THESIS

A HEDONIC ANALYSIS OF THE CLOSURE OF THE EQUINE SLAUGHTER HOUSES ON HORSE PRICES

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ABSTRACT

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Unwanted horses are a significant problem for policymakers and equine stakeholders. Alternatives for resolving the problem are unclear, in no small part because it is difficult to disentangle the relative importance of several causes. This study considers the impact of several factors on the problem by quantifying their influence on horse auction prices. Analysis segments horses into investment and recreational markets, high value and low value equine segments and by gender. Results suggest the slaughter ban impacts auction prices of some segments significantly, but other impacts are negligible.

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INTRODUCTION

Unwanted horses are a growing and significant problem in the US. These horses are malnourished or abandoned by owners that lack sufficient resources to provide adequate care. Unwanted horses impose considerable costs on state or local governments charged with enforcing animal welfare laws (Zezima 2009). Finding suitable adopters for unwanted horses is problematic due to the underlying costs of ownership. Unwanted horses are an important fiscal and animal welfare problem (Ahern *et al.* 2006; Messer IV 2004; North *et al.* 2005).

Equine industry stakeholders and policymakers seek remedies for the unwanted horse problem. The causes of the problem may include the recent closure of the horse slaughter plants in 2006 and declining economic activity due to the recession. However, it is difficult to disentangle the causes of unwanted horses or the relative importance that one cause has among others so that policy alternatives can be debated, prioritized and perhaps adopted. The objective of this study is to disentangle the causes of the unwanted horse problem by examining prices paid in auction markets.

Horses provide several functions to purchasers in the marketplace including recreational riding, competitive horse showing and training, returns to invested capital with the sale of offspring, and protein in international meat markets. Observable characteristics (e.g., muscle confirmation, competitive performance history), or combinations of characteristics, signal the likelihood that horses will be suitable for any one of these functions. Yet, a market for individual characteristics does not exist, so researchers rely on the fact that attribute values are embedded in horse prices to learn about market efficiency and structural changes in supply and demand. This study examines the implicit market for horse characteristics when determining if horse prices are

softening due to the horse slaughter ban and/or macroeconomic conditions. Significant downward pressure on horse prices leads to unwanted horses when the benefits of ownership do not outweigh costs.

LITERATURE REVIEW

Relevant literature guides the methodology of the current study. The first economic models of attribute values in horses, also called hedonic models, used a fairly limited number of non-phenotypic characteristics (e.g., Commer and Hastings 1987 and 1990) that became the standard variables for analysis of racing thoroughbred auction prices. Later efforts (Chezum and Wimmer, 1997; Commer, 1990; Neibergs, 2001; Stoeppel and Maynard, 2006; Vickner and Koch, 2001) sought better proxies for horse characteristics and expanded the scope of markets to include thoroughbred yearlings and broodmares. Fewer studies consider performance and ranch quarter horses (Lange et al., 2010; Taylor et al., 2006). Interestingly, the studies of ranch horses and quarter horses generally have lower statistical goodness of fit measures; in part because ranch horses and quarter horses are evaluated more on quality of movement and conformation rather than on the more quantifiable attributes such as show performance and genetics.

Macroeconomic shocks such as economy-wide recessions can structurally change the demand or supply of horses. As an example, it is hypothesized that recession reduce disposable income thereby depressing prices for recreational horses that may be luxury goods. Karungu et al. (1993) expanded horse pricing models to include macroeconomic variables, but not through the use of a hedonic model; rather, the authors treated thoroughbred yearlings as investment goods whose value is found with a capitalization model. Yearling prices are then a function of expected earnings, the tax rate, the interest rate, expected length of racing career of the horse, and the expected income from breeding. Buzby and Jessup (1994) integrate macroeconomic

variables into hedonic models to yield a more accurate explanatory model of yearling thoroughbred price.

