Adjusting for macro-environmental sensitivity in growth rate of Danish Landrace and Duroc pigs

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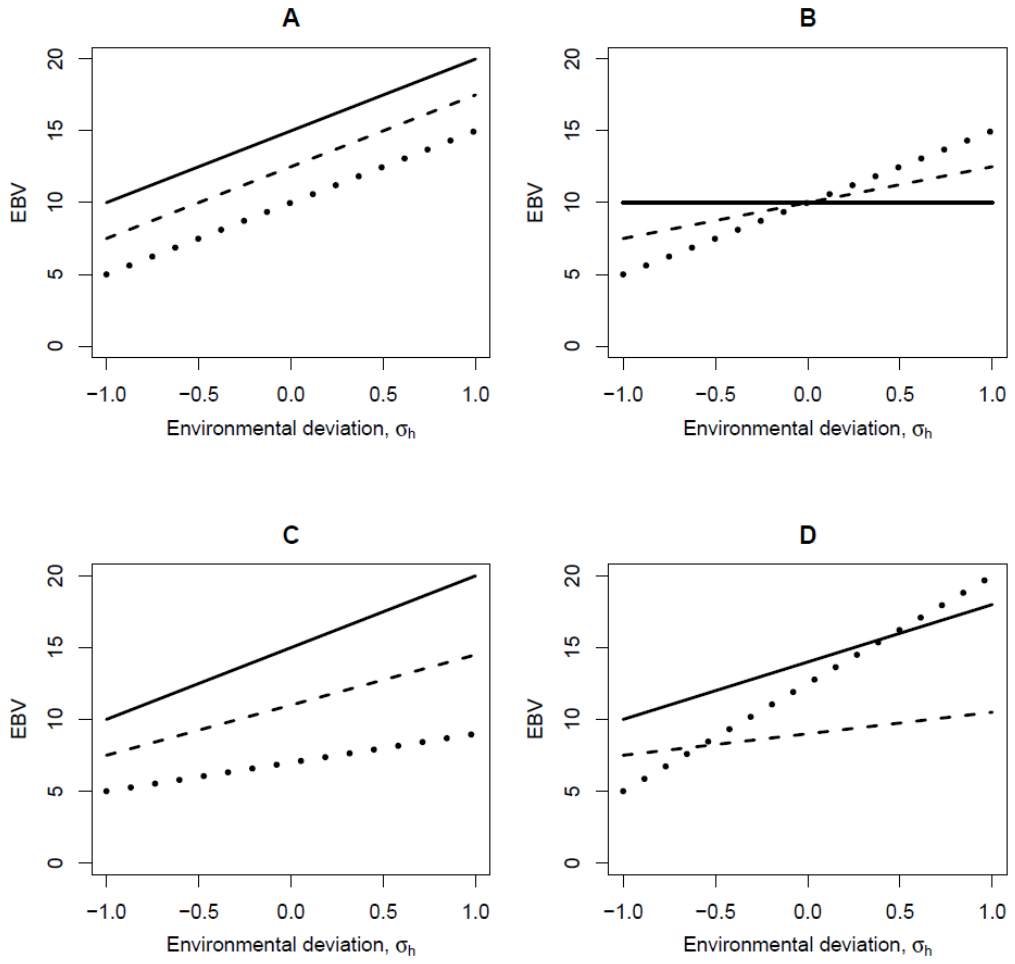
Background

- Macro-environmental sensitivity (macro-ES)
  - Change in EBV across environments
  - G×E causes variation in macro-ES
- Sources of variance heterogeneity
  - Breed
  - Sex



Model

- Univariate reaction norm model

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Za_0} + \mathbf{Ha}^* + \mathbf{Wh} + \mathbf{Vp} + \mathbf{Ll} + \mathbf{e}$$

$\mathbf{y}$: Response variable - ADG

$\mathbf{b}$: Fixed parameters

$\mathbf{a_0}$: Intercept of additive genetic variance

$\mathbf{a}^*$: Slope of additive genetic variance

$\mathbf{h}$: Herd−Year−Month on test (HYM)

$\mathbf{p}$: Group

$\mathbf{l}$: Litter

$\mathbf{e}$: Residual variance

$\mathbf{X}$, $\mathbf{Z}$, $\mathbf{W}$, $\mathbf{V}$ and $\mathbf{L}$: Design matrices

