applications of Contraceptives in White-Tailed Deer, Feral Horses, and Mountain Goats" (1993). *Contraception in Wildlife Management*. 23.

# APPENDICES

# APPENDIX A

# ECONOMICS

Table 1: Wild Horse and Burro Program Budget (https://www.blm.gov/programs/wild-horse-and-burro/about-the-program/program-data)

| **Wild Horse and Burro Program Budget** | | |
|---|---|---|
| **FY2018** | | |
| **Budget Category** | **Dollars (in millions)** | **% of Expenditures** |
| Appropriations | $75 | n/a |
| Total Expenditures* | $81.23 | n/a |
| Off-Range Holding Costs | $49.81 | 61% |
| Gathers and Removals | $6.20 | 7% |
| Adoptions | $8.26 | 10% |
| Other Activities (monitoring, etc.) | $16.92 | 20% |
| **FY2017** | | |
| **Budget Category** | **Dollars (in millions)** | **% of Expenditures** |
| Appropriations | $80.56 | n/a |
| Total Expenditures* | $82.57 | n/a |
| Off-Range Holding Costs | $48.63 | 58% |
| Gathers and Removals | $4.22 | 5% |
| Adoptions | $7.91 | 10% |
| Other Activities (monitoring, etc.) | $21.33 | 26% |
| **FY2016** | | |
| **Budget Category** | **Dollars (in millions)** | **% of Expenditures** |
| Appropriations | $80.56 | n/a |
| Total Expenditures* | $78.30 | n/a |
| Off-Range Holding Costs | $49.43 | 63.10% |
| Gathers and Removals | $3.06 | 3.90% |
| Adoptions | $7.38 | 9.40% |
| Other Activities (monitoring, etc.) | $18.43 | 23.50% |
| **FY2015** | | |
| **Budget Category** | **Dollars (in millions)** | **% of Expenditures** |
| Appropriations | $77.25 | n/a |
| Total Expenditures* | $75.17 | n/a |
| Off-Range Holding Costs | $49.38 | 65.70% |
| Gathers and Removals | $1.83 | 2.40% |
| Adoptions | $6.31 | 8.40% |
| Other Activities (monitoring, etc.) | $17.65 | 23.50% |
| **FY2014** | | |

| Budget Category | Dollars (in millions) | % of Expenditures |
|---|---|---|
| Appropriations | $77.25 | n/a |
| Total Expenditures* | $67.90 | n/a |
| Off-Range Holding Costs | $43.24 | 63% |
| Gathers and Removals | $1.20 | 2% |
| Adoptions | $4.60 | 7% |
| Other Activities (monitoring, etc.) | $18.87 | 27% |
| **FY2013** | | |
| **Budget Category** | **Dollars (in millions)** | **% of Expenditures** |
| Appropriations | $71.84 | n/a |
| Total Expenditures* | $76.10 | n/a |
| Off-Range Holding Costs | $46.17 | 61% |
| Gathers and Removals | $4.80 | 6% |
| Adoptions | $7.50 | 10% |
| Other Activities (monitoring, etc.) | $17.04 | 22% |
| **FY2012** | | |
| **Budget Category** | **Dollars (in millions)** | **% of Expenditures** |
| Appropriations | $74.89 | n/a |
| Total Expenditures* | $72.40 | n/a |
| Off-Range Holding Costs | $42.96 | 59% |
| Gathers and Removals | $7.80 | 11% |
| Adoptions | $7.10 | 10% |
| Other Activities (monitoring, etc.) | $14.55 | 20% |
| * Expenditures include funding sources from multiple program areas related to wild horse and burro management. | | |