Macroeconomic shocks can create structural shifts in demand, but so too might a ban on horse slaughter facilities. Several authors consider animal welfare both before and after the closure of the plants (Ahern *et al.* 2006; AVMA 2011; Coalition 2009; Durfee 2009; Jacobson *et al.* 2008; Messer IV 2004), but few papers looked at economic consequences. An exception is North et al. (2005) estimating a loss in value of $300 per horse using a net present value approach. Since the closure of the plants, only the Government Accountability Office (2011) has published a hedonic study that uses quartile regression to reveal the effect of the ban on a lower value, residual market for horses, rather than a market for thoroughbred, other racing stock or ranch horses.

Two common themes are exhibited by the previous studies. First, the authors all use auction data in a reduced form approach when examining the market for particular characteristics due to a lack of systematic, structural data. Characteristics of genetic type, sex, age and performance are important, and are included in the current study. It's also clear that no one study combines a hedonic modeling approach with macroeconomic variables and the horse slaughter ban on higher value, primary demand horse markets. Indeed, the specific contribution of this study is to disentangle the impact of the economy and horse slaughter ban on the prices of high end horses controlling for specific characteristics. Further examination focuses on recreational horse market vis a vis investment markets.

CHARACTERISTICS OF HORSE AUCTION MARKETS

The horse auctions considered in this study are held in Oklahoma City in November of each year concurrent with the AQHA World Show and is widely advertised within the industry. This competition brings in horses, horse enthusiasts and horse buyers from all over the country and world. The sale is open to any buyer or seller. Sellers pay a consignment fee and commission on any horse sold. Auctions are held in arenas in which the horse may be observed and a sales catalog contains relevant measurement of attributes and bloodlines. Sales are consummated through an open outcry auction coordinated by an auctioneer.

Horse auction prices are influenced by observable attributes including age, breed, size, show record, parents, and color among others. An auction buyer's bid price depends on their preferences for these characteristics, and preferences vary according to function. For example, younger horses typically represent an asset whose future earnings from competition and breeding represents the rents from investment. An older horse is more useful for teaching beginning riders and can be used for lessons, shows, and recreation because they tend to be calmer and are more reliable. Thus, age is an important characteristic in determining an auction price.

It's also true that macroeconomic conditions influence auction prices. Investment horses are luxury goods whose prices tend to track the business cycle. When consumer expectations of macroeconomic performance or household income are positive, investment expenditures in horses is increasing. In contrast, buyers of older horses are more cognizant of ownership costs. The older horse market is bolstered when feed prices are declining. Also when the economy is doing well, more discretionary income is available for recreational horse purchases and riding lessons.

Slaughter horse buyers do not participate in the higher value, primary auction markets that are considered in this study, but a relevant question is the "floor" that slaughter demand places on horse prices. The slaughter market provides a benchmark value for horses. Investors know that if a horse is not profitable (e.g., due to injury) it could be sold at a reservation price that is found in meat markets. Likewise, older recreational horses can be sold when they can no longer perform functions or otherwise need be euthanized. If slaughter market channels are closed, unwanted horses become expensive liabilities (North et al, 2005). Thus, it is hypothesized that both the slaughter market ban and macroeconomic conditions can put downward pressure on horse prices and contribute to the unwanted horse problem. The next section describes how these hypotheses are tested while controlling for important horse attributes.

METHODS

The previous discussions set the stage for a hedonic model of auction prices regressed on important attributes and structural variables. A hedonic approach estimates the relative importance of economic variables by specifying a reduced form in which observed auction prices are regressed on variables representing important supply and demand factors. The current study follows established practice (Lange *et al.* 2010; Taylor *et al.* 2006; Vickner and Koch 2001) when specifying the following:

$$(1)\ P_{i,t} = f(Z_{i,t}, C_t, S_t, M_t)$$

where α_i is an observed price received for horse i during an auction at time t, Z a vector of observed horse characteristics, and C is the vector of costs of production, S is a dummy variable representing the horse slaughter ban and M an index of macroeconomic variables measured at t. Equation (1) is given its empirical form by postulating specific variables and parameters to be estimated in as a linear function:

$$(2)\ P = \alpha_1 * age + \alpha_2 * age^2 + \alpha_3 * stallion * age + \alpha_4 * aqhapoints + \alpha_5 * dampoints + \alpha_6 * hipno + \alpha_7 * pedavailonline + \alpha_8 * sirespeed + \alpha_9 * mare + \alpha_{10} * gelding + \alpha_{11} * stallion + \alpha_{12} * sirepoints + \alpha_{13} * slaughter + \alpha_{14} * expectations + \alpha_{15} * unemployment + \mu$$