$\mathbf{H}$: Design matrix with environmental covariate

$$\begin{bmatrix} \mathbf{a_0} \\ \mathbf{a}^* \end{bmatrix} \sim \mathrm{N}\left(\mathbf{0}, \mathbf{A} \otimes \begin{bmatrix} \sigma^2_{\mathbf{a_0}} & \sigma_{\mathbf{a_0},\mathbf{a}^*} \\ \sigma_{\mathbf{a_0},\mathbf{a}^*} & \sigma^2_{\mathbf{a}^*} \end{bmatrix}\right)$$

$$\mathbf{h} \sim \mathrm{N}\left(\mathbf{0}, \mathbf{I}\sigma^2_{\mathrm{h}}\right)$$

$$\mathbf{p} \sim \mathrm{N}\left(\mathbf{0}, \mathbf{I}\sigma^2_{\mathrm{p}}\right)$$

$$\mathbf{l} \sim \mathrm{N}\left(\mathbf{0}, \mathbf{I}\sigma^2_{\mathrm{l}}\right)$$

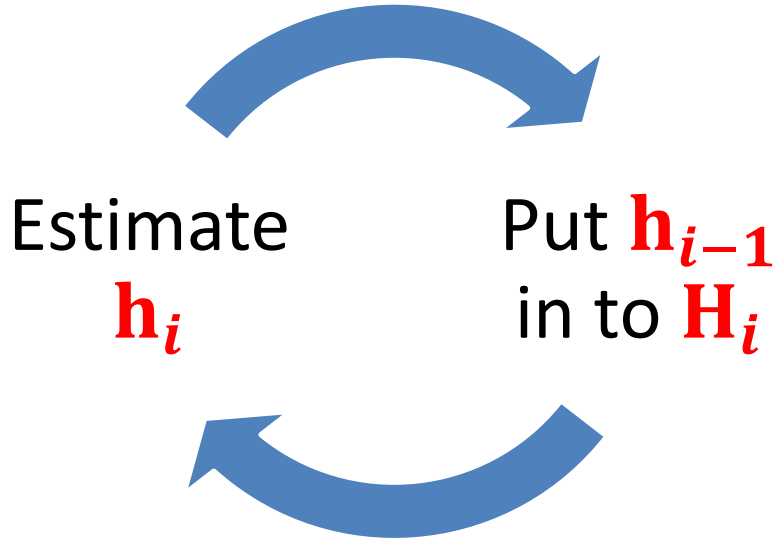
$$\begin{bmatrix} \mathrm{e}_1 \\ \vdots \\ \mathrm{e}_m \end{bmatrix} \sim \mathrm{N}\left(\mathbf{0}, \begin{bmatrix} \mathbf{I}\sigma^2_{\mathrm{e}_1} & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \mathbf{I}\sigma^2_{\mathrm{e}_m} \end{bmatrix}\right)$$

Approach

- Reaction norm model with unknown covariate (Su et al., 2006)
- $\mathbf{y} = \mathbf{Xb} + \mathbf{Za_0} + \mathbf{Ha}^* + \mathbf{Wh} + \mathbf{Vp} + \mathbf{Ll} + \mathbf{e}$

- Covariate ($\mathbf{H}$) updated in each iteration based on the HYM effect ($\mathbf{h}$)

- RJMC module in DMU (Madsen and Jensen, 2013)
- Bayesian setting (Gibbs sampling)
  - 2.5 M rounds
  - 500k burn-in
  - 200 interleave



