The Price of Disclosure in the Thoroughbred Yearling Market

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In this article, we examine disclosure as a tool to mitigate the effects of asymmetric information in a Thoroughbred yearling market. If disclosures influence market price, information contained therein must be valuable to buyers and hence diminish asymmetric information. Using public auction data, we find that disclosures do not influence price in a segment of the auction in which an implicit quality certification is available. However, in the other segment, we find evidence that some disclosures may provide valuable information to buyers.

Key Words: asymmetric information, mandatory disclosure, voluntary disclosure, Thoroughbred industry, auction, disclosure

JEL Classifications: Q13, D82, L82

In the famous article by Akerlof (1970), the author shows that in markets in which the true quality of a good is known only to the seller, markets may cease to exist if there is no way for buyers to discern true quality. To maintain trade between buyers and sellers, buyers must have some means of discovering information regarding product quality. The two primary means of discovering information are signaling, initially proposed by Spence (1973), and screening, attributed to Stiglitz (1975). In the signaling literature, sellers can be identified by type, and seller type is a signal of product quality; as a result, there are price differentials according to seller types. In the screening literature, buyers (i.e., employers) offer a menu of contracts to sellers (i.e., workers) in which workers self-select according to their type.

An example of a signaling mechanism is disclosure of information by sellers. Sellers may disclose information of their own accord (voluntary disclosure) or they may be required to disclose certain information by market regulators (mandatory disclosure). In general, it seems reasonable that producers would voluntarily disclose aspects of their product to signal high quality. Jovanovic (1982) suggests that the threat of litigation and loss of business provide incentives for sellers to voluntarily and truthfully disclose all information, positive or negative. However, mandatory disclosure remains prevalent in many markets: most food products include a standardized nutrition label providing information on serving size, calories, and fat; appliances must include labels informing consumers about the energy use of the appliance; and the octane of gasoline must be posted on gas pumps. To facilitate trade between buyers and sellers, the information disclosed should have value for the buyer, which suggests that disclosures should increase the

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amount of trade and/or affect market price (Kiesel, McCluskey, and Villas-Boas, 2011).

Mandatory disclosure laws also exist in the market for Thoroughbred yearlings sold in public auctions.[1] These disclosure laws pertain to conditions, which may adversely affect the horse's future racing and/or breeding career. One benefit of analyzing disclosures in this market is that the type of data available allows us to investigate the latter influence identified by Kiesel, McCluskey, and Villas-Boas (2011). More specifically, we test the proposition that disclosures diminish asymmetric information by influencing market prices.

Thoroughbred yearlings are frequently sold at public auctions across the world, and each auction house may have their own requirements regarding which conditions must be disclosed before the sale of a yearling. Sellers also may voluntarily disclose any other information they deem pertinent. The largest seller of Thoroughbred horses in the world, Keeneland Association, Inc., instituted mandatory disclosure practices in 1997. Through the use of mandatory disclosure policies, the company requires that certain problems, which may potentially affect a horse's racing or subsequent breeding career, be disclosed before the date the horse is sold. All disclosures, both mandatory and voluntary, are available for viewing in the veterinary repository. Prospective buyers (or their agents) hire licensed veterinarians to enter the repository and review available information on yearlings in which they are interested.[2] Veterinarians relay this information to the prospective buyer (or their agents), and then buyers incorporate this information into their bidding strategies.

Analyzing the impact of disclosures on market price through the lens of the Thoroughbred yearling auction market contributes to two distinct areas of literature. First, it advances the literature examining the determinants of prices in the market for Thoroughbred yearlings. Among the handful of articles that have studied this issue, there is some consensus on determinants of prices. Pedigree-related variables such as sire quality (the sire is the father of the yearling, and sire quality is best measured by stud fee) and dam quality (the dam is the mother of the yearling, and dam quality is measured by own racetrack performance as well as progeny racetrack performance) are consistently significant. Individual-specific characteristics such as gender (when gender matters, colts sell for higher average prices than fillies) and age (the evidence here is mixed, although one might expect that older individuals would be more expensive because they will be relatively more mature by the time of the sale) have also been widely studied. Finally, sale characteristics matter such as placement in the sale (yearlings sold earlier in the sale generally command a premium). The most relevant existing published studies are identified in Table 1; included are the variables being studied and sign of the effect when significant.

A few articles also examine different methods of mitigating asymmetric information in the market for Thoroughbred yearlings. Chezum and Wimmer (1997) illustrate that variation in seller characteristics as they relate to racing intensity influences price. More closely related to our study, however, is Wimmer and Chezum (2003). In this article, the authors investigate the role of quality certification in mitigating the type of adverse selection identified in Chezum and Wimmer (1997). More specifically, they suggest that the physical inspection required of all "select" individuals serves as part of a certification mechanism in which yearlings are implicitly certified as meeting Keeneland's quality standards for inclusion in the select part of the sale. Their results suggest that seller characteristics do not influence price in the select (certified) sales, whereas adverse selection is still present in nonselect (noncertified) sales. Moreover, the authors suggest that it is in the auction house's best interest to provide a certification service,

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[1] Yearlings are 1-year-old horses; all Thoroughbreds are officially yearlings on January 1 after the year of their birth. Thoroughbreds often begin their racing careers when they turn 2 years old; so for many horses, this is their last prerace sale.

[2] According to two veterinary clinics near the auction house, the veterinarian would examine the existing radiographs housed in the repository at a cost of approximately $105.

