Time Dependent Effects as Source of Bias in Estimating Breeding Values for Longevity and Fertility Traits

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1. Introduction

Multi Across Country Evaluation (MACE) has successfully been introduced to traits with low and moderate heritability as SCC and mastitis resistance. The genetic correlations between nearly all countries have been estimated to be very high. This is not the case for longevity and fertility traits (Mark et al., 2000; Linde and de Jong, 2002). Bias in the genetic trends of the national evaluation may influence estimation of genetic correlations between countries. The aim of this paper is to describe problems that can course bias in the national estimated breeding values for longevity and fertility traits.

2. Mendelian sampling and time dependent effects

All models used for estimating breeding values include some fixed effects in the genetic model. It is an assumption, that the result of the Mendelian sampling term is distributed randomly across the fixed effects. For milk production it means, that the same proportion of animals with a positive contribution from the Mendelian sampling term is distributed in the same calving period class effects as animals with a negative contribution from the Mendelian sampling term.

For longevity and fertility time is also included in the definition of the trait. The assumption of random distribution across fixed effects may not hold in all cases. If one country is running a very efficient progeny-testing program, the progenies are born within a very short time interval. For many Danish Holstein bulls, 150 progenies are born within a three weeks period. The result is, that the best cows for fertility will calve in the first period classes and cows with poorer fertility will calve in later period classes. A similar problem might exist for longevity since good fertility is a condition for good longevity. In order to describe the magnitude of the problem different models for fertility and longevity have been tested.

3. Models and results

Data from Danish Holstein has been used for test. Approximately 350,000 cows are annually milk controlled and 300-350 young bulls are progeny tested each year.

3.1 Fertility

The Nordic countries have started a project to investigate the possibilities for a joint Nordic evaluation of breeding values for fertility. Denmark has participated with data from 1984. One of the traits that have been investigated is days open. The first 3 lactations are included. Two models have been run on Danish data only.

Model 1 included the following effects:

1.	Herd*year of calving	Fixed
2.	Month*calving year	Fixed
3.	Calving age (1st calving)	Fixed
4.	Sire	Random

Model 2 included:

1.	Herd*year of birth	Fixed
2.	Month of calving	Fixed
3.	Sire	Random

Both models are repeatability models. The main difference between the models is, that the cows in model 1 are distributed on the fixed effects according to the time of calving and if two cows have been born on the same day the most fertile daughter will be in a time class before daughters with the poorest fertility. In model 2 there are no fixed effects that will distribute the cows in that way. To take into account that fertility depends on the month of calving model 2 still include the effect of month of calving, but it is not classified by year.

Breeding values are estimated by both models. The estimated genetic trends are different (figure 1). Over a period of 16 years the discrepancy in the estimated genetic trend was app. 10 days. Model 2 has been evaluated by Interbull test no. 3 and passed the test.

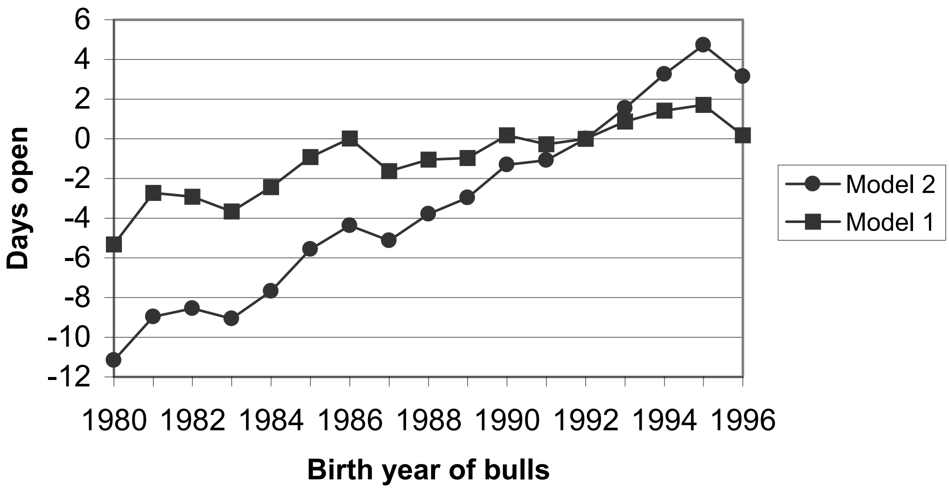

Figure 1. Genetic trend for days open for model 1 and model 2.