When estimated, the relative values of the parameters indicate the relationship between horse attributes and the structural variables and the observed prices. Attribute parameters are implicit values that auction buyers have made and are expected to be consistent with buyer preferences. The definitions of variables and the hypothesized relationship with observed auction prices is summarized by Table 1. Particular attention is focused on the last two variables: slaughter and expectations. The slaughter variable is a dummy variable measured as 1 after the slaughter ban's impacts are imposed in the industry, and the expectations variable is a proxy for consumer confidence in macroeconomic activity.

Table 1. Variables, Parameters and Hypothesized Signs in the Hedonic Estimation

Variable	Parameter	Expected Sign	Meaning	Units
age	α_1	+	Age of horse when sold	Dollars
age^2	α_2	-	Squared Age of horse when sold	Years
age*stallion	α_3	+	Interaction term	Years
aqhapoints	α_4	+	Performance points in competitions	Years
dampoints	α_5	+	Dam points earned	Points
hipno	α_6	+	Order of sale in auction	Number
pedavailonline	α_7	+	pedigree available at allbreedpedigree.com	Dummy
sirespeed	α_8	+	Published speed index	Index
mare/ gelding/ stallion	α_9 , α_{10}, α_{11}	?	Gender of Horse	Dummy
sirepoints	α_{12}	+	Sire points earned	Points
slaughter	α_{13}	+	1 if allowed to slaughter, 0 if no slaughter	Dummy
expectations	α_{14}	+	Economic Index	Index
unemployment	α_{15}	-	Economic Index	Index

DATA

In order to determine if the closure of the slaughter plants has affected the price of horses, data from an auction that occurred both before and after the closure is needed. The auction data is from the AQHA World Championship Sale that occurs in November during the AQHA World Show. Data was collected for the years 2004 through 2010. The results from the sale are publically available and can be found on www.professionalauction.com. The published results include information about sale price, age, gender, and hip number for each horse, and these are given specific labels in Table 1. Pedigree and performance information is available from www.allbreedpedigree.com. This website has pedigrees for about half the horses sold as well as information about race and show results for horses, sires and dams. Prices are deflated with the consumer price index.

Most horses within the dataset were bred or used for performance and halter competitions. The AQHA awards points for horses placing in performance and halter classes at AQHA recognized competitions throughout the year. Show points are indicators of both quality of the horse and showing experience and intensity with greater point totals indicating greater success.

Racing horses or those with racing parents, are given a speed index to indicate quality and potential of the horse. The speed index is based on past performance at the race track and is an average of race times.

Several studies argue the order of sale is a significant factor in the modeling of horse prices at auction (Lange et al., 2010; Taylor et al, 2006; Stoeppel and Maynard 2006) because buyers gather information from early transactions at the auction without actually bidding. A horse's hip number (hipno in Table 1) indicates the rank in the auction in the current study. Be-

cause buyers wait to bid, earlier horses in the auction will go for less and later horses will go for more, so the hip number coefficient should be positive.

Macroeconomic and price index variables are acquired from a variety of sources. The consumer expectations variable is collected by the University of Michigan and available at the Federal Reserve Bank Economic Research website as the consumer sentiment index (2011). Unemployment data is collected by the Burea of Labor Statistics.

Table 2 lists summary statistics of the data used in this research. While age (four years old) and gender proportions (two-thirds mares) sold are similar in both periods, several other variables differ significantly. The first major difference is in the price variable. The mean price and standard deviation before the slaughter ban was over $3,100 and $5,207 with the price and standard deviation falling to $2774.75 and $4377.32 after the slaughter ban was enacted, respectively. The maximum auction price received before the slaughter ban is roughly twice the maximum price received after the slaughter ban.

Sires earn their breeding fees by competing in the show ring, and therefore tend to have more show points than dams. The average AQHA points earned by the horses were low because they tend to be young and therefore inexperienced. It also appears that sellers increased marketing efforts after the closure of the plants. This is seen both in the increase in the average number of AQHA points the horse earned and the increase in the number of horses whose pedigrees were found online.

Table 2. Summary Statistics[1] for Variables Used in the Hedonic Estimation (N=2415)

Slaughter 2004-2006	Mean	Standard Deviation	Minimum	Maximum
Hip#	278.61	161.07	1.00	612.00
Age	4.32	4.32	-1.00	20.00
Mare	0.70	0.46	0.00	1.00
Gelding	**0.14**	**0.35**	**0.00**	**1.00**
Stallion	0.16	0.37	0.00	1.00
Price	**6,152.25**	**10,217.18**	**0.00**	**200,000.00**
Real Price	3,157.28	5,207.77	1.00	99,206.35
Pedigree Available Online	0.48	0.50	0.00	1.00
Sire AQHA Points	**41.87**	**227.01**	**0.00**	**6,000.00**
Dam AQHA Points	5.14	30.21	0.00	360.00
AQHA Points	2.81	21.97	0.00	367.00
Sire Speed Index	1.07	10.04	0.00	117.00
Non-Slaughter 2007-2010	Mean	Standard Deviation	Minimum	Maximum
Hip#	208.85	121.61	1.00	606.00
Age	4.27	4.36	-1.00	24.00
Mare	0.67	0.47	0.00	1.00
Gelding	**0.18**	**0.38**	**0.00**	**1.00**
Stallion	0.14	0.35	0.00	1.00
Price	**5,926.47**	**9,360.62**	**0.00**	**103,000.00**
Real Price	2,774.75	4,377.32	1.00	49,686.44
Pedigree Available Online	0.48	0.50	0.00	1.00
Sire AQHA Points	**25.97**	**111.84**	**0.00**	**2,030.00**
Dam AQHA Points	7.87	59.66	0.00	1,507.00
AQHA Points	3.71	21.23	0.00	420.00
Sire Speed Index	0.49	6.82	0.00	101.00

1 Means of Dummy Variables (x100) are the percentages of each represented in the auctions. Dummy variables are Mare, Gelding, Stallion, and Pedigree Available Online.

Horse of Age -1 are Embryos sold at the auction

RESULTS

Initial Sample Estimation

The parameters from equation (2) are estimated using ordinary least squares with standard errors estimates corrected for heteroskedasticity using Whites method (Gujarati and Porter 2009). Estimates are reported in Table 3 with asterisks indicating levels of significance.

Table 3 Initial Hedonic Results with Slaughter Dummy

Variable	Coefficient
AGE	201.94***
AGE^2	-16.65***
AGE*STALLION	777.83***
AQHAPOINTS	40.58***
DAMPOINTS	2.38
HIP	1.78**
PEDAVAILONLINE	504.52***
SIRESPEEDINDEX	-8.25*
MARE	1683.82***
GELDING	892.54***
STALLION	921.76
SIREPOINTS	1.05
SLAUGHTER	309.95*
R-squared	0.10

Log Likelihood statistic -23778.53
***Significant at the 1% level
**Significant at the 5% level
*Significant at the 10% level

Table 3 indicates that most variables are statistically significant in explaining the variation in auction prices, but the goodness of fit of the entire set of variables does not explain auction price variation well (measured by R-squared). Lack of fit may be because of the means by which horse buyers formulate bid prices. Horses are not only valued by their papers and show records, but also by many hard to quantify qualities such as conformation, color, quality of movement, and temperament that are viewed in the auction ring.

The horse attribute results are consistent with expectations and the other literature with age, aqhapoints and hip number being statistically significant and of the expected sign. As shown in the results, the slaughter dummy is positive and significant at the 15% level. The parameter estimates suggest that when the slaughter plants were open, the horses sold at this auction were worth $309 more to buyers than after the slaughter plants closed. That is about a 10% drop in price for the average horse. These results warrant further investigation into which segments of the industry were most affected by the slaughter ban.

