Genetic Parameters for Cattle Prices Routinely Collected at Livestock Marts

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Introduction

Animal value is the sole source of income within Irish beef herds Therefore on-farm profitability is dependent on the price obtainable for animals sold either as weanlings, post-weanlings or cows. Most international dairy breeding programmes have historically selected for increased milk production (Miglior et al., 2005). However, beef output, such as young calves and cull cows, is also an important financial contribution to a dairy farm. Within Ireland there is a large interdependency between the beef and dairy herds. A large proportion of dairy females are mated to beef bulls and a substantial proportion of the resulting crossbred females are used as dams within the national beef herd (Berry et al. (2006)). The majority of calves sold from dairy herds and sired by both beef and dairy sires are retained in Ireland and end up in specialised finishing herds which also fatten weanlings purchased from beef herds. Possible breeding goal traits to reflect beef revenue from dairy and beef enterprises include animal price, animal live-weight and cull cow value. However, there is a paucity of studies that have attempted to quantify the genetic variation present in animal price, due mainly to a lack of available phenotypes. The aim of this study was to estimate phenotypic and genetic parameters for animal live-weight and price across different stages of maturity in dairy and beef herds.

Material and methods

A total of 2,967,791 live-weight and animal value records from 2,506,110 animals sold at 71 livestock marts in Ireland between the years 2000 to 2008 inclusive, were extracted from the Irish Cattle Breeding Federation database. As part of the national beef breeding programme, progeny of test beef sires and herd contemporaries are also weighed on commercial farms and these data are captured. A total of 875,874 records from 682,694 animals, aged between 150 and 600 days, collected from 32,089 herds, between the years 2000 to 2008 were also available in this study; no price data were available on these animals. The data were divided into four distinct maturity categories, described later: calves (dairy herds), weanlings (dairy and beef herds), post weanlings (dairy and beef herds), and cows (dairy and beef herds). To accurately quantify associations, only animals sold or weighed as individuals were retained. Animals were discarded if their sire or herd of origin was unknown. Animals were also discarded if either their sale price or live-weight were unknown; live-weight information was not available on calves but the price was known. Since some animals go through marts more than once in their lifetime, animals were restricted to having one record per maturity

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category. Only records from the first date in time for calves, weanlings and post-weanlings were retained; for cows, records from the last date in time were retained.

In the present study calves were defined as animals from dairy cows sold between 2 days of age and 12 weeks of age. Only calves sold between €2 and €450 were retained. Weanlings were defined as animals sold between six and twelve months of age from beef cows (i.e. dam breed proportion >66% beef). Only weanlings weighing between 150 and 900 kg and sold for between €200 and €1200 were retained. On farm weight records were also available on 17,673 weanlings weighing between 150 and 600 kg. Post-weanlings were defined as beef and dairy animals sold between 12 and 36 months of age and this included finishing steers, heifers and bulls. Post weanling data were limited to animals that weighed between 200 and 1,000 kg and were sold for between €200 and €1,500. On farm weight records were also available on 12,843 post-weanlings weighing between 200 and 1,000 kg. Cows were defined as animals that had calved at least once or were greater than 30 months and less than 12 years of age when sold. Only cows weighing between 300 and 1,000 kg and sold between €75 and €1,500 were retained. Cows sold through livestock marts, in Ireland, include cull cows destined for slaughter, cows sold in calf, and cows not in calf when sold but that calved some time in the future (i.e. replacements). Accordingly, cows were classified both on their fate post-sale and, as a separate variable, on the number of days since last calving. Two contemporary groups were defined: mart-date of sale and herd-year-season of sale. Where on farm data were used, contemporary group was defined according to herd-date of weighing. Herd-year-season by year of sale contemporary groups were generated using an algorithm described by Crump et al. (1997).

Data analysis. Phenotypic and genetic variance components for animal price (Euro per animal) and live-weight (kg), within each maturity group, were estimated separately using animal linear mixed models in ASREML (Gilmour et al. (2007)); covariances between price and live-weight within and across ages and genders were estimated using sire linear mixed models. Fixed effects considered in all models, irrespective of maturity category were as reported previously by Mc Hugh et al. (2010). Breed proportion of the 12 most common breeds within Ireland was treated as a continuous variable with a separate effect fitted in the models for each breed. Prior to the estimation of variance components for price, residuals from a fixed effects model with price as the dependent variable and the aforementioned fixed effects included in the model (excluding contemporary groups) were standardised to the mean residual standard deviation within the contemporary group of mart-date. Standardised residuals were added back to the respective fixed effects solutions for each animal to generate a standardised price for each animal. The univariate animal model used to estimate variance components was progressively built up to include a maternal genetic effect and a permanent environmental maternal effect. The log likelihood ratio test between nested models was used to determine whether the addition of extra random components improved the fit to the data. Within each of the maturity group, a series of bivariate analyses were undertaken using a sire model to estimate genetic correlations between animal live-weight and price (where available) as well as between genders. With the exception of estimating the correlation between animal price and live-weight where animals had observations for both traits, there was no residual covariance between the two traits (e.g. animal could not be both male and female). However, the residual covariance in a sire model contains ¾ of the additive genetic covariances and therefore the residual covariance between the two traits was restricted to be three times the sire covariance

