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A HEDONIC ANALYSIS OF THOROUGHBRED HORSES IN ONLINE AUCTIONS

MADALYNN CAMP

34 Pages

A horse's lifespan ranges from 20 to 30 years while a Thoroughbred racehorse's career averages just 4.45 years. According to the American Horse Council Foundation, 33% of the horses in the United States are involved in the racing industry. Upon retiring from racing, Thoroughbreds have the option of being kept as breeding stock or sold to equestrians in the non-racing sector to begin second careers. Retired Thoroughbred racehorses may prove to be a great investment for equestrians wanting an athletic horse for an affordable price and provide a second career track for these retired racehorses. This study aims to analyze what demand determinants effect the horse's sale price after additional training. Thoroughbreds can have many active years after retiring off of the track and can be a great investment for equestrians wanting an athletic horse for an affordable price. Results show that a horse's age, gender, color, discipline affiliation, and training impact the horse's listing price. The horse's age at the time of the auction was found statistically significant, increasing the horse's price \$430.50 for every additional year while the age variable squared was also significant but at a decreasing rate of \$22.94 for every additional year. Buyers purchasing on online auctions may consider a younger, possibly inexperienced horse worth more than an older horse. The discipline of trail was found to be statistically significant, decreasing the value of the horse \$1,599.46. Trail was compared to english general riding. This result shows that buyers may have preference to horses in more competitive disciplines. The horse's price increased \$1,967.33 with the affiliation of USEF

USHJA or USEA listed on their advertisement. This affiliation membership allows buyers to search for the horse's competition record. Buyers may put more value on these memberships as they know the horse has competed in nationally ranked competitions. Female horses, mares, were found to be valued \$924.08 less than castrated male horses, geldings. Lastly, the colors chestnut and gray roan were found to be valued more than bay, brown, or black colored horses. Chestnuts were valued \$1,071.07 more while gray roan horses were valued \$1,054.05 more than the bay, brown, or black colored horses. Bay, brown, and black colored horses are more common than chestnut, gray, and roan horses which makes this result not surprising. Results from this study can help educate the equine industry on valuable traits Thoroughbreds can have outside of the racing industry.

KEYWORDS: Equine; Thoroughbred Industry; Racehorse; Hedonic Price Analysis

A HEDONIC ANALYSIS OF THOROUGHBRED HORSES IN ONLINE AUCTIONS

MADALYNN CAMP

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Fulfillment of the Requirements
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A HEDONIC ANALYSIS OF THOROUGHBRED HORSES IN ONLINE AUCTIONS

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CHAPTER I: INTRODUCTION

In 2017, there were an estimated 7.2 million horses in the United States (AHCF, 2018). Approximately 34% of horses were involved in either the racing (17%) or showing (17%) industry (AHCF, 2018). The racing industry generated \$2,954,800,000 of revenue while the competition sector brought in \$1,148,200,000 of revenue (AHCF, 2018). The top three states with the greatest number of horses includes Texas (767,100), California (534,500), and Florida (387,100) (AHCF, 2018).

While a Thoroughbred racehorse's career averages approximately 4.5 years (Gramm & Marksteiner, 2010), horses can live into their 20's and 30's (Hoffman & Valencak, 2020). With racing careers lasting less than half of the horse's life, Thoroughbred owners must choose what to do with racehorses when they retire. Owners often choose between entering the horse into a breeding program or selling the horse to other non-racing homes or otherwise.

This study utilized Sport Horse Auctions, an online auction site that sells horses of all types including sport, prospect, and breeding (SportHorseAuctions, n.d.). A sport horse is a horse utilized in disciplines such as jumping, dressage, or eventing. Sport Horse Auctions, previously known as Professional Auction Services, has been in operation since 1978. As Professional Auction Services, they sold over 80,000 horses and ponies for a total of \$200,000,000 in both live and online auctions. In 2012, Sport Horse Auctions was formed and began providing an online marketplace for the sale of horses (SportHorseAuctions, n.d.). They have held over 90 internet auctions and sold 1,800 horses for over \$12,000,000 since 2012 (SportHorseAuctions, n.d.). Websites like this create a centralized location for buyers looking for a specific type of horse without having to travel to a live auction. Sellers also have the opportunity to access more

buyers for their horse at one time from wider geographical areas, hopefully resulting in a higher sale's price.

The purpose of this study is to provide demand determinant estimations for Thoroughbred horses in online auctions. Investigating demand determinants can show individuals within the equine industry there is value to specific desirable traits outside of the horse's racing careers. A hedonic model was developed to estimate the effects of demand determinants on the bid price of Thoroughbred horses. This research highlights the success Thoroughbreds can have outside of the racing industry.

CHAPTER II: BACKGROUND

The Jockey Club was formed in 1894 to provide supervision in the Thoroughbred racing industry and act as a centralized registration location for all Thoroughbred horses in the United States, Canada, and Puerto Rico (The Jockey Club C, n.d.). Between 2012 and 2021, the number of races held in North America were declining and averaged 37,841 races per year (The Jockey Club D, n.d.). During this time, the gross purses averaged \$1,096,010 per year on a declining trend until seeing an increase of \$38 million in 2018 (The Jockey Club B & D, n.d.). After 2018, there was year over year fluctuations in gross purses which were a 4.5% increase of gross purses in 2019, a 25.5% decrease in 2020, and a 35.8% increase in 2021 (The Jockey Club B, n.d.).

