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**Title of the Poster**

DETERMINING THE VALUE OF BIRTHRANK AND PARENT AGE IN THOROUGHBRED RACEHORSES

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# DETERMINING THE VALUE OF BIRTHRANK AND PARENT AGE IN THOROUGHBRED RACEHORSES

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## MOTIVATION

- Foal Birthrank:
  - Finocchio, D.V.M. (1986) -A mare's 3rd foal has the best chance to become a stakes winners, followed by the 5th, 2nd and 4th foal.
  - Barron (1995) - Foals born at early birth ranks are more successful during their racing careers than those born later; peaks at around the 4th foal.
- Mare Age:
  - Barron (1995) -Timeform ratings are correlated with maternal age, and peaks at around 9 years; younger mares(<11) produced the most successful offspring.
  - No research relative to sire age.

## OBJECTIVES

- Investigate whether sire age, dam age, foal birthrank are taken into pricing decisions.
- Examine whether these factors are correlated with progeny career earnings.
- Compare the marginal effects.

## DATA DESCRIPTION

- 22,734 yearlings sold at KEESEP 2006-2010

Sources:

- Keeneland website- Sale catalog
- 2011 American Produce Records
- Blood-Horse Stallion Registry
- Equineline Mare Produce Records

Excluded observations:

- Horses never started racing
- Horses with zero lifetime earnings but a winning record

## TB YEARLING PRICE DETERMINANTS

- Pedigree:
  - Racing performance of sire and dam, stud fee (Vickner, 2001)
- Individual characteristics:
  - DOB, gender, birth location (Parsons, 2008).
- Day of sale (Books):
  - At Keeneland September Sale, there are usually 7-8 books listing all the yearlings; Book 1-2 normally contain the select ones. (Commer, 2000)

## SAMPLE CATALOG PAGE

## VARIABLES

Variable	Definition of Variable
PRICE (Model 1 DV)	Final hammer price
EARN (Model 2 DV)	Race earnings of each horse by 2015
BOOK (1-8)	A set of dummy variables indicating in which book the yearling was sold
DOB	= 1 if yearling is born between January 1 <sup>st</sup> and April 1 <sup>st</sup>
COLT	= 1 if yearling is a male horse
FILLY	= 1 if yearling is a female horse
RNA	= 1 if hammer price does not meet the reserve price set by the seller
DAM_AGE	The age of each dam at the present auction
SIRE_AGE	The age of each sire at the present auction
CROP	The birthrank of the yearling
STUDFEE	Advertised price of one breeding season to the sire at the time of breeding
DAMPROBT	= 1 if progeny produced by yearling's dam stakes-placed
DAMBT	= 1 if yearling's dam is stakes-placed

## DESCRIPTIVE STATISTICS

Classification	Total Yearlings	Average Price	Average Earnings
<b>By Year</b>			
2006	4,548	\$100,876	\$38,746
2007	4,885	\$94,064	\$58,456
2008	4,787	\$84,901	\$56,105
2009	4,354	\$58,106	\$58,677
2010	4,166	\$59,779	\$65,593
<b>By Gender</b>			
Colt	11,884	\$90,889	\$64,711
Filly	10,856	\$70,031	\$45,142
<b>By Date of Birth</b>			
Born before April 1st	13,043	\$88,143	\$56,246
Born After April 1st	9,697	\$71,231	\$54,189
<b>By Dam Age</b>			
Dam Age 4-10	11,875	\$80,510	\$80,510
Dam Age 11-15	7,127	\$80,717	\$54,940
Dam Age >15	3,738	\$82,680	\$44,477
<b>By Birth Rank</b>			
Birth Rank <=5	14,707	\$79,310	\$58,971
Birth Rank 6-10	6,389	\$83,558	\$50,100
Birth Rank >10	1,089	\$74,021	\$42,575
<b>By Sire Age</b>			
Sire Age 5-10	11,820	\$61,883	\$66,190
Sire Age 11-15	7,285	\$84,464	\$68,081
Sire Age >15	3,629	\$136,011	\$60,337

- We include 22,734 yearlings in this study, of which 9.69% are black-type horses. Of the 2,203 black-types horses, the 3rd crop has the highest chance of becoming black-type horses, 11.43%, followed by 2nd crop (11.12%), 5th (10.58%) and 4th (10.28%).
- More than 50% of the yearlings offered at the sale are out of younger mares (age 4-10 years old). The average price of progeny by mare age group is nearly identical; a decrease in the average career earnings of progeny is observed.