Results and discussion

Mean selling price was €158, €612, €633 and €559 for calves, weanlings, post-weanlings and cows, respectively. Direct heritability estimates for price varied from 0.10 to 0.34 across all maturity categories (Table 1). The direct heritability of live-weight ranged from 0.25 to 0.33 across the weanlings, post-weanlings and cow maturity categories. The maternal heritability and maternal repeatability were not different from zero across all maturity categories for both price and live-weight, with the exception of weanling live-weight. For weanling live-weight the direct heritability estimate was 0.26 ± 0.03 when maternal effects were included in the model. The maternal heritability was 0.07 ± 0.01 and the maternal repeatability was 0.12 ± 0.01. The coefficient of genetic variation varied from 3.2 to 34.4% for price and 3.4 to 8.9% for live-weight.

Table 1 Number of records (n), heritability (standard errors in parenthesis; on diagonal), and genetic correlations (standard errors in parenthesis; below diagonal) between price and live-weight across and within the maturity categories.

	Calf Price	Weanling Price	Weanling weight	Post-wean Price	Post-wean Weight	Cow Price	Cow weight
n	40,157	24,680	44,117	45,475	53,531	17,504	17,504
Calf Price	0.34 (0.03)						
Weanling Price	0.52 (0.07)	0.31 (0.05)					
Weanling Weight	0.13 (0.03)	0.75 (0.04)	0.25 (0.03)				
Post-wean Price	0.72 (0.04)	0.67 (0.03)	0.24 (0.09)	0.19 (0.04)			
Post-wean Weight	0.22 (0.07)	0.38 (0.09)	0.79 (0.03)	0.55 (0.06)	0.33 (0.03)		
Cow Price	0.34 (0.12)	0.83 (0.48)	0.51 (0.0.7)	0.67 (0.10)	0.75 (0.05)	0.10 (0.04)	
Cow Weight	0.27 (0.10)	0.55 (0.11)	0.16 (0.05)	0.63 (0.10)	0.75 (0.05)	0.91 (0.04)	0.25 (0.05)

Direct heritability estimates for live-weight, in this study, were consistent with previous estimates (Meyer et al. (1993); Arnold et al. (1991); Veerkamp (1998)). In contrast to live-weight, no previous heritability estimates for animal price have been reported with the exception of cow price (Schierenbeck et al. (2008)) which are similar to estimates in the present study. The heritabilities for animal price in the present study are also similar to those for live-weight in the present study as well as other production traits such as milk yield (Veerkamp (1998)) and average daily gain (Hirooka et al. (1996)).

The genetic correlation between male and female animal price across the calves, weanlings and post-weanlings was generally strong and varied from 0.44 ± 0.07 (male and female calves) to 0.90 ± 0.03 (males and females post-weanling). The genetic correlation between genders for live-weight varied from 0.59 ± 0.06 (males and females post-weanling) to 0.89 ± 0.01 (male and female weanlings). The genetic correlation between price and live-weight within maturity group varied from 0.55 ± 0.06 (post-weanling price and live-weight) to 0.91 ± 0.04 (cow price and live-weight).

The genetic correlations between price across the different maturity categories were moderate to strong and varied from 0.34 ± 0.12 (calf and cow price) to 0.83 ± 0.48 (weanling and cow price); these were stronger than the respective phenotypic correlations reported by McHugh et al. (2010) with the exception of the correlation between post-weanling price and cow price. The genetic correlations among live-weights across different maturity groups varied from 0.16 ± 0.05 (weanling and cow live-weight) to 0.79 ± 0.03 (weanling and post-weanling live-weight). A genetic correlation between live-weight and price of less than one suggests that factors other than live-weight that are not accounted for in the model are associated with price.

Conclusion

Moderate to high heritability estimates coupled with large coefficients of genetic variation and the availability of routinely collected data on both live-weight and price, clearly indicates that there is ample opportunity for selection on these two goal traits and hence they can be included in national cattle breeding programmes in Ireland both as selection criteria and as traits in the breeding objective.

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