3.2 Longevity

Longevity has been evaluated In Denmark since 2001. All calvings since 1984 are included.

Longevity is evaluated by means of a survival analysis using the program package Survival Kit (Ducrocq and Sölkner, 1998). The effects in the model for Holstein are:

Model 1:

1. Herd*year*season	Random, time dependent
2. Lactation	Fixed, time dependent
3. Lactation*stage	Fixed, time dependent
4. Change in herd size per year	Fixed, time dependent
5. Year*Season	Fixed, time dependent
6. Age at first calving	Fixed, not time dependent
7a. Phenotypic milk production	Fixed, not time dependent
7b. Phenotypic fat production	Fixed, not time dependent
7c. Phenotypic protein production	Fixed, not time dependent
8. Sire	Random not time dependent

The results of model 1 were compared with an alternative model 2:

1. Herd*year*season at 1st calving	(changed)	Random, not time dependent
2. Lactation		Fixed, time dependent
3. Calving month*lactation*stage	(changed)	Fixed, time dependent
4. Change in herd size per year		Fixed, time dependent
5. Year*Season at 1st calving	(changed)	Fixed, not time dependent
6. Age at first calving		Fixed, not time dependent
7a. Phenotypic milk production		Fixed, not time dependent
7b. Phenotypic fat production		Fixed, not time dependent
7c. Phenotypic protein production		Fixed, not time dependent
8. Sire		Random not time dependent

Both models were used on exactly the same data.

The trend of the effect year*season changed from model 1 to model 2. When model 1 is used the estimates of the effect year*season indicate a negative environmental trend (figure 2). In model 2 the risk is decreasing, which indicate that the environment is getting better. This is in good agreement with the phenotypic trend. There has been a positive phenotypic trend for better longevity, which is illustrated as the proportion of cows alive 750 days after first calving per year of disposal (figure 3).

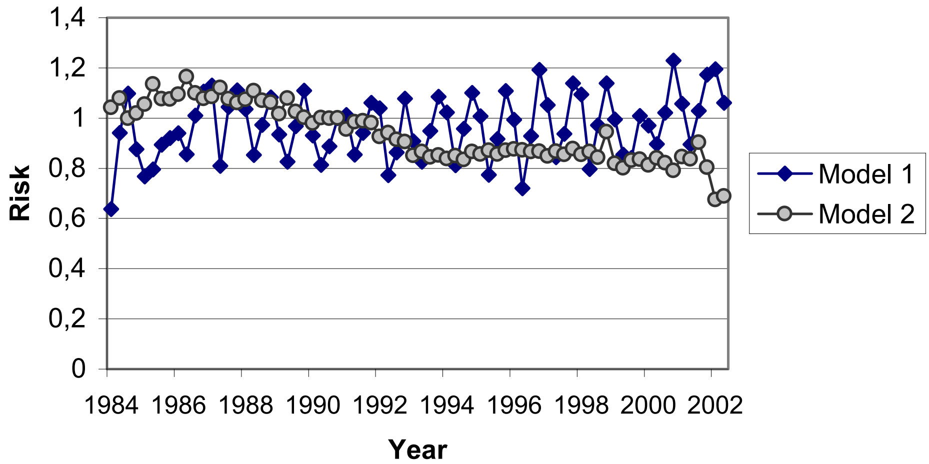

Figure 2. Risk of disposal estimated by the effect Year*Season (model 1) and Year*Season of 1st calving (model 2).

