Genetic evaluation for subjective traits

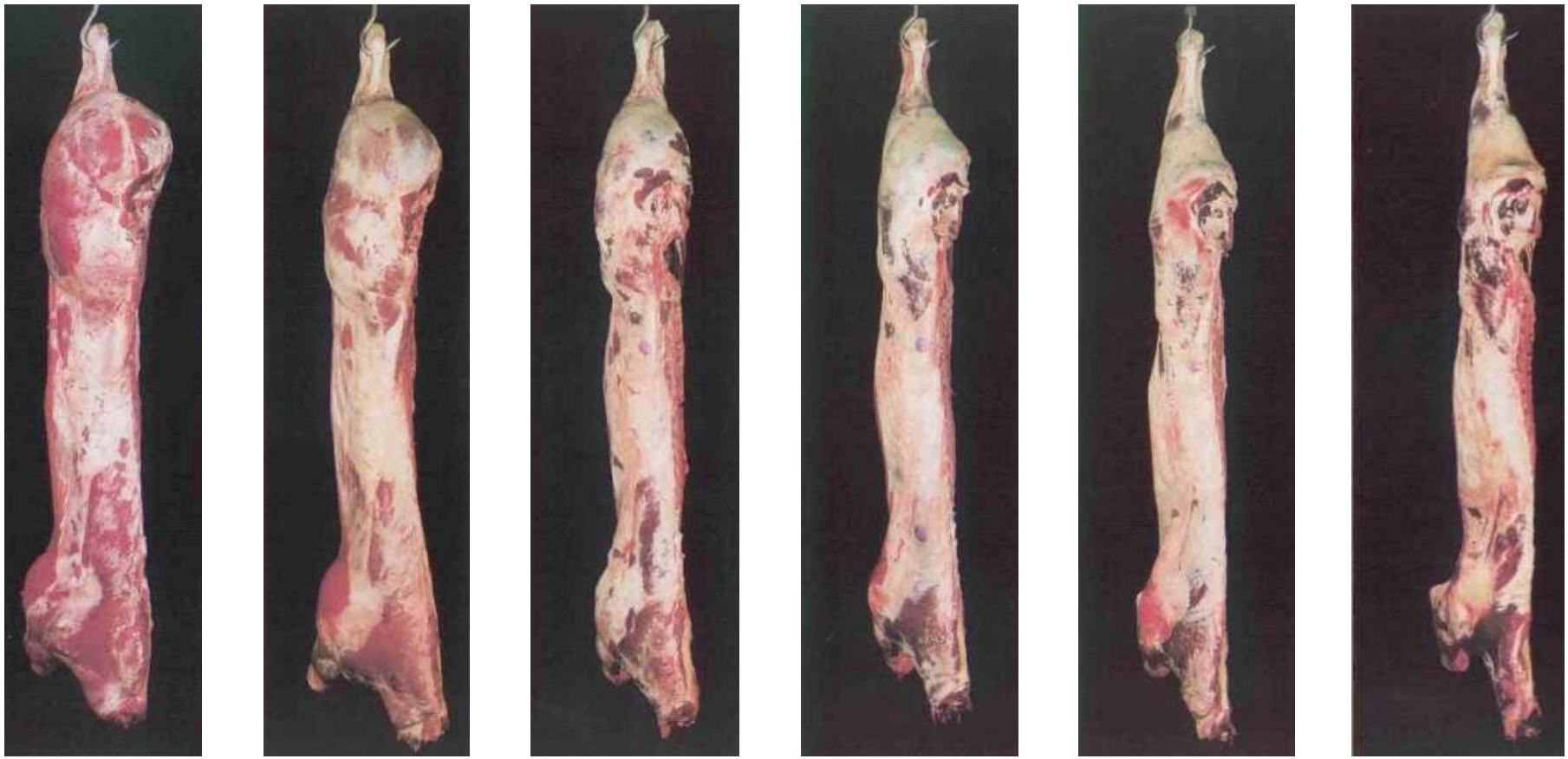
Luis Varona, Carlos Moreno and Juan Altarriba
Unidad de Genética Cuantitativa y Mejora Animal
Universidad de Zaragoza. E-50013. SPAIN

Subjective Traits

- Type Traits.
- Carcass conformation.
- Fat Cover.
- Sensory Analysis.

