

## Introduction

The latest international evaluation for dairy **production traits** took place as scheduled at the Interbull Centre. Data from thirty-four (34) countries were included in this evaluation.

International genetic evaluations for milk, fat and protein yields of bulls from Australia, Austria-Germany, Belgium, Canada, Croatia, Czech Republic, Denmark-Finland-Sweden, Estonia, France, Hungary, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Netherlands, New Zealand, Norway, Poland, Republic of South Africa, Slovak Republic, Slovenia, Spain, Switzerland, the United Kingdom, the United States of America, Portugal, Korea, Uruguay and Mexico were computed. Brown Swiss, Guernsey, Holstein, Jersey, Red Dairy Cattle and Simmental breed data were included in this evaluation.

## Changes in national procedures

Changes in the national genetic evaluation of production traits are as follows:

DFS HOL        HOL and RED HOL (RED) have merged. Cows with min 87 % HOL genes and bulls with min 93 % HOL genes have been converted to HOL. Animals with less % HOL genes will no longer be a part of the evaluation, and it is the reason, number of bulls and daughters drop more for HOL. But for most of the bulls the drop is less than 1%.

SVN HOL/BSW    Some bulls losing informations mostly as a consequence of changes  
SIM            in data base related to the pedigree completeness as well as phenotypic data improvement.

PRT HOL        Implemented new changes to evaluation model: random contemporary groups, genetic groups and new variance components

NOR RDC        The rolling definition of hys is causing the daughters to distribute somewhat differently over hys-classes at each evaluation. Therefore some bulls occasionally may loose EDC although the number of daughters stay the same. Reliability changes is a function of the EDC changes. The low correlations to last evaluation for yearclass 2011 and 2012 is due to unofficial results for these bulls. They have few daughters that are all in early lactation.

We deliver RBV's for all traits. The scaling is according to a rolling base that change somewhat at each evaluation. Therefore percentage changes in sire standard deviations between evaluations may solely be due to changes in the standard deviation in the rolling base.

DEU RDC        Few bulls whose ownership has been corrected, they are now foreign AI bulls, therefore their Type of Proof changed and some of these are not publishable anymore.

CHE HOL/BSW    Many bulls with decreases in herds/daughters/EDC. In most of the cases the  
SIM            decreases are very small. The reason for this can be found in the continuous work on the raw data by herd-book organizations.

JPN HOL        Some small changes in proofs caused by additional records and in EDCs caused by modification of pedigree.

HRV HOL/SIM    Many bulls losing information (herds/daughters/EDC) due to pedigree changes and completeness.

DEA BSW/SIM    Base change

IRL RDC/HOL    Change from 305day lactation model to random regression test day model. Lost  
JER/SIM        records on some older bulls as there are historic 305day data imported from older systems, but there aren't the underlying testday data for those old (records before late 1990's) bulls.

HUN HOL/SIM    Updated/recalculated genetic parameters.

EST HOL Updated standardization of heterogeneous variance, within  
herd-test-date-parity-milking-frequency effect, updated definition for fixed  
lactation curves

NZL BSW/GUE Continuous DNA parentage testing affecting daughters, herds, EDCs and reliabilities.  
HOL/JER  
RDC

CAM RDC First time participating with MSH in RDC population, with population code CAM.

#### INTERBULL CHANGES COMPARED TO THE DECEMBER ROUTINE RUN

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##### Subsetting:

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As decided by the ITC in Orlando, new subsetting was introduced in the september test run. Sub-setting is necessary for operational purposes and restrictions of time scales. To minimize the effect of subsetting, larger subsets with 10-12 countries and with 4 link providing countries have been applied.

##### Window:

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According to the decision taken by ITC in Orlando, the following changes have been introduced in regards to the windows used for post processing:

The upper bounds have been set to 0.99 as these were judged to have very little effect on evaluations. The lower values have been set to about the 25% percentile value. The largest changes are for the lower values for conformation traits, with the lowest window being 40% for OFL otherwise it is about 50% for all other confirmation traits. It is anticipated that these low values may not have large impact on evaluations since there were very few countries combinations whose estimated correlations fell between the old limit of 0.30 and these new limits.

#### DATA AND METHOD OF ANALYSIS

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Data were national genetic evaluations of AI sampled bulls with at least 10 daughters or 10 EDC (for clinical mastitis and maternal calving traits at least 50 daughters or 50 EDC, and for direct calving traits at least 50 calvings or 50 EDC) in at least 10 herds. Table 1 presents the amount of data included in this Interbull evaluation for all breeds.

National proofs were first de-regressed within country and then analysed jointly with a linear model including the effects of evaluation country, genetic group of bull and bull merit. Heritability estimates used in both the de-regression and international evaluation were as in each country's national evaluation.

Table 2 presents the date of evaluation as supplied by each country

Estimated genetic parameters and sire standard deviations are shown in APPENDIX I and the corresponding number of common bulls are listed in APPENDIX II.

#### SCIENTIFIC LITERATURE

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The international genetic evaluation procedure is based on international work described in the following scientific publications:

##### International genetic evaluation computation:

Schaeffer. 1994. J. Dairy Sci. 77:2671-2678  
Klei, 1998. Interbull Bulletin 17:3-7

##### Verification and Genetic trend validation:

Klei et al., 2002. Interbull Bulletin 29:178-182.  
Boichard et al., 1995. J. Dairy Sci. 78:431-437

Weighting factors:

Fikse and Banos, 2001. J. Dairy Sci. 84:1759-1767

De-regression:

Sigurdsson and G. Banos. 1995. Acta Agric. Scand. 45:207-219

Jairath et al. 1998. J. Dairy Sci. Vol. 81:550-562

Genetic parameter estimation:

Klei and Weigel, 1998, Interbull Bulletin 17:8-14

Sullivan, 1999. Interbull Bulletin 22:146-148

Post-processing of estimated genetic correlations:

Mark et al., 2003, Interbull Bulletin 30:126-135

Jorjani et al., 2003. J. Dairy Sci. 86:677-679

<https://wiki.interbull.org/public/rG%20procedure?action=print>

Time edits

Weigel and Banos. 1997. J. Dairy Sci. 80:3425-3430

International reliability estimation

Harris and Johnson. 1998. Interbull Bulletin 17:31-36

NEXT ROUTINE INTERNATIONAL EVALUATION

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Dates for the next routine evaluation can be found on  
<http://www.interbull.org/ib/servicecalendar>.

NEXT TEST INTERNATIONAL EVALUATION

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Dates for the next test run can be found on  
<http://www.interbull.org/ib/servicecalendar>.

PUBLICATION OF INTERBULL TEST RUN

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Test evaluation results are meant for review purposes only and should not be published.

