

## 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:

AUS (HOL, JER, RDC)	Some decrease in daughters and EDC due to data editing
NOR (RDC)	Delivered 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.
JPN (HOL)	Some changes in proofs caused by additional records and in EDCs caused by modification of pedigree.
DFS (JER)	Inclusion of data from Finland, France and Norway.
NZL (ALL)	Drops in information due to continuous DNA parenting testing
SVN (ALL)	Base change
DEA (SIM)	After inclusion of the Slovakian Fleckvieh population to the joined evaluation, inconsistencies in parts of the historical Slovakian data (mid 90's) have been detected. Therefore some Slovakian herds with production data in the years 1995 to 1997 were excluded from evaluation. This causes an decrease in number of daughters, herds and edc statistics for bulls with affected daughters.
EST (HOL, RDC)	Decrease in number of daughters/EDC of some bulls due to deletion of incorrect first lactation information of some cows.
ESP (HOL)	Base change
IRL (HOL, JER)	Drps in information due to pedigree verification
CZE (HOL)	Made changes in herd book related to bulls category. No foreign information for BVs are used therefore all previous ToP "21" appear now as 11 or 12 as all information comes from domestic daughters.
MEX (HOL)	Drop in information caused by pedigree correction.

## INTERBULL CHANGES COMPARED TO THE PREVIOUS ROUTINE RUN

### Subsetting:

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:

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.

The window so far applied for MAS evaluation have been found too high compared to the within-country genetic correlation between mastitis and SCS available from the literature. It has been an ITC recommendation to adjust the windows for MAS in this test run to make them more in line with the values available from the literature. The recommendation has been approved by the Steering committee. Also, according to the decision taken by ITC in Orlando (2015) to review all windows every five (5) years, an overall review of the windows for all traits will take place during the first half of 2020 with the aim of implementation set for the September 2020 test run.

#### 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 ROUTINE RUN

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 Results were distributed by the Interbull Centre to designated  
 representatives in each country. The international evaluation file comprised  
 international proofs expressed on the base and unit of each country included  
 in the analysis. Such records readily provide more information on bull  
 performance in various countries, thereby minimizing the need to resort to  
 conversions.

At the same time, all recipients of Interbull results are expected to honor  
 the agreed code of practice, decided by the Interbull Steering Committee,  
 and only publish international evaluations on their own country scale.  
 Evaluations expressed on another country scale are confidential and may only  
 be used internally for research and review purposes.

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 (August Routine Evaluation 2020).  
 Number of records for milk yield by breed

Country	BSW	GUE	HOL	JER	RDC	SIM
AUS	210	141	8412	1821	766	
BEL			2104			
CAN	250	102	12916	793	838	
CHE	3028		3531	90		3345
CZE			4786			
DEA	6095					24686
DEU			22419	187	270	
DFS			13409	2243	7828	
ESP			4031			
EST			1208		455	
FRA	409		17382			479
FRM						4791
GBR	168	350	7513	918	645	94
HUN			3437			226
IRL			2859	159	60	100
ISR			1524			
ITA	2180		9431	170		1812
JPN			6244			
KOR			1491			
LTU			1239		437	
LVA			1263		696	
NLD	198		15917	184	86	430
NOR					4202	
NZL	58	60	8027	5033	1420	
POL			10818			
PRT			2437			

SVK			1135								
SVN	391		600							670	
URY			1078								
USA	1134	795	39791	4891				736		70	
ZAF			1306	720				143			
HRV			771							854	
MEX			613								
CAM								44			
=====											
No.Records	14121	1448	207692	17209				18626		37557	
Pub. Proofs	11417	1154	153668	13824				16628		34035	
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^LAPPENDIX I. Sire standard deviations in diagonal and genetic correlations below diagonal

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BSW mil

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	650.52										
FRA	0.89	627.72									
USA	0.92	0.89	640.97								
CHE	0.91	0.88	0.87	484.56							
ITA	0.88	0.83	0.88	0.88	603.07						
DEA	0.88	0.82	0.86	0.94	0.90	464.40					
NLD	0.88	0.87	0.87	0.85	0.86	0.87	652.10				
SVN	0.83	0.81	0.82	0.81	0.81	0.81	0.82	9.23			
NZL	0.70	0.75	0.70	0.74	0.70	0.73	0.71	0.74	356.79		
GBR	0.86	0.88	0.86	0.87	0.82	0.82	0.86	0.83	0.71	276.21	
AUS	0.74	0.76	0.72	0.72	0.70	0.70	0.74	0.72	0.82	0.73	384.04

