The Price of Fame: The Effect of Award-Winning Pedigrees on the Price of Livestock Genetics

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Abstract

We estimate the impact of winning an award at a cattle show on the price of cattle genetics and that of their relatives. Dairy farmers choose from various dairy bulls for breeding. These bulls possess genetic traits that reflect their productivity, resiliency to disease, and physical characteristics. Another relevant attribute of dairy bulls is their pedigree prestige, which dairy farmers can use as a proxy for quality. We test the importance of pedigree prestige in determining dairy bull prices by examining the winners and runners-up of "Premier Sire" at the annual World Dairy Expo. Using an event study framework, we find that bulls that win Premiere Sire experience a 10% in their price compared to the second-place winner. This impact is also transmitted to their relatives, meaning the effects of prestige spillover into their genetic network.

1 Introduction

The United States is the world's leading dairy genetics exporter, with 46.4% of global sales in 2019. Consequently, any improvement in genetics indigenous to the US spreads quickly. This is also true for "celebrity sires", or animals in high demand due to their genetic traits or pedigree.

Dairy farmers periodically make breeding decisions to change the genetics of their herd by choosing a bull from the vast market of bull genetics available through artificial insemination. Each bull possesses a series of traits that may matter to dairy farmers, ranging from production traits such as milk yield to health traits such as fertility. Most of the extant literature, for example, Sy et al. (1997) and Richards and Jeffrey (1996), assume that dairy farmers choose health or production traits to maximize farm profits, which motivates a hedonic approach. In these analyses, they find that, in addition to health and production traits, the popularity of the bull is correlated to a higher price, even independent of other characteristics.

This analysis examines two missing characteristics from these models: pedigree, a key component of animal genetics pricing. It is challenging to consider pedigree to determine the price of a bull since it is not a quantitative or qualitative trait that can be included directly in a linear regression for the animal's price. However, the importance of pedigree manifests in several ways in the market for bull genetics, and one major one is through awards at cow shows. The other missing factor is the actual impact of cattle shows on the price of bulls; for lack of a proper measure of its impact on genetic prices, economists have not analyzed how it affects them. In this paper, we use the results of the world's most important dairy cattle show contest to measure its impact on the price of winners and their immediate relatives.

The World Dairy Expo meets every year and selects a "premier sire" that meets various show cattle criteria, namely physical traits, referred to as "type." While high "type" sires often have traits that correlate to traits that matter to farm profits, it may be that the award-winning status of the sire is a significant driver of price, even independent of traits considered crucial to profit. Our analysis determines whether award-winning pedigrees can explain price independent of production and health traits in the market for dairy bull genetics.

Understanding the relationship between pedigrees and the adoption of genetics is crucial for the dairy industry; the influence of pedigree can lead to repeated adoption of only a few genetic lines, which can negatively impact productivity because of inbreeding depression (Bjelland et al., 2013, Wiggans et al., 1995). Inbreeding depression is the increased prevalence of recessive (i.e., low frequency) traits caused by the mating of closely related individuals, and it is a pressing problem in dairy for breeds like the Holstein. For example, around 99% of US Holstein pedigrees can be traced back to only two ancestors: "Pawnee Farm Arlinda Chief" (born in 1962) and "Round Oak Rag Apple Elevation" (born in 1965)(Yue et al., 2015).

Thus far, very little has been written regarding the role pedigree plays in cattle genetics pricing; in this article, we use the pedigrees of winners and runner-ups of the "Premier Sire" category at the World Dairy Expo to disentangle the extent to which being related to such animals impacts animal's prices in the periods immediately after winning the price. Testing the effect of winning a dairy cattle show on the price of a bull and its relatives is a practical and tractable way to illuminate how critical famous pedigrees are to farmers when choosing bulls.

We use data on genetics traits, pedigree, and prices of bull semen from the Council on Dairy Cattle Breeders for the winners and runner-ups from the World Dairy Expo from 2002, 2003, and 2004. We chose these years because there was a very high turnout of top sires, which allows us to identify pedigree effects on prices. Our econometric analysis shows that the price of genetics for winners and relatives increased around 12% in the period immediately after winning the competition. Still, such a price premium is transitory because it quickly returns to zero after two periods.

2 Background and Conceptual Framework

2.1 The World Dairy Expo

The World Dairy Expo (WDE) is an annual event in October in Madison, Wisconsin, United States. It is one of the world's largest dairy-focused trade shows and cattle exhibitions since its creation in 1967. The expo allows dairy farmers, industry professionals, and enthusiasts to come together to showcase the latest innovations in dairy farming, technology, and genetics.

Among several activities, the WDE includes cattle shows for most dairy breeds from North America (Holstein, Ayrshire, Brown Swiss, Jersey, and Milking Shorthorn.) However, for this article, we will concentrate only on Holsteins. Any cow is eligible to participate if it has an Animal Identification Number (AIN) provided by the USDA to correctly identify the animal and link it to its production records from the National Dairy Herd Improvement Association (DHIA), as required for some classes.