^LTable 1. National evaluation data considered in the Interbull evaluation for dairy production traits (December Routine Evaluation 2017). Number of records for milk yield by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS	195	136	7722	1695	682	
BEL			1176			
CAN	217	97	11679	682	779	
CHE	2816		3184			3085
CZE			4112			
DEA	5775					23031
DEU			26824	180	416	
DFS			12582	2070	7504	
ESP			3546			
EST			1064		410	
FRA	371		16598			446
FRM						4451
GBR	141	321	6768	860	590	92
HUN			3103			204
IRL			2254	143	41	92
ISR			1346			
ITA	2028		9230	173		1572
JPN			5634			
KOR			1261			
LTU			750		426	
LVA			1046		693	
NLD	173		14786	135	62	319
NOR					4002	
NZL	48	60	7301	4693	1321	

POL			9741				
PRT			2255				
SVK			1078			563	
SVN	355		492			585	
URY			983				
USA	1063	763	36299	4356	686	43	
ZAF			1268	680	141		
HRV			701			785	
MEX			601				
CAM					38		

No.Records	13182	1377	195384	15667	17791	35268	
Pub. Proofs	10747	1097	149572	12772	15933	31881	

^LAPPENDIX I. Sire standard deviations in diagonal and genetic correlations below diagonal

BSW mil

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	624.76										
FRA	0.89	634.90									
USA	0.93	0.89	627.63								
CHE	0.90	0.89	0.87	488.41							
ITA	0.88	0.83	0.88	0.87	595.53						
DEA	0.88	0.83	0.86	0.93	0.90	460.51					
NLD	0.88	0.87	0.87	0.85	0.84	0.86	604.11				
SVN	0.83	0.81	0.82	0.81	0.81	0.81	0.82	9.62			
NZL	0.70	0.76	0.71	0.76	0.70	0.74	0.73	0.75	340.11		
GBR	0.86	0.88	0.85	0.87	0.82	0.82	0.86	0.83	0.71	246.71	
AUS	0.75	0.77	0.73	0.73	0.71	0.71	0.76	0.73	0.84	0.75	396.59

BSW fat

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	26.08										
FRA	0.89	27.10									
USA	0.91	0.89	23.53								
CHE	0.87	0.87	0.84	19.17							
ITA	0.89	0.83	0.86	0.87	22.73						
DEA	0.87	0.84	0.83	0.93	0.88	17.33					
NLD	0.87	0.86	0.86	0.85	0.84	0.86	25.49				
SVN	0.83	0.81	0.82	0.81	0.81	0.81	0.82	9.80			
NZL	0.71	0.74	0.71	0.74	0.70	0.82	0.70	0.75	14.94		
GBR	0.86	0.88	0.86	0.87	0.82	0.83	0.87	0.83	0.71	8.57	
AUS	0.74	0.75	0.73	0.71	0.70	0.71	0.73	0.73	0.83	0.73	15.66

BSW pro

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	22.38										
FRA	0.84	20.44									
USA	0.90	0.86	18.90								
CHE	0.86	0.85	0.82	15.46							
ITA	0.85	0.82	0.83	0.86	20.87						
DEA	0.87	0.82	0.82	0.91	0.89	14.33					
NLD	0.86	0.84	0.84	0.83	0.82	0.83	20.10				
SVN	0.83	0.81	0.82	0.81	0.81	0.81	0.82	9.53			
NZL	0.70	0.71	0.70	0.71	0.70	0.75	0.70	0.75	10.42		
GBR	0.85	0.86	0.83	0.85	0.81	0.83	0.86	0.83	0.70	7.14	
AUS	0.70	0.71	0.69	0.70	0.69	0.71	0.71	0.73	0.81	0.72	11.95

GUE mil

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	CAN	USA	AUS	GBR	NZL
CAN	726.31				
USA	0.94	706.88			
AUS	0.82	0.77	485.63		
GBR	0.86	0.83	0.77	242.43	
NZL	0.70	0.70	0.84	0.70	325.55

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GUE fat

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	CAN	USA	AUS	GBR	NZL
CAN	30.30				
USA	0.93	25.29			
AUS	0.80	0.76	17.73		
GBR	0.86	0.84	0.75	10.45	
NZL	0.72	0.71	0.84	0.70	16.39

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GUE pro

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	CAN	USA	AUS	GBR	NZL
CAN	22.04				
USA	0.92	19.55			
AUS	0.73	0.70	13.90		
GBR	0.85	0.83	0.73	7.18	
NZL	0.70	0.69	0.82	0.69	10.81