Beef Carcass Conformation

S **E** **U** **R** **O**



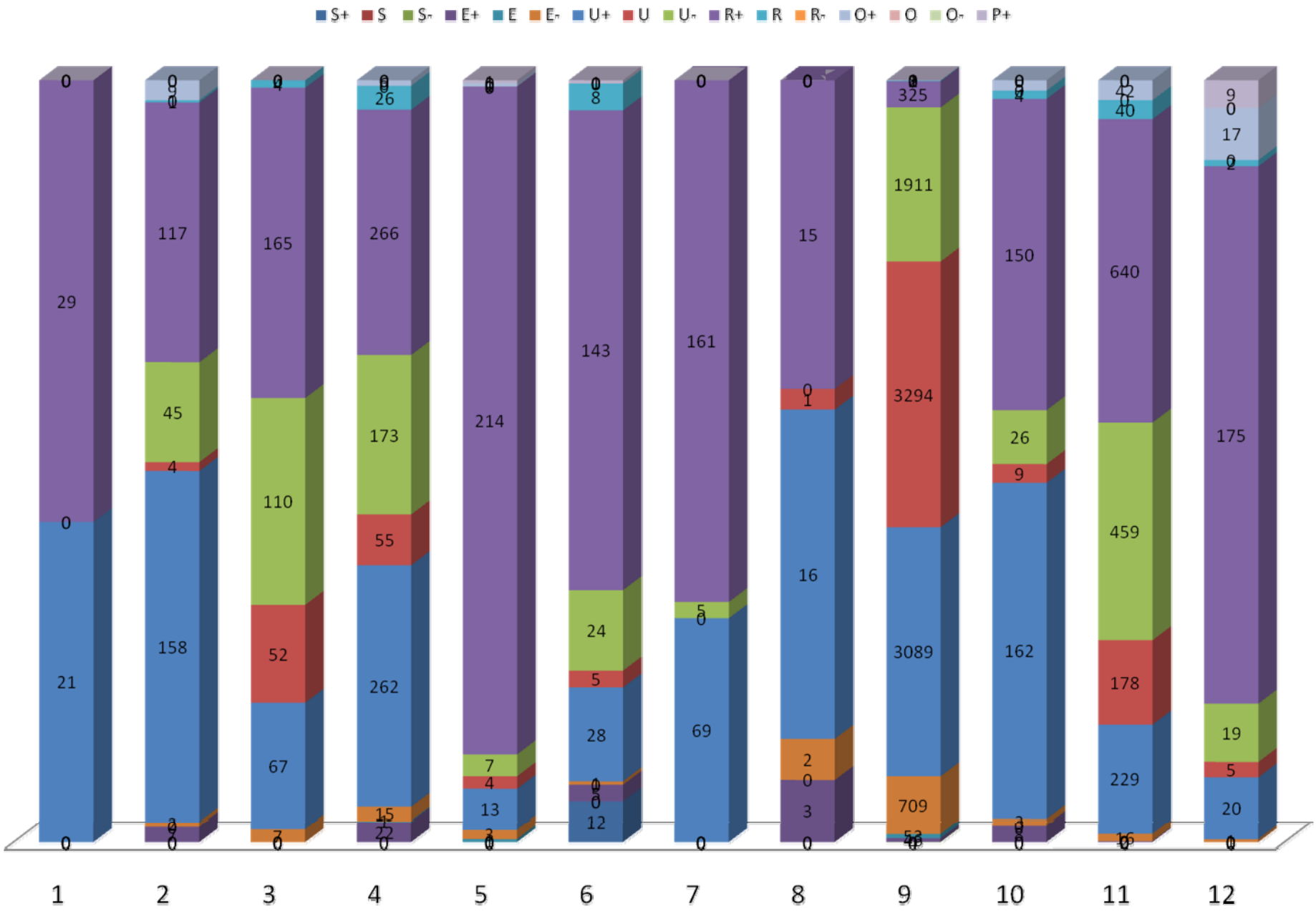
Data: Pirenaica Breed

14031	**Phenotypic Data**
12	**Slaughterhouses**
2	**Sex**
23	**Year Season Effects**
477	**Herds**
34843	**Individuals on the pedigree**