There are several classes (categories) depending on the animal's age (yearling, two, three, four, five, and six-year and older old cow), production, offspring, and date of birth. We focus our attention on the top category for bulls: *Premier Sire*. A bull gets points as a function of the points earned by his daughters and their number of occurrences in the competition, which are counted and inputted to him. Consequently, a bull gets more points due to his daughter's performance and how many compete in any given year.

The Premier Sire does not participate directly in the WDE and can still win points even after passing away. For example, the bull "Braedeale Goldwyn" won the Premier Sire category from 2008 to 2019, despite having died in 2008. This post-mortem winning streak is because his daughters won in almost every category (Steyn et al., 2023), Table 1 shows the winners and runner-ups for 2000 to 2010, there is a significant turnover from 2000 to 2004, but it disappears after 2004.

Year	Winner	Runner-up
2000	Donnandale Sky Chief	Boulet Charles
2001	Marcrest Encore	Duregal Astre Starbuck
2002	Lystel Leduc	Boulet Charles
2003	Lystel Leduc	Regancrest Elton Durham
2004	Regancrest Elton Durham	Lystel Leduc
2005	Regancrest Elton Durham	Lystel Leduc
2006	Regancrest Elton Durham	Regancrest Dundee
2007	Regancrest Elton Durham	Regancrest Dundee
2008	Braedale Goldwyn	Regancrest Dundee
2009	Braedale Goldwyn	Regancrest Dundee
2010	Braedale Goldwyn	Wilcoxview Jasper

Table 1: World Dairy Expo Premier Sire winners and runner-ups 2000-2010

Dairy farmers have two motives for weighing the importance of a pedigree in their adoption decision. First, the importance of dairy cattle shows in the dairy industry may implicitly bias farmer decisions towards cows that are likely to win shows, much in the same way, that consumers factor the popularity of a brand into their purchasing decisions. Second, some dairy farmers selling heifers can increase their value by using pedigrees in high demand. Thus, the popularity of a pedigree can matter to farmers for both utility and profit, even independent of its production or health traits. Third, given the popularity of cattle shows in general, and the WDE in particular, dairy farmers are more likely to trust the opinion of WDE judges more than a wide array of genetic traits that can be very difficult to interpret without prior knowledge of genetics.

2.2 Measurement of genetic traits

Unlike their beef counterparts, dairy farmers do not usually keep bulls within their herds; they routinely buy bull semen from genetics companies to impregnate their cows. Dairy cattle present an additional complication: all relevant genetic traits are expressed only in females, and it is not possible to directly measure the contribution of a sire (father) to the productivity of his daughters. This problem was circumvented using *large-scale genetic evaluations* (Bourdon, 2000, p. 262) that measure cow's observed traits such as milk output, butterfat production, calving ease, or pregnancy rate are measured (evaluated) three times a year. After these data are gathered, the paternal contribution to observed values can be estimated using a statistical model incorporating the measured traits with the animal's pedigree and other fixed effects.

The predicted values from such a model are called **Predicted Transmitting Ability** (PTA); we call these values "genetic traits" and are public knowledge since the last measured values are usually reported when advertising a bull.

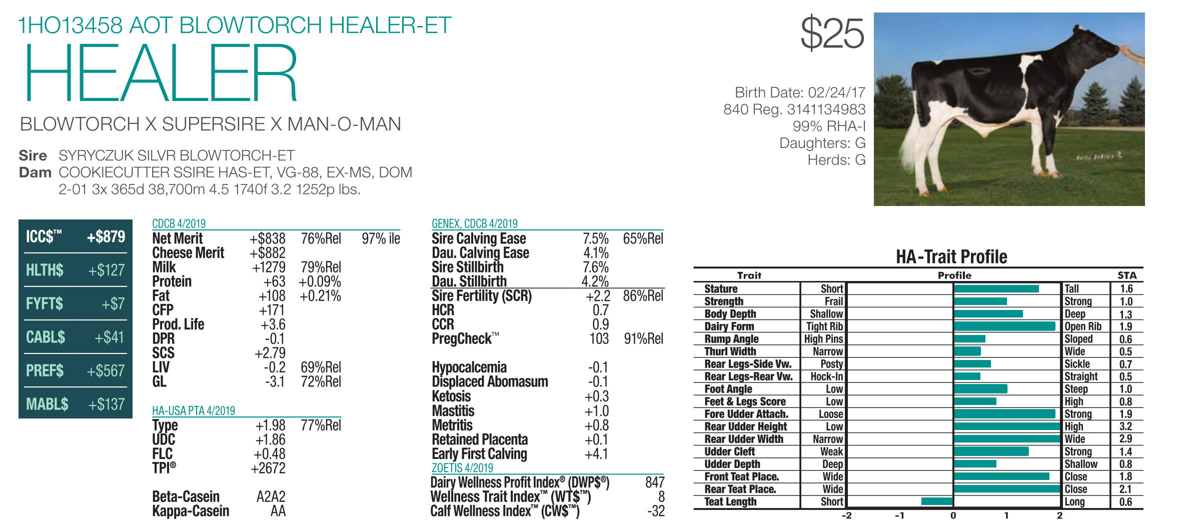

Figure 1: Sire Summary

Figure 1 is the summary for a bull called *Healer*; this document contains information on the animal's pedigree, that is, the identity of his sire (father), and dam (mother.) It also contains the last estimated values for the genetic traits he can transmit to his daughters. In the United States, dairy cattle genetic evaluations are reported by the **Council on Dairy Cattle Breeding** (CDCB), the date of measurement (April 2019 in this case.) The summary also contains a list of selection indexes (Melton et al., 1994), such as Net Merit, Cheese Merit, or Total Productivity Index (TPI); these are weighted averages of trait values measured in US dollars that capture the value of each animal in a single value that can be used to rank sires at any given time.

Pedigree plays a crucial role in the transmission of prestige. As long as a farmer knows an animal's sire, it is easy to tease out the degree of relatedness to a World Dairy Expo winner. Similarly, since genetic traits are complex to contextualize by means other than selection indexes, it is the case that a dairy farmer values prestige over genetic traits as a proxy for genetic quality.

2.3 Input Characteristics Model

Bull genetics is a crucial input in the dairy industry; its value is a function of a set of characteristics (genetic traits) that are useful to dairy production (fat/protein content of milk) or help reduce costs (somatic cell score or udder health traits). These traits cannot be purchased separately; they are "bundled" in the bulls' genotype; consequently, the price of genetics is a function of all relevant traits.

Ladd and Martin (1976) and Melton et al. (1994) present the pricing framework relevant to this problem, called the **Input Characteristics Model**, an adaptation of the neoclassical profit-maximization firm where the output is a function of a set of inputs and their characteristics.

In this framework, a dairy firm produces one output (milk), denoted by y, which is a function of a set of n inputs p genetic traits that enter the production function as an index $z(q_1, \ldots, q_p)$ such that:

$$y = f(z(q_1, \ldots, q_p)) \tag{1}$$

Note that the firm cannot choose the composition of $z(.)$ as it is supplied jointly by a genetics company. Let w_i denote the price of input i and r the price of one unit of genetic material (e.g., a straw of bull semen.)

Since $z(.)$ is assumed to be a linear homogeneous index:

$$z(q_1, \ldots, q_p) = \sum_{j=1}^{p} \frac{\partial z}{\partial q_j} q_j \tag{2}$$

Richards and Jeffrey (1996) and Walburger (2002) argue that the price paid by a dairy farmer depends on the marginal contribution of a specific bull to the farm's genetic stock; hence, the price of a semen straw must be equal to the sum of the values of all its genetic characteristics. Breeding decisions in the present are made to maximize the present value of a farm's herd, then the marginal contribution of a bull can be measured through the increment of the herd's net present value.

The value of each trait q_j is determined by its marginal impact on the price associated with index z, since the index is homogeneous of degree one, the price paid for a given index level is:

$$p_z = \sum_{j=1}^{p} \left[\frac{pf_z + \Delta V'(z)}{r} \right] \frac{\partial z}{\partial q_j} q_j \tag{3}$$

Where $\Delta V(.)$ is the change in the net present value of a dairy farm, pf_z is the value of the marginal product of z, and r is the market interest rate. The partial derivatives $\frac{\partial z}{\partial q_j}$ are assumed to be constant as a consequence of the breeding process. Animals are selected based on a weighted average of their traits, and these weights are the economic values attached to each trait (Hazel, 1943). There are several indexes frequently used by the dairy industry, such as the Total Performance Index (TPI), Net Merit (NM), and Grazing Merit (GM).

Then, a bull's value is equal to the sum of the values of all its traits, where the price of each characteristic is equal to its market value, defined as the price of the bull times the economic weight of each trait. Each r_k is the implicit price of trait k; since there are no individual markets for each trait, there can be no explicit market prices.

2.4 Hedonic Pricing

Equation 3 shows that there is a linear relationship between the price of a bull's genetics and the level of his traits; following Schroeder et al. (1992), we can estimate the equation:

$$price_i = \beta_0 + \beta_1 q_{1i} + \cdots + \beta_n q_{ni} + \epsilon_i \tag{4}$$

Where $price_i$ is the price of bull i, and q_{ki} is the k-th genetic trait, then each β_k is the implicit price of all traits. Most applications of hedonic pricing for genetic traits have focused on estimating equation 4 with cross-section data. Schroeder et al. (1992) is the earliest example of an article that uses the Ladd and Martin (1976) framework to derive a hedonic pricing scheme using 213 Holstein sires for the January 1990 evaluation. This paper uses 16 traits, two aggregate indexes, and firm fixed effects; the authors find that all productivity traits (milk, protein, fat, and reliability) are significant, as well as two udder type traits and leg width.