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HOL mil

	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	SVK
BEL	IRL	ESP	CZE	SVN	EST	ISR	HUN	POL	ZAF	JPN	LVA	SVK
LTU	PRT	KOR	URY	HRV	MEX							
CAN	765.06											
DEU	0.92	623.61										
DFS	0.94	0.93	11.13									
FRA	0.91	0.89	0.93	662.00								
ITA	0.90	0.87	0.89	0.88	567.27							
NLD	0.92	0.92	0.93	0.91	0.87	662.14						
USA	0.94	0.90	0.93	0.91	0.91	0.90	669.14					
CHE	0.90	0.89	0.92	0.94	0.88	0.91	0.89	581.10				
GBR	0.87	0.83	0.87	0.87	0.83	0.87	0.85	0.89	272.82			
NZL	0.68	0.69	0.71	0.76	0.70	0.72	0.70	0.77	0.70	314.29		
AUS	0.79	0.77	0.75	0.81	0.73	0.79	0.77	0.80	0.77	0.84	418.18	
BEL	0.85	0.87	0.82	0.83	0.81	0.85	0.81	0.82	0.82	0.69	0.79	
479.39												
IRL	0.84	0.84	0.86	0.90	0.80	0.87	0.83	0.89	0.84	0.85	0.83	
0.80	183.61											
ESP	0.93	0.91	0.92	0.92	0.89	0.91	0.93	0.90	0.84	0.69	0.78	
0.86	0.84	542.08										
CZE	0.86	0.87	0.83	0.81	0.82	0.83	0.83	0.81	0.82	0.69	0.71	
0.82	0.74	0.84	734.59									
SVN	0.82	0.81	0.81	0.81	0.81	0.81	0.81	0.82	0.82	0.70	0.70	
0.81	0.70	0.81	0.81	11.81								
EST	0.88	0.85	0.90	0.85	0.84	0.86	0.88	0.86	0.82	0.72	0.76	
0.82	0.79	0.86	0.84	0.82	530.79							
ISR	0.83	0.82	0.83	0.83	0.84	0.82	0.84	0.83	0.81	0.64	0.72	
0.82	0.70	0.84	0.82	0.83	0.83	381.13						
HUN	0.86	0.84	0.87	0.88	0.90	0.85	0.90	0.85	0.83	0.69	0.69	
0.81	0.80	0.86	0.83	0.81	0.85	0.83	667.28					
POL	0.89	0.89	0.89	0.88	0.88	0.89	0.88	0.84	0.82	0.69	0.76	
0.82	0.82	0.90	0.86	0.80	0.87	0.83	0.88	406.64				
ZAF	0.84	0.81	0.81	0.83	0.81	0.81	0.84	0.81	0.81	0.70	0.81	
0.81	0.79	0.83	0.81	0.81	0.82	0.84	0.81	0.81	523.78			
JPN	0.94	0.90	0.93	0.91	0.89	0.91	0.93	0.90	0.84	0.71	0.79	
0.85	0.84	0.91	0.85	0.81	0.88	0.87	0.85	0.90	0.84	631.14		
LVA	0.80	0.81	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.70	0.70	
0.81	0.72	0.81	0.81	0.82	0.81	0.82	0.81	0.80	0.82	0.81	450.64	
SVK	0.80	0.81	0.83	0.82	0.82	0.82	0.81	0.82	0.82	0.70	0.70	
0.82	0.74	0.82	0.81	0.82	0.83	0.83	0.85	0.81	0.81	0.82	0.82	
391.19												
LTU	0.81	0.81	0.82	0.82	0.81	0.82	0.81	0.83	0.82	0.71	0.71	
0.82	0.74	0.82	0.82	0.83	0.83	0.83	0.81	0.80	0.82	0.82	0.81	
0.83	361.83											
PRT	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.68	0.68	
0.80	0.71	0.80	0.80	0.81	0.81	0.83	0.80	0.80	0.80	0.80	0.80	
0.80	0.81	604.88										
KOR	0.86	0.81	0.84	0.82	0.81	0.82	0.84	0.82	0.82	0.72	0.75	
0.82	0.74	0.83	0.81	0.82	0.84	0.82	0.81	0.80	0.81	0.86	0.82	
0.82	0.82	0.80	480.39									
URY	0.80	0.80	0.80	0.80	0.81	0.80	0.80	0.81	0.80	0.77	0.75	
0.80	0.76	0.80	0.80	0.82	0.81	0.84	0.80	0.80	0.80	0.81	0.81	
0.81	0.81	0.80	0.80	175.95								
HRV	0.81	0.81	0.82	0.82	0.81	0.82	0.80	0.82	0.82	0.70	0.70	
0.81	0.69	0.81	0.82	0.82	0.82	0.83	0.81	0.80	0.81	0.81	0.81	
0.82	0.82	0.80	0.82	0.81	11.96							
MEX	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.69	0.69	
0.80	0.69	0.80	0.80	0.82	0.81	0.84	0.80	0.80	0.80	0.80	0.81	
0.81	0.82	0.80	0.80	0.80	0.81	381.25						

HOL	fat											
	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	SVK
BEL	IRL	ESP	CZE	SVN	EST	ISR	HUN	POL	ZAF	JPN	LVA	SVK
LTU	PRT	KOR	URY	HRV	MEX							
CAN	30.37											
DEU	0.91	24.14										
DFS	0.92	0.91	11.14									
FRA	0.91	0.89	0.92	26.83								
ITA	0.89	0.86	0.86	0.89	23.44							
NLD	0.90	0.91	0.91	0.89	0.85	25.17						
USA	0.93	0.90	0.91	0.92	0.92	0.89	24.82					
CHE	0.88	0.88	0.91	0.91	0.84	0.89	0.87	23.05				
GBR	0.86	0.86	0.88	0.89	0.83	0.88	0.87	0.90	9.40			
NZL	0.68	0.69	0.70	0.73	0.70	0.69	0.70	0.73	0.70	12.62		
AUS	0.76	0.73	0.73	0.78	0.71	0.73	0.76	0.74	0.74	0.83	14.55	
BEL	0.84	0.87	0.82	0.84	0.81	0.84	0.82	0.82	0.82	0.72	0.76	
19.86												
IRL	0.82	0.81	0.85	0.86	0.76	0.84	0.80	0.84	0.81	0.84	0.80	
0.83	7.08											
ESP	0.91	0.89	0.87	0.91	0.90	0.89	0.93	0.86	0.84	0.69	0.75	
0.83	0.80	21.79										
CZE	0.85	0.86	0.84	0.82	0.82	0.82	0.85	0.81	0.82	0.69	0.70	
0.81	0.71	0.85	22.23									
SVN	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.82	0.82	0.70	0.70	
0.81	0.70	0.81	0.81	11.54								
EST	0.87	0.86	0.91	0.87	0.87	0.85	0.87	0.85	0.82	0.80	0.78	
0.87	0.85	0.85	0.85	0.82	20.68							
ISR	0.83	0.82	0.81	0.82	0.82	0.81	0.85	0.82	0.81	0.63	0.68	
0.81	0.64	0.82	0.82	0.83	0.82	14.24						
HUN	0.85	0.84	0.83	0.88	0.90	0.83	0.91	0.81	0.82	0.69	0.69	
0.81	0.70	0.88	0.83	0.81	0.82	0.83	25.90					
POL	0.89	0.90	0.87	0.90	0.89	0.86	0.89	0.81	0.81	0.68	0.71	
0.83	0.77	0.92	0.87	0.80	0.89	0.83	0.88	16.23				
ZAF	0.80	0.81	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.69	0.70	
0.81	0.68	0.81	0.81	0.82	0.82	0.81	0.80	0.80	17.45			
JPN	0.92	0.89	0.92	0.90	0.86	0.89	0.90	0.89	0.84	0.71	0.73	
0.83	0.83	0.86	0.83	0.81	0.88	0.82	0.81	0.88	0.81	24.25		
LVA	0.80	0.81	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.70	0.70	
0.81	0.69	0.81	0.81	0.82	0.84	0.83	0.81	0.80	0.82	0.81	18.77	
SVK	0.80	0.81	0.82	0.82	0.82	0.82	0.80	0.82	0.82	0.70	0.71	
0.82	0.69	0.81	0.81	0.82	0.85	0.83	0.84	0.81	0.81	0.81	0.82	
15.11												
LTU	0.81	0.81	0.82	0.82	0.81	0.82	0.80	0.83	0.82	0.71	0.71	
0.82	0.70	0.82	0.82	0.83	0.82	0.83	0.81	0.80	0.82	0.82	0.81	
0.83	15.32											
PRT	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.68	0.68	
0.80	0.68	0.80	0.80	0.81	0.81	0.83	0.80	0.80	0.80	0.80	0.80	
0.80	0.81	24.17										
KOR	0.84	0.81	0.81	0.82	0.81	0.82	0.86	0.82	0.82	0.70	0.76	
0.82	0.70	0.85	0.81	0.82	0.83	0.82	0.81	0.83	0.81	0.83	0.82	
0.82	0.83	0.80	19.45									
URY	0.80	0.80	0.80	0.81	0.81	0.80	0.80	0.81	0.80	0.77	0.74	
0.81	0.77	0.80	0.80	0.82	0.84	0.83	0.80	0.80	0.80	0.81	0.81	
0.81	0.81	0.80	0.80	6.70								
HRV	0.81	0.81	0.81	0.82	0.81	0.82	0.80	0.82	0.82	0.70	0.71	
0.81	0.69	0.81	0.82	0.82	0.82	0.82	0.81	0.80	0.82	0.81	0.81	
0.82	0.82	0.80	0.83	0.81	12.11							
MEX	0.80	0.81	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.70	0.69	
0.81	0.69	0.81	0.81	0.82	0.83	0.85	0.81	0.81	0.81	0.81	0.82	
0.82	0.84	0.81	0.81	0.81	0.82	13.32						