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BSW fat

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	27.71										
FRA	0.89	26.77									
USA	0.90	0.89	23.67								
CHE	0.86	0.87	0.84	19.15							
ITA	0.89	0.83	0.86	0.86	23.04						
DEA	0.85	0.84	0.84	0.94	0.88	17.36					
NLD	0.87	0.85	0.86	0.84	0.85	0.86	26.17				
SVN	0.82	0.81	0.82	0.81	0.81	0.81	0.82	9.64			
NZL	0.71	0.72	0.70	0.73	0.70	0.80	0.70	0.74	15.90		
GBR	0.86	0.89	0.86	0.88	0.82	0.82	0.86	0.83	0.71	10.23	
AUS	0.73	0.73	0.73	0.70	0.70	0.70	0.71	0.72	0.81	0.72	15.35

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BSW pro

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	23.38										
FRA	0.84	20.21									
USA	0.89	0.86	18.96								
CHE	0.84	0.83	0.83	15.35							
ITA	0.85	0.82	0.83	0.84	21.24						
DEA	0.85	0.81	0.82	0.92	0.88	14.50					
NLD	0.85	0.83	0.84	0.83	0.83	0.84	21.71				
SVN	0.82	0.81	0.82	0.81	0.81	0.81	0.82	9.08			
NZL	0.70	0.70	0.69	0.71	0.70	0.72	0.69	0.74	11.74		
GBR	0.84	0.85	0.83	0.84	0.81	0.82	0.85	0.82	0.70	7.93	
AUS	0.71	0.70	0.69	0.70	0.69	0.70	0.69	0.72	0.81	0.70	11.82

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GUE mil

	CAN	USA	AUS	GBR	NZL
CAN	775.25				
USA	0.94	775.30			
AUS	0.80	0.76	470.24		
GBR	0.87	0.83	0.75	244.40	
NZL	0.71	0.70	0.84	0.71	301.82

GUE fat

	CAN	USA	AUS	GBR	NZL
CAN	31.00				
USA	0.93	27.75			
AUS	0.78	0.76	17.12		
GBR	0.86	0.84	0.74	10.17	
NZL	0.72	0.72	0.82	0.70	14.80

GUE pro

	CAN	USA	AUS	GBR	NZL
CAN	23.78				
USA	0.91	21.35			
AUS	0.71	0.69	13.35		
GBR	0.85	0.82	0.71	7.29	
NZL	0.70	0.69	0.81	0.69	10.05