Another early example is Madalena et al. (1996), which uses data on semen prices and traits for a sample of 32 *Gyr* and 73 *Nellore* sires from Brazil in 1993. This paper includes two other elements not present in most of the related literature: pedigree and dummies for winning cattle shows; the former is included via regressing the price on the degree of relatedness to the "premier sires" of each breed to control for the effect of winning cattle shows a dummy equal to 1 for sires that were either winners of runner-ups of both national and state shows are included. The authors find that most of the effect is driven by the animals' pedigree and by the winner dummy rather than their breed, weight, or body measures; unfortunately, this article does not measure PTAs for productivity traits.

Carvalho et al. (2022) use a sample of 554 Gyr, Guzerá and Girolando dairy bulls from Brazil that were marketed in June 2019; they use PTAs for Milk yield, age at first birth, fat, protein, and solids, they also include genetic company, breed, and sexed semen dummies. Across breeds, only the milk PTA has a significant coefficient; concerning other variables, company, breed, and sex dummies are also significant.

Another line of research similarly uses surveys to choice experiments, Sy et al. (1997), for example, surveyed 253 dairy farmers in Manitoba, Canada, in August-October 1993. This method does not require actual observed semen prices, but instead of providing a partial effect of traits on prices, it allows the researchers to estimate a partial ordering (ranking) of preferences using an Ordered Probit model. Researchers were able to separate the effects on different segments of the cattle market (bulls and steers, breeders and feeders); in this sample, weaning weight, temperament, and calving ease are significant in determining rankings.

3 Data and Empirical Approach

3.1 Data description

Our data comes from the **National Association of Animal Breeders** (NAAB), a trade group of dairy genetics companies. Over the last 20 years, NAAB has reported the entire set of genetic traits for the dairy bulls marketed by its member companies and a posted price for advertising (Hutchins and Hueth, 2023).

To market a bull in the United States, the animal must be registered and tested ("evaluated") for the presence of a set of around fifty different genetic traits. The Council on Dairy Cattle Breeding (CDCB) calculates and publishes these traits thrice yearly (May, August, and November). Most U.S. traits are expressed as *Predicted Transmitting Abilities*, or PTAs, that measure the predicted difference of an animal's offspring from the average population. In most cases, PTAs are expressed in the units used to measure the trait. It is usual to summarise the data on a set of traits into an index, a weighted average of traits used to rank bulls (Lush, 1937).

We use these evaluation and price data for 4,262 bulls from 2000 to 2003, totaling 452 observations. The bulls in our data set are evaluated for 22 production, health, type, and reproductive traits (PTAs). Production traits predict future milk, fat, and protein yields of mature daughters in pounds compared to cows of the same breed born in the same base year. Health traits measure the heritability of a group of measures of life expectancy of cattle. Fertility traits capture a cow's ability to conceive as well as the likelihood of experiencing spontaneous abortions. Finally, type traits measure a series of visual traits of cows, which can be associated with the "beauty" of the cow and, therefore, highly regarded in cattle shows.

Our data set also contains information about each bull's male line ancestry, some dating back to the mid 20^{th} century (10 generations); this allows us to build up the pedigree for each bull in the sample. It is relatively easy to build up the pedigree by linking sons to sires and grandsires until the last recorded generation is found, however, this leaves us without a way to link animals to their brothers, (paternal) cousins, and half-brothers. We use the *ggroups* pedigree building R package (Nilforooshan and Saavedra-Jiménez, 2020) to get around this issue.

Finally, the data on World Dairy Expo winners from 2000 is publicly available on the expo website; we use the data for the **Premier Sire** category. For a bull to earn high enough points, he must either be the sire of a cow that earns top positions in several categories or have a large enough number of daughters in a similar position.

3.2 Empirical framework

Our objective is to determine the impact of an award-winning pedigree on the price of bull genetics, conditional on the levels of their genetic traits. To do so, we will exploit the high turnover rate between winners and runner-ups between 2000 and 2003, but such a situation did not repeat after 2004, due to a long reign of two "supersires": *Regancrest Elton Durham* and *Braedeale Goldwyn*, the latter extended his winning streak into 2019. Similarly, our hedonic pricing model requires that most bulls have a reported price included in their sire summary, but after 2010, most companies stopped reporting such asked prices in the summary. Figure 2 shows that the percentage of companies that do not report an ask price for their bull's genetics has steadily increased since 2010.