HOL pro

	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	SVK
BEL	IRL	ESP	CZE	SVN	EST	ISR	HUN	POL	ZAF	JPN	LVA	SVK
LTU	PRT	KOR	URY	HRV	MEX							
CAN	21.25											
DEU	0.88	17.72										
DFS	0.92	0.91	10.59									
FRA	0.87	0.84	0.92	18.25								
ITA	0.87	0.83	0.87	0.85	17.36							
NLD	0.88	0.89	0.89	0.85	0.83	18.75						
USA	0.91	0.87	0.91	0.88	0.89	0.86	17.43					
CHE	0.85	0.84	0.88	0.91	0.85	0.85	0.85	16.95				
GBR	0.85	0.82	0.87	0.87	0.81	0.86	0.84	0.87	7.28			
NZL	0.68	0.69	0.69	0.69	0.70	0.69	0.69	0.69	0.69	9.04		
AUS	0.69	0.69	0.70	0.72	0.69	0.71	0.69	0.72	0.72	0.81	10.95	
BEL	0.80	0.82	0.81	0.81	0.81	0.82	0.80	0.81	0.82	0.69	0.70	
14.12												
IRL	0.75	0.74	0.79	0.82	0.72	0.80	0.76	0.81	0.79	0.80	0.80	
0.72	5.64											
ESP	0.90	0.86	0.89	0.88	0.86	0.87	0.90	0.85	0.84	0.69	0.70	
0.81	0.77	15.73										
CZE	0.80	0.81	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.69	0.69	
0.81	0.68	0.81	17.14									
SVN	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.82	0.82	0.70	0.70	
0.82	0.70	0.81	0.81	11.12								
EST	0.81	0.83	0.85	0.82	0.81	0.82	0.82	0.83	0.82	0.71	0.71	
0.82	0.70	0.82	0.81	0.83	15.71							
ISR	0.83	0.82	0.82	0.83	0.82	0.82	0.83	0.83	0.81	0.64	0.64	
0.82	0.62	0.83	0.82	0.84	0.83	9.85						
HUN	0.82	0.81	0.85	0.86	0.87	0.81	0.87	0.82	0.81	0.69	0.69	
0.81	0.68	0.82	0.80	0.81	0.81	0.82	20.96					
POL	0.85	0.84	0.85	0.82	0.83	0.83	0.83	0.80	0.80	0.68	0.69	
0.80	0.73	0.86	0.80	0.81	0.85	0.83	0.84	10.92				
ZAF	0.80	0.81	0.81	0.81	0.81	0.81	0.80	0.81	0.81	0.69	0.75	
0.81	0.70	0.81	0.81	0.82	0.82	0.83	0.81	0.80	13.64			
JPN	0.91	0.86	0.91	0.87	0.87	0.87	0.91	0.86	0.83	0.70	0.70	
0.81	0.76	0.88	0.81	0.81	0.84	0.83	0.81	0.86	0.81	17.21		
LVA	0.80	0.81	0.81	0.81	0.81	0.81	0.80	0.82	0.81	0.70	0.70	
0.81	0.69	0.81	0.81	0.82	0.82	0.83	0.81	0.80	0.82	0.81	13.28	
SVK	0.80	0.81	0.82	0.82	0.81	0.82	0.80	0.82	0.82	0.70	0.70	
0.82	0.69	0.82	0.81	0.83	0.83	0.84	0.84	0.81	0.82	0.82	0.82	
11.01												
LTU	0.81	0.81	0.82	0.82	0.81	0.82	0.81	0.83	0.82	0.71	0.71	
0.83	0.70	0.82	0.81	0.84	0.83	0.84	0.81	0.80	0.83	0.82	0.82	
0.83	10.87											
PRT	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.68	0.68	
0.80	0.68	0.80	0.80	0.81	0.81	0.83	0.80	0.80	0.80	0.80	0.80	
0.80	0.81	18.11										
KOR	0.83	0.81	0.82	0.82	0.81	0.82	0.81	0.82	0.82	0.69	0.70	
0.82	0.69	0.83	0.81	0.82	0.83	0.83	0.81	0.80	0.81	0.82	0.82	
0.82	0.83	0.80	13.25									
URY	0.80	0.80	0.80	0.80	0.81	0.80	0.80	0.81	0.80	0.71	0.69	
0.80	0.69	0.80	0.80	0.82	0.82	0.84	0.80	0.80	0.80	0.81	0.81	
0.81	0.82	0.80	0.80	5.30								
HRV	0.81	0.81	0.82	0.82	0.81	0.82	0.80	0.82	0.82	0.70	0.70	
0.82	0.69	0.81	0.81	0.82	0.82	0.83	0.81	0.80	0.82	0.82	0.81	
0.83	0.82	0.80	0.83	0.81	11.68							
MEX	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.70	0.69	
0.81	0.70	0.81	0.81	0.83	0.84	0.87	0.81	0.81	0.81	0.81	0.83	
0.82	0.85	0.81	0.81	0.81	0.83	11.39						



JER mil

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	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	566.36										
DFS	0.93	9.23									
USA	0.92	0.93	614.73								
NZL	0.74	0.71	0.70	282.21							
AUS	0.82	0.76	0.76	0.83	380.47						
GBR	0.85	0.85	0.82	0.70	0.74	215.86					
NLD	0.92	0.93	0.90	0.72	0.78	0.85	604.64				
ZAF	0.89	0.87	0.85	0.78	0.82	0.81	0.82	378.18			
ITA	0.89	0.87	0.88	0.74	0.78	0.83	0.85	0.87	525.43		
DEU	0.90	0.91	0.89	0.70	0.77	0.84	0.91	0.82	0.88	513.32	
IRL	0.82	0.81	0.79	0.86	0.84	0.78	0.83	0.80	0.79	0.82	181.29

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JER fat

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	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	25.63										
DFS	0.90	11.43									
USA	0.91	0.90	24.45								
NZL	0.69	0.70	0.74	12.09							
AUS	0.79	0.72	0.77	0.84	13.84						
GBR	0.83	0.84	0.82	0.70	0.71	9.97					
NLD	0.88	0.87	0.86	0.70	0.72	0.85	24.30				
ZAF	0.81	0.82	0.80	0.69	0.71	0.81	0.82	14.30			
ITA	0.88	0.85	0.86	0.70	0.73	0.83	0.84	0.83	25.09		
DEU	0.89	0.89	0.86	0.70	0.74	0.84	0.89	0.82	0.86	23.54	
IRL	0.80	0.79	0.77	0.81	0.81	0.76	0.81	0.72	0.74	0.79	6.35

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JER pro

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	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	18.04										
DFS	0.91	10.43									
USA	0.89	0.92	18.39								
NZL	0.69	0.70	0.69	8.50							
AUS	0.73	0.70	0.69	0.81	10.50						
GBR	0.85	0.85	0.82	0.69	0.71	6.61					
NLD	0.88	0.89	0.86	0.70	0.72	0.85	19.25				
ZAF	0.83	0.82	0.80	0.69	0.72	0.81	0.82	11.45			
ITA	0.85	0.84	0.85	0.70	0.70	0.82	0.83	0.85	18.86		
DEU	0.86	0.91	0.86	0.70	0.71	0.83	0.88	0.82	0.85	17.59	
IRL	0.75	0.76	0.73	0.86	0.81	0.74	0.78	0.71	0.73	0.75	5.66

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SIM	pro	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR
HRV	USA											
CHE	16.67											
DEA	0.86	15.47										
FRM	0.93	0.88	19.46									
ITA	0.82	0.81	0.81	15.60								
SVN	0.84	0.81	0.84	0.81	8.98							
FRA	0.90	0.87	0.89	0.83	0.82	21.27						
HUN	0.83	0.82	0.89	0.85	0.84	0.85	12.47					
NLD	0.84	0.92	0.87	0.82	0.83	0.84	0.82	23.43				
IRL	0.78	0.72	0.82	0.71	0.73	0.82	0.69	0.75	6.17			
SVK	0.83	0.81	0.83	0.81	0.83	0.83	0.85	0.83	0.73	9.95		
GBR	0.86	0.89	0.88	0.82	0.82	0.87	0.81	0.86	0.76	0.83	6.81	
HRV	0.83	0.81	0.89	0.81	0.82	0.82	0.83	0.82	0.73	0.83	0.82	
11.09												
USA	0.85	0.83	0.84	0.87	0.81	0.88	0.87	0.86	0.76	0.81	0.84	
0.81	14.68											

^LAPPENDIX II. Number of common bulls

BSW

common bulls below diagonal

common three quarter sib group above diagonal

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	77	160	117	109	125	47	27	21	64	83
FRA	65	0	116	150	174	199	79	49	19	55	58
USA	145	78	0	302	225	306	74	36	26	87	120
CHE	91	113	285	0	409	536	86	69	21	70	106
ITA	89	139	157	350	0	648	114	87	24	76	107
DEA	99	148	270	431	545	0	130	94	29	75	114
NLD	44	65	65	77	94	124	0	38	21	41	53
SVN	24	48	29	66	86	87	39	0	6	21	25
NZL	19	15	23	16	18	24	14	5	0	18	24
GBR	57	43	77	51	52	50	31	15	15	0	55
AUS	82	45	113	68	76	79	40	20	20	48	0

BSW

common bulls below diagonal

common three quarter sib group above diagonal

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	77	160	117	109	125	47	27	21	64	83
FRA	65	0	116	150	174	199	79	49	19	55	58
USA	145	78	0	302	225	306	74	36	26	87	120
CHE	91	113	285	0	409	536	86	69	21	70	106
ITA	89	139	157	350	0	648	114	87	24	76	107
DEA	99	148	270	431	545	0	130	94	29	75	114
NLD	44	65	65	77	94	124	0	38	21	41	53
SVN	24	48	29	66	86	87	39	0	6	21	25
NZL	19	15	23	16	18	24	14	5	0	18	24
GBR	57	43	77	51	52	50	31	15	15	0	55
AUS	82	45	113	68	76	79	40	20	20	48	0

## BSW

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common bulls below diagonal
common three quarter sib group above diagonal

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	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	77	160	117	109	125	47	27	21	64	83
FRA	65	0	116	150	174	199	79	49	19	55	58
USA	145	78	0	302	225	306	74	36	26	87	120
CHE	91	113	285	0	409	536	86	69	21	70	106
ITA	89	139	157	350	0	648	114	87	24	76	107
DEA	99	148	270	431	545	0	130	94	29	75	114
NLD	44	65	65	77	94	124	0	38	21	41	53
SVN	24	48	29	66	86	87	39	0	6	21	25
NZL	19	15	23	16	18	24	14	5	0	18	24
GBR	57	43	77	51	52	50	31	15	15	0	55
AUS	82	45	113	68	76	79	40	20	20	48	0

## GUE

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common bulls below diagonal
common three quarter sib group above diagonal

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	CAN	USA	AUS	GBR	NZL
CAN	0	65	44	29	14
USA	56	0	60	86	31
AUS	43	56	0	38	27
GBR	24	88	33	0	15
NZL	11	29	27	13	0

## GUE

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common bulls below diagonal
common three quarter sib group above diagonal

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	CAN	USA	AUS	GBR	NZL
CAN	0	65	44	29	14
USA	56	0	60	86	31
AUS	43	56	0	38	27
GBR	24	88	33	0	15
NZL	11	29	27	13	0

## GUE

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common bulls below diagonal
common three quarter sib group above diagonal

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	CAN	USA	AUS	GBR	NZL
CAN	0	64	44	29	13
USA	55	0	60	86	31
AUS	43	56	0	38	27
GBR	24	88	33	0	15
NZL	11	29	27	13	0