A Thoroughbred's racing career averages just 4.45 years (Gramm & Marksteiner, 2010). Upon completion of a horse's racing career, they may be entered into a breeding program. Stallions, uncastrated male horses, are evaluated on their racing record, conformation, and ancestry when determining if they will be utilized for breeding purposes (Merriam-Webster A, n.d., Steiner & Umphenour, 2009). In 2021, there were 1,181 active stallions registered with the Jockey Club and less than 20% were first year stallions (The Jockey Club E & F, n.d.). As 48.4% of active stallions have been at stud for five or more years, new incoming stallions have to compete with their offspring racing records (The Jockey Club E, n.d.). Evaluating a new stallion's potential cannot always be a quick task as their offspring do not start racing until they are at least 2 years old. When determining if a mare will breed to a specific stallion, genetic profiles are often compared, searching for compatibility (Bloodhorse, 2003). A breeder's goal when finding genetic compatibility in two breeding stock is to create a more successful offspring. Genetic compatible horses can increase a progeny's "performance levels, constitution, and physique" (Bloodhorse, 2003).

The number of Thoroughbreds being utilized for breeding purposes has been on the decline. As of September 1st, 2022, there were 27,700 broodmares, mares utilized for breeding purposes, bred in 2021, which was down 7.7% from 2019 while the number of stallions being bred decreased 21.1% from 2019 to 2021 (The Jockey Club H, 2022). In 2019, there were 19,086 foals registered with The Jockey Club while registrations in 2021 were estimated to be 17,840, a 6.5% decrease (The Jockey Club A, n.d.). This was lower than the yearly average of foals registered with The Jockey Club as between 2012 and 2021, averaging 20,327 foals (The Jockey Club A, n.d.). Between 2012 and 2021, there was an increase in registered foals between 2014 and 2015, but registrations continued to decrease through 2021. Stiroh studied the declining foal crop, the number of foals born, between 1990 and 2020 to determine the factors causing this decline (Voss, 2022). Stiroh reported between 1990 and 2019, there was a 53% decrease in foal crop along with a 56% decrease in individual breeders (Voss, 2022). Stiroh concluded the parimutuel handle, the betting system utilized in the racing industry, “followed nearly exactly the same trends as foal crop, in terms of timing and severity” (Voss, 2022). Between 2020 and 2021, there was an 11.8% increase in betting in the United States (The Jockey Club E, n.d.). If the trend in foal crop continues to follow the parimutuel handle like Dr. Stiroh’s findings, an increase in foal crop can result in an increase in Thoroughbreds needing homes.

In the past, horse slaughter used to be an option for retired Thoroughbreds. After World War II, horses that were not able to be utilized for riding or moving artillery were exported to European countries as a meat source (Stull, 2012). Some of these horses were slaughtered in the United States and Canada before being shipped to Europe, while some were also shipped live, resulting in high mortality rates due to poor transportation conditions (Stull, 2012). Legislation, passed in 1979 in the United States, prohibited live horses from being shipped internationally for

slaughter purposes (Stull, 2012). In the 1990s, horses began to be seen as companion animals which caused a shift in public perceptions leading to a change in slaughter practices (Stull, 2012). By 2006, federal funding to inspect slaughter facilities was eliminated, thus abolishing slaughter in the United States, and resulting in slaughter businesses relocating to Mexico (Stull, 2012). As a result, the number of horses exported to Mexico increased 312% between 2006 and 2007 (AVMA, 2008). In 2019, the American Veterinary Medical Association (AVMA) reported 53,947 horses of all breeds were sent to Mexico for slaughter, which is down 26% from 2018 (AVMA, 2020).

Thoroughbreds retiring from the racetrack who are not being used for breeding purposes or sent to slaughter facilities are often sold to individuals wanting to train them in a second riding discipline. A second career involves training a former racehorse in another discipline that is different from what they were trained in originally. These disciplines often include hunter, jumper, barrel racing, and eventing. Training or participating in non-racing disciplines gives Thoroughbreds the opportunity to have second careers and homes after retiring the racetrack. Depending on the horse, they could stay in their second discipline for the remainder of their life.

The Jockey Club has many organizations they endorse to encourage the adoption of retired racehorses with the possibility of participating in a second career. Thoroughbred Aftercare Alliance (T.A.A.), Thoroughbred Charities of America (T.C.A.), and Thoroughbred Incentive Program (T.I.P.) are just a few of the supported organizations (Jockey Club, n.d.). Thoroughbred Aftercare Alliance provides accreditation to organizations that retrain, rehome, or retire off the track Thoroughbreds (T.A.A., n.d.). The Thoroughbred Aftercare Alliance's accreditation process ensures the organization has proper operations, education, horse health care management, facility standards and services, and adoption policies and protocols (T.A.A., n.d.).

Thoroughbred Charities of America provides grants to non-profit organizations that fall into one of the following categories: Thoroughbred rehabilitation, repurposing, rehoming, and retirement program; Thoroughbred incentive programs; backstretch and farm employee programs; equine-assisted therapy programs that utilize Thoroughbreds; and equine research (T.C.A., n.d.).

