Genetic parameters for energy efficiency traits in Nordic Red dairy cattle

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Background

- Feed efficiency is the one of the last "major" traits that is still not included in dairy cattle breeding programs
- Lack of information on
  - Trait description: what exactly IS feed efficiency?
  - Practical problems: how to measure it?
  - Genetics: how heritable is it?
  - Complexity: how would it affect production, health and other traits if feed efficiency would be included as a breeding goal?

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Aim of the study

- Genetic parameters for energy efficiency: residual energy intake and energy conversion efficiency
- Genetic relationships of energy efficiency with milk production, body weight, body condition and energy balance
- Nordic Red dairy cattle

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Feed efficiency data

- MTT Agrifood Research Finland Rehtijärvi and Minkiö farms
  - 1998-2001 and 2006-2012
- ASMO Nordic Red dairy cattle MOET nucleus heifers
  - 1st lactation test period
  - 40 animals in test at the same time
- 400 animals from 146 sires
  - lactation weeks 2 - 30
  - no feed intake when in pasture

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Energy efficiency definitions

Weekly averages lwk 2 - 30 for:

- Residual energy intake (REI)
  - Energy intake - (need for maintenance + milk + energy from BW gain or loss)
  - Requirements estimated from data, REI = cow-wise mean of prediction equation residuals
  - *MJ ME/d*
- Energy conversion efficiency (ECE)
  - Milk energy output/energy intake
  - Calculated from data
  - *kg ECM/MJ ME intake*

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Other studied traits

Weekly averages lwk 2 - 30 for:

- Energy corrected milk (ECM) *kg/d*
- Dry matter intake (DMI) *kg/d*
- Body weight (BW) *kg*
- Body condition score (BCS) *1 to 5*
- Energy balance (EB) *MJ ME/d*
  - Energy intake - (need for maintenance + need for milk)
  - Calculated from official Finnish dairy feed requirements

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Analyses

- Random regression models
  - Fixed effects: calving year-month, calving age
  - Lactation stage correction Ali and Schaeffer 1987
  - *pe* and *a* modelled with 2nd degree Legendre polynomials
- Multitrait models
  - Each lactation month treated as a separate trait (4-wk periods * 8)
  - Fixed effects: calving age, year and season
  - Random effects: *a*
- Both: REML with pedigree two generations back

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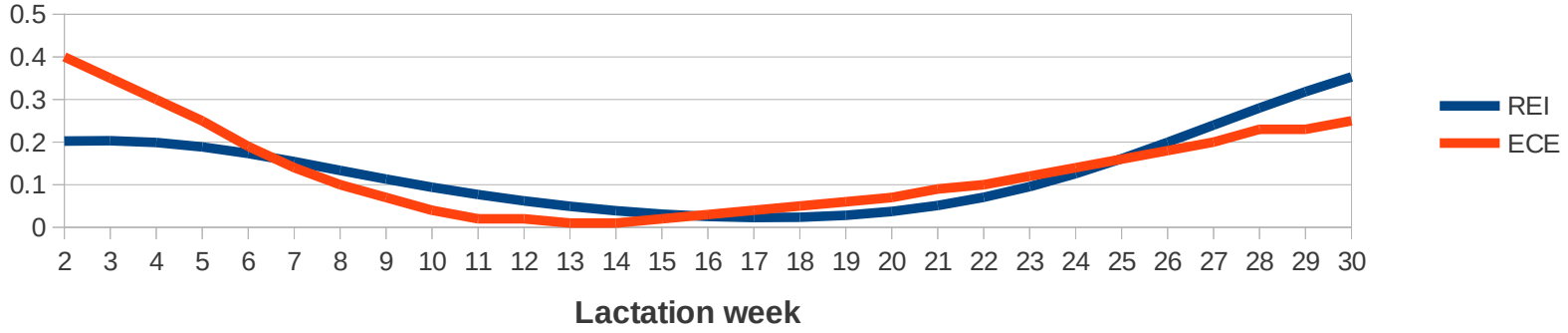
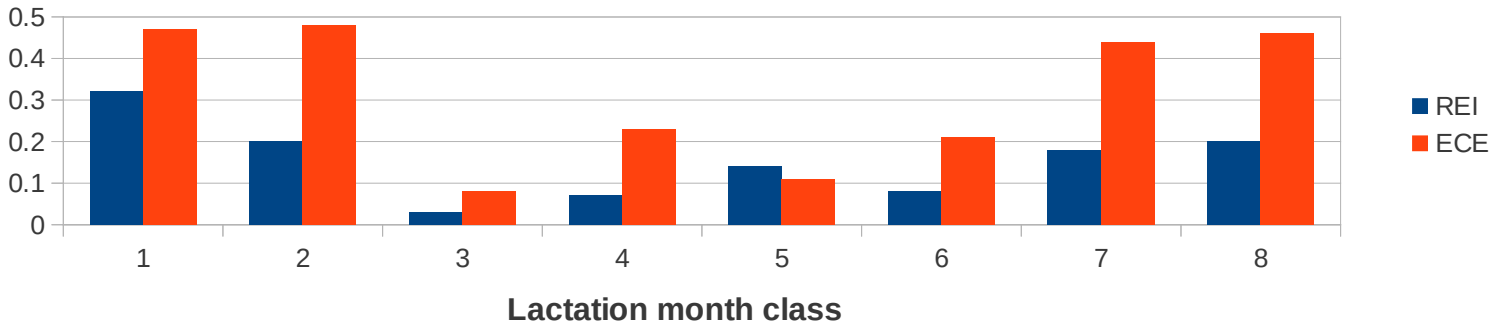
Heritabilities efficiency traits