HOL

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common bulls below diagonal

common three quarter sib group above diagonal

	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	BEL	IRL	ESP	CZE	SVN	EST	ISR
HUN	POL	ZAF	JPN	LVA	SVK	LTU	PRT	KOR	URY	HRV	MEX							
CAN	0	2154	1179	1266	1419	1217	2815	741	1406	633	1182	466	399	1128	954	171	208	97
837	1086	465	1159	377	392	200	899	584	427	239	354							
DEU	1330	0	2544	2375	2332	3162	3335	1048	1943	901	1541	764	699	1417	1779	268	369	147
1142	2055	574	1359	646	694	447	1159	558	455	550	348							
DFS	880	1540	0	1483	1410	1832	1810	629	1383	753	1137	543	590	901	1137	217	253	129
806	1334	487	863	408	380	270	855	425	382	344	282							
FRA	747	1115	702	0	1598	1782	2289	584	1397	730	1145	609	580	1021	1148	179	225	115
852	1410	459	1100	358	395	205	848	456	367	242	293							
ITA	909	1302	914	726	0	1522	2326	634	1397	684	1077	522	508	1127	1171	210	234	115
903	1338	473	1059	421	375	242	924	521	405	318	323							
NLD	1047	2723	1469	992	1073	0	2186	780	1552	939	1309	788	689	984	1348	219	314	136
863	1504	499	936	444	501	259	964	427	387	382	293							
USA	2826	2074	1226	1119	1299	1780	0	870	1913	970	1654	578	600	1381	1507	202	298	149
1153	1713	617	1734	523	506	293	1188	752	617	317	440							
CHE	585	895	551	503	546	755	770	0	613	357	532	397	309	497	491	128	142	54
400	580	254	416	244	214	104	470	230	192	178	171							
GBR	1542	1327	963	791	933	1264	1592	557	0	835	1240	545	726	974	959	188	223	115
770	1124	493	924	360	348	229	877	439	399	289	313							
NZL	620	681	512	403	458	845	895	302	706	0	1095	346	580	482	567	119	123	100
456	583	354	500	210	239	142	519	278	314	188	191							
AUS	1106	1048	755	723	690	1094	1549	463	1006	1085	0	496	568	778	776	161	192	95
628	881	457	784	314	290	184	719	386	384	249	261							
BEL	419	709	469	562	431	850	461	376	492	269	409	0	310	437	423	128	117	57
350	485	242	344	190	195	97	434	196	175	173	157							
IRL	330	542	437	397	366	588	476	286	672	462	450	277	0	395	411	92	105	73
346	454	281	344	160	170	110	384	172	213	139	143							
ESP	641	865	644	704	765	847	839	403	749	362	539	412	355	0	782	170	177	99
686	906	433	812	309	298	183	760	410	336	242	275							
CZE	628	1312	692	666	747	1154	1103	342	614	385	471	306	273	528	0	193	232	112
833	1176	379	756	381	442	219	746	427	344	310	267							
SVN	119	253	179	123	172	186	150	95	135	81	115	99	66	125	144	0	80	41
144	215	91	146	102	76	47	150	87	68	90	62							
EST	108	256	147	100	125	224	192	80	121	62	89	70	52	81	145	48	0	44
173	272	98	174	162	105	71	172	93	91	107	67							
ISR	62	119	100	60	74	110	134	36	78	81	61	33	51	60	81	31	28	0
98	118	56	91	61	46	37	94	51	60	56	40							
HUN	734	874	605	536	733	687	1092	320	657	362	463	277	275	538	734	111	106	75
0	824	379	636	278	298	172	652	402	336	223	280							
POL	792	1685	991	820	925	1284	1504	464	860	425	610	413	335	618	915	191	190	93
709	0	396	847	502	402	294	910	490	374	395	308							
ZAF	399	439	365	313	347	417	590	208	424	291	392	196	229	382	252	63	49	39
311	290	0	405	153	174	94	414	252	259	136	207							
JPN	501	491	416	345	424	439	673	254	424	248	392	209	190	354	298	82	58	39
338	406	264	0	289	283	166	633	479	352	181	288							
LVA	208	516	259	164	265	296	430	124	215	120	155	111	92	169	259	69	105	43
213	402	89	121	0	161	143	356	188	161	216	134							
SVK	264	517	196	202	209	338	326	108	195	142	144	104	84	150	356	44	49	19
212	268	95	100	78	0	82	303	188	165	117	121							
LTU	92	419	135	49	113	135	186	39	102	62	71	36	45	73	134	20	34	17
103	214	36	44	106	38	0	178	114	94	121	64							
PRT	893	1046	731	697	824	956	1219	410	790	418	550	418	319	719	605	118	117	68
637	909	370	363	280	206	110	0	421	366	283	330							
KOR	531	362	287	251	407	287	862	156	318	198	278	121	112	291	302	54	46	32
337	408	192	273	108	116	52	353	0	273	115	244							
URY	401	324	271	212	294	304	777	141	334	248	288	125	160	271	253	38	54	31
287	315	220	206	101	112	57	330	224	0	114	229							
HRV	121	566	263	144	232	339	237	118	203	110	155	137	95	185	231	73	76	42
173	347	90	83	175	60	82	228	51	67	0	105							
MEX	354	283	232	225	293	240	526	148	280	150	213	138	114	247	218	46	49	25
268	286	193	216	89	75	29	342	230	216	72	0							