The first 100 days after a horse retires from the track can impact their success in a second career (Vandergrift, n.d.). The horse's mental and physical condition should be evaluated as they could be experiencing gastric ulcers, injury, or confusion due to their new environment (Vandergrift, n.d.). These factors, along with evaluating the horse's hooves and feed can increase their comfort and hopefully their performance (Vandergrift, n.d.). Due to this recommended downtime after the track, organizations accredited through Thoroughbred Aftercare Alliance could provide this to increase success after adoption or purchase of the Thoroughbred.

Individuals interested in purchasing a Thoroughbred for a second career may want to enter in competitions at the local, regional, or national level. There are options for these Thoroughbreds to participate in competitions that are for Thoroughbreds only, such as the Thoroughbred Incentive Program (T.I.P.), or that are nationally ranked under the US Equestrian Federation (USEF). The USEF acts as the equestrian sport's national governing body (USEF, n.d.). Competing at USEF-recognized competitions provide an opportunity for prize money and year-end awards. Thoroughbred-only competitions such as T.I.P. were created for Thoroughbreds following their racing or breeding careers, with the goal to incentivize owners to retrain them in other disciplines (T.I.P., n.d.). Competitions are held across the country for riders to accumulate points with their Thoroughbreds to be eligible for the championships in disciplines such as hunter, jumper, dressage, and western (T.I.P., n.d.).

Buyers looking to purchase a horse may begin their search online or through personal networking within the equine industry. According to the U.S. Department of Commerce (2021), online shopping grew 32.4% between 2019 and 2020. As shopping online has increased, livestock sales on online platforms began emerging. Websites have been created to host online auctions to sell horses, but auctions are not the only way to sell a horse online. There are various websites such as BigEq, Equine, EquineNow, and social media outlets that allow sellers to advertise their horse for sale outside of an auction setting. These sites allow owners to advertise their horse at a set price. If an individual is interested in purchasing the horse, they can contact the seller to go see the horse in person and possibly ride it if both parties consent. The chance for the buyer to see the horse in-person is one of the main differences in selling in an online auction compared to in person. Another way individuals sell their horses is through their personal network. The owner, or possibly trainer, may have connections to others in the equine industry that may be interested in the horse they are selling. These sellers may reach out to other trainers or professionals in the industry to promote their horse for sale or inquire if they have a client looking to buy a horse such as the one they are selling.

Return rates of purchasing various products online was at least 30% while shopping in-person has an 8.89% return rate (Saleh, 2022). As purchasing products from online auctions does not allow shoppers to return products after purchase, buyers have an increased risk as they are unable to return the product. The same is true of horses purchased in an online auction. The elevated risk of shopping online could be reduced by including information within the horse's online advertisement. Since the buyers may be purchasing the horse without seeing it in person, the horses should be advertised appropriately for the buyer to make a purchasing decision. Buying a horse sight unseen does not give the buyers the opportunity to evaluate the horse's

characteristics in person or possibly ride the horse before making an offer. Pictures or videos can help the buyer evaluate the animal's confirmation and physical attributes. Price is also important when it comes to buying and selling online. In online auctions, there may be a reserve, or minimum bid, set on the horse; if the final bid does not meet or exceed that reserve amount, the horse may not sell. Reserves may not be visible to buyers on the horse's advertisement, so buyers are going to bid until they reach their maximum willingness to pay or are the final bidder, unsure if they will meet the reserve or not.

The factors affecting the price can change depending on the use of the animal. For example, Thoroughbred yearlings not only have their pedigree and conformation that can affect the price, but also body weight and wither height (Kentucky Equine Research, 2017). As yearlings may be purchased with the intent of racing, individuals buying a horse outside of racing may not find their pedigree and conformation to be as important when assessing the purchase price. Horses outside of racing may have other factors that affect the sale price such as age and the amount of training or experience the horse has which may influence the buyer's decisions (Melvin et. al., 2020).

CHAPTER III: LITERATURE REVIEW

Thoroughbred racing has been a part of United States history for decades, as it started in 1665 (Eisenberg, 2004). Numerous studies have been conducted pertaining to the Thoroughbred racing industry such as auction pricing, Thoroughbred breeding, and economic impacts of the industry. Despite the various studies on the Thoroughbred racing industry, minimal studies exist regarding Thoroughbreds upon completion of their racing careers.

Young Thoroughbreds may first be sold at auction as weanlings, a horse between 5 and 11 months of age. Auction prices of these weanlings were studied by Hansen and Stowe (2017). The authors discovered that buyers assess a weanling's value by evaluating pedigrees of the sire and dam to determine expected quality (Hansen and Stowe, 2017). Poerwanto and Stowe (2010) investigated yearling, a horse between one and two years old, prices in comparison to sire representation, how many horses were produced with the same father, at Thoroughbred sales (Merriam-Webster B, n.d.). The authors discovered the average price of the yearlings produced by a specific sire increased when that sire was represented through other yearlings at the sale (Poerwanto and Stowe, 2010). Young Thoroughbreds are valued by expected racing potential and pedigree. Therefore, as the Thoroughbred horses age or finish their racing careers, their valuation can be perceived differently.