Split Sample Estimation – Age and Gender

As mentioned previously, horses may be purchased as investment from which future earnings are derived (the investment segment of the market) or for recreational riding (recreational segment). The slaughter plant closure likely impacted the investment segment more than the recreation segment of the industry. These horses have an uncertain stream of income associate with them; that is, breeders cannot perfectly forecast the quality of offspring. Horses that do not sire profitable offspring (or provide stud fee revenues) may have ownership costs exceeding their returns. The slaughter market is a residual market for these horses, and reduces the risk of purchasing investment horses. It provides a minimum value for the horse so that the buyer is not losing money disposing of the horse if it is not profitable. Without the slaughter market, buyers are forced to pay for euthanasia and disposal of the horse and investing in horses becomes riskier. This may have caused the investment horse market to change more significantly than the recreational horse market.

To test this empirically, the data is split into younger and older horses and is split into breeding stock groups. The divide of younger and older horses is at 3 years when the horse be-

comes rideable and has started its show career. The breeding stock are mares and stallions, the non-breeding stock are geldings. These groups are then divided by the closure of the slaughter plants and implicit prices are compared. The results in tables 4 and 5 show how the segments of the horse industry are impacted differently.

Table 4 Slaughter Impact on Investment and Recreational Segments
Dependent Variable is Auction Price

	Young Horses	**Older Horses**
Variable	**(Investment)**	**(Recreational)**
AGE	97.19	-8.75
AGE^2	-48.23	-8.59
AGE*STALLION	577.77	773.15
AQHAPOINTS	63.06**	37.52**
DAMPOINTS	10.98	1.21
HIP	0.39	3.65**
PEDAVAILONLINE	223.83	629.18**
SIREPOINTS	0.25	5.62**
SIRESPEEDINDEX	-6.09	-8.45
MARE	2435.61***	1967.10
GELDING	1707.57***	1111.36
STALLION	1886.71***	1335.99
SLAUGHTER	-92.65	729.55**
R-squared	0.04	0.14

Table 5 Slaughter Impact on Breeding Stock versus Geldings
Dependent Variable is Auction Price

	Breeding Horses	**Geldings**
Variable		
AGE	178.75**	574.98***
AGE^2	-15.91***	-39.25***
AGE*STALLION	769.68***	
AQHAPOINTS	45.34***	29.33
DAMPOINTS	3.48	-7.03
HIP	1.97**	3.33***
PEDAVAILONLINE	695.73***	-153.51
MARE	1590.40***	
STALLION	815.53	
SLAUGHTER	379.13*	300.83*
R-squared	0.10	0.11

***Significant at the 1% level
**Significant at the 5% level
*Significant at the 10% level

Table 4 shows how younger and older horses are valued differently. For younger horses, gender and show record mattered significantly more than other factors. Because these horses are investments, being able to breed and then sell off their offspring is more important than for older horses. Contrary to expectations, the slaughter closure impacted the older horses more than the younger horses. The slaughter variable is the wrong sign and not significant, there may be other factors driving the purchase of these younger horses such as macroeconomic factors such as economic recession. The time series is not large enough to fully test annual macroeconomic data.

Older horses may have been harder hit by the slaughter closures for several reasons. Buyers may be looking for horses than can turn over a profit more quickly so younger horses are more valuable for resale. Buyers may not be expanding recreational herds and may consider older horses too much of a risk.

Table 5 shows how breeding stock is valued compared to non-breeding stock. For breeding stock, their pedigree being available online and their performance are highly valued compared to non-breeding stock where their performance record is a more important determinant of their price. The slaughter dummy variable indicates that the breeding stock lost more value than the non-breeding stock.

Macroeconomic Factors: Consumer Expectations and Unemployment Rate

Two macroeconomic factors were tested in the model, consumer expectations and the unemployment rate. When the consumer expectations variable is included, slaughter becomes insignificant and the wrong sign. This may be because that consumer expectations fell at the same time as the slaughterhouses closed and that there is not enough variation in the slaughter dummy to pick up the full effect of the closure. When the unemployment rate is included, it is found to

be insignificant in the model and slaughter continues to have a negative effect on horse prices. This may also mean that there are other macroeconomic factors affecting the market that are not measured by these variables. Expectations and Unemployment Models.