Carcass Conformation

VAL		SLAUGHTERHOUSE												TOTAL
		1	2	3	4	5	6	7	8	9	10	11	12	
S	+	0	0	0	0	0	12	0	0	0	0	0	0	12
	=	0	0	0	0	0	0	0	0	0	0	0	0	0
	-	0	0	0	0	0	0	0	0	4	0	0	0	4
E	+	0	7	0	22	0	5	0	3	46	8	2	0	93
	=	0	0	0	1	1	0	0	0	53	0	0	0	55
	-	0	2	7	15	3	1	0	2	709	3	16	1	759
U	+	21	158	67	262	13	28	69	16	3089	162	229	20	4134
	=	0	4	52	55	4	5	0	1	3294	9	178	5	3607
	-	0	45	110	173	7	24	5	0	1911	26	459	19	2779
R	+	29	117	165	266	214	143	161	15	325	150	640	175	2400
	=	0	1	4	26	0	8	0	0	8	4	40	2	93
	-	0	0	0	0	0	0	0	0	1	0	0	0	1
O	+	0	9	0	6	1	0	0	0	2	5	42	17	82
	=	0	0	0	0	0	0	0	0	0	0	0	0	0
	-	0	0	0	0	0	0	0	0	0	0	0	0	0
P	+	0	0	0	0	1	1	0	0	1	0	0	9	12
	=	0	0	0	0	0	0	0	0	0	0	0	0	0
	-	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL		50	343	405	826	244	227	235	37	9443	367	1606	248	14031

Carcass Conformation



Model I: Standard Animal Model

S	+	18
	=	17
	-	16
E	+	15
	=	14
	-	13
U	+	12
	=	11
	-	10
R	+	9
	=	8
	-	7
O	+	6
	=	5
	-	4
P	+	3
	=	2
	-	1

$$\mathbf{y} = \mathbf{Xb} + \mathbf{Wp} + \mathbf{Zu} + \mathbf{e}$$

$$\mathbf{b} \propto k_1$$

$$\mathbf{p} \sim N\left(0, \mathbf{I}\sigma_p^2\right) \qquad \sigma_a^2 \propto k_3$$

$$\mathbf{u} \sim N\left(0, \mathbf{A}\sigma_a^2\right) \qquad \sigma_p^2 \propto k_2$$

$$\mathbf{e} \sim N\left(0, \mathbf{I}\sigma_e^2\right) \qquad \sigma_e^2 \propto k_4$$

Model II: Threshold Model

$$f\left(\mathbf{y}|\mathbf{l}\right)=\prod_{i=1}^{N} f\left(y_i|l_i,\mathbf{t}\right)$$

$$f\left(y_i|l_i,\mathbf{t}\right)=1\left(l_i<t_1\right)1\left(y_i=1\right)+1\left(t_1<l_i<t_2\right)1\left(y_i=2\right)+\ldots\ldots\ldots$$
$$+1\left(t_k<l_i\right)1\left(y_i=k+1\right)$$

$$\mathbf{l}=\mathbf{X}\mathbf{b}_l+\mathbf{W}\mathbf{p}_l+\mathbf{Z}\mathbf{u}_l+\mathbf{e}_l$$

$$\mathbf{b}_l \propto k_1 \qquad \mathbf{u}_l \sim N\left(0,\mathbf{A}\sigma_a^2\right) \qquad \sigma_{a_l}^2 \propto k_3$$

$$\mathbf{p}_l \sim N\left(0,\mathbf{I}\sigma_p^2\right) \qquad \mathbf{e}_l \sim N\left(0,\mathbf{I}\sigma_e^2\right) \qquad \sigma_{p_l}^2 \propto k_2$$

$$\sigma_{e_l}^2=1$$

Model III: Specific Slaughterhouse Threshold Model

$$f(\mathbf{y}|\mathbf{l}) = \prod_{i=1}^{M} \prod_{j=1}^{N_m} f(y_{ij}|l_{ij}, \mathbf{t}_i)$$

$$f(y_{ij}|l_{ij}, \mathbf{t}_i) = 1(l_{ij} < t_{1i}) 1(y_{ij} = 1) + 1(t_{1i} < l_{ij} < t_{2i}) 1(y_{ij} = 2) + \ldots\ldots\ldots + 1(t_{ki} < l_{ij}) 1(y_{ij} = k+1)$$