HOL mil

	CAN	DEU	DFS	FRA	ITA	NLD	USA	CHE	GBR	NZL																				
CAN	788.95																													
DEU	0.93	645.71																												
DFS	0.94	0.94	11.22																											
FRA	0.91	0.90	0.92	655.70																										
ITA	0.89	0.87	0.88	0.88	583.19																									
NLD	0.92	0.93	0.93	0.90	0.87	670.33																								
USA	0.93	0.92	0.90	0.91	0.90	0.89	713.88																							
CHE	0.89	0.91	0.90	0.93	0.88	0.91	0.88	572.17																						
GBR	0.86	0.84	0.85	0.86	0.82	0.86	0.84	0.89	274.68																					
NZL	0.68	0.68	0.69	0.74	0.68	0.70	0.69	0.75	0.69	340.72																				
AUS	0.77	0.75	0.72	0.78	0.71	0.75	0.75	0.78	0.74	0.82	417.84																			
BEL	0.85	0.87	0.82	0.83	0.80	0.82	0.81	0.81	0.80	0.69	0.77	500.57																		
IRL	0.83	0.83	0.83	0.89	0.80	0.86	0.82	0.87	0.82	0.82	0.81	0.86	182.15																	
ESP	0.93	0.92	0.91	0.92	0.89	0.91	0.92	0.89	0.84	0.68	0.77	0.86	0.84	541.59																
CZE	0.86	0.88	0.84	0.81	0.81	0.81	0.85	0.80	0.80	0.68	0.71	0.82	0.73	0.84	702.34															
SVN	0.83	0.82	0.81	0.82	0.81	0.81	0.81	0.81	0.81	0.70	0.70	0.81	0.70	0.81	11.27															
EST	0.89	0.87	0.90	0.86	0.84	0.85	0.89	0.86	0.81	0.71	0.76	0.81	0.76	0.86	0.85	0.82	547.09													
ISR	0.83	0.83	0.84	0.83	0.84	0.83	0.85	0.84	0.82	0.63	0.67	0.83	0.69	0.84	0.83	0.84	0.87	0.85	0.90	0.83	387.41									
HUN	0.86	0.85	0.86	0.87	0.89	0.85	0.90	0.85	0.82	0.68	0.68	0.80	0.79	0.86	0.82	0.81	0.84	0.84	0.80	0.88	664.05									
POL	0.89	0.90	0.89	0.88	0.87	0.88	0.88	0.85	0.82	0.68	0.74	0.82	0.80	0.89	0.85	0.82	0.87	0.83	0.88	420.47										
ZAF	0.84	0.80	0.81	0.83	0.80	0.80	0.83	0.81	0.80	0.69	0.78	0.80	0.77	0.83	0.80	0.81	0.82	0.84	0.80	0.80	0.80	531.53								
JPN	0.94	0.91	0.93	0.91	0.89	0.91	0.93	0.89	0.83	0.69	0.76	0.84	0.82	0.91	0.84	0.83	0.87	0.87	0.85	0.90	0.83	629.04								
LVA	0.80	0.80	0.81	0.81	0.80	0.80	0.80	0.81	0.81	0.69	0.69	0.81	0.71	0.80	0.80	0.81	0.81	0.83	0.81	0.80	0.81	496.34								
SVK	0.80	0.81	0.82	0.81	0.81	0.80	0.80	0.81	0.81	0.69	0.69	0.81	0.73	0.81	0.80	0.82	0.82	0.85	0.83	0.82	0.81	0.82	0.81	383.81						
LTU	0.81	0.80	0.81	0.81	0.81	0.81	0.80	0.82	0.81	0.70	0.70	0.81	0.71	0.81	0.81	0.82	0.82	0.84	0.81	0.80	0.82	0.81	0.81	0.82	367.34					
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	0.73	0.80	0.80	0.81	0.81	0.83	0.80	0.80	0.80	0.81	0.80	0.80	593.25					
KOR	0.86	0.80	0.83	0.81	0.80	0.81	0.86	0.81	0.81	0.70	0.74	0.82	0.74	0.85	0.80	0.82	0.83	0.84	0.80	0.80	0.81	0.86	0.81	0.81	0.82	0.80	491.42			
URY	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.81	0.80	0.76	0.74	0.80	0.72	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	167.07			
HRV	0.81	0.80	0.81	0.81	0.80	0.80	0.80	0.81	0.81	0.69	0.69	0.81	0.69	0.80	0.80	0.81	0.81	0.83	0.81	0.80	0.80	0.81	0.81	0.81	0.81	0.80	0.80	11.45		
MEX	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.81	0.80	0.69	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	0.81	0.82	0.80	0.80	0.81	380.78

HOL fat



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JER	mil											
	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	597.42											
DFS	0.93	9.15										
USA	0.92	0.92	682.22									
NZL	0.74	0.72	0.74	267.00								
AUS	0.80	0.73	0.76	0.82	382.29							
GBR	0.84	0.83	0.82	0.69	0.71	209.06						
NLD	0.91	0.92	0.88	0.71	0.76	0.84	620.79					
ZAF	0.88	0.86	0.85	0.77	0.81	0.81	0.81	380.81				
ITA	0.90	0.87	0.89	0.75	0.79	0.82	0.85	0.89	549.24			
DEU	0.91	0.94	0.93	0.70	0.74	0.83	0.93	0.83	0.88	563.37		
IRL	0.81	0.79	0.77	0.89	0.82	0.76	0.82	0.76	0.78	0.80	179.74	
CHE	0.88	0.88	0.85	0.73	0.79	0.84	0.90	0.82	0.85	0.90	0.83	317.10

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JER	fat											
	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	26.85											
DFS	0.90	11.14										
USA	0.90	0.89	26.51									
NZL	0.69	0.69	0.72	11.87								
AUS	0.77	0.70	0.77	0.80	13.65							
GBR	0.83	0.83	0.82	0.69	0.70	9.29						
NLD	0.87	0.86	0.85	0.69	0.71	0.85	25.17					
ZAF	0.81	0.81	0.80	0.69	0.70	0.81	0.81	14.27				
ITA	0.89	0.84	0.87	0.71	0.73	0.82	0.84	0.82	26.62			
DEU	0.91	0.91	0.90	0.69	0.75	0.84	0.90	0.81	0.87	22.24		
IRL	0.79	0.78	0.75	0.81	0.81	0.75	0.80	0.71	0.74	0.78	6.26	
CHE	0.86	0.85	0.83	0.73	0.77	0.84	0.86	0.81	0.84	0.89	0.80	15.60