Variance estimates

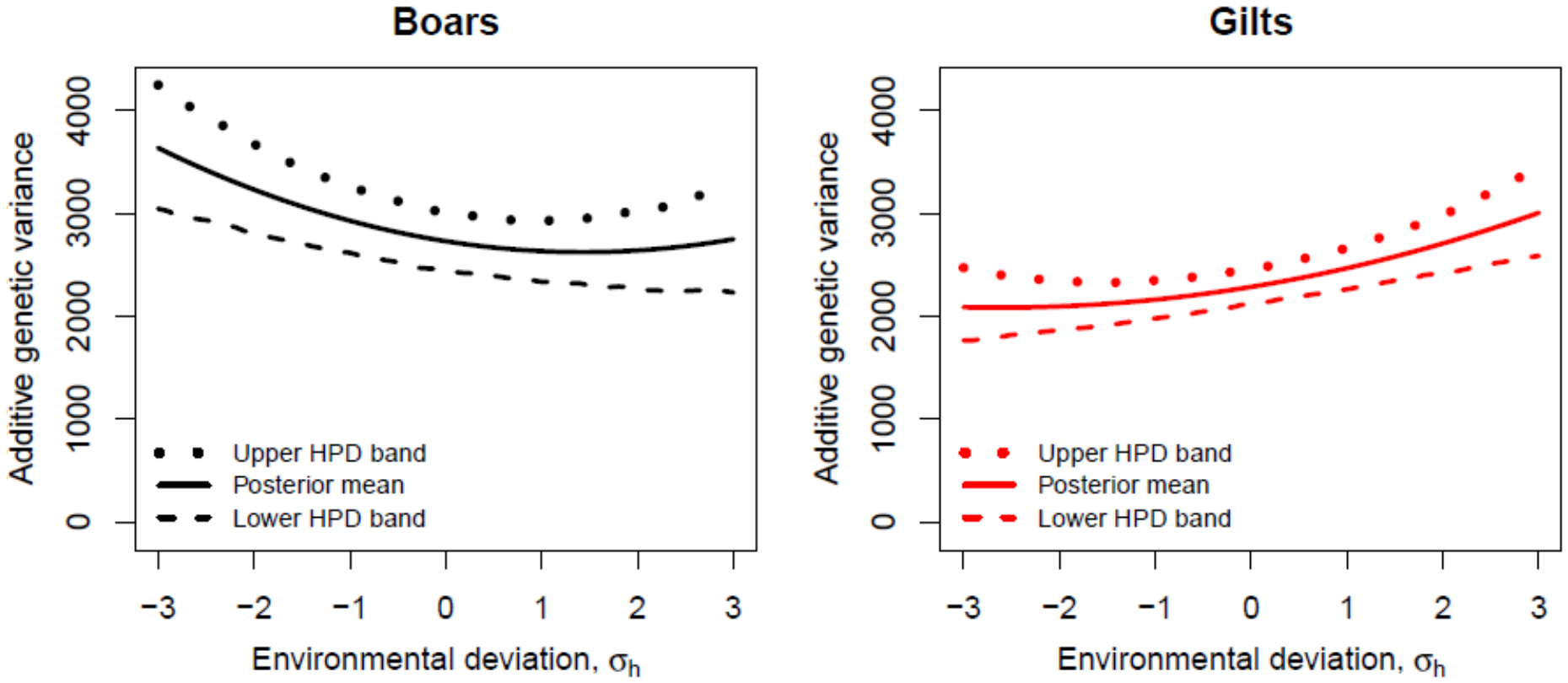
- Significant G×E
- Significant correlation between direct EBVs and macro-ES EBV in Landrace

	Duroc		Landrace	
	Boars	Gilts	Boars	Gilts
$\sigma^2_{a_0}$	1385[a]	1333[a]	2728[a]	2284[a]
$\sigma^2_{a^*}$	0.014[a]	0.024[a]	0.012[a]	0.012[a]
r_{a_0,a^*}	-0.227	0.144	-0.206[a]	0.321[a]
σ^2_h	5076[a]	3755[a]	4706[a]	2769[a]