Table 1. Summarized Results from Related Papers

	Commer (1991)	Buzby and Jessup (1994)	Chezum and Wimmer (1997)	Vickner and Koch (2001)	Robbins and Kennedy (2001)	Wimmer and Chezum (2003)	Parsons and Smith (2008)
Sire stud fee		+	+	+	+		+
Sire racing history	N/S	N/S				N/S	
Sire black type progeny	+						
Sire progeny earnings	N/S					+	
Sire no. of progeny in sale	N/S			N/S			N/S
Sire no. of progeny wins							
Sire no. of foals in crop						+	
Sire freshman/juvenile			+	N/S			+
Prior successful "nicks"			+	N/S			
Dam black type	N/S	+			N/S	+	N/S
Dam racing performance	+		N/S	+	+		N/S
Dam no. of winners	N/S						
Dam black-type progeny	+		+	N/S	+	+	+
Dam progeny earnings					+		
Dam extended family black type	+		N/S	N/S	+		+
Dam age/no. of foals			N/S	N/S		–	+
Colt	+	N/S	+	–	+	+	+
Age of yearling	+	–	+		+	N/S	+
Stakes nominations	+				+		+
Select portion of sale	+			+	+	+	
Classic distance pedigree			+	N/S		+	
State-bred	+	N/S	–	N/S			
Number of repository visits				+			
Consignor size				N/S		N/S	
Breeder racing intensity			–	N/S			
Dispersal sale		N/S					
Dependent variable	Sold price	Sold ln(price)	Hammer ln(price)	Hammer ln(price)	Sold ln(price)	Sold ln(price)	Sold ln(price)
R^2	0.3942	0.2569[a]	0.5565[b]	0.716[c]	0.37[d]	0.42 noncertified/ 0.46 certified	0.62[e]

[a] From Regression 3.

[b] From Model 1.

[c] From Model 1.

[d] From Model A.

[e] From Model 4.

N/S, variable was included but was not significant.

because the auction house also benefits from mitigating adverse selection.

Our model includes nearly all explanatory variables, which have previously been identified as being significant; to this, we add variables related to the presence or absence of disclosures. Until now, pre-existing health conditions that may influence the price buyers are willing to pay for a yearling, or whether they are willing to buy at all, have been treated as unobservable by the econometrician. The omission of these variables, however, suggests that estimates from previous studies may be biased.

Second, although an important topic, the role of disclosure in markets with imperfect information has been underexplored empirically, and our article contributes to this area of research. Kiesel, McCluskey, and Villas-Boas (2011) provide a review of the literature on nutritional labeling and its effect on consumer choices. Most relevant to our study, the authors discuss the limited literature in which field data are used in empirically investigating the relationship between consumer behavior and nutritional labels. Of these studies, the most closely related article is Mathios (2000), which analyzes the role of voluntary and mandatory disclosure in the market for salad dressings using scanner data. The author finds that companies voluntarily disclose information only when it is beneficial to them. However, mandatory disclosure of fat and calorie content leads to a significant decrease in sales and profits of high-fat salad dressings. Kiesel, Buschena, and Smith (2005) analyze the effects of voluntary labeling on the demand for milk without a genetically modified growth hormone; they find that voluntary labeling increased the demand for hormone-free milk. In addition, the authors find that demand for voluntary labeling may have increased over time. Of course, these results will depend on the degree to which consumers have confidence in the information disclosed (see Nayga, 2000). Finally, in the context of financial trades, both Bagnoli and Lipman (1996) and Mikkelson and Ruback (1985) provide evidence that disclosure of information affects prices. Fishman and Hagerty (1995) show that disclosure of trades by insiders, called informed individuals, may actually increase insiders' expected profits.

The research presented in this article has implications for other markets as well. For example, consider the market for used cars, in which information asymmetry is well established. Commercial services are available for interested consumers; these services function similarly to the veterinary repository by providing a detailed history of an automobile. For example, one commercial web-based service provides detailed vehicle history reports based on an automobile's vehicle identification number (VIN) and charges a fee to those wishing to use their service.[3] Customers receive information that helps them determine the true value of the car. Another relevant market is the market for previously owned homes. In this market, before sale, sellers must disclose a variety of common problems along with major issues, including the use of lead paint and the presence of mold. With detailed data on disclosures in both of these markets, one could use the methodology in this article to determine the average market price of reported characteristics, ultimately aiding buyers in negotiating the purchase of a used car or previously owned home.

As is seen in previous research, mandatory and voluntary disclosures impact the seller differently. Kiesel, Buschena, and Smith (2005) and Mathios (2000) find voluntary disclosure is related to increases in demand and/or profit. On the other hand, Mathios (2000) finds that mandatory disclosure decreases sales and profits. We anticipate a similar divergence in results in the market for Thoroughbred yearlings. Because conditions required to be disclosed before sale have the potential to adversely affect the future racing and/or breeding career of a yearling, we expect mandatory disclosures to

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[3] According to the company's web site, each report checks for the following: major accident; mileage rollback; multiple owners; frame damage; lease, personal, taxi, or police use; total loss; rebuilt; flood damage; airbag deployment; mileage rollover; salvaged; hail damage; branded a lemon; last reported mileage; junked; state-owned; length of ownership; estimated miles driven per year; not actual mileage; recall information; and warranty information.

decrease price. However, in this market, the role of information disclosed voluntarily is unclear; there may be at least one of two mechanisms at play, signaling or reputation. If voluntary disclosures are used as signaling mechanisms, sellers would provide only positive information. In this event, voluntary disclosures should either have no effect on price or be positively correlated with price as in Mathios (2000). If voluntary disclosures are used as reputation mechanisms, sellers disclose all information, positive or negative, as suggested by Jovanovic (1982). Under this scenario, voluntary disclosures could also be negatively correlated with price.

Using data from the 2008 Keeneland September Yearling Sale in Lexington, KY, we find that disclosures only sometimes influence price. In a segment of the auction in which an implicit quality certification[4] is available, disclosures do not influence price. However, among "noncertified" individuals, we find evidence that some types of mandatory disclosures provide valuable information to buyers by impacting market price.