Upon completion of their racing careers, the mares, female horses, may be sent to breeding facilities to begin reproducing future racehorses. As their purpose is to reproduce, additional factors other than their racing career statistics can be taken into consideration when determining a purchasing price. Stoeppel and Maynard (2006) investigated the price of broodmares in foal from the 2005 Keeneland November breeding stock sale. Of the 2,400 broodmares that sold at the sale, 409 were randomly selected and 298 of those were pregnant

(Stoeppel & Maynard, 2006). The price of the broodmares ranged from \$1,700 to \$3,700,000 while the average was \$170,000 (Stoeppel & Maynard, 2006). The authors concluded age, past foal earnings, the mare's total earnings, and the day they sold were significant. Age decreased the sale price by \$13,695.45 for each year increased in age on average, as that is one less year the mare can be bred (Stoeppel & Maynard, 2006). Past foal earnings above the mean increased the sales price by \$0.18, on average, for each additional dollar won as it showed potential for future offspring. The mare's total earnings increased the sales price by \$0.20, on average, for each additional dollar won, due to the expectation of their offspring inheriting some of those genetics (Stoeppel & Maynard, 2006). As young Thoroughbreds are valued on their racing potential, broodmares are valued on their offspring potential.

There is limited information regarding where the Thoroughbred goes upon completion of their racing career. If the horses are not sent to be bred or rehomed, these Thoroughbreds may be sent to adoption facilities. Some horses may be available for adoption or purchase immediately following their racing careers while others may require rehabilitation from career-related injuries. The average of Thoroughbred injuries per 1,000 starts between 2012 and 2020 was 1.7 (The Jockey Club, 2021). These injured horses need time to recover which can have an impact on the price and length of stay at adoption facilities, rehoming facilities, or on the track. Stowe and Kibler (2015) investigated what characteristics affect a retired Thoroughbred racehorses' length of stay at an adoption facility before adoption and the likelihood of the horse being returned to an adoption facility postadoption. Prior to adoption, soundness was the most important factor to the horse being adopted (Stowe and Kibler, 2015).

Nonprofit organizations are also available to help Thoroughbred's transition to new homes after their racing careers. In the United States, there are approximately 6,400 nonprofit

horse adoption organizations (GuideStar, n.d.). Of these nonprofits, over 50% are Thoroughbred specific organizations which includes affiliate organizations, organizations apart of a larger organization, and/or organizations with multiple facilities (GuideStar, n.d.). Nonprofit equine rescue organizations were studied by Holcomb et al. (2010) to learn about the unwanted U.S. horse population. Information pertaining to the relinquished equines, of all breeds, included health, training, behavior, factors contributing relinquishment, costs, rehabilitation needs, and rehoming procedures was collected from 144 U.S. nonprofit organizations (Holcomb et al., 2010). While many breeds were taken in by these organizations, more than 20% were Thoroughbreds (Holcomb et al., 2010). Of the organizations that participated in the study, information regarding 280 horses was collected. Only 73 out of 280 horses were rehomed and 43.8% of them were rehomed within 2 to 6 months of their arrival to the facility (Holcomb et al., 2010). Of the 73 rehomed horses, 33% had no adoption costs, 17.8% had a cost of under \$200, 35.6% were between \$200 and \$1,000, and 8.2% were between \$1,001 and \$5,000 (Holcomb et al., 2010). These findings can be important to individuals within the industry as nonprofit organizations are another avenue to purchase a horse inexpensively. Of the organizations surveyed, their maximum capacity was approximately 6,000 horses, which is significantly lower than the 100,000 estimated unwanted horses per year (Holcomb et al., 2010; Bump, 2008; Messer, 2008). Overall, these studies analyzed a small sample of the nonprofit organizations across the country as the current organizations registered with GuideStar is significantly more than the 144 studied by Holcomb et al. (2010) and the 70 organizations Kibler and Stowe (2015) identified as involving retired Thoroughbred horses. Further investigation should be completed to determine where the remainder of the unwanted horse population is going.

Determining the price of a horse is not like pricing other agricultural commodities. For example, unlike other livestock such as cattle or hogs, horses are not priced on live markets, or the Chicago Board of Trade. Private treaties are utilized predominantly in the equine industry, with sellers setting the price of the horse. Negotiations may occur between the parties as the buyer may have specific requirements they're looking for in a horse pertaining to "level of training, breed, age, sex, height, pedigree, success in showing or competitions, success of progeny, and color, among other factors" (Kibler & Thompson, 2020). Lange et al. (2010) and Taylor et al. (2006) studied auction prices and data from Texas ranch horses and show-quality quarter horses. Lange et al. (2010) concluded that color, order of sale, sex, age-sex interaction, and the ranch of origin affect the price of ranch horses in Texas. Taylor et al. (2006) found the factors impacting the sale price included genetic traits, age, color, and sex. The variables measuring a horse's performance positively affected the sale price which shows buyers appreciate horses with competition records (Taylor et al., 2006). While some of the favorable characteristics between the two studies are similar, the differences show the intended use of the horse can affect what characteristics the buyers are looking for.

