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Alternatives for modeling of traits within the calving traits complex

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Hypothesis and aim of the study

- Cases of stillbirth (and loss of calf within 48 h) have very different physiological reasons
- A “light“ calf may die for other reasons than a “heavy“ one
- This could be accounted for by **combining** SB and CE
- CE evaluations in Germany as in many other countries use four classes (easy – normal – heavy – operation)
- Distribution of data across these classes is very skewed – Try a binary way of coding?
- Endless debates in the literature on the genetic correlation between direct and maternal effects

Data

- 21 herds (large cooperator herds)
- Oct 2005 – Apr2011
- Birth weights available
- Edits:
  - Holstein
  - Single births
  - Birth weights > 30 kg
  - Known sire of calf and sire of dam
- Data:
  - 81.419 calvings; 43.619 cows, 30.589 heifers

Re-coding of original data

Codes for CE	
No information (0)	
Easy (1)	0
Normal (2)	1
Heavy (3)	1
Operation (4)	

Codes for result of calving	
Living calf (1-5)	0
Born dead (6)	1
Died within 48 hours (7)	
Died after day 2 (8)	
Abnormal/genetic defect (9)	

	All	Heifers	Cows
Births w problems (%)	32,0	44,1	24,7
Heavy births (%)	9,8	14,9	6,7
Stillbirths (%)	5,4	8,7	3,4

Result of re-coding

CALVING EASE

EASY-ASSISTED

… not too unevenly distributed

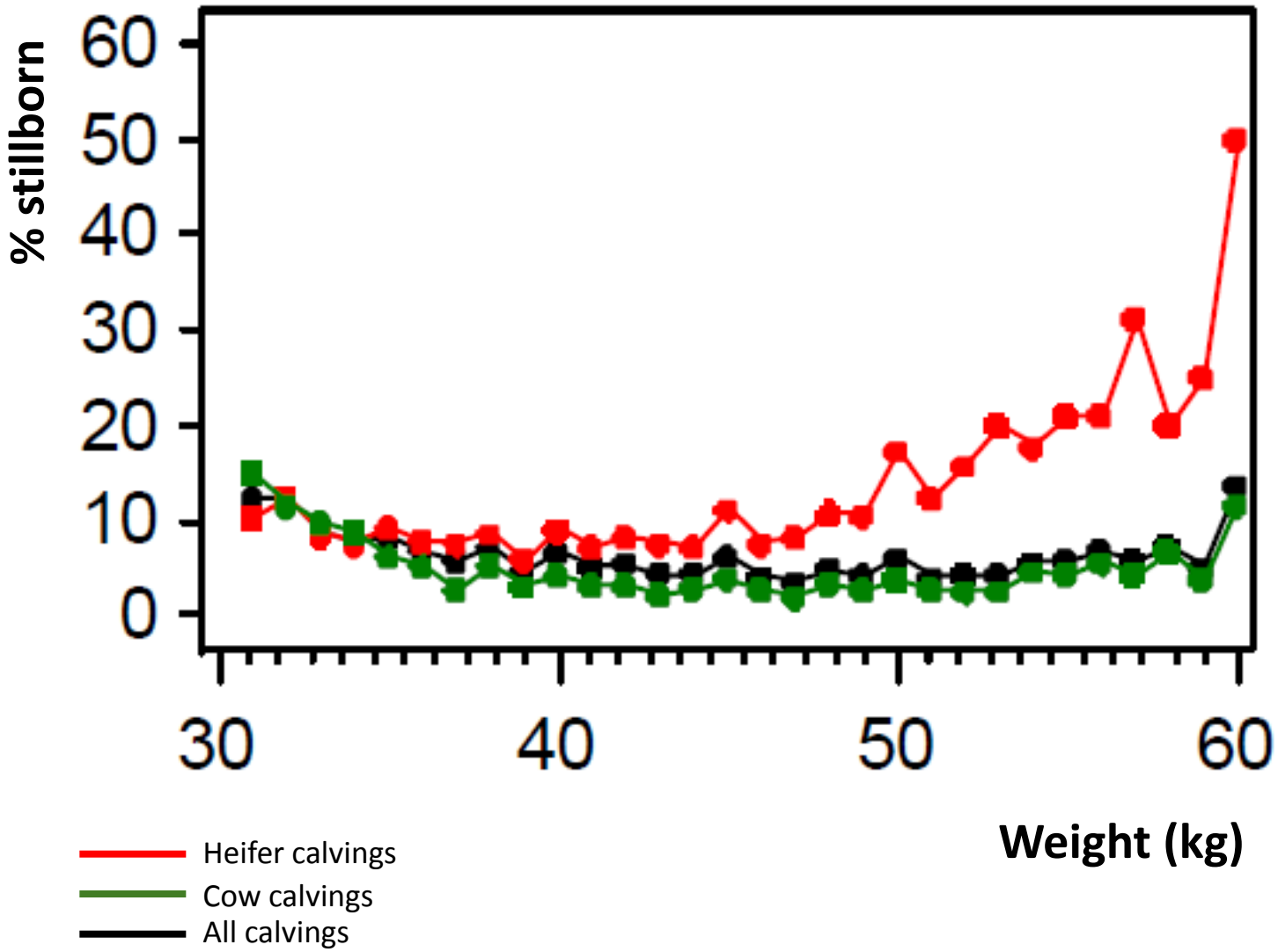
NORMAL-HEAVY

… makes more sense?