- Highest h^2 estimates in beginning and end of study period

Random regression:

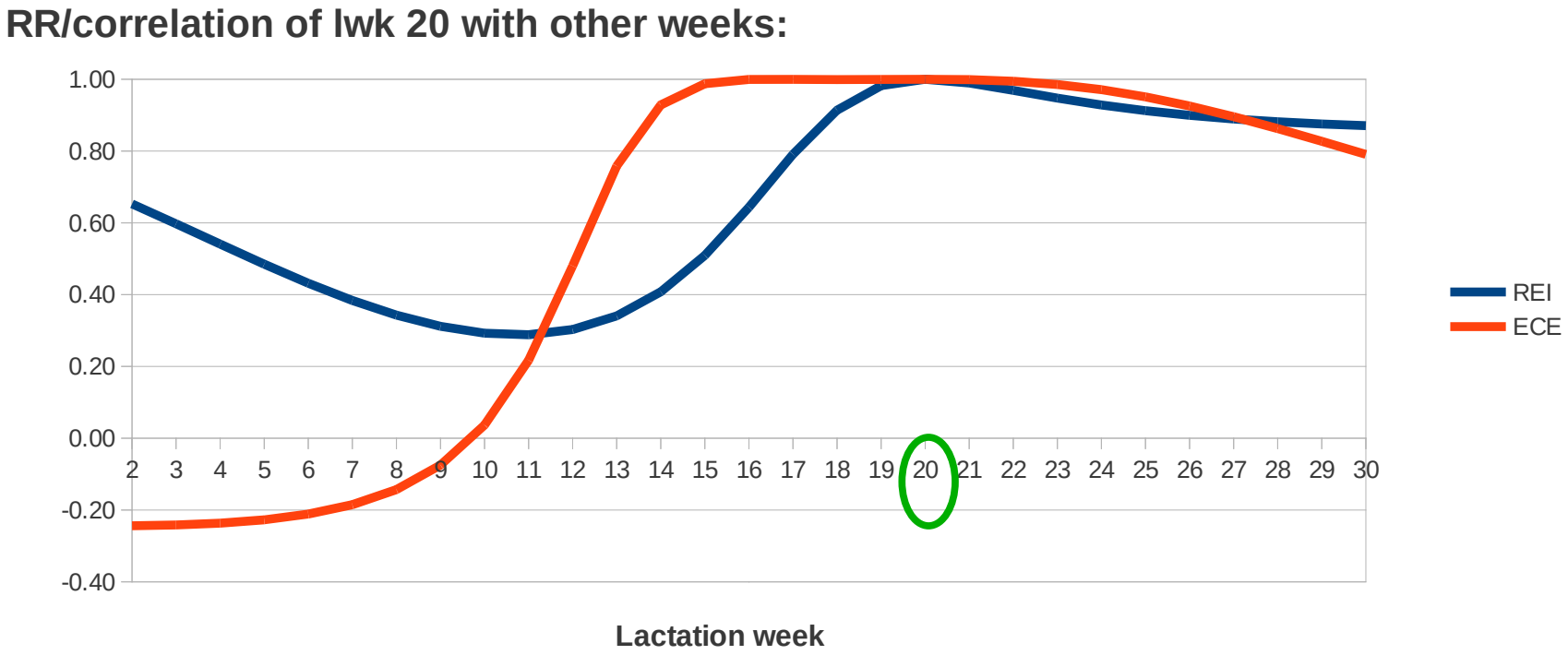


Multitrait:



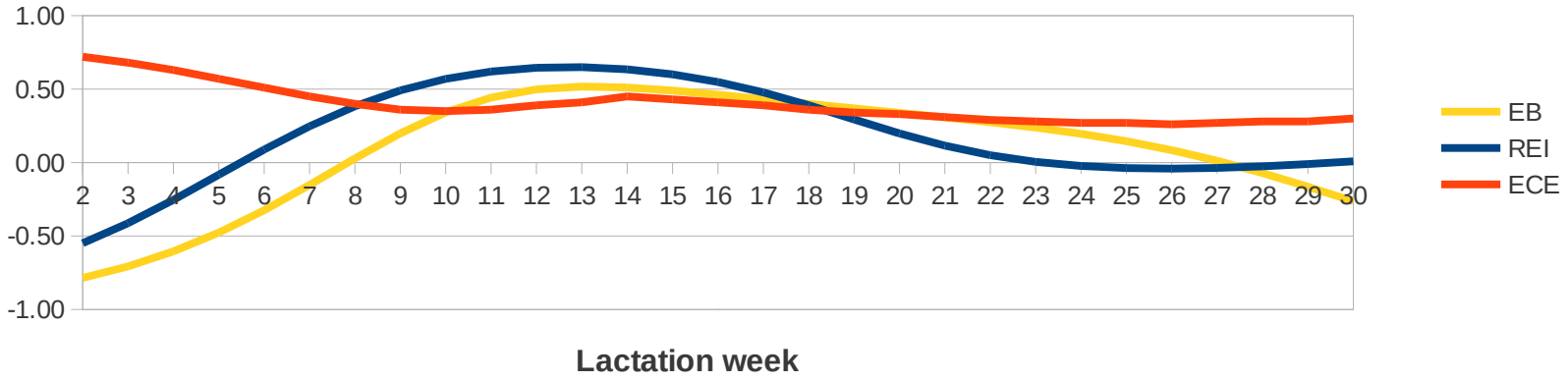
Genetic correlations within efficiency traits

- At least 2 different efficiency periods during early to mid-lactation with partially different genetic mechanisms?