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HOL

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common bulls below diagonal

common three quarter sib group above diagonal

	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	BEL	IRL	ESP	CZE	SVN	EST	ISR
HUN	POL	ZAF	JPN	LVA	SVK	LTU	PRT	KOR	URY	HRV	MEX							
CAN	0	2155	1179	1267	1422	1217	2816	741	1406	633	1182	466	399	1128	954	171	208	97
837	1087	465	1158	377	392	200	899	585	427	239	135							
DEU	1332	0	2544	2375	2336	3162	3335	1048	1942	901	1541	764	699	1417	1779	268	369	147
1142	2055	574	1357	646	694	447	1158	558	455	550	130							
DFS	881	1540	0	1483	1413	1832	1810	629	1382	753	1137	543	590	901	1137	217	253	129
806	1334	487	862	408	380	270	855	425	382	344	116							
FRA	748	1115	702	0	1601	1782	2289	584	1396	730	1145	609	580	1021	1148	179	225	115
852	1410	459	1099	358	395	205	847	456	367	242	120							
ITA	912	1307	917	729	0	1525	2331	636	1398	687	1080	524	510	1130	1171	210	234	117
905	1341	474	1059	421	375	242	924	523	407	318	119							
NLD	1048	2723	1469	992	1078	0	2186	780	1551	939	1309	788	689	984	1348	219	314	136
863	1504	499	935	444	501	259	963	427	387	382	121							
USA	2828	2074	1226	1119	1309	1780	0	870	1913	970	1654	578	600	1381	1507	202	298	149
1153	1713	617	1732	523	506	293	1188	752	617	317	142							
CHE	586	895	551	503	548	755	770	0	612	357	532	397	309	497	491	128	142	54
400	580	254	415	244	214	104	470	230	192	178	92							
GBR	1543	1327	963	791	934	1264	1592	557	0	834	1239	544	726	974	958	188	223	115
770	1123	493	923	359	348	229	876	439	399	288	124							
NZL	621	681	512	403	462	845	895	302	706	0	1095	346	580	482	567	119	123	100
456	583	354	500	210	239	142	519	278	314	188	97							
AUS	1106	1048	755	723	693	1094	1549	463	1006	1085	0	496	568	778	776	161	192	95
628	881	457	783	314	290	184	719	386	384	249	114							
BEL	419	709	469	562	432	850	461	376	492	269	409	0	310	437	423	128	117	57
350	485	242	344	190	195	97	434	196	175	173	89							
IRL	330	542	437	397	368	588	476	286	672	462	450	277	0	395	411	92	105	73
346	454	281	343	160	170	110	384	172	213	139	76							
ESP	642	865	644	704	770	847	839	403	749	362	539	412	355	0	782	170	177	99
686	906	433	811	309	298	183	760	410	336	242	116							
CZE	628	1311	691	666	747	1153	1103	342	614	385	471	306	273	527	0	193	232	112
833	1176	379	755	381	442	219	745	427	344	310	91							
SVN	119	253	179	123	172	186	150	95	135	81	115	99	66	125	144	0	80	41
144	215	91	145	102	76	47	150	87	68	90	33							
EST	108	256	147	100	125	224	192	80	121	62	89	70	52	81	145	48	0	44
173	272	98	173	162	105	71	172	93	91	107	27							
ISR	62	119	100	60	76	110	134	36	78	81	61	33	51	60	81	31	28	0
98	118	56	91	61	46	37	94	51	60	56	14							
HUN	735	874	605	536	735	687	1092	320	657	362	463	277	275	538	734	111	106	75
0	824	379	635	278	298	172	652	402	336	223	106							
POL	793	1685	991	820	927	1284	1504	464	860	425	610	413	335	618	914	191	190	93
709	0	396	846	502	402	294	910	490	374	395	98							
ZAF	400	439	365	313	349	417	590	208	424	291	392	196	229	382	252	63	49	39
311	290	0	404	153	174	94	414	252	259	136	99							
JPN	500	489	415	343	421	437	667	253	421	247	389	209	189	352	297	81	57	39
337	403	263	0	289	282	166	632	479	351	181	122							
LVA	208	516	259	164	265	296	430	124	215	120	155	111	92	169	259	69	105	43
213	402	89	121	0	161	143	356	188	161	216	43							
SVK	264	517	196	202	209	338	326	108	195	142	144	104	84	150	355	44	49	19
212	268	95	99	78	0	82	303	188	165	117	56							
LTU	92	419	135	49	113	135	186	39	102	62	71	36	45	73	134	20	34	17
103	214	36	44	106	38	0	178	114	94	121	24							
PRT	895	1045	731	694	824	955	1220	409	790	418	549	418	319	720	604	117	116	68
636	908	371	362	280	207	110	0	421	366	283	121							
KOR	532	362	287	251	411	287	861	156	318	198	278	121	112	291	302	54	46	32
337	408	192	272	108	116	52	353	0	273	115	92							
URY	401	324	271	212	297	304	777	141	334	248	288	125	160	271	253	38	54	31
287	315	220	203	101	112	57	331	224	0	114	98							
HRV	121	566	263	144	232	339	237	118	203	110	155	137	95	185	231	73	76	42
173	347	90	83	175	60	82	228	51	67	0	44							
MEX	162	142	120	123	124	130	181	93	148	94	118	93	77	131	72	26	17	9
112	98	109	118	27	41	7	143	95	105	30	0							

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HOL

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common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL	AUS	BEL	IRL	ESP	CZE	SVN	EST	ISR
HUN	POL	ZAF	JPN	LVA	SVK	LTU	PRT	KOR	URY	HRV	MEX							
CAN	0	2154	1179	1266	1419	1217	2809	741	1406	633	1182	466	399	1128	954	171	208	97
837	1086	465	1156	377	392	200	899	584	427	239	134							
DEU	1330	0	2544	2375	2332	3162	3331	1048	1942	901	1541	764	699	1417	1779	268	369	147
1142	2055	574	1357	646	694	447	1159	558	455	550	129							
DFS	880	1540	0	1483	1410	1832	1808	629	1382	753	1137	543	590	901	1137	217	253	129
806	1334	487	862	408	380	270	855	425	382	344	115							
FRA	747	1115	702	0	1598	1782	2288	584	1396	730	1145	609	580	1021	1148	179	225	115
852	1410	459	1099	358	395	205	848	456	367	242	119							
ITA	909	1302	914	726	0	1522	2326	634	1396	684	1077	522	508	1127	1171	210	234	115
903	1338	473	1058	421	375	242	924	521	405	318	118							
NLD	1047	2723	1469	992	1073	0	2185	780	1551	939	1309	788	689	984	1348	219	314	136
863	1504	499	934	444	501	259	964	427	387	382	120							
USA	2823	2072	1226	1119	1299	1780	0	870	1912	970	1651	577	600	1380	1507	202	298	149
1153	1713	617	1729	523	505	293	1188	753	617	317	141							
CHE	585	895	551	503	546	755	770	0	612	357	532	397	309	497	491	128	142	54
400	580	254	414	244	214	104	470	230	192	178	91							
GBR	1542	1327	963	791	933	1264	1592	557	0	834	1239	544	726	974	958	188	223	115
770	1123	493	923	359	348	229	876	439	399	288	123							
NZL	620	681	512	403	458	845	895	302	706	0	1095	346	580	482	567	119	123	100
456	583	354	500	210	239	142	519	278	314	188	96							
AUS	1106	1048	755	723	690	1094	1547	463	1006	1085	0	496	568	778	776	161	192	95
628	881	457	783	314	290	184	719	386	384	249	113							
BEL	419	709	469	562	431	850	460	376	492	269	409	0	310	437	423	128	117	57
350	485	242	344	190	195	97	434	196	175	173	88							
IRL	330	542	437	397	366	588	476	286	672	462	450	277	0	395	411	92	105	73
346	454	281	343	160	170	110	384	172	213	139	75							
ESP	641	865	644	704	765	847	839	403	749	362	539	412	355	0	782	170	177	99
686	906	433	811	309	298	183	760	410	336	242	115							
CZE	628	1311	691	666	747	1153	1103	342	614	385	471	306	273	527	0	193	232	112
833	1176	379	755	381	442	219	746	427	344	310	90							
SVN	119	253	179	123	172	186	150	95	135	81	115	99	66	125	144	0	80	41
144	215	91	145	102	76	47	150	87	68	90	33							
EST	108	256	147	100	125	224	192	80	121	62	89	70	52	81	145	48	0	44
173	272	98	172	162	105	71	172	93	91	107	27							
ISR	62	119	100	60	74	110	134	36	78	81	61	33	51	60	81	31	28	0
98	118	56	91	61	46	37	94	51	60	56	14							
HUN	734	874	605	536	733	687	1092	320	657	362	463	277	275	538	734	111	106	75
0	824	379	635	278	298	172	652	402	336	223	105							
POL	792	1685	991	820	925	1284	1504	464	860	425	610	413	335	618	914	191	190	93
709	0	396	846	502	402	294	910	490	374	395	97							
ZAF	399	439	365	313	347	417	590	208	424	291	392	196	229	382	252	63	49	39
311	290	0	404	153	174	94	414	252	259	136	98							
JPN	498	489	415	343	421	436	666	253	421	247	389	209	189	352	297	81	56	39
337	403	263	0	289	282	166	632	479	351	181	121							
LVA	208	516	259	164	265	296	430	124	215	120	155	111	92	169	259	69	105	43
213	402	89	121	0	161	143	356	188	161	216	43							
SVK	264	517	196	202	209	338	325	108	195	142	144	104	84	150	355	44	49	19
212	268	95	99	78	0	82	303	188	165	117	56							
LTU	92	419	135	49	113	135	186	39	102	62	71	36	45	73	134	20	34	17
103	214	36	44	106	38	0	178	114	94	121	24							
PRT	894	1046	732	697	824	957	1220	410	790	418	550	418	319	720	606	118	117	68
637	909	371	362	280	207	110	0	421	366	283	120							
KOR	531	362	287	251	407	287	863	156	318	198	278	121	112	291	302	54	46	32
337	408	192	272	108	116	52	353	0	273	115	92							
URY	401	324	271	212	294	304	777	141	334	248	288	125	160	271	253	38	54	31
287	315	220	203	101	112	57	331	224	0	114	97							
HRV	121	566	263	144	232	339	237	118	203	110	155	137	95	185	231	73	76	42
173	347	90	83	175	60	82	228	51	67	0	43							
MEX	159	140	119	122	123	129	179	92	146	93	117	92	76	130	70	26	16	9
111	97	108	116	27	41	7	142	95	103	29	0							