$$\mathbf{l} = \mathbf{X}\mathbf{b}_l + \mathbf{W}\mathbf{p}_l + \mathbf{Z}\mathbf{u}_l + \mathbf{e}_l$$

$$\mathbf{b}_l \propto k_1 \qquad \mathbf{u}_l \sim N(0, \mathbf{A}\sigma_a^2) \qquad \sigma_{a_l}^2 \propto k_3$$

$$\mathbf{p}_l \sim N(0, \mathbf{I}\sigma_p^2) \qquad \mathbf{e}_l \sim N(0, \mathbf{I}\sigma_e^2) \qquad \sigma_{p_l}^2 \propto k_2$$

$$\sigma_{e_l}^2 = 1$$

Variance Components

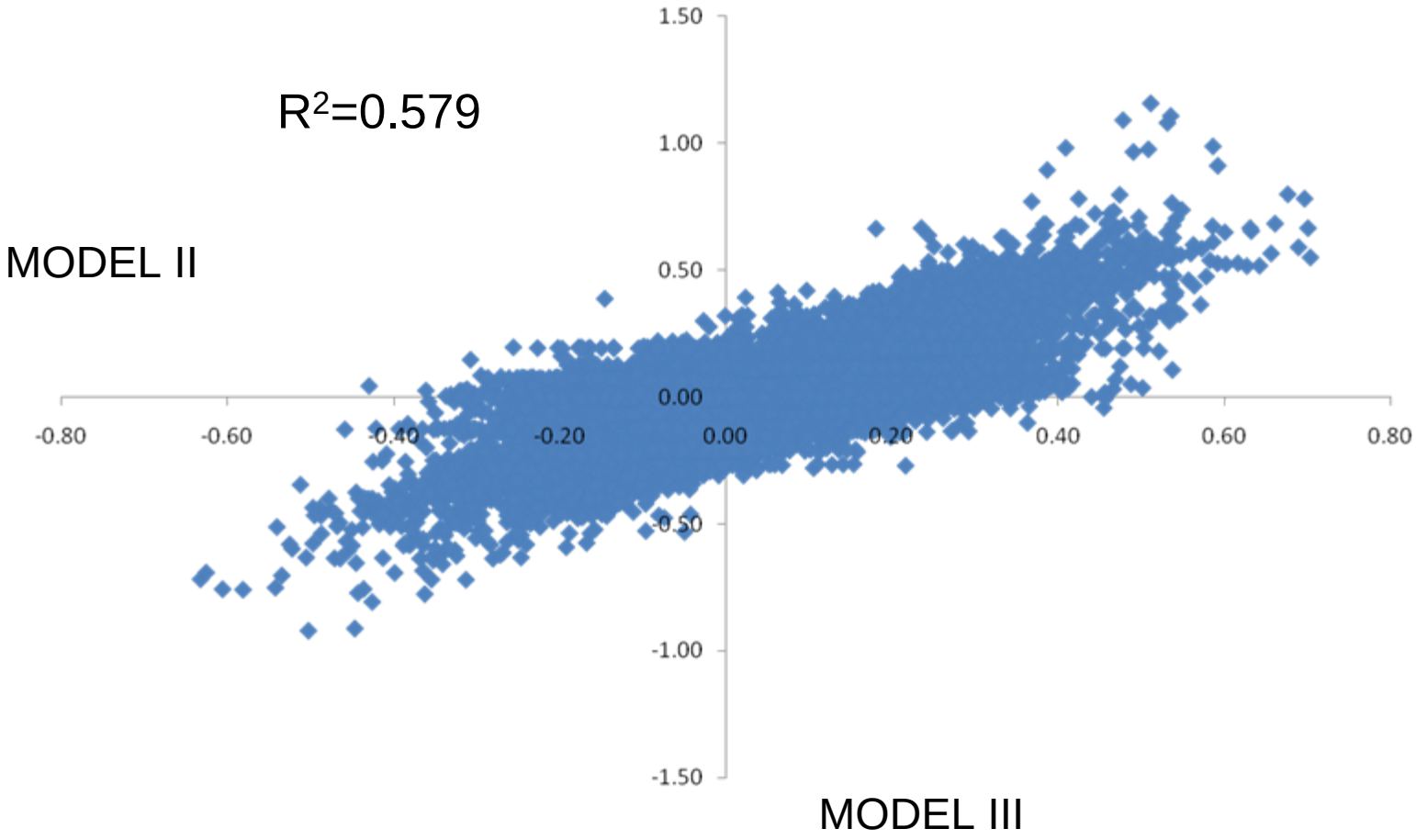
MODEL	Va	Vp	Ve	h^2	DIC
I	0.36	0.11	0.90	0.26	20997.22
	(0.05)	(0.01)	(0.04)	(0.03)	
II	0.48	0.49	1.00	0.24	19548.25
	(0.09)	(0.05)		(0.03)	
III	0.48	0.56	1.00	0.23	18057.62
	(0.08)	(0.06)		(0.02)	