The article proceeds as follows. The second section provides a brief background on Thoroughbred sales at Keeneland as well as the history of disclosures and details regarding the different types of disclosures that must be made. The third section presents the empirical model, and the fourth section describes the data. The fifth section includes results and a discussion and the sixth section concludes.

Background

Keeneland Association, Inc. (hereafter Keeneland), holds four Thoroughbred sales annually; by far the largest of these is the September yearling sale. In fact, this sale is the largest of its kind internationally, selling over 3,000 yearlings per year at this sale for the last 15 years. The market at this particular sale is global; buyers come from all over the world to purchase these yearlings with the intent of racing them, reselling them at a later date, and/or using them for breeding purposes; many yearlings purchased by international buyers are exported to their home countries. The sale is divided into eight "books," which are groups of yearlings. Books 1 and 2 are universally considered the "select" portion of the sale by industry participants; Books 3–8 are considered the "nonselect" portion of the sale.[5] Of the yearlings nominated to the September yearling sale, all of their pedigrees are graded, and approximately half are physically inspected. Yearlings included in Books 1 and 2 meet Keeneland's criteria to be considered among the select individuals based on grading of pedigree and conformation. Wimmer and Chezum (2003) suggest that this inspection process serves as part of a certification mechanism in which yearlings in Books 1 and 2 are implicitly certified as meeting Keeneland's quality standards for inclusion in the select part of the sale.[6] Books 1 and 2 notwithstanding, the average quality of yearlings declines throughout the remainder of the books.[7]

The overall physical quality of a yearling Thoroughbred is an important determinant in

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[4] In this market, implicit quality certification is gained through the division of the auction into "select" and "nonselect" portions of the sale. Individual horses sold in the "select" sale are implicitly certified as meeting quality criteria; those that are sold in the "nonselect" portion of the sale are not.

[5] Before 2003, Keeneland held a separate sale in July of each year specifically for the select yearlings. However, Mare Reproductive Loss Syndrome (MRLS) in 2001 and 2002 caused the spontaneous abortion of thousands of foals, and as a result of the decreased size of the foal crop, it was decided to combine the July and September sales. The July Select sale then became Books 1 and 2 at the September sale.

[6] We adopt the terminology used in Wimmer and Chezum (2003), in which "certified" and "noncertified" are used interchangeably with "select" and "nonselect," respectively. Note that this "certification" is implicit, as stated, and that Keeneland provides no warranties or guarantees for yearlings placed in Books 1 and 2 (or any other books).

[7] There are no yearlings whose true value is known to the buyer or seller. A high sales price does not guarantee high future performance on the racetrack or in the breeding shed. Any given yearling may become injured, sick, suffer from fertility problems, or may simply not be fast enough to win a race. For example, a colt sold for $10.2 million in 1983. This colt never raced and also had fertility problems; he was retired from breeding after just two seasons.

its ability to perform in the future as a racehorse and/or breeding animal. To facilitate the transmission of veterinary information germane to a yearling's physical quality, Keeneland instituted an on-site veterinary repository in 1996. All mandatory and voluntary disclosures as well as radiographs are housed in this repository. Keeneland offers no guarantee to the soundness of any yearling it sells, but the current mandatory disclosure policy does offer a level of buyer protection. Any yearling found to have a condition as outlined in the ninth and tenth Conditions of Sale that is not disclosed as mandated (regardless of whether the seller is aware of the condition or not, see subsequently for further discussion) is subject to return by the buyer, which is called a sales rescission (Keeneland Association, Inc., 2008a). A sales rescission can be costly to the seller in terms of loss of sales revenue as well as reputation, and it can be costly to all parties involved, including the auction house, in the event that legal action is taken. Consignors are often hired by Thoroughbred owners to physically present the yearling for sale at the auction and function similarly to a real estate agent representing the seller of a house. The burden lies on the consignor to be aware of any such conditions that would need to be disclosed under the rules of mandatory disclosure. If the sale is rescinded, the seller is liable to the auction house for the sales commission, court costs, and other fees incurred by both the auction house and the buyer. Therefore, the seller is ultimately responsible for examining the yearling to determine if they have any conditions that would make it subject to return. The approximate costs to the seller for these tests are $600–700.[8]

Under the ninth and tenth Conditions of Sale, conditions that must be disclosed at the

yearling sale include cribbing (a stable vice that has been linked to a higher incidence of stomach ulcers and certain types of colic), abnormalities of the reproductive organs in a male horse either through cryptorchidism (having an undescended testicle) or through gelding (castration), a "deviation from the norm in the eyes," wobbler syndrome,[9] invasive joint surgery, "surgical intervention of the upper respiratory tract," surgery of any abdominal organ (except to repair a ruptured bladder in a newborn foal), or having been nerved (a surgical procedure where certain nerves are blocked to mask lameness). Many common conformation surgeries, which are considered to be cosmetic, are not subject to mandatory disclosure. If the purchaser thinks this information is important, they are to ask the seller, and the seller should "respond truthfully to their best knowledge, information, and belief" (Keeneland Conditions of Sale, 2008). Each one of the conditions identified poses additional risk to the yearling's future breeding and/or racing career. For example, ridglings may underperform on the racetrack as a result of discomfort caused by cryptorchidism, and in addition, they may experience more fertility problems than a colt without the condition.

Empirical Model

In this article, like in previous studies, we use a hedonic pricing model to estimate the determinants of Thoroughbred yearling sales prices, including whether disclosures explain sales prices. Then, we can test our proposition that disclosures diminish asymmetric information and hence influence price.