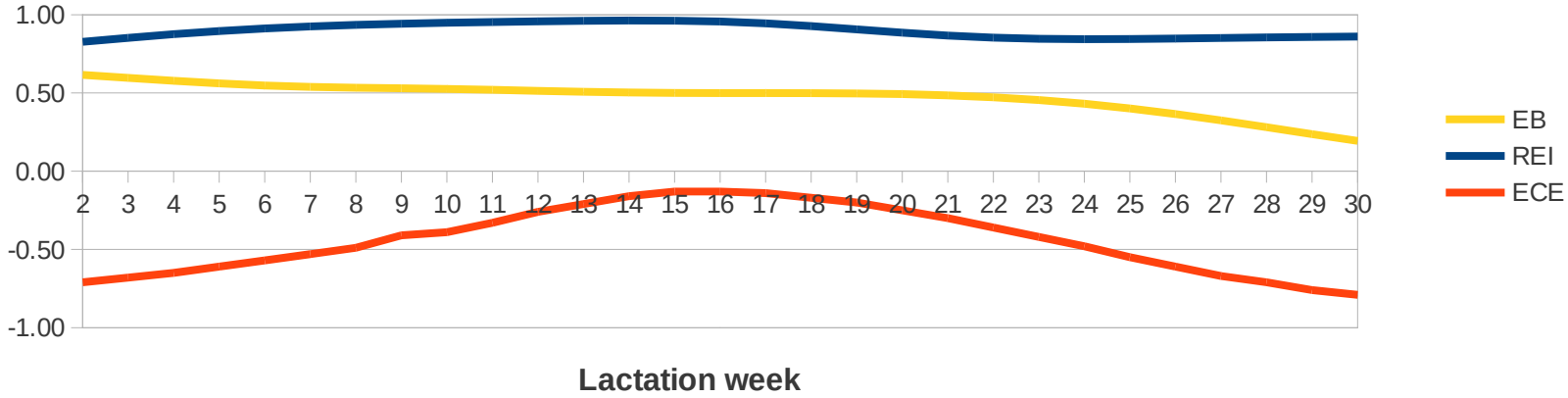


Genetic correlations efficiency vs. others

RR/ECM:



RR/DMI:



Conclusions

- Energy efficiency in dairy cows is moderately heritable
- Energy efficiency during early and mid- to late lactation probably has partially different genetic backgrounds
  - But: first 10 weeks after calving the most challenging period for modelling -> more info on body composition changes needed
- Trait definition still problematic
  - REI genetically similar to EB: correlated with ECM and BW
  - ECE easy to understand but strongly correlated to component traits: what is new?
  - Efficiency measures rely on prediction of energy requirements from pre-defined feeding norms -> biologically more relevant indicator traits?

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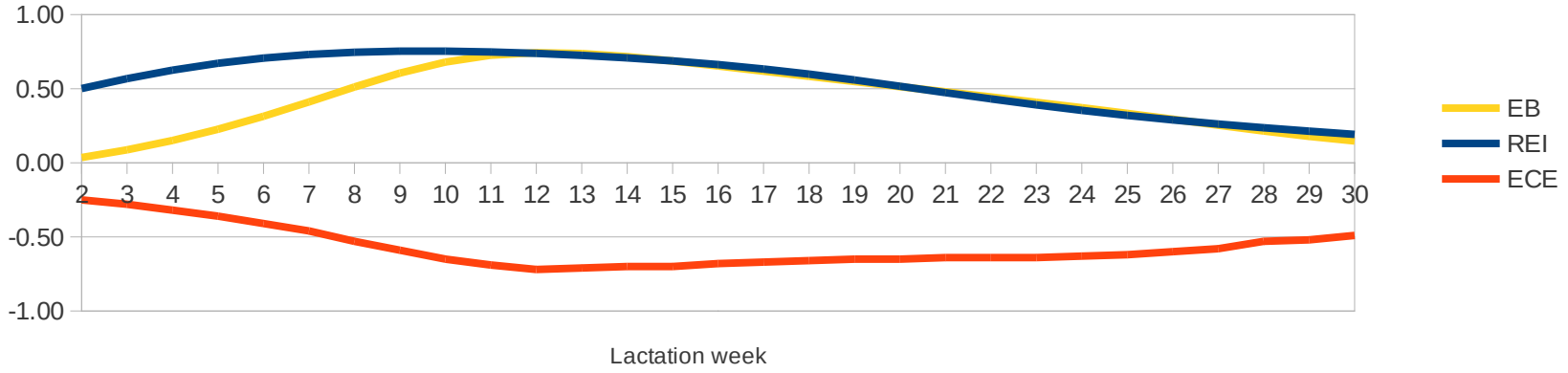
Genetic correlations efficiency vs. others (2)

RR/BW:



RR/BCS: