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Validation of region effects in the random regression model for Simmental cattle in Germany and Austria

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Abstract

In November 2002 the joint random regression test day model for Germany and Austria was introduced for milk production traits in Simmental. These countries comprise very different regions due to differences in climate and topography as well as in herd management. Therefore, separate effects for lactation stage, pregnancy, calving-year-season and production-year-month have been defined within regions in the fixed model. The herd specific environment is accounted for by a herd test day effect. In addition, heterogeneous variances are considered within region-production-year-month-lactation subclasses and herd test days (Lidauer et al., 2002). In order to examine the effect of the region in comparison to the effect of the herd itself, four herds were treated as if they were displaced to regions with different average production intensities in Bavaria, a state in Southern Germany. A separate evaluation for protein yield was performed and compared to the routine evaluation with the herds in their original region. Results show only minor changes in average EBVs of animals in displaced herds. The average of the difference in EBV for protein yield for the four herds ranged from –0.16 to +0.11 kg. The observed differences have shown that the defined regions have only small effect on EBVs. The influence of the herd specific environment covered by the herd test day effect is much more important in comparison to the average effect of the defined regions. Regions are nevertheless useful for small herds and the estimation of lactation curves.

Introduction

Since November 2002 a joint random regression test day model for Germany and Austria is applied for routine genetic evaluation of Simmental milk performance data. The two countries comprise very heterogeneous regions due to differences in climate and topography as well as in herd management. With the transition from lactation model to test day model the fixed model was completely reconsidered. Heterogeneous variances over time and between regions and herds are accounted for with a multiplicative mixed model approach (Lidauer et al., 2002). Due to small herd sizes most of the environmental influences, like days in milk, calving age and pregnancy were modelled within regions, except the herd test day. The region definition currently applied originated from analyses of production conditions by agricultural economists (Würfl et al., 1984).

The introduction of test day model EBVs led to substantial reranking of bull dams, correlations between lactation and test day model EBVs were around 0.85. This raised the question from practical breeders whether the region definition for fixed effects could be responsible for this reranking. The effect of the defined regions on estimated breeding values was validated in an analysis, where the performance data of four herds were virtually moved between different regions in the Southern German state of Bavaria followed by a separate evaluation run for protein yield.

Material and Methods

The analyses were based on German and Austrian test day data for protein yield from routine evaluation of February 2003. The evaluation comprised 104 million test day records from all lactations and pedigree consisted of 6.9 million animals. A detailed overview over the joint test day model can be found at Emmerling et. al (2002) and at the description of national evaluations on the INTERBULL website (http:// www-interbull.slu.se). Therefore only a short overview will be given here.

The estimation of separate fixed effects for regions should account for the different environmental influences on milk production traits within Bavaria (Emmerling, 2001). These differences result from variable production conditions which are based on e.g. height over sea level, amount of rain per year, temperature averaged by year, number of days in vegetation or type of soil. Würfl et al. (1984) has defined 48 single regions in Bavaria, which can be systematically combined to larger areas with similar production conditions.

The multiple lactation test day model considers the following fixed effects:

- herd test day across lactation;
- production year x month x region$^{\#\#}$ x lactation (1..4,5+) (PYMRL);
- quadratic regression on calving age within region$^{\#}$ x lactation (1..4);
- cubic regression on days carried calf within region$^{\#}$ x lactation (1..4,5+);
- lactation stage correction with quadratic Legendre polynomials plus two exponential terms within subgroups, where subgroups are defined by calving year, calving season, calving age, calving region$^{\#}$ and parity (1..4,5+).

Two different region definitions are used in the current evaluation model:

A) Region$^{\#}$ is used for all fixed effects, except PYMRL, and consists of four classes in Bavaria (Figure 1).

B) Region$^{\#\#}$ stands for a more detailed region definition in the PYMRL effect. The defined nine regions$^{\#\#}$ in Bavaria are subregions of region$^{\#}$ (Figure 1). The PYMRL effect considers the interaction between year-month of production and parity within regions. The main reason for the inclusion of this effect in the model is the consideration of heterogeneous variances between the classified PYMRL subclasses. Additionally heterogeneity is considered within herd test days, which are modeled as a random effect with an autocorrelated structure beside the fixed PYMRL effect in the variance model. Details about the applied multiplicative mixed model approach in the joint German and Austrian test day model are described by Lidauer et al. (2002).