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JER

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common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	0	72	361	159	224	140	31	135	68	65	8
DFS	57	0	145	116	115	136	81	122	98	109	22
USA	374	116	0	327	441	208	69	269	100	111	31
NZL	169	90	401	0	411	187	62	184	84	83	88
AUS	227	80	476	459	0	187	59	214	83	80	39
GBR	139	120	224	189	189	0	69	151	104	93	43
NLD	24	79	73	55	50	63	0	64	54	54	16
ZAF	130	98	278	190	201	151	59	0	91	85	23
ITA	65	95	107	82	78	105	53	84	0	73	12
DEU	63	101	114	77	69	90	50	81	75	0	16
IRL	4	18	30	96	33	45	15	21	12	16	0

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JER

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common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	0	72	361	159	224	139	31	135	68	65	8
DFS	57	0	145	116	115	135	81	122	98	109	22
USA	374	116	0	327	441	207	69	269	100	111	31
NZL	169	90	401	0	411	186	62	184	84	83	88
AUS	227	80	476	459	0	186	59	214	83	80	39
GBR	139	120	224	189	189	0	69	151	103	93	43
NLD	24	79	73	55	50	63	0	64	54	54	16
ZAF	130	98	278	190	201	151	59	0	91	85	23
ITA	65	95	107	82	78	105	53	84	0	73	12
DEU	63	101	114	77	69	90	50	81	75	0	16
IRL	4	18	30	96	33	45	15	21	12	16	0

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JER

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common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL
CAN	0	72	361	159	224	139	31	135	68	65	8
DFS	57	0	145	116	115	135	81	122	98	109	22
USA	374	116	0	327	441	207	69	269	100	111	31
NZL	169	90	401	0	411	186	62	184	84	83	88
AUS	227	80	476	459	0	186	59	214	83	80	39
GBR	139	120	224	189	189	0	69	151	103	93	43
NLD	24	79	73	55	50	63	0	64	54	54	16
ZAF	130	98	278	190	201	151	59	0	91	85	23
ITA	65	95	107	82	78	105	53	84	0	73	12
DEU	63	101	114	77	69	90	50	81	75	0	16
IRL	4	18	30	96	33	45	15	21	12	16	0

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SIM

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common bulls below diagonal

common three quarter sib group above diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	0	300	175	82	6	12	2	81	55	31	55	1	18
DEA	268	0	241	797	171	244	44	226	57	358	53	488	17
FRM	224	288	0	152	17	3	3	109	68	56	72	2	28
ITA	83	700	186	0	96	136	19	157	56	134	47	207	20
SVN	6	158	17	93	0	54	10	44	1	45	0	68	0
FRA	9	204	1	123	50	0	11	53	1	53	0	83	0
HUN	1	30	1	15	8	8	0	4	1	12	0	17	0
NLD	83	235	131	153	42	53	4	0	50	59	51	82	15
IRL	52	50	73	54	1	1	1	45	0	11	38	3	14
SVK	23	365	55	113	44	45	10	50	4	0	10	85	3
GBR	63	56	92	52	0	0	0	52	33	5	0	0	18
HRV	1	511	1	197	58	77	16	81	2	68	0	0	0
USA	19	24	43	27	0	0	0	18	14	3	25	0	0

SIM

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common bulls below diagonal

common three quarter sib group above diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	0	300	175	82	6	12	2	81	55	31	55	1	18
DEA	268	0	241	797	171	244	44	226	57	358	53	486	17
FRM	224	288	0	152	17	3	3	109	68	56	72	2	28
ITA	83	700	186	0	96	136	19	157	56	134	47	205	20
SVN	6	158	17	93	0	54	10	44	1	45	0	68	0
FRA	9	204	1	123	50	0	11	53	1	53	0	83	0
HUN	1	30	1	15	8	8	0	4	1	12	0	17	0
NLD	83	235	131	153	42	53	4	0	50	59	51	82	15
IRL	52	50	73	54	1	1	1	45	0	11	38	3	14
SVK	23	365	55	113	44	45	10	50	4	0	10	83	3
GBR	63	56	92	52	0	0	0	52	33	5	0	0	18
HRV	1	509	1	195	58	77	16	81	2	66	0	0	0
USA	19	24	43	27	0	0	0	18	14	3	25	0	0

SIM

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common bulls below diagonal

common three quarter sib group above diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	SVK	GBR	HRV	USA
CHE	0	300	175	82	6	12	2	81	55	31	55	1	18
DEA	268	0	241	797	171	244	44	226	57	358	53	487	17
FRM	224	288	0	152	17	3	3	109	68	56	72	2	28
ITA	83	700	186	0	96	136	19	157	56	134	47	206	20
SVN	6	158	17	93	0	54	10	44	1	45	0	68	0
FRA	9	204	1	123	50	0	11	53	1	53	0	83	0
HUN	1	30	1	15	8	8	0	4	1	12	0	17	0
NLD	83	235	131	153	42	53	4	0	50	59	51	82	15
IRL	52	50	73	54	1	1	1	45	0	11	38	3	14
SVK	23	365	55	113	44	45	10	50	4	0	10	84	3
GBR	63	56	92	52	0	0	0	52	33	5	0	0	18
HRV	1	510	1	196	58	77	16	81	2	67	0	0	0
USA	19	24	43	27	0	0	0	18	14	3	25	0	0