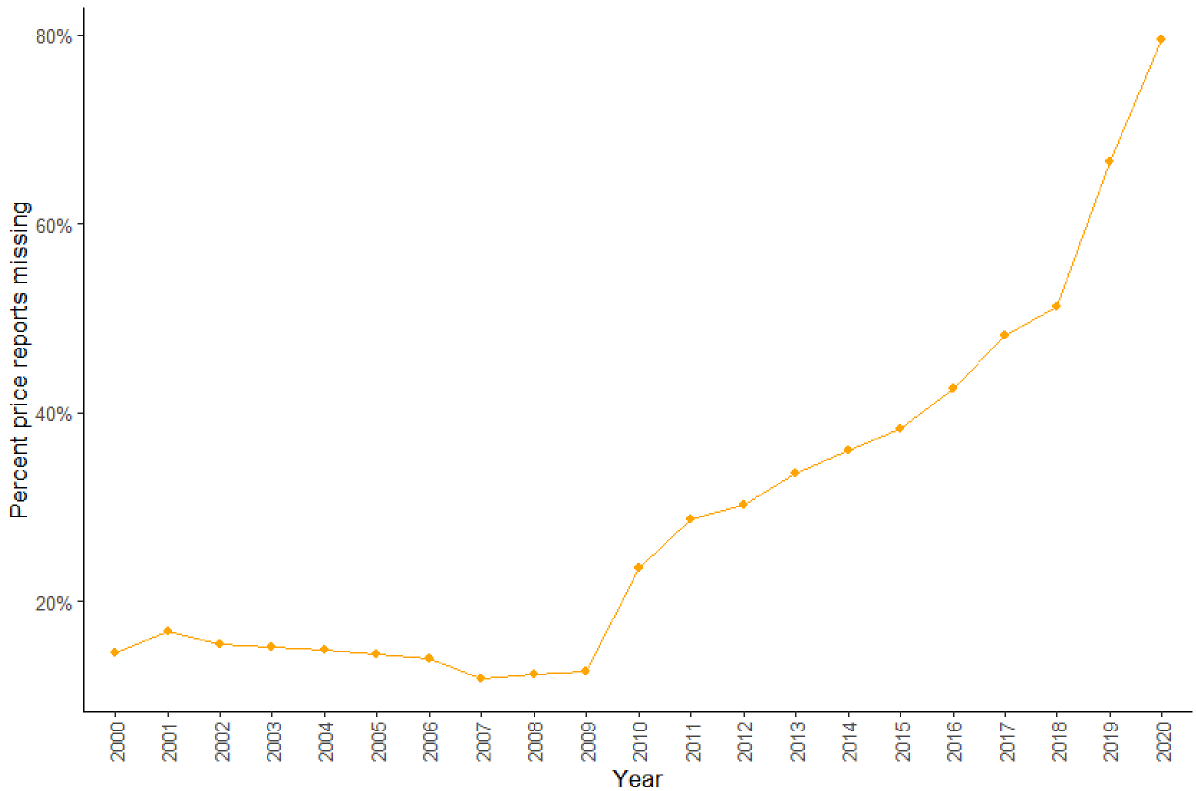

Figure 2: Percent companies not reporting prices for their cattle

Incorporating an animal's pedigree into a linear model is problematic because it cannot be easily converted into a continuous or categorical variable. We propose a different approach since the World Dairy Expo is a cattle show where cows are evaluated regarding their observed traits. Then, a fraction of their total points are inputted to their sires, and the price difference between the relatives of the winner and the runner-up's relatives, in a context of high turnover, must be explained chiefly by random factors.

Thus, our identification strategy depends on the assumption that conditional on a set of PTAs, the price difference between the two groups must be random. Consequently, on average, the runner-up's relatives are a good counterfactual for the winner's relatives. Interestingly, in terms of genetic traits, there is a significant difference for many traits, but with the opposite sign to what one would expect, that is, runner-up's relatives tend to have higher levels than winner's relatives.

Variable	Control mean (n = 126)	Treatment mean (n = 337)	t.statistic	p.value	df
Production traits					
Milk	1366.841	1326.074	1.996	0.047	194.194
Fat	1.977	1.131	11.393	0.000	240.576
Protein	1.287	1.580	-3.785	0.000	273.710
Longevity and Health traits					
Somatic cell score	37.820	43.231	-2.207	0.028	217.114
Productive life	1.999	0.813	11.212	0.000	174.613
Conformation traits					
Type	2.027	1.809	2.619	0.009	299.167
Stature	1422.469	1380.570	0.686	0.493	289.615
Strength	1.291	1.471	-2.100	0.037	244.177
Body depth	45.992	45.982	0.005	0.996	207.117
Dairy form	2.584	1.433	9.934	0.000	188.248
Rump angle	-0.539	-0.311	-2.555	0.011	261.210
Thurl width	2.569	2.331	3.072	0.002	286.063
Rear legs side view	2.215	2.045	2.466	0.014	304.506
Rear legs rear view	0.025	0.088	-0.564	0.573	264.047
Foot angle	3.186	3.286	-5.608	0.000	339.823
Fore udder	2.388	2.310	0.976	0.330	288.241
Rear udder height	1.820	0.982	9.429	0.000	223.345
Rear udder width	1.346	1.221	1.194	0.234	247.251
Udder cleft	0.297	0.004	3.112	0.002	348.119
Udder depth	2.567	1.261	15.043	0.000	330.459
Teat front place	2.369	1.963	9.647	0.000	281.936
Teat length	2.085	1.695	3.837	0.000	243.773
Other					
TPI	1.783	1.679	0.985	0.326	288.011
Semen price	24.961	21.134	4.034	0.000	185.181