Table 6. Adding Macroeconomic Variables: Expectations and Unemployment
Dependent Variable is Auction Price

	Expectations	**Unemployment**
Variable		
AGE	209.40***	200.75***
AGE^2	-16.84***	-16.64***
AGE*STALLION	781.47**	775.61**
AQHAPOINTS	40.47***	40.89***
DAMPOINTS	2.23	2.49
HIP	1.61**	1.76**
PEDAVAILONLINE	390.10**	528.79***
SIRESPEEDINDEX	-9.47**	-8.61*
MARE	-973.52	1056.80**
GELDING	-1795.37***	290.20
STALLION	-1720.86**	304.33
SIREPOINTS	1.02	1.06
SLAUGHTER	-392.78	501.41*
EXPECTATIONS	37.95***	
UNEMPLOYMENT		83.90
R-squared	0.11	0.11

Because these results may show that slaughter is not significant, especially in the expectations model, more comparison between the two time periods was needed. To test if there was a structural change between the periods, a chow break-point test was performed on both models. As shown in the chart, both models have a break-point when the slaughter plants closed at the 1% probability level. This is especially important to note for the expectations model as it means that while the slaughter dummy variable did not capture the effect of the closure, there was a structural change in the market at the same time the plants closed.

Table 7. Structural Breakpoint Test

	Chow Break Point Test Statistic	Probability	F-Critical
Unemployment Model:	4.48	0.05	**1.70**
Expectations Model:	4.50	0.01	**2.09**

Quality Analysis

Further exploration of which horses were most affected by the closure of the slaughter plants is done by sorting observations into a low price category and a high price category. The sort is performed with two measures: mean price and median price.

Table 8. Estimated Parameters when Population is Split By Median or Mean Price
Dependent Variable is Auction Price

	Mean		Median	
	Low	High	Low	High
Variable	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
AGE	40.52***	-23.14	8.33	122.39
AGE^2	-2.43***	-5.73	-0.69	-14.49
AGE*STALLION	43.65***	850.65*	43.49***	874.07**
AQHAPOINTS	0.54	33.42**	1.12	40.85**
DAMPOINTS	0.56**	2.17	-0.12	-0.13
HIP	0.00	2.92	0.12	2.92**
PEDAVAILONLINE	-18.60	931.23**	4.17	778.93***
SIRESPEEDINDEX	-2.53	-17.20	-0.82	-8.31
MARE	1192.05***	5667.25***	832.10***	3401.44***
GELDING	1085.46***	3968.27***	794.55***	2442.44***
STALLION	1057.48***	5398.55***	716.33***	2861.55***
SIREPOINTS	0.01	2.44	0.04	3.27**
SLAUGHTER	164.91***	32.64	117.31***	-22.55
R-squared	0.01	0.09	0.03	0.11

Estimated parameters are similar between the mean and median split categories. The numbers are slightly different if you split by median price or mean price, but both models tell the same story. The slaughter variable is significant in the lower priced horses while its estimated impact may be higher in the high priced horses. This result may be due to the higher priced horses being much more variable in prices. The high price group includes horses sold from around $3,000 to $100,000. The lower priced horses have a greater risk attached to them, while investors pay less, and hope to get their money back through training or showing the horse they may also end up with a horse that is not valuable enough to breed or sound enough to show. The higher value horses have had their values established either through their pedigree or show record and are often already proven to be valuable breeding stock and sound to compete.

Slaughter closure impact over time

Finally, to see how the closure of the plants affected the value of horses over the time period studied, parameters are estimated at incremental time steps. For example, the parameters are estimated using the first year's data (2007), and then parameters are estimated for a two year time step (2007-2008) et cetera. As seen indicated in Table 9, the estimated impact of the slaughter variable is small and statistically insignificant, but increases over the next several years. The market appears to have started adjusting by 2010 as the total combined impact is much smaller when that year is included.