Table 2: Wild Horse and Burros Under BLM Care (https://www.blm.gov/programs/wild-horse-and-burro/about-the-program/program-data)

| **Wild Horses and Burros under BLM Care** | | | |
|---|---|---|---|
| **Facility Type** | **Horses** | **Burros** | **Total** |
| Off-Range Corrals | 12,433 | 1,596 | 14,029 |
| Off-Range Pastures | 36,205 | 0 | 36,205 |
| Public Off-Range Pastures | 701 | 0 | 701 |
| Total Off-Range Population | 49,339 | 1,596 | 50,935 |

# APPENDIX B

## *NUMBEROFBIDS* REGRESSION AT 95% CONFIDENCE LEVEL

Table 3: *NumberofBids* Base Model

**Model Summary**

| | | | | | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | $R^2$ | Adjusted R Square | Std. Error of Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .779[a] | .606 | .541 | 11.668 | .606 | 9.237 | 9 | 54 | .000 |

a. Predictors: (Constant), Saddle Training, Colored, Halter Training, Born on Range, Gender, Date of Sale, Age, Time in Holding (Days)

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 11317.954 | 9 | 1257.550 | 9.237 | .000[b] |
| | Residual | 7351.656 | 54 | 136.142 | | |
| | Total | 18669.609 | 63 | | | |

a. Dependent Variable: Number of Bids
b. Predictors: (Constant), Saddle Training, Colored, Halter Training, Height in Hands, Born on Range, Gender, Date of Sale, Age, Time in Holding (Days)

**Coefficients[a]**

| | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | -.566 | 6388.926 | | .000 | 1.000 |
| | Date of Sale | -5.063E-9 | .000 | -.001 | -.011 | .991 |
| | Born on Range | -1.844 | 4.404 | -.041 | -.419 | .677 |
| | Gender | 5.942 | 4.544 | .170 | 1.307 | .197 |
| | Age | -1.076 | .770 | -.163 | -1.397 | .168 |
| | Colored | 1.298 | 3.170 | .037 | .410 | .684 |
| | Height in Hands | 5.950 | 2.070 | .308 | 2.874 | .006 |
| | Time in Holding (Days) | -.002 | .003 | -.095 | -.700 | .487 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Halter Training | 13.508 | 6.225 | .212 | 2.170 | .034 |
| | Saddle Training | 59.896 | 9.224 | .610 | 6.494 | .000 |
| a. Dependent Variable: Number of bids | | | | | | |

Table 4: *NumberofBids* Modified

**Model Summary**

| | | | | | | Change Statistics | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | $R^2$ | Adjusted R Square | Std. Error of Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .779[a] | .606 | .549 | 11.561 | .606 | 10.584 | 8 | 55 | .000 |

a. Predictors: (Constant), Saddle Training, Colored, Halter Training, Born on Range, Gender, Date of Sale, Age, Time in Holding (Days)

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 11317.937 | 8 | 1414.742 | 10.584 | .000[b] |
| | Residual | 7351.672 | 55 | 133.667 | | |
| | Total | 18669.609 | 63 | | | |

a. Dependent Variable: Number of Bids
b. Predictors: (Constant), Saddle Training, Colored, Halter Training, Height in Hands, Born on Range, Gender, Age, Time in Holding (Days)

**Coefficients[a]**

| | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | -70.373 | 25.369 | | -2.774 | .008 |
| | Born on Range | -1.850 | 4.327 | -.041 | -.427 | .671 |
| | Gender | 5.944 | 4.500 | .170 | 1.321 | .192 |
| | Age | -1.007 | .757 | -.163 | -1.423 | .160 |
| | Colored | 1.299 | 3.139 | 0.37 | .414 | .681 |
| | Height in Hands | 5.958 | 1.926 | .308 | 3.094 | .003 |
| | Time in Holding (Days) | -.002 | .003 | -.095 | -.710 | .481 |
| | Halter Training | 13.493 | 6.030 | .212 | 2.238 | .029 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Saddle Training | 59.868 | 8.773 | .610 | 6.824 | .000 |
| a. Dependent Variable: Number of Bids | | | | | | |

Table 5: *NumberofBids* Modified - Color Expanded

**Model Summary**

| | | | | | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | $R^2$ | Adjusted R Square | Std. Error of Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .795[a] | .632 | .496 | 12.223 | .632 | 4.645 | 17 | 46 | .000 |

a. Predictors: (Constant), Sorrel, Born on Range, Red Roan, Pinto, Grulla, Chestnut, Palomino, Halter Training, Saddle Training, Blue Roan, Height in Hands, Bay, Brown, Gender, Black, Age, Time in Holding (Days)

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 11797.548 | 17 | 693.973 | 4.645 | .000[b] |
| | Residual | 6872.062 | 46 | 149.393 | | |
| | Total | 18669.609 | 63 | | | |

a. Dependent Variable: Number of Bids
b. Predictors: (Constant), Sorrel, Born on Range, Red Roan, Pinto, Grulla, Chestnut, Palomino, Halter Training, Saddle Training, Blue Roan, Height in Hands, Bay, Brown, Gender, Black, Age, Time in Holding (Days)

**Coefficients[a]**

| | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | -75.801 | 29.223 | | -2.594 | .013 |
| | Born on Range | -1.886 | 4.750 | -.042 | -.397 | .693 |
| | Gender | 6.522 | 5.015 | .186 | 1.301 | .200 |
| | Age | -1.038 | .839 | -.157 | -1.238 | .222 |
| | Height in Hands | 6.301 | 2.253 | .326 | 2.797 | .008 |
| | Time in Holding (Days) | -.003 | .003 | -.130 | -.846 | .402 |
| | Halter Training | 13.140 | 6.726 | .206 | 1.954 | .057 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Saddle Training | 60.082 | 9.750 | .612 | 6.163 | .000 |
| | Bay | 1.116 | 5.646 | .024 | .198 | .844 |
| | Black | 2.441 | 5.252 | .056 | .465 | .644 |
| | Brown | -1.199 | 6.530 | -.022 | -.184 | .855 |
| | Blue Roan | 12.967 | 10.174 | .132 | 1.275 | .209 |
| | Chestnut | .803 | 12.742 | .006 | 0.63 | .950 |
| | Grulla | .115 | 13.668 | .001 | .008 | .993 |
| | Palomino | 5.055 | 7.235 | .072 | .699 | .488 |
| | Pinto | 11.395 | 12.837 | .083 | .888 | .379 |
| | Red Roan | 4.763 | 12.834 | .035 | .371 | .712 |
| | Sorrel | 2.718 | 5.354 | .060 | .508 | .614 |

a. Dependent Variable: Number of Bids

**Excluded Variables[a]**

| Model | | Beta In | T | Sig. | Partial Correlation | Collinearity Statistics Tolerance |
|---|---|---|---|---|---|---|
| 1 | Gray | [b] | | | | .000 |

a. Dependent Variable: Number of Bids
b. Predictors in the Model: (Constant), Sorrel, Born on Range, Red Roan, Pinto, Grulla, Chestnut, Palomino, Halter Training, Saddle Training, Blue Roan, Height in Hands, Bay, Brown, Gender, Black, Age, Time in Holding (Days)

Table 6: *NumberofBids* Best Fit Model

**Model Summary**

| | | | | | | Change Statistics | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | $R^2$ | Adjusted R Square | Std. Error of Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .795[a] | .632 | .632 | 11.848 | .632 | 6.000 | 14 | 49 | .000 |

a. Predictors: (Constant), Sorrel, Born on Range, Red Roan, Pinto, Palomino, Halter Training, Saddle Training, Blue Roan, Height in Hands, Black, Gender, Brown, Age, Time in Holding (Days)

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 11791.291 | 14 | 842.235 | 6.000 | .000[b] |
| | Residual | 6878.318 | 49 | 140.374 | | |
| | Total | 18669.609 | 63 | | | |

a. Dependent Variable: Number of Bids

b. Predictors: (Constant), Sorrel, Born on Range, Red Roan, Pinto, Palomino, Halter Training, Saddle Training, Blue Roan, Height in Hands, Black, Gender, Brown, Age, Time in Holding (Days)

**Coefficients[a]**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | -75.140 | 27.970 | | -2.594 | .010 |
| | Born on Range | -1.925 | 4.586 | -.043 | -.420 | .676 |
| | Gender | 6.680 | 4.800 | .191 | 1.392 | .170 |
| | Age | -1.070 | .798 | -.162 | -1.341 | .186 |
| | Height in Hands | 6.290 | 2.171 | .325 | 2.897 | .006 |
| | Time in Holding (Days) | -.003 | .003 | -.126 | -.888 | .379 |
| | Halter Training | 13.389 | 6.354 | .210 | 2.107 | .040 |
| | Saddle Training | 59.753 | 9.293 | .609 | 6.430 | .000 |
| | Black | 1.909 | 4.285 | .044 | .445 | .658 |
| | Brown | -1.745 | 5.673 | -.032 | -.308 | .760 |
| | Blue Roan | 12.339 | 9.206 | .126 | 1.340 | .186 |
| | Palomino | 4.627 | 6.644 | .066 | .696 | .489 |
| | Pinto | 10.948 | 12.242 | .079 | .894 | .376 |
| | Red Roan | 4.358 | 12.280 | .032 | .355 | .724 |
| | Sorrel | 2.206 | 4.409 | .049 | .500 | .619 |

a. Dependent Variable: Number of Bids

# APPENDIX C

## *FINALPRICES* REGRESSION AT 95% CONFIDENCE LEVEL

Table 7: *FinalPrices* Base Model Output

**Model Summary**

| | | | | | | Change Statistics | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | $R^2$ | Adjusted R Square | Std. Error of Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .918[a] | .842 | .813 | $88.31304 | .842 | 28.345 | 10 | 53 | .000 |

a. Predictors: (Constant), Number of Bids, Born on Range, Time in Holding (Days), Colored, Date of Sale, Halter Training, Height in Hands, Age, Saddle Training, Gender

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2210678.735 | 10 | 221067.873 | 28.345 | .000[b] |
| | Residual | 413357.203 | 53 | 7799.193 | | |
| | Total | 2624035.938 | 63 | | | |

a. Dependent Variable: Final Prices
b. Predictors: (Constant), Number of Bids, Born on Range, Time in Holding (Days), Colored, Date of Sale, Halter Training, Height in Hands, Age, Saddle Training, Gender

**Coefficients[a]**

| | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | 23534.898 | 48356.739 | | .487 | .628 |
| | Date of Sale | -1.696E-6 | .000 | -.031 | -.483 | .631 |
| | Born on Range | -41.314 | 33.384 | -.077 | -1.238 | .221 |
| | Gender | -15.575 | 34.937 | -.038 | -.446 | .658 |
| | Age | 1.435 | 5.930 | .018 | .242 | .810 |
| | Colored | 8.263 | 24.029 | .020 | .344 | .732 |
| | Height in Hands | -3.387 | 16.824 | -.015 | -.201 | .841 |
| | Time in Holding (Days) | .007 | .022 | .028 | .322 | .749 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Halter Training | -112.419 | 49.127 | -.149 | -2.288 | .026 |
| | Saddle Training | -80.591 | 93.165 | -.069 | -.865 | .391 |
| | Number of Bids | 11.795 | 1.030 | .995 | 11.451 | .000 |

b. Dependent Variable: Final Prices

Table 8: *FinalPrices* Output – Modified

**Model Summary**

| | | | | | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | $R^2$ | Adjusted R Square | Std. Error of Estimate | R Square Change | F Change | df 1 | df2 | Sig. F Change |
| 1 | .918[a] | .842 | .819 | $86.75116 | .842 | 36.709 | 8 | 55 | .000 |

b. Predictors: (Constant), Saddle Training, Colored, Halter Training, Born on Range, Date of Sale, Time in Holding (Days), Number of Bids, Gender

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2210118.918 | 8 | 276264.865 | 36.709 | .000[b] |
| | Residual | 413917.020 | 55 | 7525.764 | | |
| | Total | 2624035.938 | 63 | | | |

a. Dependent Variable: Final Prices
b. Predictors: (Constant), Saddle Training, Colored, Halter Training, Born on Range, Date of Sale, Time in Holding (Days), Number of Bids, Gender

**Coefficients[a]**

| | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | 20405.842 | 44941.274 | | .454 | .652 |
| | Number of Bids | 11.711 | .941 | .988 | 12.44 | .000 |
| | Halter Training | -115.395 | 46.783 | -.153 | -2.467 | .017 |
| | Date of Sale | -1.472E-6 | .000 | -.027 | -.451 | .654 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Time in Holding (Days) | .008 | .020 | .030 | .376 | .708 |
| | Born on Range | -39.776 | 31.071 | -.074 | -1.280 | .206 |
| | Gender | -14.111 | 33.847 | -.034 | -.417 | .678 |
| | Colored | 8.245 | 23.513 | .020 | .351 | .727 |
| | Saddle Training | -79.235 | 91.068 | -.068 | -.870 | .388 |
| a. Dependent Variable: Final Prices | | | | | | |

Table 9: *FinalPrices* Output - Two Variables

| **Model Summary** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Change Statistics | | |
| Model | R | $R^2$ | Adjusted R Square | Std. Error of Estimate | R Square Change | F Change | df1 | df2 |
| 1 | .911[a] | .830 | .825 | $85.44503 | .830 | 149.207 | 2 | 61 |
| a. Predictors: (Constant), Halter Training, Number of Bids | | | | | | | | |

| **ANOVA[a]** | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 2178683.904 | 2 | 1089341.952 | 149.207 | .000[b] |
| | Residual | 445352.034 | 61 | 7300.853 | | |
| | Total | 2624035.938 | 63 | | | |
| a. Dependent Variable: Final Prices<br>b. Predictors: (Constant), Halter Training, Number of Bids | | | | | | |

| **Coefficients[a]** | | | | | | |
|---|---|---|---|---|---|---|
| | | Unstandardized Coefficients | | Standardized Coefficients | | |
| Model | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | 125.185 | 12.321 | | 10.160 | .000 |
| | Number of Bids | 11.101 | .644 | .936 | 17.226 | .000 |
| | Halter Training | -119.174 | 41.014 | -.158 | -2.906 | .005 |
| a. Dependent Variable: Final Prices | | | | | | |

Table 10: *FinalPrices* – Best Fit Model – Colored Variable Expanded

**Model Summary**

| | | | | | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | $R^2$ | Adjusted R Square | Std. Error of Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .945[a] | .893 | .846 | $80.03010 | .893 | 19.247 | 19 | 44 | .000 |

b. Predictors: (Constant), Saddle Training, Red Roan, Pinto, Grulla, Chestnut, Blue Roan, Palomino, Halter Training, Brown, Sorrel, Born on Range, Bay, Height in Hands, Gender, Date of Sale, Black, Age, Number of Bids, Time in Holding (Days)

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2342223.990 | 19 | 123274.947 | 19.247 | .000[b] |
| | Residual | 281811.948 | 44 | 6404.817 | | |
| | Total | 2624035.938 | 63 | | | |

c. Dependent Variable: Final Prices

d. Predictors: (Constant), Saddle Training, Red Roan, Pinto, Grulla, Chestnut, Blue Roan, Palomino, Halter Training, Brown, Sorrel, Born on Range, Bay, Height in Hands, Gender, Date of Sale, Black, Age, Number of Bids, Time in Holding (Days)

**Coefficients[a]**

| | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| Model | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | 2826.885 | 47826.451 | | .059 | .953 |
| | Age | -.897 | 5.625 | -.011 | -.159 | .874 |
| | Height in Hands | 14.233 | 17.239 | .062 | .826 | .413 |
| | Date of Sale | -2.079E-7 | .000 | -.004 | -.060 | .952 |
| | Time in Holding (Days) | -.003 | .022 | -.010 | -.118 | .907 |
| | Number of Bids | 11.104 | .968 | .937 | 11.470 | .000 |
| | Born on Range | -29.973 | 31.811 | -.056 | -.942 | .351 |
| | Gender | -26.907 | 33.604 | -.065 | -.801 | .428 |
| | Bay | 6.004 | 36.999 | .011 | .162 | .872 |
| | Black | -8.842 | 34.598 | -.017 | -.256 | .799 |
| | Brown | 2.127 | 43.077 | .003 | .049 | .961 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Blue Roan | 270.785 | 68.450 | .233 | 3.956 | .000 |
| | Chestnut | -16.376 | 85.352 | -.010 | -.192 | .849 |
| | Grulla | 20.885 | 90.054 | .013 | .232 | .818 |
| | Palomino | -29.910 | 47.715 | -.036 | -.627 | .534 |
| | Pinto | 42.004 | 86.815 | .026 | .484 | .631 |
| | Red Roan | -72.702 | 85.220 | -.045 | -.853 | .398 |
| | Sorrel | 9.240 | 35.208 | .017 | .262 | .794 |
| | Halter Training | -111.613 | 46.588 | -.148 | -2.396 | .021 |
| | Saddle Training | -41.066 | 87.579 | -.035 | -.469 | .641 |

a. Dependent Variable: Final Prices

**Excluded Variables[a]**

| Model | | Beta In | t | Sig. |
|---|---|---|---|---|
| 1 | Gray | [b] | | |

a. Dependent Variable: Final Prices
b. Predictors in the Model: (Constant), Saddle Training, Red Roan, Pinto, Grulla, Chestnut, Blue Roan, Palomino, Halter Training, Brown, Sorrel, Born on Range, Bay, Height in Hands, Gender, Date of Sale, Black, Age, Number of Bids, Time in Holding (Days)

Table 11: *FinalPrices* Color Expanded - Three Variables

**Model Summary**

| | | | | | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | $R^2$ | Adjusted R Square | Std. Error of Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .939[a] | .881 | .875 | $72.04610 | .881 | 148.511 | 3 | 60 | .000 |

a. Predictors: (Constant), Halter Training, Blue Roan, Number of Bids

**ANOVA[a]**

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 2312597.480 | 3 | 770865.827 | 148.511 | .000[b] |
| | Residual | 311438.457 | 60 | 5190.641 | | |
| | Total | 2624035.938 | 63 | | | |

a. Dependent Variable: Final Prices
b. Predictors: (Constant), Halter Training, Blue Roan, Number of Bids

**Coefficients[a]**

| | Unstandardized Coefficients | Standardized Coefficients | |
|---|---|---|---|

| Model | | B | Std. Error | Beta | t | Sig. |
|---|---|---|---|---|---|---|
| 1 | (Constant) | 118.512 | 10.472 | | 11.317 | .000 |
| | Number of Bids | 10.822 | .546 | .913 | 19.814 | .000 |
| | Blue Roan | 264.606 | 52.095 | .227 | 5.079 | .000 |
| | Halter Training | -105.908 | 34.681 | -.140 | -3.054 | .003 |
| c. Dependent Variable: Final Prices | | | | | | |

# VITA

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Southern Illinois University Carbondale
Bachelor of Science, Agribusiness Economics, May 2018

Research Paper Title:
An Exploration of the Physical Qualities that Most affect the Number of Bids Received by Wild Horses Placed in BLM's Internet Auctions

Major Professor: Dr. Ira Altman