Table 2: Balance table for all variables

We are interested in the time impact of winning the World Dairy Expo on the average price across the two families; as an event study, we stack all three years (2001-2003) into one single time index ranging from three periods before to two periods after. Since the WDE takes place in October, the effect must be noticeable on the immediate subsequent evaluation (November); we then define the base period as the August evaluation.

Our empirical specification is:

$$price_{ikt} = \sum_{t=-3}^{3} \beta_t treat_{ikt} + \mathbf{X}_{it}\Gamma + \gamma_k + \tau_t + \varepsilon_{ikt} \tag{5}$$

Where $price_{ikt}$ is the price of a straw from bull i that belongs to family k in period t, $treat_{ikt}$ is the treatment dummy, equal to 1 if k are the winner's relatives and 0 otherwise. $\mathbf{X}_{it}$ is the matrix of PTAs, γ_k and τ_t are family and period fixed effects.

Using genetic traits on a hedonic pricing model presents several issues; the most important one is collinearity (Thompson et al., 2022); most traits are highly correlated with others in the same class (production, health, and longevity); as a consequence, coefficient estimates are not reliable and standard errors are inaccurate. Table 4 presents the Variance Inflation Factors for all PTAS, a measure of the increment in the variance of a coefficient due to collinearity. A value of VIF greater than five indicates collinearity, which is the case for eight PTAs.

To deal with this issue, we run a LASSO selection model, assuming that the actual model is sparse, that is, most coefficients can be set to zero with little effect on the R^2 of the model. Figure 3 shows the optimal value of the penalty coefficient (λ) in a lasso model, selected by 10-fold cross-validation, and how it leads to a model with only five covariates: type, daughters in milk, productive life, protein yield, and fat percent.