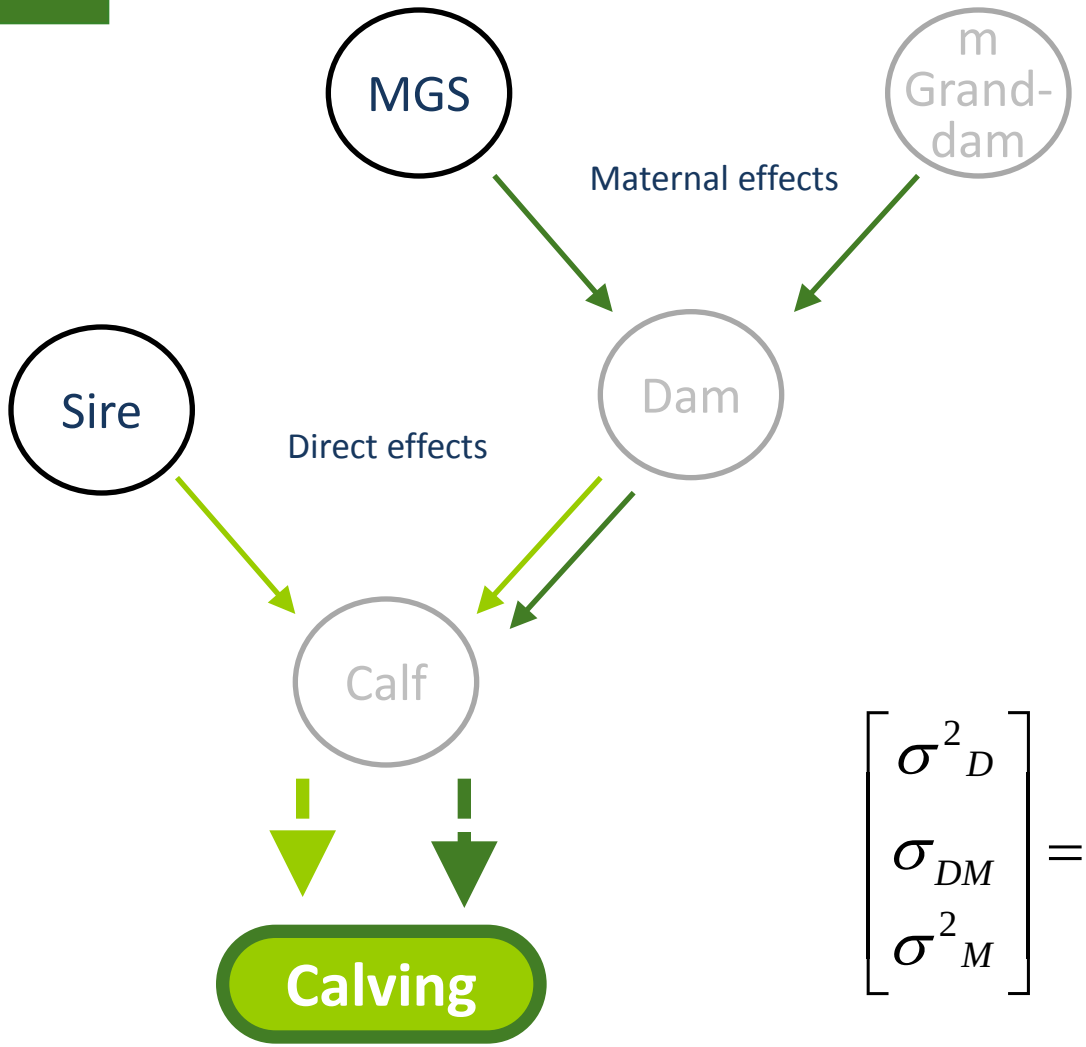
STILLBIRTH

… nothing to be done

Stillbirths vs. weight of calf



Modelling



Sire-Maternal-Grandsire Model

$$\begin{bmatrix} \sigma^2_D \\ \sigma_{DM} \\ \sigma^2_M \end{bmatrix} = \begin{bmatrix} 4 & 0 & 0 \\ -2 & 4 & 0 \\ 1 & -4 & 4 \end{bmatrix} \begin{bmatrix} \sigma^2_S \\ \sigma_{S,MGS} \\ \sigma^2_{MGS} \end{bmatrix}$$

Results: The traditional way, but new traits

Estimates of direct and maternal heritabilities

	Direct (h^2 + SE)						Maternal (h^2 + SE)					
	Heifers		Cows		All		Heifers		Cows		All	
Stillbirth (SB)	0,138	0,031	0,074	0,026	0,104	0,021	**0,281**	0,051	0,032	0,028	0,180	0,033
EASY-ASSISTED (CE1)	0,141	0,020	0,102	0,014	0,111	0,012	0,101	0,019	0,069	0,016	0,087	0,013
NORMAL-HEAVY (CE2)	0,148	0,026	0,103	0,023	0,122	0,017	0,109	0,026	0,102	0,033	0,079	0,017
Birth weight (BW)	0,302	0,025	0,262	0,024	0,279	0,016	0,071	0,013	0,096	0,015	0,077	0,010
Gestation length (GL)	0,443	0,031	0,419	0,024	0,439	0,022	0,066	0,013	0,091	0,015	0,086	0,011

Defining alternatives

Distribution of data across sub-cells of new binary traits, i.e. for SB x CE1 and SB x CE2 (%)

	EASY-ASSISTED (CE1)	
	easy	**assisted**
alive	54,3	36,2
dead	2,2	6,3

	NORMAL-HEAVY (CE2)	
	normal	**heavy**
alive	80,3	11,1
dead	4,8	3,7

Derive new binary traits from the sub-cells

1 This sub-cell is valid

0 This sub-cell is not valid (➔ one of the three others is …)

Forming four traits for each SB x CE combination

Example: SB x CE1

	EASY-ASSISTED (CE1)	
	easy	**assisted**
alive	54,3	36,2
dead	2,2	6,3

1	0
Alive - Easy	Rest
Alive – Assisted	Rest
Dead – Easy	Rest
Dead - Assisted	Rest

Forming four traits for each SB x CE combination

Example: SB x CE1, alive-easy

	EASY-ASSISTED (CE1)	
	easy	**assisted**
alive	54,3	36,2
dead	2,2	6,3

1	0
Alive – Easy	Rest
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Forming four traits for each SB x CE combination

Example: SB x CE1, dead-easy

	EASY-ASSISTED (CE1)	
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alive	54,3	36,2
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1	0
Alive – Easy	Rest
Alive- Assisted	Rest
Dead – Easy	Rest
Dead - Assisted	Rest

Forming four traits for each SB x CE combination

Example: SB x CE1, dead-assisted

	EASY-ASSISTED (CE1)	
	easy	**assisted**
alive	54,3	36,2
dead	2,2	6,3

1	0
Alive – Easy	Rest
Alive – Assisted	Rest
Dead – Easy	Rest
Dead - Assisted	Rest

Forming 4 traits x 2 CE definitions

8 binary traits (4x SB x CE1, 4x SB-CE2)

➔ Heifer calvings

➔ Univariate S-MGS models

Results: heritabilities and $r_{g\ (dir\ x\ mat)}$

SB x EASY-ASSISTED (CE1)

	Alive - Easy		Alive-Assisted		Dead-Easy		Dead-Assisted	
h^2_{dir}	0,14	0,020	0,10	0,016	0,12	0,052	0,14	0,034
h^2_{mat}	0,12	0,021	0,05	0,014	0,11	0,069	0,26	0,055
$r_{g\ dir\ x\ mat}$	-0,02	0,128	0,05	0,168	0,32	0,525	-0,10	0,186

SB x NORMAL- HEAVY (CE2)

	Alive - Normal		Alive - Heavy		Dead - Normal		Dead - Heavy	
h^2_{dir}	0,12	0,022	0,12	0,026	0,09	0,033	0,24	0,057
h^2_{mat}	0,15	0,027	0,06	0,023	0,25	0,060	0,25	0,072
$r_{g\ dir\ x\ mat}$	-0,12	0,146	-0,00	0,224	0,00	0,25	-0,32	0,189

Results: heritabilities and $r_{g\ (dir\ x\ mat)}$

SB x EASY-ASSISTED (CE1)

	Alive - Easy		Alive-Assisted		Dead-Easy		Dead-Assisted	
h^2_{dir}	0,14	0,020	0,10	0,016	0,12	0,052	0,14	0,034
h^2_{mat}	0,12	0,021	0,05	0,014	0,11	0,069	0,26	0,055
$r_{g\ dir\ x\ mat}$	-0,02	0,128	0,05	0,168	0,32	0,525	-0,10	0,186

SB x NORMAL-HEAVY (CE2)

	Alive - Normal		Alive - Heavy		Dead - Normal		Dead - Heavy	
h^2_{dir}	0,12	0,022	0,12	0,026	0,09	0,033	0,24	0,057
h^2_{mat}	0,15	0,027	0,06	0,023	0,25	0,060	0,25	0,072
$r_{g\ dir\ x\ mat}$	-0,12	0,146	-0,00	0,224	0,00	0,25	-0,32	0,189

Conclusions

- Estimates for heritabilities at the upper end of the literature
  ➔ exact documentation in cooperator herds

- Stillbirths are a mixture formed of light and heavy calves

- Genetic correlation direct x maternal depends heavily on the way how SB and CE are combined

- Large calves from very difficult births should be tackled via birth weight

- Heritability for stillbirth in easy/normal calvings is large enough to be used in genetic selection

Thank You!