Kibler and Thompson (2020) investigated buyer preferences for nonracing stock-type horses sold through online public auctions. Utilizing a hedonic pricing model, the authors were able to determine what characteristics affected the horse's sale price the most (2020). Gray and sorrel horses were found to be valued lower than bay horses (Kibler and Thompson, 2020). Mares and fillies were sold for more than stallions while geldings were not found to be statistically significant in comparison to stallions (Kibler and Thompson, 2020). Lastly, marketing advertisement including lines of notes and videos were found to be statistically significant, meaning these factors affected the buyer's decision to place a bid. Additional lines of

notes (minimum 0 for sire and dam) increased the chance of the horse selling along with the horse's sales price increasing by 3.4% for each additional line of notes and the number of videos increased the price 10.8% for each additional video posted (Kibler and Thompson, 2020).

Through these studies, data has been analyzed pertaining to the Thoroughbred racing industry. Studies have also been completed investigating online equine auctions, not specific to Thoroughbreds. Additional studies should be completed relating to Thoroughbreds after their racing careers and where they end up. This data could be useful to not only show how many Thoroughbreds are staying in the racing industry for breeding, but also show Thoroughbreds have potential to be retrained upon completion of their racing careers.

CHAPTER IV: METHODOLOGY

The data for this study was collected by students at the University of Tennessee under the guidance of Dr. Jada Thompson and Dr. Jennie Ivey. Data on 2,433 horses, of all breeds, from 47 online horse auctions were collected. As this study pertains to specifically Thoroughbred horses, horses of other breeds were not utilized in the analysis. This resulted in 245 Thoroughbreds, collected from 39 online auctions (Sport Horse Auctions), between 2012 through 2020, were analyzed. The total number of auctions decreased from 47 to 39 due to Thoroughbreds not being in 8 of the auctions. The total number of horses used in the analysis decreased to 170 due to missing information; 57 did not have a bid price, 11 did not have a height listed, 4 were from Canada, 1 did not have a location listed, and 2 displayed a color of palomino, which was not utilized in this study.

Table 1 includes descriptions of variables utilized in this study and Table 2 provides summary statistics for each variable. The *Auction Year* ranged from 2012 to 2020 and allows for market changes to be considered in the analysis. The horse's age in years at the time of auction was accounted for with *Age When Auctioned* and *Age When Auctioned*². *Age When Auctioned*² can provide information regarding the decrease of the horse's bid price as the useful life of the horse decreases. The youngest horse in the study was 1 year old while the oldest was 20 years old with an average age of 8.64 years. Horses 3 years old or younger made up 5.9% of the study, while 45.9% of the horses ranged between 4 and 8 years old and 48.2% were 9 years old or older. Physical characteristics of the horse include sex, color, and size. The binary variable of the horse's sex is accounted through *Gelding*, a castrated male horse, and *Mare*, a female horse. The majority of the horses were *Mare* (62.9%) while less than half of the horses were *Gelding* (37.1%). Color is analyzed through three different colors, *Bay/Brown/Black*, *Chestnut*,

Gray/Roan as these are colors the Jockey Club recognizes. The *Gray/Roan* horses accounted for the least number of horses at 12.4%, *Chestnut* followed accounting for 25.9% of the horses, while *Bay/Brown/Black* account for 61.8% of the horses. In regard to sex and color, *Gelding* and *Bay/Brown/Black* were utilized as the base variables. Size was analyzed in centimeters and ranged from 147.32 cm to 180.34 cm (average of 164.48 cm).

Information presented through the sale advertisement of the horse is an important component for sellers in online auctions. Online auctions may not give the buyers the opportunities to see the horse in person, though sellers overcome this through providing images, video, and detailed information of the horse. Images include *Non-Action Shot*, showing the horse's conformation through front, back, side, and hoof pictures, and *Action Shot*, showing the horse moving or working. Over 70% of the sample were listed with Non-Action Shot (range 1 to 11). *Action Shots* were in 82.4% of the horses listing with the most being 6 in one listing. *Videos* were included in 90.6% of the listings with some having as many as 4 videos. *Videos* can show a horse's movement and abilities where individuals can also assess their conformation. All of the horses in the study had at least one picture while 9% of the horses did not have a video displayed. A horse's conformation can be analyzed through "balance, structural correctness, way of going, muscling, and breed/sex characteristics" (Duberstein, 2012). All these criteria may be analyzed through a horse's video, while imaging can easily provide information regarding structural correctness and muscling. Additional information pertaining to the horse can be provided through *Notes*. *Notes* were analyzed through the number of lines in the section which could include information such as racing history, show experience, athletic capabilities, or demeanor. All horses had at least three lines of notes while the maximum was 72 lines.