	Thresholds by Slaughterhouse											
	1	2	3	4	5	6	7	8	9	10	11	12
S+/S	-	-	-	-	-	4.48 (0.26)	-	-	-	-	-	-
S/S-	-	-	-	-	-	4.43 (0.26)	-	-	-	-	-	
S-/E+	-	-	-	-	-	4.38 (0.26)	-	-	5.33 (0.22)	-	-	-
E+/E	-	4.36 (0.27)	-	4.32 (0.24)	-	4.09 (0.25)	-	3.57 (0.47)	4.28 (0.11)	3.96 (0.23)	5.97 (0.39)	-
E/E-	-	4.28 (0.27)	-	4.27 (0.24)	5.95 (0.57)	4.04 (0.25)	-	3.30 (0.45)	3.96 (0.10)	3.90 (0.23)	5.75 (0.39)	-
E-/U+	-	4.07 (0.25)	4.59 (0.28)	3.95 (0.22)	4.94 (0.37)	3.95 (0.25)	-	2.71 (0.40)	2.74 (0.06)	3.66 (0.21)	4.65 (0.23)	5.23 (0.54)
U+/U	2.67 (0.40)	1.55 (0.15)	2.99 (0.21)	2.15 (0.19)	3.82 (0.27)	3.08 (0.23)	2.34 (0.20)	1.05 (0.28)	1.14 (0.03)	1.20 (0.12)	2.99 (0.19)	3.35 (0.28)
U/U-	2.61 (0.41)	1.51 (0.15)	2.44 (0.22)	1.92 (0.18)	3.59 (0.26)	2.96 (0.22)	2.32 (0.20)	0.91 (0.28)	0	1.11 (0.12)	2.48 (0.20)	3.17 (0.26)
U-/R+	2.53 (0.41)	1.07 (0.14)	1.51 (0.21)	1.19 (0.18)	3.27 (0.24)	2.50 (0.22)	2.21 (0.20)	0.82 (0.28)	-1.48 (0.05)	0.85 (0.12)	1.48 (0.19)	2.65 (0.24)
R+/R	-	-0.88 (0.20)	-1.45 (0.31)	-0.72 (0.21)	-1.65 (0.29)	-0.50 (0.27)	-	-	-3.06 (0.14)	-1.46 (0.19)	-0.50 (0.19)	-0.21 (0.22)
R/R-	-	-0.99 (0.21)	-	-1.57 (0.25)	-1.77 (0.32)	-1.29 (0.35)	-	-	-3.45 (0.18)	-1.78 (0.24)	-0.88 (0.20)	-0.28 (0.22)
R-/O+	-	-1.05 (0.21)	-	-1.64 (0.26)	-1.90 (0.33)	-1.46 (0.39)	-	-	-3.59 (0.21)	-1.89 (0.26)	-0.89 (0.20)	-0.31 (0.23)
O+/O	-	-	-	-	-2.25 (0.38)	-1.66 (0.42)	-	-	-3.94 (0.29)	-	-	-0.96 (0.25)
O/O-	-	-	-	-	-2.49 (0.44)	-1.92 (0.48)	-	-	-4.13 (0.34)	-	-	-1.02 (0.25)
O-/P+	-	-	-	-	-2.78 (0.52)	-2.24 (0.55)	-	-	-4.36 (0.40)	-	-	-1.10 (0.26)