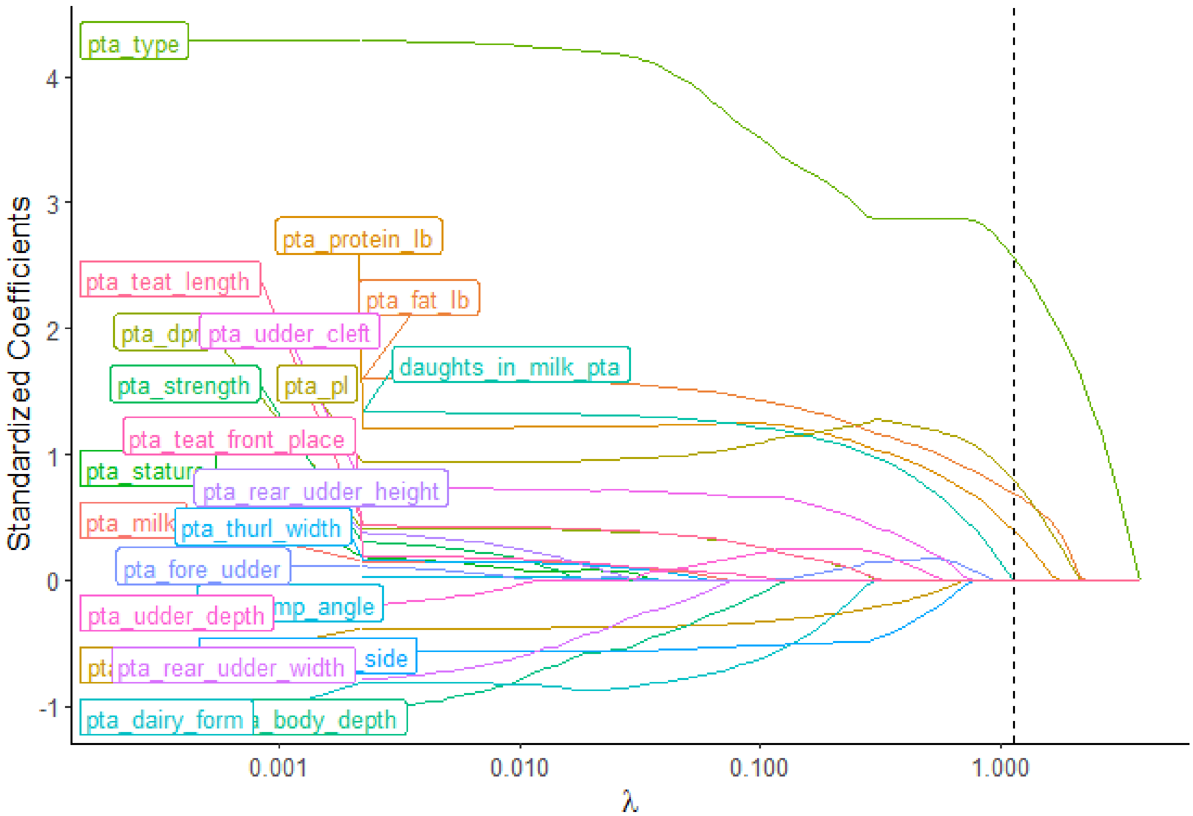

Figure 3: Coefficient progression as a function of the penalty

Type is the difference in score classification points relative to the herd average, it predicts the animal's genetic ability to transmit to the offspring's final classification or appraisal score in the breed's program as evaluated by the Holstein association.

Daughters in milk measures the expected number of daughters in milk (either pregnant or milking their calves) relative to the herd average.

Productive Life is defined as the additional months of life in the milking string; it predicts the time that female offspring are expected to remain in the milking herd before removal by culling or death, expressed as the difference in months of productivity compared to the breed base.

Protein Yield is the expected second-lactation protein production in pounds compared to the breed average, it predicts the expected milk protein production of future mature daughters, in pounds, compared to other cows born in the same base year.

Fat Percent is the expected second-lactation fat production in pounds compared to the breed average. This trait predicts the animal's genetic ability to transmit concentration of milk fat; expressed as percentage points compared to the breed base.

4 Results

We regress the price of animal *i*'s semen from family *k* at period *t* on the set of significant PTAs after running a LASSO selection model on the full set of PTAs on the semen price (protein content, productive life, and type), plus a set of lead and lags of the treatment dummy and family fixed effects:

Table 3: Event Study

	Reported price of a semen straw (USD)		
	No covariates	Selected PTAs	All PTAs
	(1)	(2)	(3)
event_lag3	−0.109	−0.636	−0.621
	(0.592)	(0.594)	(0.540)
event_lag2	0.252	−0.387	−0.299
	(0.735)	(0.840)	(0.812)
event	2.658**	2.756**	2.520**
	(1.180)	(1.059)	(1.132)
event_lead1	−0.837	−0.688	−1.010
	(1.309)	(1.397)	(1.255)
event_lead2	−1.432	−0.967	−1.290
	(1.088)	(1.135)	(0.979)
event_lead3	−2.194**	−1.685	−0.967
	(1.026)	(1.079)	(0.929)
Observations	459	452	452
Adjusted R^2	0.798	0.816	0.839
Notes:	***Significant at the 1 percent level.		
	**Significant at the 5 percent level.		
	*Significant at the 10 percent level.		

Model (1) does not include PTAs, model (2) includes only the traits with nonzero coefficients after running lasso, and model (3) includes all covariates. In the first two models, winners and relatives have a significant premium on the evaluation from a month immediately after the WDE; however, the effect is transitory and quickly returns to zero for subsequent evaluations. The winner's relatives increase around $2.5 in the period after, representing a 14% premium for the winner's relatives with respect to the runner-up's relatives.