Additional information that could be beneficial to the buyer could include *Pre-Sale Vet Information, Jockey Club Registration, USEF/USHJA/USEA Membership, Health Concerns*, and discipline (*Dressage, Jumper, Hunter Under Saddle, Trail, and English General Riding*). *Pre-Sale Vet Information* informs the buyer on information provided from a veterinarian. This information could include details on the horse's general health along with the soundness (Mansmann, 2019). Information provided from a veterinarian can help inform the buyer of any present or past issues the horse has faced to be better prepared to manage the horse once purchased. Only 15.9% of the horses provided any *Pre-Sale Vet Information. Jockey Club Registration* and *USEF/USHJA/USEA Membership* inform the buyer if the horse is a part of these organizations. While the horses could still be a part of these organizations if the seller did not include it in the listing, 34.7% horses were listed to be registered with The Jockey Club and 10% were listed to have a *USEF/USHJA/USEA Membership*. USEA (United States Eventing Association) and USHJA (United States Hunter Jumper Association) are discipline specific organizations that fall under USEF. Any negative information pertaining to the horse's health was represented in *Health Concerns*. Data within this variable includes any major surgeries, past lameness, other defects, abnormalities, or blemishes, along with if they crib or weave in their stall or paddock. *Health Concerns* were listed on 33.5% of the horses. Information regarding the specific discipline the horse was a prospect for or already trained in, was defined under the specific disciplines of *Dressage, Jumper, Hunter Under Saddle, Trail, and English General Riding*. The discipline with the greatest number of horses listed to have experience or potential was *Jumper* (37.1%). Horses listed in the other disciplines included *Hunter Under Saddle* (31.8%), *Trail* (25.3%), *Dressage* (24.7%), and *English General Riding* (19.4%).

The hedonic pricing model has been utilized in many studies involving the equine industry. Within the Thoroughbred industry, Hansen and Stowe (2017) determined the impact of Thoroughbred weanling characteristics on price when sold at auction, Neibergs (2001) investigated the demand characteristics of broodmares, Stoeppel and Maynard (2006) looked specifically at Thoroughbred broodmares in foal and how their characteristics affected their auction price, and Stowe and Kibler (2015) investigated characteristics of Thoroughbred racehorses adopted from nonprofit organizations. Studies pertaining to non-Thoroughbreds at auction include Kibler and Thompson's (2020) analysis of the price of stock-type horses and Taylor et al. (2006) determining the price determinants of show quality quarter horses.

A hedonic model is utilized when estimating the value of characteristics affecting the price of a good. This model will be used in this study to analyze what characteristics have the most impact on the horse's bid price. Results from a hedonic model will help inform horse buyers what the value of individual traits are. The model pertaining to this study is as follows:

$$\begin{aligned} \text{Bid} = & \alpha + \beta_1 \text{AuctionYear} + \beta_2 \text{AgeWhenAuctioned} + \beta_3 (\text{Age When Auctioned})^2 + \\ & \beta_4 \text{Mare} + \beta_5 \text{Chestnut} + \beta_6 \text{GrayRoan} + \beta_7 \text{Sizeincm} + \beta_8 \text{NonActionShot} + \\ & \beta_9 \text{ActionShot} + \beta_{10} \text{Videos} + \beta_{11} \text{TheJockeyClub} + \beta_{12} \text{UsefUshjaUsea} + \\ & \beta_{13} \text{PreSaleVetInfoProvided} + \beta_{14} \text{NotesofLines} + \beta_{14} \text{HealthConcern} + \\ & \beta_{15} \text{Dressage} + \beta_{16} \text{Jumper} + \beta_{17} \text{HunterUnderSaddle} + \beta_{18} \text{Trail} + \beta_{19} \text{cons} + \varepsilon, \end{aligned}$$

where *Bid* is the bid price of the horse by the buyer. The variables include alpha (α), beta (β_x), and epsilon (ε). Alpha is utilized as the intercept term while beta represents the Thoroughbred attribute coefficient and epsilon is the error term.

Analyzing the dependent variable, the horse's *Bid Price*, can provide information on the valuation of the horse according to the buyer, not the seller. As there were some horses that did

not sell, an assumption could be made that the seller valued the horse more than the buyer.

Independent variables of this model include the year of auction, age when auctioned, physical characteristics, advertisement marketing, veterinary information, Jockey Club registration, USEF, USHJA, or USEA registration, length of description, and discipline.

CHAPTER V: RESULTS

Results are presented in Table 3 and were calculated utilizing Stata, a statistical data software. The results conclude 6 out of the 18 variables were statistically significant. For a variable to be statistically significant, they must be found to have an impact on the bid price when all else is equal. The age of the horse when auctioned was found statistically significant at the 1% level and positive. For every year increased in age, the value of the horse increased \$430.50. When the age variable was squared, it was also found significant but at a decreasing rate of \$22.94 per squared year of age. This accounts for every year the horse's age increases, there will be a turning point, or an age where they don't have as much potential, and the horse's age will begin to decrease their price. This shows buyers purchasing on online auctions consider a younger, possibly inexperienced horse to be worth more than an older horse. This result supports the fact that the horse's age can affect the horse's price depending on the use of the horse. Age negatively affected the price of broodmares in Stoeppel & Maynard's (2006) study as the horse increased in age, the amount of time the horse could be bred would decrease.

Physical characteristics of the horse including gender and color were significant at the 5% and 10% level, respectively, while size was not. Mares were found to be valued, on average, \$924.08 less than geldings. Chestnut and gray, or roan, horses were valued \$1,071.07 and \$1,054.05 more than bay, brown, or black horses, respectively. This result is not surprising as chestnut and gray or roan horses are not as common as bay, brown, or black horses. In this study, approximately 26% of the horses were chestnut and 12% of the horses were gray or roan, making up less than half of the total sample. The significance of color is also shown through other studies including Lange et al. (2010), Taylor et al. (2006), and Kibler and Thompson (2020). The results from Kibler and Thompson (2020) regarding color were not consistent with the findings

from this study. Kibler and Thompson (2020) found gray horses to be valued less than bay horses in their nonracing, stock-type horse study. The findings from this study imply that color preference can change across different breeds and disciplines.

Advertisement through imaging, videos, or notes was not found to be statistically significant. This was not expected as buyers utilize this information to look at a horse's conformation or athletic ability. A previous study by Kibler and Thompson (2020) found the following variables significant: lines of notes, back pictures, side pictures, action shot, and videos. The result from this study could imply these types of advertising information are required when selling on these online auctions.

Registration memberships to The Jockey Club and USEF/USHJA/USEA help inform owners of the horse's current or past experience. A horse being registered to The Jockey Club was not found significant, suggesting buyers do not place value on the horse's past career experience. Membership to USEF, USHJA, or USEA was found significant at the 5% level and added a value of \$1,967.33 to the bid price. Taylor et al. (2006) also found that buyers appreciate horses with a competition record as their performance positively affected the sales price. Buyers wanting a horse with past show experience may place more value on this registration as they would be able to look up past competition experience along with how the horse placed.

Information pertaining to the horse's health was accounted for in *Pre-Sale Vet Information Provided* and *Health Concern*. These variables were found to be not significant. When a seller discloses this type of information, a buyer not only knows information pertaining to the horse's health, but they are able to make the decision on if they are willing to take on the financial responsibility of that horse's health concern, if any. Only 16% of the horses included *Pre-Sale Vet Information* and 34% included indication of a *Health Concern*. Stowe and Kibler

(2015) determined that soundness was the most important factor to the horse being adopted. While soundness was not a factor in this study, information pertaining to it could have been included in any information provided by a veterinarian. The non-significance of these variables could be related to the lack of horses with this information or the buyer's willingness to take on the financial burden these health problems may entail. Also, due to the combination of all health concerns into one variable, results may have been impacted due to the possibility of buyers having different health concern preferences. Combining all health concerns together was due to low response rate for individual concerns.

The type of disciplines the horses were either trained in or prospects for included dressage, jumper, hunter under saddle, trail, and English general riding. When compared to *English General Riding*, trail was the only variable found to be significant at the 1% level. Horses with *Trail* listed were valued \$1,599.46 less than *English General Riding horses*. This result could suggest the bidders on these auction sites were looking for more of a competition horse. The variation in price could also show the difference in value of horses in the two disciplines.

CHAPTER VI: CONCLUSION

As Thoroughbred's racing careers are short compared to their life expectancy, these horses have plenty of useful value left in them. Determining significant demand determinants of Thoroughbred horses at auction educates individuals within the equine industry what characteristics are most valuable when they are shopping for or selling a horse. Horses are considered a luxury good, so increasing the buyer's knowledge on this information can decrease their risk.

While other factors could be considered important to individual buyers, this study concluded age, gender, color, registration, and discipline to be significant determinants of the bid price. Buyers from auctions were found to pay a premium for geldings over mares. The colors of chestnut and gray or roan brought in a higher bid than bay, brown, or black horses. While registration for The Jockey Club did not affect the bid price, registration within USEF, USHJA, or USEA was found to bring in a premium bid, suggesting buyers will pay more for Thoroughbreds who have second career show experience. Lastly, horses with experience or potential in *Trial* were found to be valued less than horses with experience or potential in *English General Riding*, suggesting auction site bidders could be searching for a more competitive horse.

Limitations to this study include the total number of Thoroughbreds utilized for the study. As the auctions were not specific to Thoroughbreds, the total number of horses collected was reduced significantly due to this breed requirement. Investigating Thoroughbred only sales may offer further insight into the value of the breed. Another limitation was the wide spread of ages of the horses. The wide age range deterred the study from investigating specifically horses just coming out of their racing careers or horses who had successfully transitioned into second careers. As the study included both horses that were trained and untrained, further investigation

of each group separately can allow for comparison in pricing. This comparison can help inform individuals in the equine industry of the value of training Thoroughbreds after their racing careers.

Due to the nature of the equine industry buying and selling horses with private treaties, analyzing online auctions provides great insight to how buyers and sellers value a horse. Investigating Thoroughbred horses specifically allows buyers to gain insight on the value of these horses after completion of a racing career. This research could also benefit the sellers of these horses as they will have a better understanding of how to price their horse according to such characteristics.

Additional research should be completed on the valuation of Thoroughbred horses to educate buyers on the increase in value of training a retired racehorse in a second career. Research should also be conducted on where Thoroughbred racehorses go upon completion of their careers. This research would help educate not only the racing industry, but also individuals within the equine industry to understand the various purposes Thoroughbreds can be used for after their racing careers.

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TABLES

Table 1 - Descriptions of Variables Utilized in the Hedonic Model of Thoroughbred Horses

Variable	Definitions
<i>Bid Price</i>	The highest bid the horse received
<i>Auction Year</i>	The year the horse was listed for Auction
<i>Age When Auctioned</i>	Age of horse in years when auctioned
<i>Gelding</i>	=1 if horse is a gelding
<i>Mare</i>	=1 if horse is a mare
<i>Bay/Brown/Black</i>	=1 if horse color was listed bay or black
<i>Chestnut</i>	=1 if horse color was listed chestnut
<i>Gray/Roan</i>	=1 if horse color was listed gray or roan
<i>Size (in cm)</i>	Height in centimeters
<i>Non-Action Shot</i>	Count of non-action pictures ¹ of the horse
<i>Action Shot</i>	Count of action pictures of the horse
<i>Videos</i>	Count of videos of the horse
<i>Pre-Sale Vet Information</i>	=1 if pre-sale veterinary information was available
<i>Jockey Club Registration</i>	=1 if the horse was advertised as being Jockey Club Registered
<i>USEF/USHJA/USEA Membership</i>	=1 if the horse was advertised as having a USEF/USHJA/USEA Membership
<i>Notes</i>	Count of lines in note section
<i>Health Concerns</i>	=1 if the horse had any health concerns ²
<i>Dressage</i>	=1 if the horse participated or was a prospect for dressage
<i>Jumper</i>	=1 if the horse participated or was a prospect for jumper
(Table Continues)	

Table 1, Continued

Variable	Definitions
<i>Hunter Under Saddle</i>	=1 if the horse participated or was a prospect for hunter under saddle
<i>Trail</i>	=1 if the horse participated or was a prospect for trail
<i>English General Riding</i>	=1 if the horse participated or was a prospect for english general riding

1. Includes if the horse was advertised with a front, back, or side picture

2. Includes Major Surgery, Past Lameness, Other defects/abnormalities/blemishes, and Cribber/Weaver

Table 2 – Summary Statistics of Thoroughbred Online Auction Data

Variable Name	N	Mean	Standard Deviation	Min	Max
Bid Price	170	\$2439.12	\$2726.45	\$100.00	\$20,000.00
Auction Year	170	2016.65	2.28	2012	2020
Age When Auctioned	170	8.64	3.68	1	20
Gender					
Gelding	63	0.37	0.48	0	1
Mare	107	0.63	0.48	0	1
Color					
Bay/Brown/Black	105	0.62	0.49	0	1
Chestnut	44	0.26	0.44	0	1
Gray/Roan	21	0.12	0.33	0	1
Size (in cm)	170	164.78	5.47	147.32	180.34
Imaging					
Non-Action Shot	120	1.96	1.71	0	11
Action Shot	140	0.82	0.38	0	6
Video	154	1.82	1.14	0	4
Pre-Sale Vet Information	27	0.16	0.37	0	1
Jockey Club Registration	59	0.35	0.48	0	1
USEF/USHJA/USEA Membership	17	0.10	0.30	0	1
Notes (# of lines)	170	16.62	11.63	3	72
Health Concern	57	0.34	0.47	0	1
Type of Discipline					
(Table Continues)					

Table 2, Continued

Variable Name	N	Mean	Standard Deviation	Min	Max
Dressage	42	0.25	0.43	0	1
Jumper	63	0.37	0.48	0	1
Hunter Under Saddle	54	0.32	0.47	0	1
Trail	43	0.25	0.44	0	1
English General Riding	33	0.19	0.40	0	1

Table 3 – Coefficients, Standard Error, and Marginal Values of Thoroughbred Characteristics from Online Auctions

Variable Name	Coefficient Estimates	Standard Error	95% Confidence Interval	
<i>Auction Year</i>	31.53	(107.05)	-179.99	243.05
<i>Age When Auctioned</i>	430.50*	(158.69)	116.95	744.05
<i>Age When Auctioned²</i>	-22.94*	(6.74)	-36.25	-9.63
<i>Mare</i>	-924.08**	(427.84)	-1769.45	-78.70
<i>Chestnut</i>	1071.07***	(555.28)	-26.11	2168.25
<i>Gray Roan</i>	1054.05***	(536.41)	-5.84	2113.94
<i>Size in cm</i>	10.59	(28.93)	-46.57	67.75
<i>Non-Action Shot</i>	-187.58	(124.83)	-434.22	59.06
<i>Action Shot</i>	-17.70	(112.40)	-239.79	204.40
<i>Videos</i>	207.86	(177.81)	-143.47	559.20
<i>The Jockey Club</i>	-356.36	(425.98)	-1198.05	485.34
<i>USEF USHJA USEA</i>	1967.33**	(820.24)	346.61	3588.05
<i>Pre-Sale Vet Info Provided</i>	811.19	(779.98)	-729.98	2352.37
<i>Notes (# of lines)</i>	14.49	(22.30)	-29.58	58.56
<i>Health Concern</i>	-182.39	(537.39)	-1244.22	879.45
<i>Dressage</i>	300.82	(740.88)	-1163.09	1764.74
<i>Jumper</i>	1105.74	(703.87)	-285.05	2496.52
<i>Hunter Under Saddle</i>	229.83	(463.89)	-686.78	1146.43
<i>Trail</i>	-1599.46*	(604.58)	-2794.05	-404.86

(Table Continues)

Table 3, Continued

<i>Number of Observations</i>	170
<i>F(19,150)</i>	2.53
<i>Prob > F</i>	0.0010
<i>R-squared</i>	0.2548
<i>Root MSE</i>	2498.3

Note: Significance at the 1%, 5%, and 10% levels are indicated by *, **, and ***, respectively