In a hedonic pricing model, a differentiated product (in this case, a yearling) is demanded by buyers because of its own characteristics. The price of the good, then, is a function of

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[8] These tests typically include a physical examination of the eyes, heart, and reproductive organs; an endoscopic (scope) evaluation; and a full set of 36 radiographs. A physical examination, which includes examination of the eyes, heart, and reproductive organs, costs approximately $32.50–40. An endoscopic (scope) evaluation costs approximately $65–80, and a full set of radiographs costs approximately $500–590.

[9] Wobbler syndrome is a condition of the neck (cervical) spinal column, which causes an unsteady gait in horses; clearly, horses with wobbler's syndrome are poor candidates for racehorses, although there are a few exceptions.

the quantity and quality of its attributes. In our model, the auction price represents the price of the good, and attributes of the good are individual-specific characteristics such as the presence or absence of disclosures, age, gender, placement in the sale, and sire and dam quality.[10]

We estimate the following hedonic pricing model:

$$\text{(1)} \qquad \ln PRICE_i = \alpha + x_i\beta + \varepsilon_i$$

where $PRICE_i$ is the price for individual yearling i, x_i is a $n \times k$ matrix of explanatory variables (n is the total number of observations, and k is the number of regressors), and ε_i is a normally distributed, zero mean, constant variance error term. Given equation (1), the marginal effect of characteristic j when x_j is continuous is given by the derivative of the price function with respect to characteristic j, or $\frac{\partial(lnPRICE)}{\partial x_j} = \beta_j$. When x_j is discrete, β_j is interpreted as the percent change in price when characteristic j is present; we evaluate this effect at the mean to provide a marginal value.

The set of explanatory variables includes individual-specific characteristics such as gender, age and state foaled, health, the number of visits to the veterinary repository, stud fee of the sire, demand for a sire's services as measured by the number of yearlings entered in the sale by a given sire (Poerwanto and Stowe, 2010), if the sire is represented by his first or second crop of foals sold at auction,[11] sire progeny quality, dam racing quality, and dam progeny quality as well as sale characteristics such as book placement.

Following the approach of Wimmer and Chezum (2003), we estimate the model presented in equation (1) separately on select yearlings and nonselect yearlings. Books 1 and 2, which before 2003 comprised a distinct sale, attract a largely different set of buyers than the remainder of the sale. So, although in our data the select and nonselect sales are technically no longer distinct sales, in practice they remain quite different. More specifically, for the select books, we estimate Model 1:

$$
\begin{aligned}
\ln(PRICE)_i = {}& \alpha + \beta_0 + \beta_1 VET_i + \beta_2 SCOPE_i + \beta_3 EYE_i + \beta_4 RNA_i + \beta_5 VET_i * RNA_i \\
& + \beta_6 SCOPE_i * RNA_i + \beta_7 EYE_i * RNA_i + \beta_8 BOOK1_i + \beta_9 REPVISITS_i \\
& + \beta_{10} AGE_i + \beta_{11} AGE_i^2 + \beta_{12} COLT_i + \beta_{13} KY_i + \beta_{14} DERBY_i + \beta_{15} FIRSTCROP_i \\
& + \beta_{16} SECONDCROP_i + \beta_{17}(\ln 2008\ FEE_i) + \beta_{18} PROGREP_i \\
& + \beta_{19} DAMBLACKTYPE_i + \beta_{20} DAMBTPROGENY_i + \varepsilon_i
\end{aligned}
$$

(Model 1)

Similarly, for the nonselect books, we estimate Model 2:

$$
\begin{aligned}
\ln(PRICE)_i = {}& \alpha + \beta_0 + \beta_1 VET_i + \beta_2 SCOPE_i + \beta_3 EYE_i + \beta_4 RNA_i \\
& + \beta_5 VET_i * RNA_i + \beta_6 SCOPE_i * RNA_i + \beta_7 EYE_i * RNA_i + \beta_8 BOOK3_i \\
& + \beta_9 BOOK4_i + \beta_{10} BOOK5_i + \beta_{11} BOOK6_i + \beta_{12} BOOK7_i + \beta_{13} REPVISITS_i \\
& + \beta_{14} AGE_i + \beta_{15} AGE_i^2 + \beta_{16} COLT_i + \beta_{17} KY_i + \beta_{18} DERBY_i + \beta_{19} FIRSTCROP_i \\
& + \beta_{20} SECONDCROP_i + \beta_{21}\ln(2008\ FEE_i) + \beta_{22} PROGREP_i \\
& + \beta_{23} DAMBLACKTYPE_i + \beta_{24} DAMBTPROGENY_i + \varepsilon_i
\end{aligned}
$$

(Model 2)

[10] As a result of data limitations, we consider sales in only 1 year and must exclude macroeconomic factors considered by Karungu, Reed, and Tvedt (1993) such as interest and exchange rates and by Neibergs and Thalheimer (1997) such as average purses in a given year and the value of tax benefits.

[11] First and second crop sires are young sires whose progeny have not yet had the chance to prove their quality on the racetrack. Before the great recession of 2008, buyers have been willing to pay a premium for progeny of these unproven sires.

In the next section, we describe the data used in the study and discuss the variables included in Models 1 and 2.