Table 9. Time Step Regressions
Dependent Variable is Auction Price

	2007	2007-2008	2007-2009	Total Impact
Variable	**Coefficient**	**Coefficient**	**Coefficient**	**Coefficient**
AGE	201.24*	165.04*	232.80***	201.94***
AGE^2	-15.29*	-13.31*	-17.33***	-16.65***
AGE*STALLION	1,377.06***	1,185.56***	909.82***	777.83***
AQHAPOINTS	50.59**	41.47***	41.13***	40.58***
DAMPOINTS	-0.62	0.60	0.29	2.38
HIP	2.74***	2.97***	3.22***	1.78**
PEDAVAILONLINE	659.77***	689.33***	685.91***	504.52***
SIRESPEEDINDEX	-11.35*	-8.97*	-9.22**	-8.25*
MARE	1,517.18***	1,180.18***	965.04***	1,683.82***
GELDING	625.45	476.74	351.19	892.54***
STALLION	-367.34	-432.54	-148.17	921.76
SIREPOINTS	1.03	1.03	1.07	1.05
SLAUGHTER	80.20	430.44**	430.45**	309.95*
R-squared	0.18	0.16	0.14	0.10

CONCLUSION

The closure of the horse slaughter plants has been a controversial topic in the US and was opposed by many in the industry due to fears of loss of value of the horses which would lead to increased levels of abuse and abandonment. Within just a few years years after the closure of the plants many of these fears have come to fruition as seen in news articles and other reports. This study has shown that many of these issues may be due to horses losing market value after the closure of the slaughter plants. The loss of value for horses has been felt even at the highest level of horses as shown in this study by using horses sold at the AQHA World Sale. The slaughter market was an important residual market for the horse industry to keep investors involved and the market value of horses high enough that their lives are valuable to their owners.

The closure of the slaughter plants has had a significant impact on the market price of horses sold at the AQHA world sale. This shows that the ban had far reaching effects beyond just the horses that would have been slaughtered. The AQHA sale has some of the top horses in the industry and these horses are not likely to end up sold to slaughter houses for meat. Since the lack of the residual market is measurable in these top horses, this means that lower end horses that are likely to end up in the slaughter market are probably affected by this ban significantly more. The lack of a residual market has increased the risk in the industry and has hurt investment in the industry.

LIMITATIONS

This study has suggested that the closure of the slaughter plants is a significant contributor to the unwanted horse problem. As discussed earlier there are several ways to improve upon this research. These include improvements in the model and data on the horses. These improvements would create a clearer picture of the horse market and allow the conclusions to be more definitive on the sources of the unwanted horse problem. With more definitive conclusions, a better case could be built for the policy solutions that would solve the unwanted horse problem.

To improve the model there are several paths that could be taken. If the data could be gathered, creating a structural model of the horse market would allow for a clearer picture of how the supply and demand shifters are affecting the market. As stated in the introduction the information such as systematic horse slaughter numbers, export quantities, and prices are not tracked in the US and would be necessary to create the structural model.

If a structural model cannot be created from lack of data, the reduced form hedonic model can still be improved with data that is available within the breed associations. The AQHA and the Jockey Club keep records on all horses registered within their associations including information about color, complete show records, sire and dam cross results all of which could be used to create a more complete model of the differences in quality of the horses sold at their auctions around the country. This data is available but at a cost of $20 or more per horse. Being able to control more fully for the quality differences in horses will allow the true significance of the macroeconomic variables to be realized.

This study was also limited in that it only looked at one auction at one time of year. Most horse auctions do not post electronic results from their auction for public use. If results from sev-

eral auctions held throughout the year and throughout the country could be obtained, results would be more reflective of the total impact of the closure of the slaughter plants on the horse industry. Included in this would also be the use of a longer time period before the closure of the plants to more fully account for the change in the horse market.

This study was further limited by its use of only AQHA registered horses. While the Quarter Horse has the highest population of horses in the US, registered horses are least likely to be affected by the closure of the slaughter plant. Registered horses are bred to show and reproduce, and are much less likely to end up at the slaughter plants than grade or unregistered horses. Some horse professionals have postulated that thoroughbreds may be more likely to end up in slaughter houses because of their temperament and heavy racing at a young age which often causes career ending lameness. These hypotheses should be tested in further research.

The results of this study warrant further research with a more robust data set. It is clear even from the limited data and modeling techniques that slaughter has had a negative impact on the price of horses and this issue should be addressed with further research with the goal of determining a policy solution to the unwanted horse problem.

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