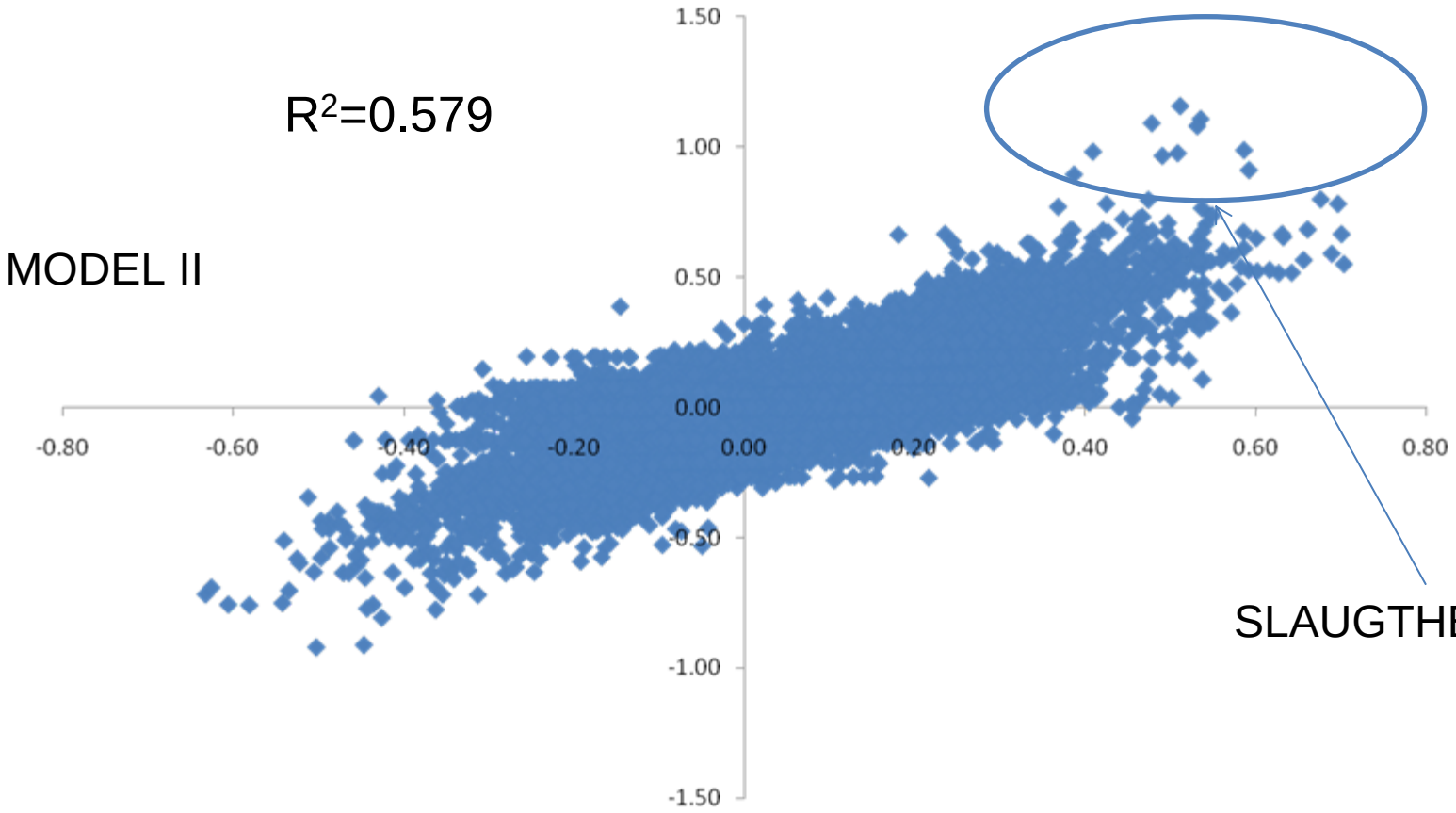
	Thresholds by Slaughterhouse											
	1	2	3	4	5	6	7	8	9	10	11	12
S+/S	-	-	-	-	-	4.48 (0.26)	-	-	-	-	-	-
S/S-	-	-	-	-	-	4.43 (0.26)	-	-	-	-	-	
S-/E+	-	-	-	-	-	4.38 (0.26)	-	-	5.33 (0.22)	-	-	-
E+/E	-	4.36 (0.27)	-	4.32 (0.24)	-	4.09 (0.25)	-	3.57 (0.47)	4.28 (0.11)	3.96 (0.23)	5.97 (0.39)	-
E/E-	-	4.28 (0.27)	-	4.27 (0.24)	5.95 (0.57)	4.04 (0.25)	-	3.30 (0.45)	3.96 (0.10)	3.90 (0.23)	5.75 (0.39)	-
E-/U+	-	4.07 (0.25)	4.59 (0.28)	3.95 (0.22)	4.94 (0.37)	3.95 (0.25)	-	2.71 (0.40)	2.74 (0.06)	3.66 (0.21)	4.65 (0.23)	5.23 (0.54)
U+/U	2.67 (0.40)	1.55 (0.15)	2.99 (0.21)	2.15 (0.19)	3.82 (0.27)	3.08 (0.23)	2.34 (0.20)	1.05 (0.28)	1.14 (0.03)	1.20 (0.12)	2.99 (0.19)	3.35 (0.28)
U/U-	**2.61 (0.41)**	**1.51 (0.15)**	**2.44 (0.22)**	**1.92 (0.18)**	**3.59 (0.26)**	**2.96 (0.22)**	**2.32 (0.20)**	**0.91 (0.28)**	**0**	**1.11 (0.12)**	**2.48 (0.20)**	**3.17 (0.26)**
U-/R+	2.53 (0.41)	1.07 (0.14)	1.51 (0.21)	1.19 (0.18)	3.27 (0.24)	2.50 (0.22)	2.21 (0.20)	0.82 (0.28)	-1.48 (0.05)	0.85 (0.12)	1.48 (0.19)	2.65 (0.24)
R+/R	-	-0.88 (0.20)	-1.45 (0.31)	-0.72 (0.21)	-1.65 (0.29)	-0.50 (0.27)	-	-	-3.06 (0.14)	-1.46 (0.19)	-0.50 (0.19)	-0.21 (0.22)
R/R-	-	-0.99 (0.21)	-	-1.57 (0.25)	-1.77 (0.32)	-1.29 (0.35)	-	-	-3.45 (0.18)	-1.78 (0.24)	-0.88 (0.20)	-0.28 (0.22)
R-/O+	-	-1.05 (0.21)	-	-1.64 (0.26)	-1.90 (0.33)	-1.46 (0.39)	-	-	-3.59 (0.21)	-1.89 (0.26)	-0.89 (0.20)	-0.31 (0.23)
O+/O	-	-	-	-	-2.25 (0.38)	-1.66 (0.42)	-	-	-3.94 (0.29)	-	-	-0.96 (0.25)
O/O-	-	-	-	-	-2.49 (0.44)	-1.92 (0.48)	-	-	-4.13 (0.34)	-	-	-1.02 (0.25)
O-/P+	-	-	-	-	-2.78 (0.52)	-2.24 (0.55)	-	-	-4.36 (0.40)	-	-	-1.10 (0.26)

	Thresholds by Slaughterhouse											
	1	2	3	4	5	6	7	8	9	10	11	12
S+/S	-	-	-	-	-	4.48 (0.26)	-	-	-	-	-	-
S/S-	-	-	-	-	-	4.43 (0.26)	-	-	-	-	-	
S-/E+	-	-	-	-	-	4.38 (0.26)	-	-	5.33 (0.22)	-	-	-
E+/E	-	4.36 (0.27)	-	4.32 (0.24)	-	4.09 (0.25)	-	3.57 (0.47)	4.28 (0.11)	3.96 (0.23)	5.97 (0.39)	-
E/E-	-	4.28 (0.27)	-	4.27 (0.24)	5.95 (0.57)	4.04 (0.25)	-	3.30 (0.45)	3.96 (0.10)	3.90 (0.23)	5.75 (0.39)	-
E-/U+	-	4.07 (0.25)	4.59 (0.28)	3.95 (0.22)	4.94 (0.37)	3.95 (0.25)	-	2.71 (0.40)	2.74 (0.06)	3.66 (0.21)	4.65 (0.23)	5.23 (0.54)
U+/U	2.67 (0.40)	1.55 (0.15)	2.99 (0.21)	2.15 (0.19)	3.82 (0.27)	3.08 (0.23)	2.34 (0.20)	1.05 (0.28)	1.14 (0.03)	1.20 (0.12)	2.99 (0.19)	3.35 (0.28)
U/U-	2.61 (0.41)	1.51 (0.15)	2.44 (0.22)	1.92 (0.18)	3.59 (0.26)	2.96 (0.22)	2.32 (0.20)	0.91 (0.28)	0	1.11 (0.12)	2.48 (0.20)	3.17 (0.26)
U-/R+	**2.53 (0.41)**	**1.07 (0.14)**	**1.51 (0.21)**	**1.19 (0.18)**	**3.27 (0.24)**	**2.50 (0.22)**	**2.21 (0.20)**	**0.82 (0.28)**	**-1.48 (0.05)**	**0.85 (0.12)**	**1.48 (0.19)**	**2.65 (0.24)**
R+/R	-	-0.88 (0.20)	-1.45 (0.31)	-0.72 (0.21)	-1.65 (0.29)	-0.50 (0.27)	-	-	-3.06 (0.14)	-1.46 (0.19)	-0.50 (0.19)	-0.21 (0.22)
R/R-	-	-0.99 (0.21)	-	-1.57 (0.25)	-1.77 (0.32)	-1.29 (0.35)	-	-	-3.45 (0.18)	-1.78 (0.24)	-0.88 (0.20)	-0.28 (0.22)
R-/O+	-	-1.05 (0.21)	-	-1.64 (0.26)	-1.90 (0.33)	-1.46 (0.39)	-	-	-3.59 (0.21)	-1.89 (0.26)	-0.89 (0.20)	-0.31 (0.23)
O+/O	-	-	-	-	-2.25 (0.38)	-1.66 (0.42)	-	-	-3.94 (0.29)	-	-	-0.96 (0.25)
O/O-	-	-	-	-	-2.49 (0.44)	-1.92 (0.48)	-	-	-4.13 (0.34)	-	-	-1.02 (0.25)
O-/P+	-	-	-	-	-2.78 (0.52)	-2.24 (0.55)	-	-	-4.36 (0.40)	-	-	-1.10 (0.26)