Data

The data consist of 4,795 yearlings that were offered for sale at the 2008 Keeneland September Yearling Sale. This number includes yearlings that were sold as well as those that did not meet their reserve price, but it excludes those cataloged for the sale and subsequently withdrawn before the sale began.[12]

Several sources provided data for this study. The Keeneland Association, Inc., online database of auction results (www.keeneland.com) provided sales results as well as book number, name of sire, and name of dam. The published Keeneland Sale Catalogues (Keeneland Association, Inc., 2008b) included gender, foaling date (month, day, and year), and state where the yearling was foaled. From this complete list, we were able to calculate the total number of progeny that were represented by each sire in the sale. *The Thoroughbred Times Buyer's Guide* (Thoroughbred Times, 2008) listed the sire's stud fee in the year the yearling was conceived (2006) along with the sire's stud fee in the year the yearling was sold (2008), how many crops of foals the sire has produced to date, information on the success of the genetic cross of the sire and dam family lines, the dosage index and center of distribution (quantitative measures of expected speed and stamina based on an individual's pedigree), the average purse earnings for other foals out of the yearling's dam, and the Racing Index of the yearling's dam (a quantitative measure of the quality of a racehorse based on the average earnings per start). Data detailing the type of disclosures logged in the Keeneland Repository as well as the number of repository visits was obtained from the Keeneland Association, Inc.,

computer database (Keeneland Association, Inc., 2008c).

Table 2 lists and describes the variables used in this study.

PRICE represents the hammer price[13] for each yearling; the dependent variable in Model 1 is the natural log transformation of *PRICE*, ln(*PRICE*). *RNA* is a dummy variable equal to one if the yearling did not meet its reserve price. We expect the coefficient on *RNA* to be negative, similar to the result in Neibergs (2001). The negative sign suggests a disagreement between buyer and seller perception of market value. In other words, either horses are undervalued by buyers in the market, as suggested by Neibergs (2001), or sellers are overvaluing their horses and set the reserve price too high relative to buyer willingness to pay. *BOOK 1* is a dummy variable equal to one if a yearling is offered for sale in the first book, or group of yearlings, of the sale; the same interpretation applies for *BOOK 2–BOOK 8*. We expect higher prices for earlier books because quality generally declines across books. *REPVISITS* is the number of times a yearling's repository records were viewed by buyers' veterinarians before sale and may be considered an indicator of the yearling's desirability; the higher quality the yearling, the more buyer interest there will be and hence the more views of records. The number of repository visits is independent of the presence of any disclosures.

Other individual-specific characteristics include *AGE*, which is the age of the yearling in terms of the number of days they were born past January 1. According to this definition, an increase in *AGE* corresponds to a younger horse. Because yearlings born earlier have more time to mature before the sale, we expect *AGE* to be negatively related to price. We also include the quadratic term AGE^2 to test whether

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[12] One yearling was withdrawn from the sample. His hammer price of $7.7 million dollars, which did not meet the reserve price, was almost 2.5 times as much as the next highest priced horse in the sale, thereby making him an outlier. In addition, later discoveries indicated there may have been irregular bidding behavior on this individual.

[13] The "hammer price" is the last price announced by the auctioneer before the gavel strikes the wood. This price may not result in a sale if the yearling's reserve price was not met. Yearlings not meeting their reserve prices are referred to as RNA yearlings (for "reserve not attained"). The percentage of yearlings that did not meet their reserve price for each book of the sale ranges from 20% to 30%.

Table 2. Descriptions of Variables

Variable	Description	Expected Sign
PRICE	Final hammer price	N/A (dependent variable)
RNA	= 1 if a yearling does not meet the reserve price set by the seller	−
VET	= 1 if a vet statement disclosure is present in the repository	−
SCOPE	= 1 if a scope disclosure is present in the repository	−
EYE	= 1 if an eye disclosure is present in the repository	−
BOOK 1–8	A set of dummy variables indicating in which of Books 1–8 the yearling was sold	
REPVISTS	The number of views of a yearling's repository records before sale	+
AGE	Age of the yearling in days born past January 1	
COLT	= 1 if yearling is a colt	+
KY	= 1 if yearling is Kentucky-bred	+
DERBY	= 1 if the yearling meets the criteria for racing at a "classic" distance based on their Dosage Index and Center of Distribution statistics	+
FIRSTCROP	= 1 if yearling is from sire's first crop of foals	+
SECONDCROP	= 1 if yearling is from sire's second crop of foals	+
2008FEE	Stud fee of the yearling's sire at time of auction	+
PROGREP	Number of same-sired progeny at the auction	+
DAMBLACKTYPE	= 1 if yearling's dam is stakes-placed	+
DAMBTPROGENY	Number of black-type progeny produced by yearling's dam	+

N/A, not applicable.

this effect is nonlinear. *COLT* is a dummy variable equal to one if the yearling is male. Prior studies have found that when significant, *COLT* is positively related to price. *KY* is a dummy variable equal to one if the yearling is Kentucky-bred; evidence from prior studies is mixed regarding both the sign and significance of this variable. *DERBY* is a dummy variable equal to one if the yearling's dosage index and center of distribution indicate he or she has a pedigree capable of producing horses that can run the "classic" distance, like the Kentucky Derby.[14] We anticipate this variable will be positive.

Variables related to the yearling's sire include *FIRSTCROP*, *SECONDCROP*, *2008FEE*, and *PROGREP*. The dummy variable *FIRSTCROP* (*SECONDCROP*) is equal to one if the yearling is part of its sire's first (second) crop of foals available for sale at the yearling sales. We expect the sign on these two variables to be positive because buyers have traditionally been willing to pay a premium for unproven stallions. *2008FEE* is the stud fee of the yearling's sire for the year of the auction; a stud fee is a current indicator of sire quality and has been shown to be a strong driver of sales prices in prior studies, and hence we expect the sign on this variable to be positive.[15] Finally, *PROGREP* is the total number of yearlings at the sale by

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[14] More specifically, *DERBY* = 1 if the Dosage Index is less than 4 and the Center of Distribution is less than 1.25.