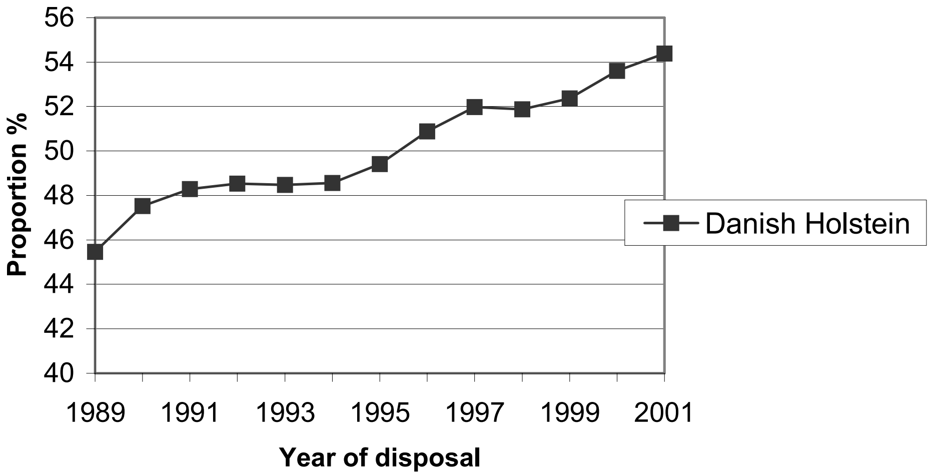

Figure 3. Phenotypic trend in proportion of cow surviving 750 days after first calving, estimated per year of disposal.

The effect of lactation increased moving from model 1 to model 2 (figure 4). This change in the effect may indicate that rho is underestimated as a consequence of the bias in the effect Year*Season. We tried to increase rho from 1.07 to 1.30. The change had no effect on the estimated breeding values or the genetic trend, but the effect of lactation decreased.

If the environmental trend is negative and the phenotypic trend is positive, the genetic trend also has to be positive. The genetic trend for bull born in the period 1980 to 1997 has also been estimated to be positive with a strange slope in the recent years (figure 5).

When model 2 is used the effect of year*season of 1st calving indicate that the environmental trend is positive (figure 2) and as a result of this the genetic trend has changed (figure 5). The trend is nearly 0.

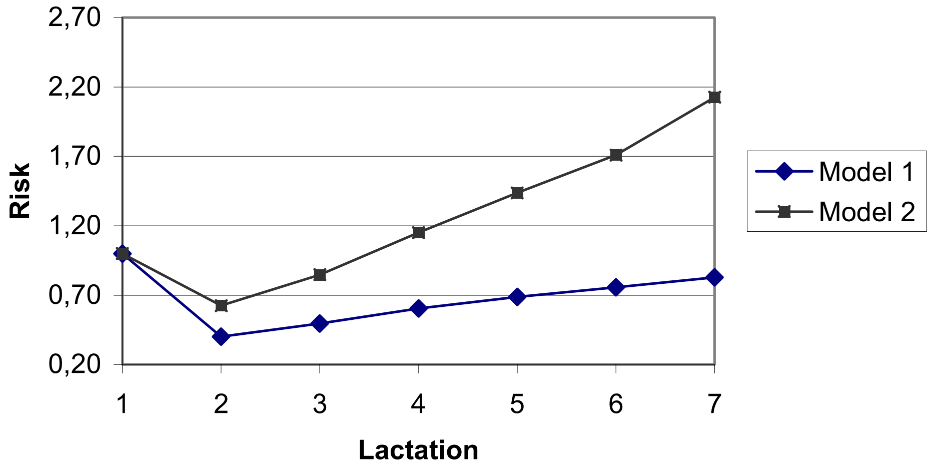

Figure 4. The risk of disposal per lactation estimated by model1 and model 2.

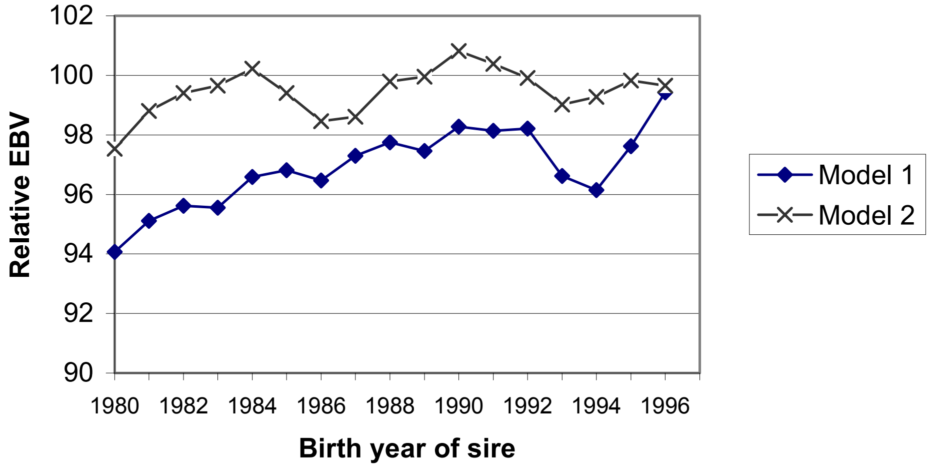

Figure 5. The estimated genetic trend by model 1 and model 2.