Breeding Values



Breeding Values



Carcass Conformation

VAL		SLAUGHTERHOUSE												TOTAL
		1	2	3	4	5	**6**	7	8	9	10	11	12	
S	+	0	0	0	0	0	**12**	0	0	0	0	0	0	12
	=	0	0	0	0	0	**0**	0	0	0	0	0	0	0
	-	0	0	0	0	0	**0**	0	0	4	0	0	0	4
E	+	0	7	0	22	0	**5**	0	3	46	8	2	0	93
	=	0	0	0	1	1	**0**	0	0	53	0	0	0	55
	-	0	2	7	15	3	**1**	0	2	709	3	16	1	759
U	+	21	158	67	262	13	**28**	69	16	3089	162	229	20	4134
	=	0	4	52	55	4	**5**	0	1	3294	9	178	5	3607
	-	0	45	110	173	7	**24**	5	0	1911	26	459	19	2779
R	+	29	117	165	266	214	**143**	161	15	325	150	640	175	2400
	=	0	1	4	26	0	**8**	0	0	8	4	40	2	93
	-	0	0	0	0	0	**0**	0	0	1	0	0	0	1
O	+	0	9	0	6	1	**0**	0	0	2	5	42	17	82
	=	0	0	0	0	0	**0**	0	0	0	0	0	0	0
	-	0	0	0	0	0	**0**	0	0	0	0	0	0	0
P	+	0	0	0	0	1	**1**	0	0	1	0	0	9	12
	=	0	0	0	0	0	**0**	0	0	0	0	0	0	0
	-	0	0	0	0	0	**0**	0	0	0	0	0	0	0
TOTAL		50	343	405	826	244	**227**	235	37	9443	367	1606	248	14031

Conclusions

- Slight changes in genetic parameter estimation

- Relevant changes in the ranking of candidates of selection and genetic response
  - Expected response
    - Model II: 0.253
    - Model III: 0.294

16% of response increase

- Possible improvements: Fuzzy Logic

Thanks!!