[15] In the empirical model, we use the natural log of *2008FEE*. The stud fee variable is positively skewed, but the natural log of stud fees follows a more symmetric distribution. As a result, this transformation helps avoid the resulting problems of heteroscedasticity and nonnormality of the residuals. This transformation has been used in a number of other article for the same reason, including Chezum and Wimmer (1997), Maynard and Stoeppel (2007), Parsons and Smith (2008), Poerwanto and Stowe (2010), and Vickner and Koch (2001).

each yearling's sire. Evidence is mixed regarding the expected sign of this variable. Because a higher *PROGREP* indicates a higher supply of foals from a given sire, we would expect the sign to be negatively related to price; Vickner and Koch (2001) refer to this as "progeny cannibalism." However, *PROGREP* can also be considered a proxy for sire attractiveness, in which case *PROGREP* is positively related to price (like in Poerwanto and Stowe, 2010).

Two variables capture mare quality. *DAMBLACKTYPE* is equal to one if the yearling's dam placed in a stakes race.[16] *DAMBTPROGENY* is the number of progeny produced by the yearling's dam that have placed in a stakes race. We expect the signs on both coefficients to be positive.

The variables of interest are *VET*, *SCOPE*, and *EYE*, which correspond to the three types of disclosures that may be present in the repository. *VET* (*SCOPE*, *EYE*) is equal to one if there is a veterinary statement (scope, eye) disclosure present in the repository.[17] The content of all disclosures is unknown; all that is known is whether one exists. However, industry experts are able to provide information as to what is likely contained in the repository as well as whether it is mandatory or voluntary.

A vet statement disclosure included in the repository could include information regarding any surgeries, abnormalities, illnesses, medications, or any other veterinary-related information deemed pertinent to the sale of the yearling. In some cases such as invasive joint surgery, this vet statement would be mandatory.[18] Two large, reputable consignors suggest that, as

a conservative estimate, at least 90% of vet statement disclosures in the repository are mandatory governed by the Conditions of Sale. In addition, these consignors agree that the policy of most consignors is to disclosure all conditions in the repository that are required to be disclosed but no more; they could see no rationale for disclosing more than is required. However, if purchasers request information about other conditions, they would share that information verbally (but not formally in the repository).

A seller includes a scope disclosure in the repository detailing the findings of an endoscopic evaluation of the airways of the yearling. These evaluations are generally graded, although the grading scale depends on the attending veterinarian. Any information included in a scope disclosure is provided voluntarily; however, prospective buyers often perform their own endoscopic examinations, and the purchaser may also conduct a postsale endoscopic examination as well.

An eye disclosure in the repository details any abnormalities in the eye. These abnormalities are classified as irregularities that either will or will not affect vision performance. These irregularities are required to be disclosed by the ninth Condition of Sale and hence are considered mandatory.

Because the overwhelming fraction of vet statement disclosures and all eye disclosures are required according to the ninth and tenth Conditions of Sale, we expect *VET* and *EYE* to be negatively related to price. Because information included in scope disclosures is disclosed voluntarily, the impact on price can be positive or negative depending on the mechanism at play.

Figure 1 illustrates the percentage of yearlings with each type of disclosure segmented by book. Of the three types of disclosures, vet statement disclosures are the most prevalent; they are present for over 20% of the yearlings in Book 1. The percentage of yearlings with vet statement disclosures is then decreasing by book number. The incidence of scope and eye disclosures is generally uniform across books and remains below 5%. The differences in percentage of disclosure statements by book

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[16] In other words, a horse earns "black type" (literally, their names on the sales catalog page are printed in bold font, black letters) if it finishes first, second, or third in a stakes race.

[17] Note that a yearling can have a positive number of repository visits even if there are no veterinary statements, scope disclosures, or eye disclosures on file; recall that radiographs are also included in the repository.

[18] Two consignors we spoke to suggested that this may be the most common reason for including a vet statement disclosure and usually identifies either the removal of bone chips from joints or the removal of osteochondritis dissecans lesions.
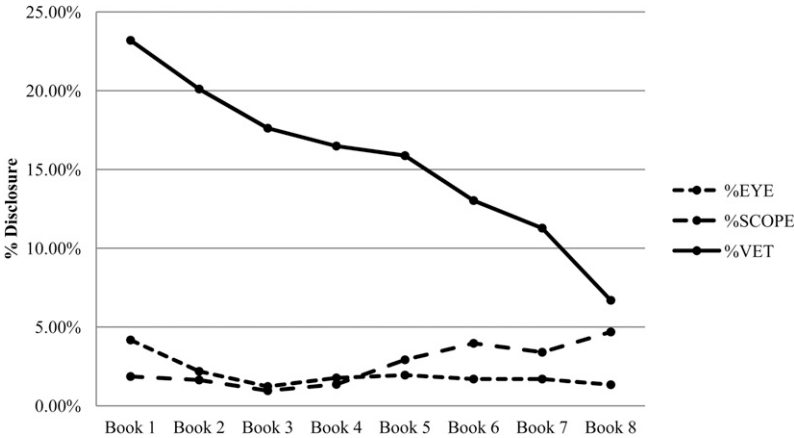
Figure 1. Percent of Yearlings with Each Type of Disclosure by Book

between sold and RNA yearlings are not significant at the 10% level or better, although the difference in the incidence of scope disclosures in Book 8 is significant at the 11% level.

Table 3 provides summary statistics for the variables used in this study for both select and nonselect horses; each sample is divided into "sold" and "RNA" yearlings. By examining the table, one can immediately observe differences in select and nonselect yearlings according to the dependent variable as well as sire and dam quality variables.

