A Hedonic Price Analysis of Risk Preferences in Yearling Thoroughbred Buyers

Xiurui 'Iris' Cui

Abstract: Hedonic pricing model is used to investigate yearling thoroughbred buyer's risk preferences for four consecutive years 2006-2009 and illustrate how they correlate with the economic climate.

A Hedonic Price Analysis of Risk Preferences in Yearling Thoroughbred Buyers

Xiurui 'Iris'Cui

AEC 624 Term Paper

Table of Contents

A Hedonic Price Analysis of Risk Preferences in Yearling Thoroughbred Buyers

Xiurui 'Iris' Cui

In this article, hedonic pricing model is used to investigate yearling thoroughbred buyer's risk preferences for four consecutive years 2006-2009 and illustrate how they correlate with the economic climate.[1] We test the hypothesis that buyers are willing to pay a premium for progeny by stallions of unknown quality when the market is strong. Using public auction data, we find that in the year of 2006, buyers were willing to pay more premiums for yearlings by freshmen sire, and we observed that the magnitude of the coefficient on 2008 interaction term mitigated the premium that buyers had been willing to pay for progeny of freshmen sires.[2]

Key Words: Hedonic pricing model, thoroughbred yearling, buyer risk preferences, freshmen sires

When buyers make purchasing decisions they rely heavily on the collective information such as horse's racing performance, their pedigree and racing or auction records of the sire and dam. However when buyers purchase the yearlings by sires with unknown quality, they are taking additional risks. In this paper, we use auction results from 2006 to 2009 to test the hypothesis that 2008 financial crisis strongly affects buyer's risk preferences by examining how unproven freshmen sires impact on the price of their progeny change through these four years. Knowing how buyer's risk preferences change at different economic period is important for evaluating the health and confidence of the thoroughbred industry, also important for sellers to understand the premium of progeny by stallions of unknown quality in different years. By

setting more realistic reserve prices, sellers are likely to sell more horses and bring more income to the auction.

For years, scholars have been interested in finding out what are the important determinants for pricing thoroughbreds. Hedonic pricing model is used in most studies in the thoroughbred industry. It was shown that yearling prices are influenced by individual-specific characteristics as well as macro-economic variables (Buzby J.C. 1994). There were other studies including different explaining variables in the pricing model which later showed to be significant. Study by Steven S. V. estimated a hedonic hammer price model and concluded that intensity of the seller was not statistically significant and inversely related to hammer price.[3] The study by D. Poerwanto, C. J. Stowe (2010), discovered that the average price of a sire's yearlings would be influenced by an increased supply of foals by the same sire. In another study by Stowe (2010), freshman sire stud fees were analyzed.[4] It was noted that stallion owners differentiated their products by referring to the freshman sire's own racetrack performance, state of standing and coming from a prominent sire line are found to be significant statistically. A study by Emily J.P. and C. J. Stowe (2013) showed that mandatory disclosure such as vet report decreased the hammer price in the sale of Thoroughbred yearlings.

A few studies examined the impact of macroeconomics in pricing yearlings, but none of which specified how the economic climate influenced buyer's risk preference. Besides discussing the roles of several important determinants in pricing yearlings which have been proven to be significant in the former studies, our study identifies the importance of buyer's risk preference by analyzing the marginal effect of sire of unknown quality combing with the effect of year to

price, as well as providing information to yearling sellers, buyers and the auction cooperation about pricing thoroughbred yearlings at different stage of the market.

Using data from the 2006-2009 *Keeneland September Yearling Sale*, we find that in the year of 2006, buyers were willing to pay more premiums for yearlings by freshmen sire, and we observed that the magnitude of the coefficient on 2008 interaction term mitigated the premium that buyers had been willing to pay for progeny of freshmen sires.