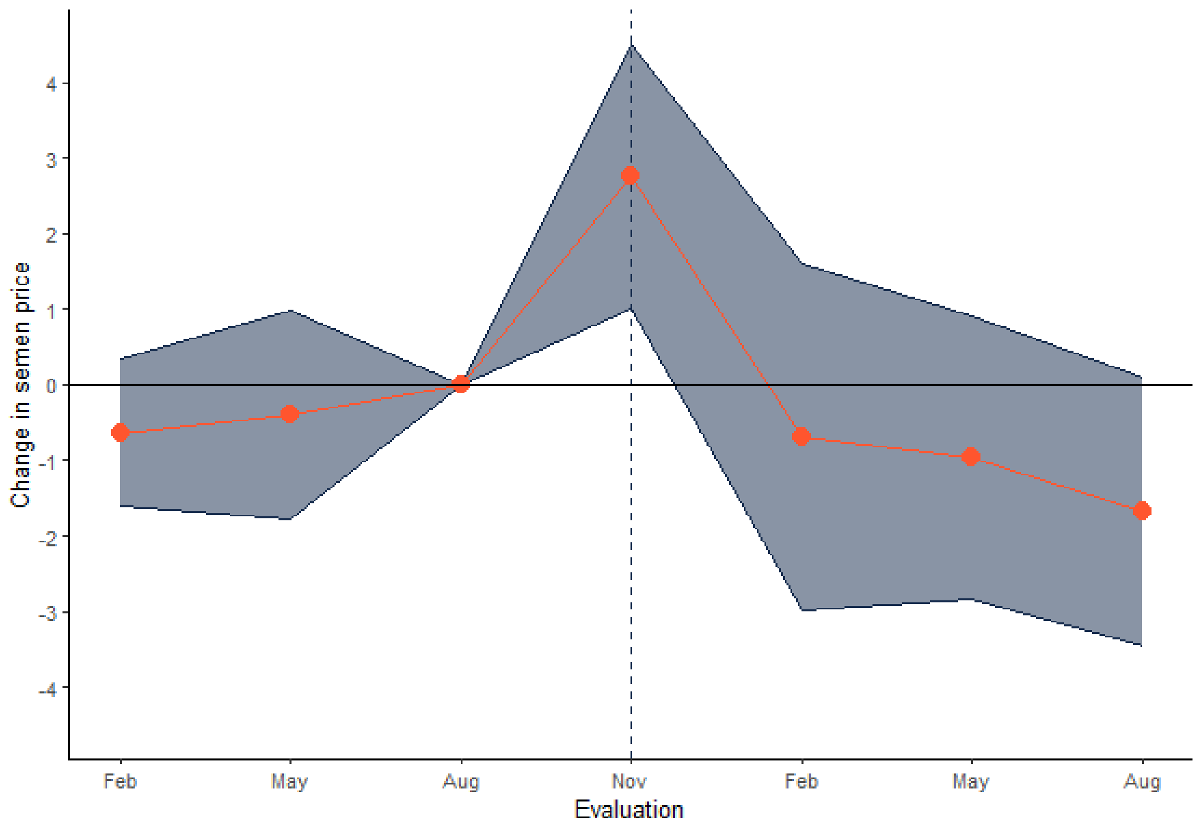

Figure 4: Coefficient plot for model (2)

Our analysis suggests that heterogeneity in ancestry, measured here with family fixed effects, explains as much variation in price as production and health traits, the adjusted R^2 statistic after including PTAs increases 2% when we add the selected PTAs and 4% when the entire set is included. We also use a lasso penalized regression method to explore which traits can best predict price. After selecting the optimal penalty parameter using cross-validation, we find only three traits with a non-zero coefficient: pounds of fat in milk, productive life, and *type*. Since type is used to select winners in the World Dairy Expo, this highly suggests the importance of award-winning pedigree in determining price.

5 Conclusion

Dairy farmers make breeding decisions to alter the gene pool of their herd by choosing a bull based on his traits, but those traits are expressed only in females, for that reason, those characteristics must either be evaluated on the animal's daughters or through genomic testing.

Before discovering such traits, farmers chose a bull based on his ancestry or physical characteristics ("type".) This article argues that because these methods are still in use by the dairy industry, there is a positive effect on the price of a bull after winning the Premier Sire category in the World Dairy Expo that also "trickles down" to all his relatives whose genetics are supplied in the market at the same time.

Previous articles focused only on genetic traits (PTAs) and observable traits such as the coat color, weight, or breed of an animal but did not consider pedigree for their analyses. One likely reason is that pedigree cannot be easily converted into a continuous or discrete variable that can be used as an independent variable in a hedonic regression model. Also, until recently, obtaining pedigree data in a form that could be used for economic analysis was challenging.

We used the WDE winners and runner-ups for three years (2001-2003), when there was a significant turnover of bulls at the top of the ranking. The point difference between the first and the second position was relatively small, thus providing us with a natural experiment to test the impact of pedigree on the price of bull genetics. The total points accrued by any contestant is a function of his daughter's performance; hence, whatever matters for the WDE judges matters for the whole market. Consequently, cattle shows play a crucial role in influencing how farmers think of genetics by explicitly showing the link between traits and observed characteristics of an animal.

We show that the price of the winner's genetics is significantly higher than that of runner-ups, but just for the period immediately after the WDE, then the difference wanes completely. The impact is fleeting, partly because of the nature of the cattle show, as it is held once a year, and partly because evaluations are held thrice a year, so new information takes four months to arrive; thus, if an animal does not match the expectations conveyed by his price, his value must quickly drop.

Our empirical application includes a set of three stacked treatments, which may lead to negative weights for the coefficient estimates (Callaway and Sant'Anna, 2021, Goodman-Bacon, 2021). When there are more than two periods stacked and a non-treated group, some treated groups may have a negative weight for some periods; a future version of this article will deal with this issue in greater detail.

6 Appendix

PTA	VIF
pta_rear_udder_height	10.29
pta_rear_udder_width	8.67
pta_strength	8.27
pta_type	7.29
pta_protein_lb	6.85
pta_body_depth	5.64
pta_udder_depth	5.23
pta_thurl_width	5.15
pta_stature	4.93
pta_fore_udder	4.33
pta_udder_cleft	4.26
pta_milk	3.93
pta_fat_lb	3.66
pta_teat_front_place	3.16
pta_dairy_form	3.09
pta_scs	2.65
pta_teat_length	2.52
pta_pl	2.33
pta_rump_angle	2.10
pta_rear_legs_side	2.03
pta_dpr	1.91
daughts_in_milk_pta	1.84

Table 4: Variance Inflaction factors

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