Results

Regression results for the select yearlings sold in Books 1 and 2 are found in Table 4. We find that most of the attributes identified in previous studies are significant with the expected signs: the coefficients on *LN*(*FEE2008*), *BOOK 1*, *REPVISITS*, and *KY* are all positive and significant at the 1% level. The coefficient *RNA* is negative and significant at the 1% level, as expected. *DERBY* and *DAMBTPROGENY* are positive and significant at the 5% level, and *COLT* is positive and significant at the 10%

Table 3. Means (standard deviations) for Select and Nonselect Sold and RNA Yearlings

	Select	Nonselect
PRICE	$219,066.60 ($231,087.40)	$40,672.77 ($51,006,80)
VET	0.21 (0.41)	0.14 (0.35)
SCOPE	0.02 (0.13)	0.03 (0.16)
EYE	0.03 (0.17)	0.02 (0.13)
RNA	0.30 (0.45)	0.24 (0.43)
REPVISITS	5.88 (4.38)	2.26 (3.15)
AGE	77.80 (34.31)	81.66 (34.69)
COLT	0.54 (0.50)	0.50 (0.50)
KY	0.90 (0.29)	0.81 (0.40)
DERBY	0.88 (0.32)	0.84 (0.37)
FIRSTCROP	0.10 (0.30)	0.22 (0.41)
SECONDCROP	0.08 (0.27)	0.15 (0.36)
2008FEE	$97,752.27 ($77,016.53)	$25,934.12 ($25,999.68)
PROGREP	43.55 (15.96)	32.99 (18.74)
DAMBLACKTYPE	0.41 (0.49)	0.29 (0.46)
DAMBTPROGENY	0.66 (1.02)	0.38 (0.74)
n	1107	3418

Table 4. Regression Results for Model 1, Select Yearlings

Model 1—Dependent Variable: LN(PRICE)	
Variable	Coefficient Estimate (standard error)
VET	–0.025 (0.067)
SCOPE	–0.132 (0.199)
EYE	–0.139 (0.172)
RNA	–0.243*** (0.061)
VET*RNA	0.093 (0.121)
SCOPE*RNA	0.082 (0.429)
EYE*RNA	0.361 (0.281)
BOOK 1	0.621*** (0.053)
REPVISITS	0.119*** (0.005)
AGE	0.002 (0.003)
AGE^2	–0.0002 (0.0002)
COLT	0.054 (0.046)
KY	0.238*** (0.078)
DERBY	0.162** (0.071)
FIRSTCROP	0.051 (0.078)
SECONDCROP	0.029 (0.087)
LN(2008FEE)	0.285*** (0.034)
PROGREP	0.002 (0.001)
DAMBLACKTYPE	0.058 (0.047)
DAMBTPROGENY	0.057** (0.023)
CONSTANT	7.204*** (0.400)
n	1107
Adjusted R^2	0.4964
$F(19,1087)$	55.51
Prob > F	0.0000

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

level. Our main focus, however, is on the disclosure variables *VET*, *SCOPE*, and *EYE*. None of the disclosure variables are statistically significant. Although all three types of disclosures exist among horses in Books 1 and 2 at the same frequencies statistically, none influences price; this result can be interpreted in a few ways. First, Books 1 and 2 are the select books of the sale; the yearlings in these books are subjected to thorough inspection by the auction house before the sale and, based on the results of the inspection, are placed in the highest quality portion of the sale. Thus, it may be the case that the mere act of being placed in Book 1 or 2 is an implicit type of disclosure both by the auction house and the sellers, and any disclosures provided in the repository do not provide any additional information that is valued by the market, at least in terms of affecting price. This result is similar in spirit to Wimmer and Chezum (2003) in which quality certification mitigates adverse selection. A second possibility is that the disclosures may contain information that does not influence the future performance of the yearling. Instead, sellers include all information, including that not included in the Conditions of Sale, to prevent a sales rescission. This explanation seems unlikely, however, based on industry experts' suggestions that the general policy of consignors is to only disclose in the repository that is required to be disclosed.

Of particular interest in this result is that vet statement disclosures are most prevalent in the select books (23.2% in Book 1 and 20.1% in Book 2, respectively; refer to Figure 1); the presence of these disclosures does not influence price, although the vast majority of these disclosures are mandatory. Industry experts indicate that the most common type of vet statements, which report invasive joint surgery, are actually quite common and the procedure is believed to have no bearing on the future performance of the yearling. They also suggest that the incidence of these procedures is high among the select yearlings because these are the ones for whom it is economically beneficial to have the procedure performed; by rectifying problems such as bone chips or osteochondritis dissecans lesions, their pedigree and physical quality promise to result in a high sales price.

Regression results for the nonselect yearlings sold in Books 3–8 are found in Table 5. Once again, we find that most of the attributes from previous studies are significant with the expected signs: the coefficients on *LN(FEE2008)*, *BOOK3 – BOOK7,* and *REPVISITS* are positive and significant at the 1% level, and prices are declining across books. *AGE* is not significant, but AGE^2 is significant at the 1% level; in the nonselect portion of the sale, we find that youth is increasingly penalized. Dam quality variables positively influence price, again at the 1% level. Like in the model for select yearlings, *RNA* is negative and significant at the 1% level. One unexpected result is that *DERBY* is negative and significant at the 5% level. One