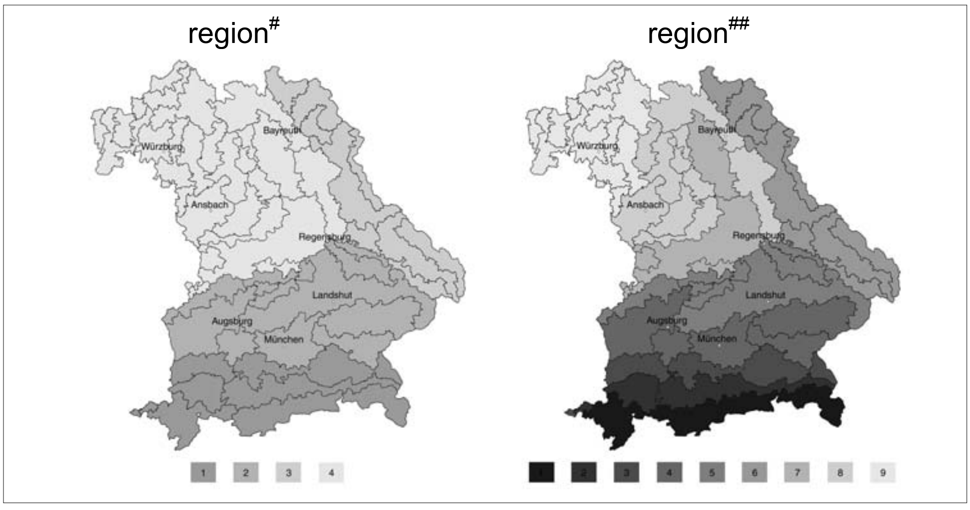

Figure 1: Definition of four regions$^{\#}$ and nine regions$^{\#\#}$ within Bavaria.

Four herds with an overall of 1.054 cows in genetic evaluation were displaced in the routine data (Table 1). All test day records (1990-2003) of these cows were recoded to the other region. Regions under focus were the Northern Bavarian regions, where dairy farming is done under intensive conditions, and the Southern Bavarian regions where grassland conditions are dominant. Three herds were displaced southwards, while one herd was displaced northwards.

Estimated breeding values for 305-day protein yield were calculated based on daily EBVs from genetic evaluation with displaced herds. These EBVs were compared to official EBVs from routine evaluation.

Table 1: Four herds with original and recoded region code after displacement.

		original region		recoded region	
	n cows	#	##	#	##
Herd A	283	4	8	2	4
Herd B	398	4	7	2	4
Herd C	210	4	7	2	4
Herd D	163	1	2	4	8

Results and Discussion

Statistics of the differences between EBVs for 305-day protein yield from displaced data run and routine evaluation are shown in table 2.

With the displacement of the herds the test day records are corrected by the specific effects of the new region. The higher production level in Northern Bavarian regions lead to a higher correction for environmental effects, i.e. days carried calf, calving age and lactation stage influence is stronger in these regions. Therefore EBVs of cows from herd D decreased on average. In case of herd B and C the lower correction for environmental effects caused slightly higher EBVs, while EBVs of cows from herd A do not change on average.

These changes were expected and confirm that different regions have different estimators for environmental effects. However it is obvious that the region effects only have minor influences on the EBVs of the cows. Compared to the genetic standard deviation for 305-day protein yield of 16.4 kg even absolute changes of individual cows are small.

Table 2: Statistics of differences between EBVs from displaced data run and routine evaluation.

	n cows	mean	std.dev.	min.	max
Herd A	283	0.0004	0.3210	-0.9	0.7
Herd B	398	0.1052	0.2633	-0.7	0.7
Herd C	210	0.1055	0.2787	-0.7	1.2
Herd D	163	-0.1589	0.8588	-2.2	2.2

Due to the sophisticated fixed model with separate region specific effects on many places in the fixed model, a clear comparison between estimates of fixed region effects is not feasible. Moreover the multiplicative method to account for heterogeneous variances between herds and regions leads to a shifting of fixed effect estimates. Heterogeneous variances between regions lead to a *different* shifting of region specific effects. This leads to wrong contrasts between region specific fixed effects. A comparison of region estimates would only be possible, if they would be backscaled with the corresponding correction factors.

The analysis of correction factors for heterogeneous variances out of both evaluations showed only small differences for the displaced herds. For the smaller herd D the heterogeneity on region level contributes more information to the estimation of correction factors compared to the larger herds A, B or C. In these latter herds, the heterogeneity on herd test day level contributes more information to the estimation of correction factors for heterogeneous variances.

Conclusion

The applied practical approach of herd displacement for validation of region effects on EBVs was found to be useful. The differences in EBVs of single cows result from the sum of the different region specific fixed effects in the model and the change of region for the observations in the heterogeneous variance correction part.

As a conclusion from the analyses of displaced herds, the effect of the region definition on EBVs in the joint German and Austrian test day model can be denoted as minor. The influence of the herd specific environment covered by the herd test day effect is much more important in comparison to the average effect of the defined regions. Regions are nevertheless useful to improve the fit of the fixed model (Emmerling, 2001). In addition the definition of regions is advantageous when heterogeneous variances are accounted for in test day data with small herd structure.

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