[a] significantly different from zero

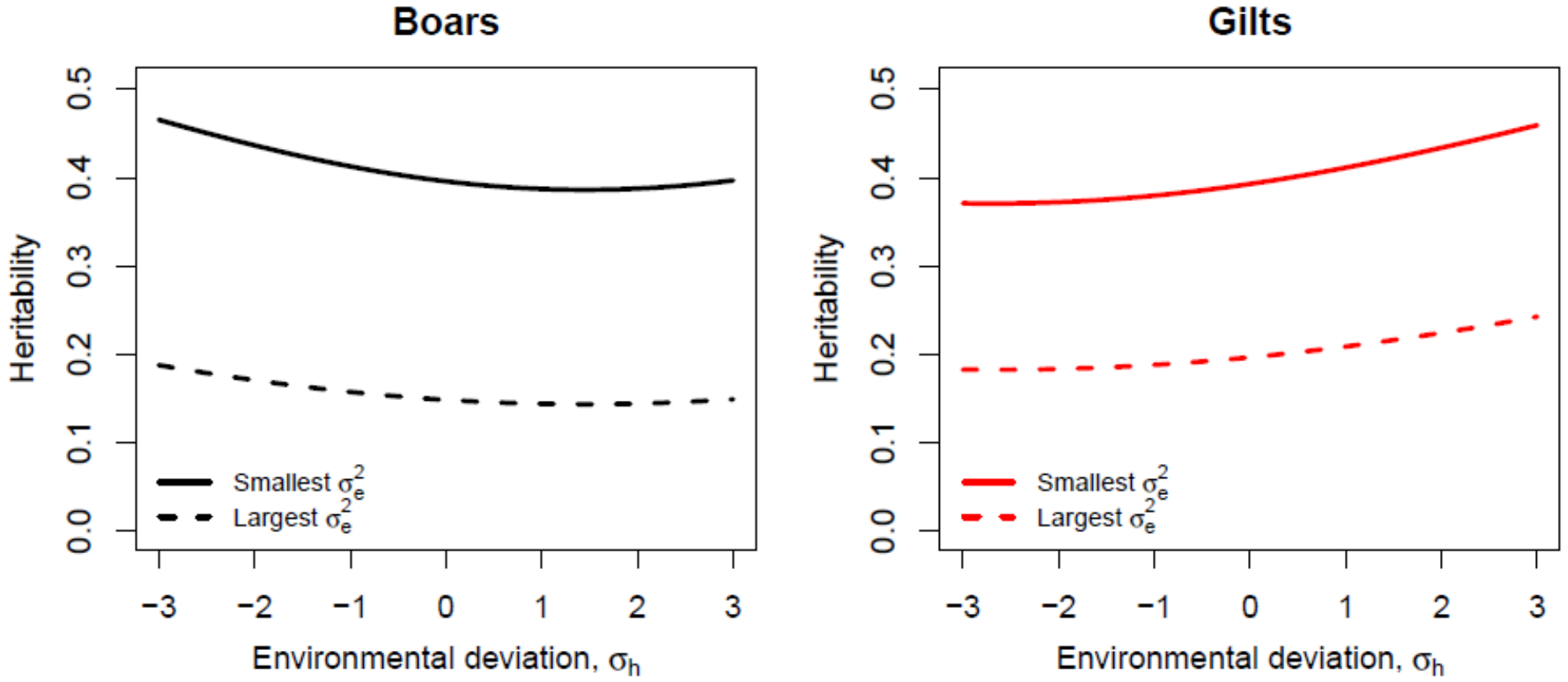
Additive genetic variance of ADG

Landrace



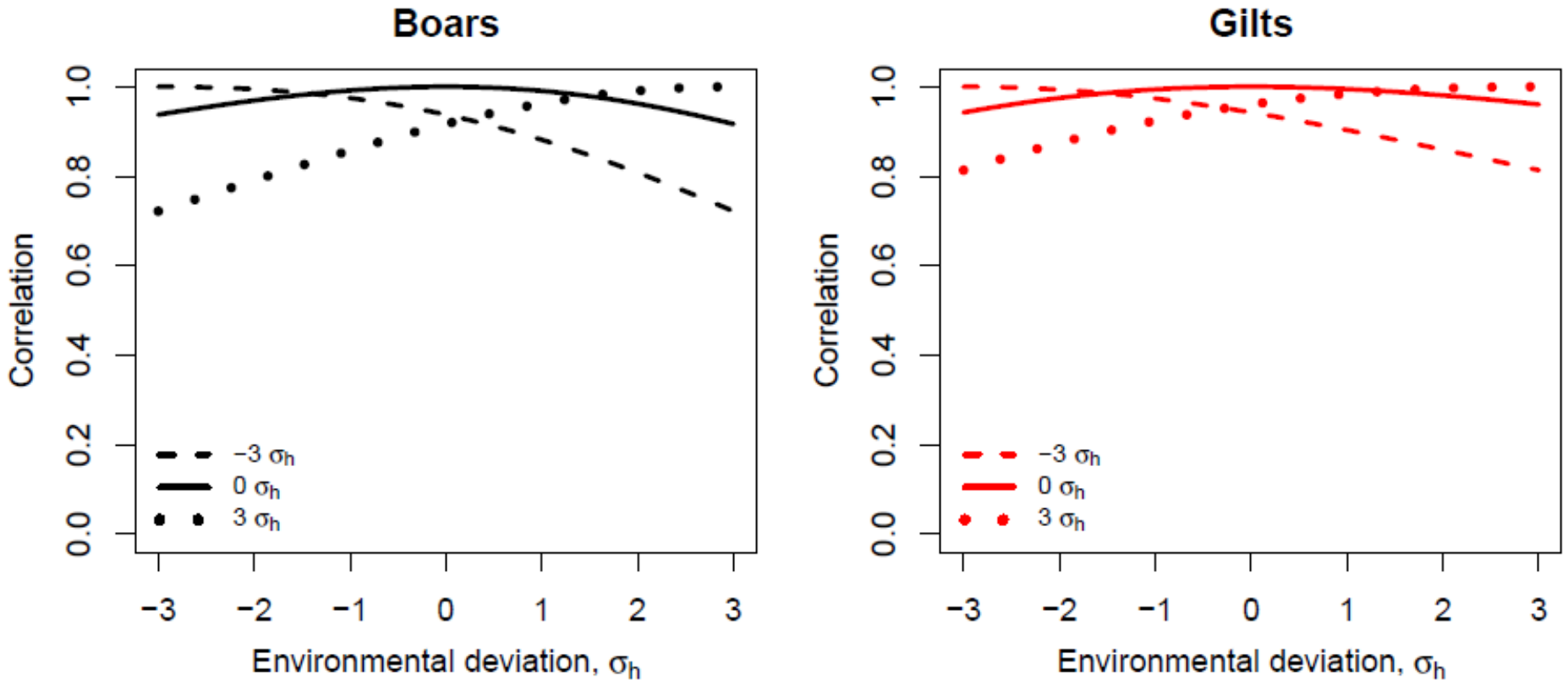
Heritability of ADG

Landrace



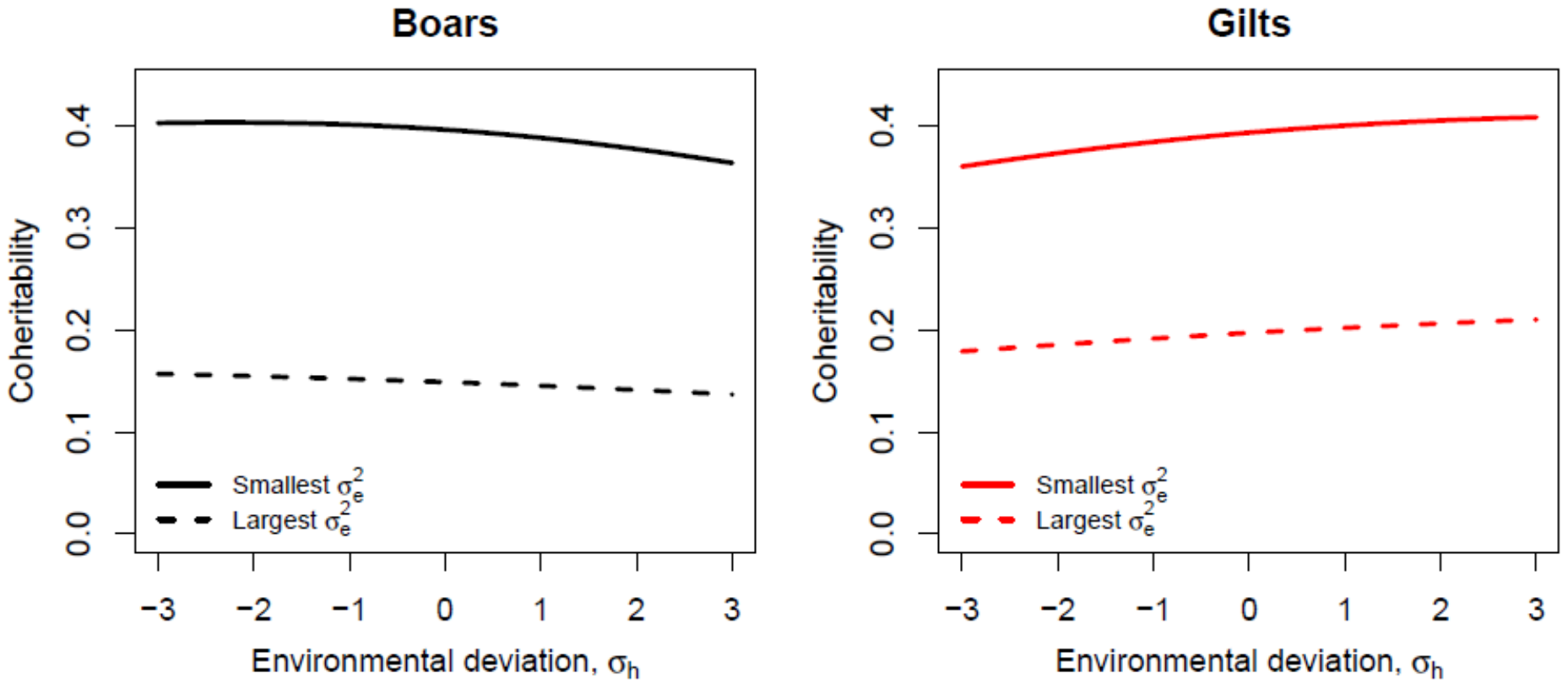
Correlation of ADG in different environments

Landrace



Coheritability

Landrace



Conclusion

- Possibility for adjusting for macro-ES
- Variance of macro-ES differs between breeds
- Correlations between direct and macro-ES EBVs differ between both breeds and sexes

Thank you