## EMPIRICAL MODEL

- Hedonic Price Model:
 
$$\ln(\text{price}_i) = \alpha + x_i\beta + \varepsilon_i \quad (1)$$
- Multivariate Regression Analysis:
 
$$\ln(\text{earnings}_i) = \alpha + x_i\beta + \varepsilon_i \quad (2)$$
- Marginal Effects:
  - For continuous variables  $x_i$ , (age, birthrank) the marginal value is estimated as:
 
$$MV = \beta_i \bar{x}$$
  - For other continuous variables  $x_i$ , we use the log form in the model, the marginal value is estimated as:
 
$$MV = \beta_i \left( \frac{\bar{x}}{\bar{x}} \right)$$
  - For dummy variables  $x_i$ , the marginal value is estimated as:
 
$$MV = \text{EXP}(\beta_i + \ln(\bar{y}_{i=0})) - \bar{y}_{i=0}$$

## RESULTS

Results from the three hedonic pricing models are below.

Dependent Variable	Model 1a	Model 1b	Model 1c
	LNPRICE	LNPRICE	LNPRICE
Variables Name	Parameter Estimate (Std Error)	Parameter Estimate (Std Error)	Parameter Estimate (Std Error)
Book2	-0.6473*** (0.0333)	-0.6469*** (0.0333)	-0.6473*** (0.0333)
Book3	-1.1149*** (0.0353)	-1.1150*** (0.0353)	-1.1149*** (0.0353)
Book4	-1.6875*** (0.0366)	-1.6888*** (0.0366)	-1.6874*** (0.0366)
Book5	-2.1127*** (0.0388)	-2.1127*** (0.0389)	-2.1125*** (0.0388)
Book6	-2.7505*** (0.0406)	-2.7523*** (0.0406)	-2.7503*** (0.0406)
Book7	-3.1539*** (0.0436)	-3.1555*** (0.0437)	-3.1536*** (0.0437)
Book8	-3.5137*** (0.0536)	-3.5138*** (0.0537)	-3.5132*** (0.0537)
DOB	0.0930*** (0.0155)	0.0938*** (0.0154)	0.0934*** (0.0156)
Filly	-0.1028*** (0.0151)	-0.1025*** (0.0151)	-0.1028*** (0.0151)
RNA	-0.3163*** (0.0175)	-0.3166*** (0.0175)	-0.3162*** (0.0175)
lnStudfee	0.1671*** (0.0115)	0.1645*** (0.0115)	0.1668*** (0.0115)
DAMPROBT	0.3000*** (0.0215)	0.2873*** (0.0210)	0.3004*** (0.0215)
DAMBT	0.1066*** (0.0165)	0.1204*** (0.0168)	0.1080*** (0.0173)
CROP	0.0397*** (0.0165)	-	0.0412*** (0.0175)
CROP <sup>2</sup>	-0.0085*** (0.0025)	-	-0.0085*** (0.0025)
CROP <sup>3</sup>	0.0003*** (0.0001)	-	0.0003*** (0.0001)
DAM_AGE	-	0.1167*** (0.0345)	-0.0014 (0.0052)
DAM_AGE <sup>2</sup>	-	-0.0089*** (0.0027)	-
DAM_AGE <sup>3</sup>	-	0.0002*** (0.0001)	-
SIRE_AGE	-0.2159*** (0.0304)	-0.2140*** (0.0304)	-0.2159*** (0.0304)
SIRE_AGE <sup>2</sup>	0.0167*** (0.0021)	0.0166*** (0.0021)	0.0167*** (0.0021)
SIRE_AGE <sup>3</sup>	-0.0004*** (0.0000)	-0.0004*** (0.0000)	-0.0004*** (0.0000)
YEAR2007	0.1761*** (0.0239)	0.1871*** (0.0238)	0.1768*** (0.0240)
YEAR2008	-0.0949*** (0.0239)	-0.0840*** (0.0239)	-0.0943*** (0.0241)
YEAR2009	-0.6271*** (0.0241)	-0.6158*** (0.0240)	-0.6265*** (0.0242)
YEAR2010	-0.8726*** (0.0247)	-0.8619*** (0.0246)	-0.8719*** (0.0248)
Intercept	11.2931*** (0.1849)	11.4575*** (0.1849)	11.3022*** (0.1879)
N	22734	22734	22734
Adjusted R <sup>2</sup>	0.5275	0.5270	0.5274
F Value	1104.29	1207.35	1058.24
Prob > F	<.0001	<.0001	<.0001

Results from the three multiple regressions are below. (continued)

Dependent Variable	Model 2a	Model 2b	Model 2c
	LNEARN	LNEARN	LNEARN
Variables Name	Parameter Estimate (Std Error)	Parameter Estimate (Std Error)	Parameter Estimate (Std Error)
Book2	0.1466 (0.0884)	0.1471 (0.0884)	0.1466* (0.0884)
Book3	0.3207*** (0.0949)	0.3210*** (0.0949)	0.3204*** (0.0949)
Book4	0.5046*** (0.1009)	0.5065*** (0.1009)	0.5047*** (0.1009)
Book5	0.4319*** (0.1092)	0.4384*** (0.1092)	0.4343*** (0.1092)
Book6	0.4981*** (0.1177)	0.5062*** (0.1177)	0.5009*** (0.1177)
Book7	0.4801*** (0.1282)	0.4885*** (0.1282)	0.4837*** (0.1283)
Book8	0.3514** (0.1549)	0.3669*** (0.1549)	0.3578** (0.1550)
DOB	-0.0518 (0.0409)	-0.0363 (0.0407)	-0.0473 (0.0410)
Filly	-0.1727*** (0.0400)	-0.1734*** (0.0400)	-0.1730*** (0.0400)
RNA	0.2508*** (0.0468)	0.2513*** (0.0468)	0.2514*** (0.0468)
lnPrice	0.4312*** (0.0172)	0.4319*** (0.0172)	0.4312*** (0.0172)
lnStudfee	-0.2105*** (0.0311)	-0.2164*** (0.0312)	-0.2137*** (0.0312)

## RESULTS

Dependent Variable	Model 2a	Model 2b	Model 2c
	LNEARN	LNEARN	LNEARN
Variables Name	Parameter Estimate (Std Error)	Parameter Estimate (Std Error)	Parameter Estimate (Std Error)
DAMPROBT	0.0045 (0.0563)	-0.0114 (0.0554)	0.0110 (0.0565)
DAMBT	0.1060** (0.0436)	0.1484*** (0.0444)	0.1256*** (0.0459)
CROP	-0.0564*** (0.0078)	-	-0.0347** (0.0176)
DAM_AGE	-	-0.0434*** (0.0061)	-0.0190 (0.0138)
SIRE_AGE	-0.0249*** (0.0047)	-0.0246*** (0.0047)	-0.0248*** (0.0047)
YEAR2007	0.2318*** (0.0637)	0.2555*** (0.0636)	0.2407*** (0.0640)
YEAR2008	0.2272*** (0.0640)	0.2506*** (0.0639)	0.2362*** (0.0644)
YEAR2009	0.4851*** (0.0654)	0.5087*** (0.0653)	0.4938*** (0.0657)
YEAR2010	0.6391*** (0.0675)	0.6627*** (0.0675)	0.6481*** (0.0679)
Intercept	7.0993*** (0.4015)	7.3198*** (0.4075)	7.2184*** (0.4107)
N	22734	22734	22734
Missing Values	3620	3620	3620
Adjusted R <sup>2</sup>	0.0484	0.0483	0.0484
F Value	49.58	49.47	47.31
Prob > F	<.0001	<.0001	<.0001

Marginal Effects of Crop, Dam Age and Sire Age on Prices.

Polynomial Variables	Selection	LNPRICE		
		Models 1a (CROP)	Models 1b (DAM_AGE)	Models 1c (CROP, DAM_AGE)
Crop	Crop 2 <sup>nd</sup> -3 <sup>rd</sup>	\$728.57	-	\$890.47
	Crop 16 <sup>th</sup> -17 <sup>th</sup>	-\$161.90	-	-\$32.38
Dam Age	Dam Age 9-10:	-	\$50.20	-
	Dam Age 23-24	-	-\$551.64	-
Sire Age	Sire Age 10-11	-\$153.81	-\$161.90	-\$153.81
	Sire Age 20-21	\$412.86	\$291.43	\$412.86

Marginal Effects of Crop, Dam Age and Sire Age on Earnings.

Polynomial Variables	LNEARN		
	Models 2a (CROP)	Models 2b (DAM_AGE)	Models 2c (CROP, DAM_AGE)
Crop	-\$769.67	-	-\$473.54
Dam Age	-	-\$256.31	-
Sire Age	-\$144.15	-\$142.41	-\$143.57

## DISCUSSION & IMPLICATION

- Yearling buyers are willing to pay more for the 3rd crop foals, followed by 2nd and 1st crop foals.
- Buyers are willing to pay more for the foals out of younger mares (4-10 years old), foals by sires age from 11 to 18 years.
- Progeny birthrank, dam age, sire age all have negative effects on race earnings.
- Reverse effects are discovered:
  - Day of sale (Books), RNA, stud fee
- Nonsignificant variables:
  - Date of birth, dam produce record (black-type progeny)
- Provides information on yearling buyers' behavior at TB auctions:
  - Yearling sellers/owners : pricing strategies.
  - Breeders/Mare owners: breeding plans.
  - Stallion owners: stallion pricing & marketing strategies.
- Racehorse buyers can benefit from these findings in making investment decisions.

## CONTACTS

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