The article proceeds as follows. The second section provides a brief background of *Keeneland* as well as *Keeneland September Yearling Sale.* 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

Bluegrass state Kentucky is known for its signature thoroughbred industry, which plays an important role in providing revenue and jobs to the state government. *Keeneland*, founded in 1936, Lexington, Kentucky, has a deep history and worldwide influence in thoroughbred industry both in racing and breeding. Recent economic impact study conducted by the University of Kentucky's Center for Business and Economic Research, Gatton College of Business and Economics, showed that *Keeneland'*s premier Spring and Fall race meets and four globally Thoroughbred sales including the September Yearling Sale, in 2014 generated a $590 million economic impact for Lexington and Fayette County, Kentucky. *Keeneland September Yearling Sale* is globally well-known as the Thoroughbred yearling auction, the largest sale of one-year-old thoroughbred, which is one of the primary indicators of evaluating the health of

the horse industry. Approximately 20 percent of groups participating in the September Yearling sales were from outside the U.S. while another 45 percent were from states other than Kentucky. However, during the economic recession, total number of yearling sold at *Keeneland* decreased dramatically, and total income took a devastating fall. In 2006, 40 horses sold at the auction were sold more than $1 million with average price of $112,427 which fell to $60,734 in 2009 with more than 40 percent decrease. Last year, 2014 September Yearling Sale, 2,819 horses were sold with average price getting back to 99,312, there were 13 yearlings that brought seven-figure prices, without adjusting for inflation. Many predicted even though the industry has a clear sign it's recovering from the crisis that top horse values would never recover to their 2005-2007 highs. Figure 1 shows the average/median price per yearling sold in US from 2006-2014, which illustrates that the financial crisis hit the yearling auctions dramatically from 2008, and there's a sign of economic recovery from the year 2011-2012.

Figure 1. Average/Median Price per Yearling Sold in US

Empirical Model

Hedonic pricing model is used in this study to identify each factor affects the price, which the main assumption is that the price of a product is determined both by internal and external characteristics. However, in this study, the quality of the product, thoroughbred yearling, is unknown. A freshman sire with a successful racing career and/or good blood line, his offspring will be assumed to be more likely to succeed in the future and bring more profit for the buyers.

Equation (1) specifies the model to be estimated:

$$ln(\,y_i\,) = \alpha + x_i\beta + \varepsilon_i,$$

where $ln(\,y_i\,)$ is the yearling price, x_i is an n×k matrix of explanatory variables (n is the total number of observations and k is the number of regressors), and ε_i is the error term. Several explanatory variables are used in this pricing model, including gender, DOB of the yearling, the sire's stud fee, the dam's performance and dam's progeny performance. Natural log is calculated for the variables that have a dollar value, which include PRICE and STUDFEE.

Data

Sale summaries of *Keeneland September Sale* of four consecutive years from 2006 to 2009 were obtained from the official *Keeneland* website. Freshman sires' information were obtained through annual *Blood-Horse MarketWatch Freshman Sires*. The advertised stud fee of each stallion was obtained from *2011 American Produce Records*; several missing data were obtained from *Blood-Horse Stallion Registry*. Dams' performance on the racetrack and dam's progeny

performance statistics were retrieved from *2011 American Produce Records*, which contains detailed race and auction records and pedigrees of all Thoroughbred horses from 1960-2010.

Names and the definitions of the variables are presented in table 1.

Given these variables, the joint model for four years being estimated is written as:

$$ln(PRICE_i) = \beta_0 + \beta_1 BOOK_i + \beta_2 DOB_i + \beta_3 FILLY_i + \beta_4 RNA_i + \beta_5 KY_i + \beta_6 ln(STUDFEE_i)$$

$$+ \beta_7 DAMPROBT_i + \beta_8 DAMBT_i + \beta_9 FRESHMANSIRE_i + \beta_{10} YEAR2007$$

$$+ \beta_{11} YEAR2008 + \beta_{12} YEAR2009 + \beta_{13} YEAR2007FRESHMANSIRE$$

$$+ \beta_{14} YEAR2008FRESHMANSIRE + \beta_{15} YEAR2009FRESHMANSIRE + \varepsilon_i$$

Table 1. Definitions of Variables

Variable	Definition of Variable
PRICE	Final hammer price or reserved price.
BOOK(1-8)	A set of dummy variables indicating in which book the yearling was sold.
DOB	=1 if yearling is born before April 1st.
COLT	= 1 if yearling is a colt.
FILLY	= 1 if yearling is a filly.
GELD	= 1 if yearling is a gelding.
RIDG	= if yearling is a ridgling (If one or both of the testicles didn't descend).
RNA	= 1 if a yearling does not meet the reserve price set by the seller.