Table 5. Regression Results for Model 2, Non-select Yearlings

Model 2—Dependent Variable: LN(PRICE)	
Variable	Coefficient Estimate (standard error)
VET	–0.182*** (0.063)
SCOPE	–0.002 (0.145)
EYE	0.079 (0.175)
RNA	–0.156*** (0.050)
*VET*RNA*	0.010 (0.132)
*SCOPE*RNA*	–0.160 (0.267)
*EYE*RNA*	0.254 (0.341)
BOOK3	1.915*** (0.087)
BOOK4	1.554*** (0.080)
BOOK5	1.175*** (0.075)
BOOK6	0.838*** (0.086)
BOOK7	0.379*** (0.072)
REPVISITS	0.127*** (0.007)
AGE	0.004 (0.003)
AGE^2	–0.00005*** (0.00002)
COLT	0.047 (0.039)
KY	0.074 (0.049)
DERBY	–0.129** (0.052)
FIRSTCROP	–0.052 (0.051)
SECONDCROP	0.056 (0.057)
LN(2008FEE)	0.153*** (0.036)
PROGREP	0.002 (0.001)
DAMBLACKTYPE	0.116*** (0.043)
DAMBTPROGENY	0.148*** (0.026)
CONSTANT	6.985*** (0.334)
n	3416
Adj. R^2	0.4570
F(23,3394)	120.75
Prob > F	0.0000

Note: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

possible explanation is that there may be a perception that yearlings that truly have the ability to compete in classic race distances will only be found in the select books; many buyers may actually discount the *DERBY* measure in later-book yearlings. Another possibility is that US racing is trending toward shorter, faster races, so yearlings with classic race distance pedigrees are not as desirable. Finally, the coefficient on *PROGREP* is positive and significant at the 15% level among the sold yearlings, providing weak evidence of the result in Poerwanto and Stowe (2010) against progeny cannibalism.

Among the disclosure variables, we find that the variable indicating the presence of a vet statement disclosure in the repository, *VET*, is negative and significant at the 1% level. Because the coefficient estimate is negative, this result suggests that vet statements contain information, which may potentially adversely affect the yearling's ability to run successfully or to be able to reproduce later. The marginal value of a vet statement disclosure evaluated at the mean is –$7,459.67; in other words, the presence of a vet statement disclosure reduces sales price by an average of almost $7,500. The interaction term *VET*RNA* is insignificant, indicating that the presence of a vet statement disclosure does not differentially affect hammer prices for sold and RNA yearlings.

The variables indicating the presence of a scope or eye disclosure statement as well as the corresponding interaction terms with RNA are insignificant at all conventional levels.[19,20] The insignificant results on the scope variables are expected, because any scope disclosure is voluntary; we would not expect sellers to reveal potentially detrimental information unless required to do so. The results on the eye variables suggest that any information revealed in the eye disclosures is considered irrelevant to buyers in a yearling's future racing and/or breeding career and is supported by experts' estimation that at least 95% of eye statement disclosures report conditions that do not affect vision performance, and even if vision is affected, there are a number of horses that have raced successfully with limited vision.

Summary and Conclusion

In recent years, the integrity of the sales process in Thoroughbred auctions has received plenty

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[19] We excluded two outliers from the analysis that led to strong and misleading estimates for the *SCOPE* variable. Less than 3% of nonselect yearlings had scope disclosures in the repository, and these two omitted observations did not receive any bids in the auction ring, which skewed the results.

[20] In addition, we tested whether the presence of a disclosure impacts the probability of an *RNA* after controlling for other variables using a probit model. We found no significant results.

of attention. One component of improving the integrity of the sales process is the mandatory disclosure of certain conditions before the time of sale. Such a policy mitigates asymmetric information and encourages trade between buyers and sellers. In general, based on limited previous empirical research on the role of disclosure in markets with imperfect information, we expect conditions reported through mandatory disclosures to reduce price, and because sellers will rationally voluntarily disclose only information that benefits them, or at least does not hurt them, we expect conditions disclosed voluntarily to either not affect or increase price.

In this article, we have information regarding the presence or absence of three types of disclosures: a vet statement disclosure, a scope disclosure, and an eye disclosure. The majority of vet statements and eye disclosures report conditions governed by the Conditions of Sale and as such are considered mandatory disclosures, whereas all scope disclosures are voluntary. We expect to find different impacts on market price accordingly.

Among the select yearlings, we find that none of three types of disclosures significantly influences hammer price. In light of the high frequency of vet statement disclosures in this group of yearlings, this result suggests that the implicit quality certification that accompanies being placed in Books 1 and 2 may eliminate individuals with significant conditions that may negatively impact their future performance, and any other remaining conditions disclosed are viewed as nonconsequential among buyers. Among the nonselect yearlings, we find that one of the three types of disclosures does, in fact, discount price. The presence of a vet statement disclosure in the repository for yearlings costs approximately 18% of the average price of a yearling. This result provides further support for the type of result in Mathios (2000) in which mandatory disclosures reduce price. It is possible, then, that in this market, voluntary disclosures are used not as signaling mechanisms, because they appear to be used as high-quality signals in the contexts studied by Kiesel, Buschena, and Smith (2005) and Mathios (2000), but rather as a reputation mechanism.

The results from this article are useful to buyers and sellers in the sales process as well as to auction houses. Understanding the premium for different types of disclosures will allow sellers to set more realistic reserve prices and hence sell more of their horses, thereby increasing trade. Through a lower price, buyers are compensated for taking additional risk by purchasing a yearling that has a condition that could potentially affect its future performance on the racetrack or in the breeding shed.

More generally, these results suggest that disclosure in the sale of Thoroughbred yearlings achieves the goal of mitigating some degree of asymmetric information between buyers and sellers and hence encouraging trade, even if this does not always manifest itself through an influence on price. Both voluntary and mandatory disclosures provide an avenue to transmit information to potential buyers, whether or not they ultimately have value to the market in terms of sales price. By offering a formal policy on what must be disclosed, the auction house allows buyers to bid knowing that they are made aware of the presence of certain types of adverse information.

Finally, other markets in which disclosures are used to reduce asymmetric information such as the used car market and the market for previously owned houses stand to benefit from empirical research on the role of disclosures. Informing buyers about known existing conditions as well as the average market value of those conditions ultimately promotes trade between market participants.

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