In Denmark a relative index with average 100 for 5-7 years old AI bulls and a standard deviation of 5 is used. As a result of the change in the genetic trend many bulls change EBV, and most of the bulls increased their EBVs (table 1). But for the bulls born after 1989 and with second batch daughters the average relative index decrease. The correlation within years is 0.94-0.95, but the overall correlation is only 0.92. The difference is caused by the different genetic trend in model 1 and model 2. VanRaden and Powell, 2002 reported that the proportion of second crop bulls in top ranking was very high. Changing from model 1 to model 2 the proportion of second crop bulls born after 1989 in top 100 dropped from 19 to 9.

Table 1. Change in relative index for longevity for bulls born after 1989 when moving from model 1 to model 2.

Change in index for longevity	All bulls	Bulls with min 500 daughters
-8	2	2
-7		
-6	4	4
-5	5	3
-4	19	6
-3	65	7
-2	124	6
-1	15	7
0	229	4
1	335	6
2	583	3
3	551	5
4	368	2
5	128	
6	21	
7	3	
Total	2616	55

4. Discussion

For both fertility and longevity the genetic trend changed in an unfavourable direction when model 2 were used instead of model 1. The genetic trend for fertility is more similar to the phenotypic trend. It is also very difficult to understand, that there should only be a small genetic decline in fertility despite of many analysis have shown a moderate unfavourable genetic correlation between production and fertility, and for some decades only production has been the selection criteria. The bias in each effect of month*calving year is small; the effects will accumulate over time because every new test bull will have the daughters distributed as previously described.

The bias in the estimated breeding values will have the largest effect in countries with young bulls used in a very short period, as in Denmark for Holstein. If the period for using young bulls is longer or a grater proportion of proven bull is used the bias will become smaller. This may explain why the bias may be smaller in some countries than in others.

As for fertility it is difficult to understand that the genetic trends for functional longevity in the last decade has been favourable, when the genetic trends for mastitis resistance and fertility have been unfavourable, and functional longevity is genetically correlated to these traits. The change from model 1 to model 2 decreased the number of second crop bulls in the top 100 bulls born after 1989 from 19 bulls to 9 bulls. The changes in model eliminate much of the discrepancy that exist, when there is a positive trend and the old bulls are still in the top. This also indicate, that model 1 create a bias in the genetic trend. The correlation between EBVs calculated within year is higher than the overall correlation. When bulls are tested in several countries, they always get their EBV's first in the country, where they first were tested and later on in other countries. This may decrease the estimated genetic correlations for longevity between countries.

Finland and Denmark had in 2002 developed a model for longevity under Finnish conditions. During the process when model 1 was selected as first choice the risk of disposal nearly doubled in a ten years period. This led to the considerations about bias in the model and alternative models. Model 2 does not correct, as efficient for the environment as model 1, but the model does not introduce bias. That was the reason why the method to handle time dependent effects as described in model 2 was chosen for the Finnish model for longevity. In Denmark we plan to change our models for fertility and functional longevity in spring 2003.

References

Ducrocq, V. & Sölkner, J. 1998. "The survival Kit V3.0", a package for large analyses of survival data. *Proc. 6th World Congr. on Genet. Appl. to Livest. Prod. 27,* 447-448.

Linde, R. & de Jong, G. 2002. Intermediate report mace longevity. CR-Delta, Netherlands.

Mark, T., Nielsen, U.S., Pösö, J., Gundel, M. & Svendesen, M. 2001. Genetic relationships among functional traits in the Nordic Holstein populations. Proc. 2001 Interbull meeting in Budapest, Hungary. *Interbull Bulletin 27,* 60.