KY	= 1 if the yearling is Kentucky-bred.
STUDFEE	Advertised price of one breeding season to the sire.
FRESHMANSIRE	= 1 if the sire bred for the first season.
DAMPROBT	= 1 if progeny produced by yearling's dam stakes-placed.
DAMBT	= 1 if yearling's dam is stakes-placed.
YEAR(2006-2009)	A set of indicator variables of the auction year.
YEARFRESHMANSIRE	Joint indicator variables of YEAR (2006-2009) and FRESHMANSIRE.

PRICE represents the hammer price or the reserve price for each yearling, which in the model is the natural log of PRICE, ln (PRICE). RNA is a dummy variable equal to one if the yearling did not meet its reserve price. BOOK (1-8) is a set of dummy variables indicating in which book the yearling was sold, BOOK1 is omitted from the model. We expect higher prices for earlier books because selected quality yearlings usually are presented the beginning of the auction. DOB, which is related to the birth date of the yearling, takes the value of one if the yearling was born before April 1st which is considered to be an early foal in the thoroughbred industry, and we expect a positive sign for this variable to price since the early born yearlings are usually bigger in size and more mature physiologically by September than late-born yearlings, which is preferred by most buyers. COLT is omitted in the model; Filly is expected to be negatively related to price.[6] 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. Variable STUDFEE is related to the sire's quality because higher stud fee indicates a more successful sire

history and to be a more popular sire at the season, which is expected to be a strong driver of sales prices, which variable in the model is the natural log transformation of STUDFEE, ln (STUDFEE). Variables related to the dam's quality include DAMPROBT and DAMBT. DAMBT is equal to one if the yearling's dam placed in a stakes race, same as DAMPROBT takes one if progenies of the dam have placed in a stakes race. We expect the signs on both coefficients to be positive. A set of dummy variables YEAR (2006-2009) capture the effect of the time period as it went through the recession, such as interest rate etc, which reflects the change of average yearling price of each year, indicative variable Year2006 is omitted. FRESHMANSIRE takes the value of one if the yearling was the sire's first crop. Joint variables, YEAR (2006-2009) FRESHMANSIRE, are created since we are interested in the change of buy's risk preferences towards freshman sire throughout the years. We anticipate the signs for 2007 joint variables to be positive because there are studies shows that buyers tend to pay more for yearlings by unproven sires when the market is strong, and we expect the coefficients for the year 2008 and 2009 joint variables to decrease significantly to be negative and show a downward pattern.

Results

Table 2 Regression Results for Joint Model.

Variable	Parameter Estimates	Standard Error
BOOK2	-0.730***	0.034
BOOK3	-1.130***	0.036
BOOK4	-1.660***	0.037
BOOK5	-2.019***	0.040
BOOK6	-2.559***	0.041
BOOK7	-3.143***	0.043
BOOK8	-3.509***	0.053
DOB	0.121***	0.016

FILLY	-0.084***	0.016
RNA	-0.273***	0.018
KY	-0.055**	0.022
lnSTUDFEE	0.172***	0.012
DAMPROBT	0.193***	0.017
DAMBT	0.094***	0.017
FRESHMANSIRE	0.084*	0.045
YEAR2007	0.191***	0.025
YEAR2008	-0.057**	0.025
YEAR2009	-0.606***	0.025
YEAR2007FRESHMANSIRE	-0.031	0.059
YEAR2008FRESHMANSIRE	-0.134**	0.060
YEAR2009FRESHMANSIRE	-0.076	0.059
CONSTANT	10.425	0.139
N	18,575	
Adjusted R^2	0.5442	
F Value	1,057.21	
Prob > F	<.0001	

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

Regression results for the joint model of yearlings sold in four years are present in table 2.[5] We find that most of the attributes identified in previous studies are significant with the expected signs: the coefficients on and BOOK (2-8) are all negative and significant at the 1% level, Book 1 and 2 are selected with highest quality of yearlings. Coefficient of DOB is positive and significant at the 1% level, because early born yearlings tend to be bigger in size. Signs of FILLY and RNA are both negative and significant at the 1% level, parameters reflect qualities of sire and mare, lnSTUDFEE, DAMPROBT and DAMBT are shown to be positive and significant at the 1% level. The coefficient of KY is negative and significant at the 5% level, which early studies showed mixed signs of this variable. Main focus of this paper is on FRESHMANSIRE, year indicative variables and their joint variables. The coefficient of FRESHMANSIRE is positive and significant at the 5% level, which has been discovered in early studies that buyers are willing to pay more

for freshmen sires. Coefficient of YEAR2007 is positive and significant at the 1% level, showing a higher average price than the year of 2006. Coefficient of YEAR2008 turned negative, significant at the 5% level, as coefficient of YEAR2009 decreased dramatically indicating the average price of yearling at the auction dropped significantly. Out of three joint variables, only the coefficient of YEAR2008FRESHMANSIRE turns out to be significant at the 5% level, neither of the YEAR2007FRESHMANSIRE and YEAR2009FRESHMANSIRE variables are statistically significant. Figure 2 illustrates the percentage of progenies of freshmen sires by year. Although the coefficients show a pattern which complies with the specific time period, which in 2008, financial crisis hit the late auction, buyers were much more cautious and reluctant to take additional risks, yet in 2009, the entire book size decreased and the average price also fell significantly which is shown in Figure 3, so buyers were less reluctant to take more risks. A second possibility is that less yearlings entered with lower prices, and buyers who were willing to purchase high value horses were the ones whose business were not highly affected by the great recession.

Figure 2. Percent of Progenies of Freshmen Sires Keeneland September Sale 2006-2009

Figure 3. Average Yearing Price Keeneland September Sale 2006-2009
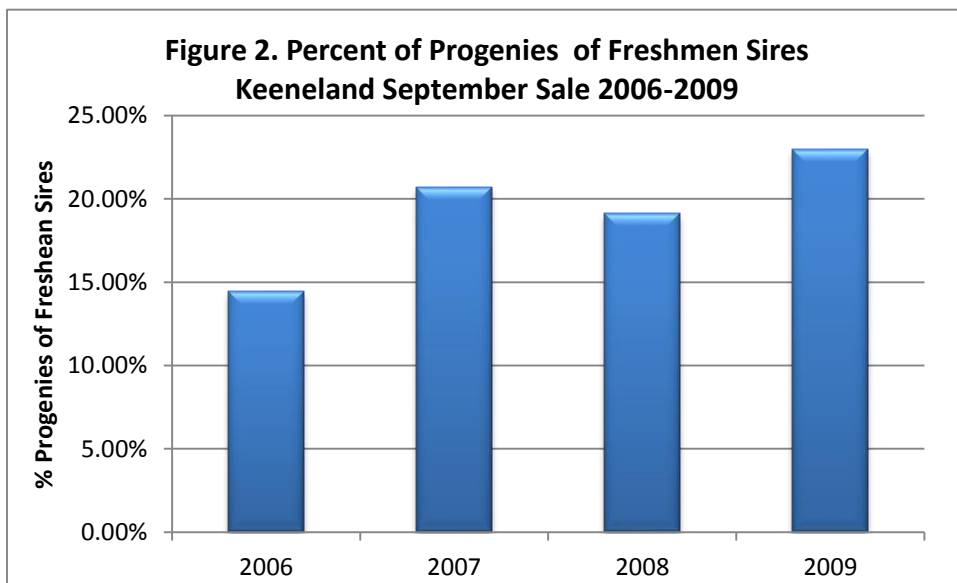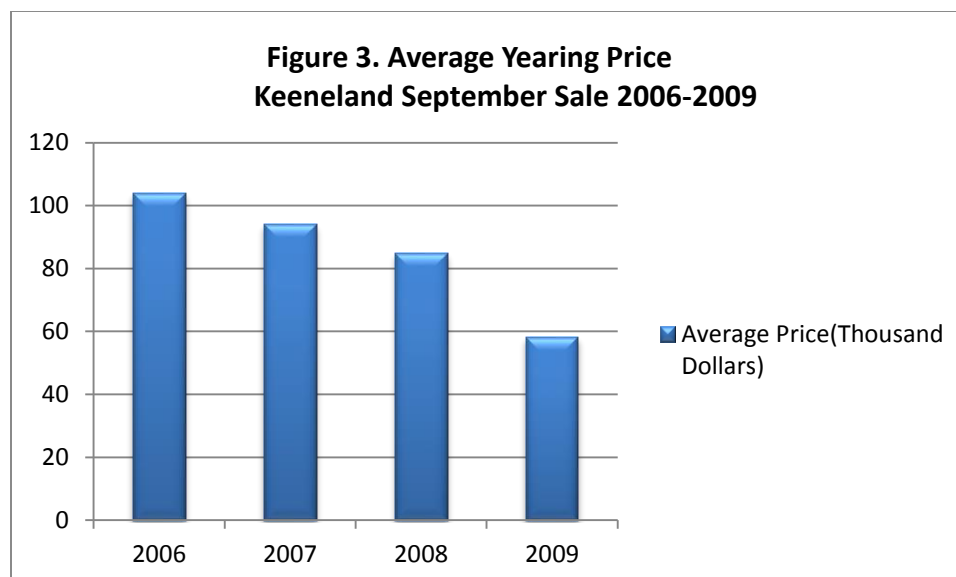
Summary and Conclusion

Quality of a thoroughbred is measured by racetrack performance, blood line and/or breeding value, which will not be known for years for yearlings, particularly in this case the quality of the offspring of a freshman sire will be more difficult to estimate. Thus, buyers are taking higher risks to purchase high value products with unknown quality. In this article, we have information of the September Yearling Sale for four consecutive years, and we expect to find buyers are willing to pay premium for yearlings by sires with unknown quality when the market is strong and avoid the risk when market is uncertain. Decreasing of average price of yearlings sold at *Keeneland* is observed and 2006 September Sale is shown to be the best year for yearlings of freshman sires in the four years since buyers willing to pay more premium than the year before which indicates the thoroughbred market to be stong. Understanding the premium for yearlings at different time period is benefit for sellers in the sales as well as for auction houses. More generally, these results suggest that the health of yearling sale industry is highly depend on the health of the entire economy, and buyers' risk preference changes with the weather of

the economy. Further research may extend the year range based on this paper to investigate how the thoroughbred industry complies with the economic weather and confirm if horse buyers truly regained confidence of the industry by comparing the premium for freshmen sires in consecutive years. In addition, interaction variables can be constructed between the year dummy variables and Stud fee to further investigate the marginal effect of stud fee on hammer price. Other further study should target the impact of other significant factors on buyer's risk preferences such as yearling's confirmation, the freshman sire track performance and second and third dam performance. In addition, besides *Keeneland September Yearling Sale*, there are other signature thoroughbred sales took place in other states throughout the years, such as *Fasig-Tipton* all age Sale and Florida *OBS* two year old in training Sale, which all contribute together to the thoroughbred industry.

References

Buzby, J. C. and Jessup, E. L. (1994) The relative impact of macroeconomic and yearling specific variables in determining Thoroughbred yearling price, Applied Economics, 26, 1–8.

Christopher R. Bollinger. (April, 2015) A Measure of the Economic Impact of Keeneland Racing and Sales on Lexington-Fayette County. Center for Business and Economic Research.

Emily J. Plant and C. Jill Stowe (2013): The Price of Disclosure in the Thoroughbred Yearling Market, Journal of Agricultural and Applied Economics, 45, 2, 243–257

Maynard, L.J. and K.M. Stoeppel (2007): Hedonic Price Analysis of Thoroughbred Broodmares in Foal. Journal of Agribusiness 25, 181–95.

Neibergs, J.S. (2001): A Hedonic Price Analysis of Thoroughbred Broodmare Characteristics, Agribusiness

17, 299–314.

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

Stowe, C. J. and Ajello, B. (2010) A hedonic price analysis of differentiated products of unknown quality: freshmansire stud fees in the thoroughbred breeding industry, Journal of Agribusiness, 28, 19–30.

Appendix

1. Yearling is a one-year-old thoroughbred horse. Foals are usually born at different time of the year varying from January to late May, turning one year old at the following January 1ˢᵗ.
2. Freshman sire is one stallion who just retired from the race track or other discipline, who bred mares for the first time, their offspring will be referred as the first crop.
3. The "hammer price" refers to the last price called by the auctioneer before the gavel strikes the wood. This may or may not result in a sale, depending on whether the yearling's reserve price was met.
4. A stud fee is the price paid by a mare owner for one breeding season to a stallion.
5. The sample size is reduced to 18,575 of four years due to missing observations such as missing stud fee.
6. Colt is a male horse age less than 4, whereas filly is referred to female horse age less than 4.