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JER	pro											
	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	19.35											
DFS	0.91	10.49										
USA	0.89	0.91	20.30									
NZL	0.69	0.69	0.68	8.44								
AUS	0.71	0.69	0.68	0.80	10.40							
GBR	0.83	0.84	0.81	0.69	0.69	6.75						
NLD	0.87	0.88	0.84	0.69	0.70	0.84	19.66					
ZAF	0.82	0.81	0.80	0.69	0.70	0.81	0.81	11.39				
ITA	0.86	0.84	0.85	0.69	0.71	0.81	0.83	0.86	20.18			
DEU	0.89	0.93	0.91	0.69	0.69	0.83	0.90	0.81	0.85	17.59		
IRL	0.74	0.74	0.73	0.85	0.81	0.73	0.77	0.71	0.73	0.75	5.69	
CHE	0.84	0.84	0.83	0.70	0.70	0.83	0.85	0.81	0.83	0.86	0.78	10.73

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RDC	mil														
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	602.18														
NOR	0.90	11.99													
USA	0.92	0.92	707.27												
NZL	0.69	0.71	0.69	314.95											
AUS	0.74	0.74	0.75	0.83	412.17										
GBR	0.84	0.82	0.83	0.69	0.77	251.93									
DFS	0.91	0.91	0.88	0.69	0.74	0.83	10.32								
DEU	0.93	0.86	0.91	0.70	0.74	0.85	0.93	657.74							
ZAF	0.82	0.88	0.84	0.72	0.75	0.81	0.81	0.81	605.19						
EST	0.88	0.89	0.90	0.75	0.75	0.82	0.86	0.85	0.83	495.52					

LVA	0.82	0.83	0.81	0.73	0.72	0.82	0.81	0.81	0.83	0.82	325.45				
LTU	0.83	0.83	0.82	0.72	0.71	0.82	0.81	0.81	0.84	0.83	0.82	311.86			
IRL	0.83	0.76	0.81	0.82	0.81	0.80	0.81	0.83	0.78	0.77	0.74	0.76	178.35		
NLD	0.91	0.92	0.89	0.72	0.77	0.86	0.93	0.93	0.81	0.86	0.82	0.82	0.84	771.78	
CAM	0.89	0.90	0.95	0.78	0.78	0.88	0.89	0.89	0.89	0.90	0.89	0.89	0.84	0.89	466.77

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RDC fat

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	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	23.48														
NOR	0.88	11.46													
USA	0.90	0.83	26.49												
NZL	0.69	0.77	0.71	12.85											
AUS	0.72	0.74	0.77	0.83	15.44										
GBR	0.84	0.81	0.84	0.69	0.73	8.53									
DFS	0.90	0.89	0.87	0.70	0.75	0.84	10.33								
DEU	0.92	0.91	0.91	0.70	0.74	0.87	0.91	24.79							
ZAF	0.81	0.88	0.84	0.70	0.70	0.81	0.81	0.81	19.63						
EST	0.87	0.84	0.88	0.78	0.74	0.83	0.85	0.85	0.83	19.65					
LVA	0.82	0.83	0.81	0.73	0.71	0.82	0.81	0.82	0.83	0.84	13.89				
LTU	0.83	0.83	0.82	0.72	0.72	0.82	0.81	0.81	0.84	0.83	0.82	14.79			
IRL	0.81	0.74	0.80	0.81	0.81	0.78	0.81	0.80	0.70	0.82	0.72	0.75	7.36		
NLD	0.89	0.87	0.88	0.69	0.72	0.86	0.91	0.93	0.81	0.84	0.82	0.82	0.81	27.60	
CAM	0.89	0.89	0.95	0.76	0.78	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.84	0.89	22.81

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RDC pro

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	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	18.20														
NOR	0.88	11.43													
USA	0.89	0.90	20.17												
NZL	0.69	0.72	0.69	9.32											
AUS	0.69	0.74	0.70	0.80	12.10										
GBR	0.83	0.82	0.82	0.69	0.71	6.95									
DFS	0.89	0.89	0.87	0.69	0.70	0.83	10.46								
DEU	0.90	0.87	0.90	0.70	0.70	0.84	0.92	19.40							
ZAF	0.81	0.88	0.81	0.70	0.72	0.81	0.81	0.81	16.35						
EST	0.83	0.83	0.87	0.75	0.72	0.83	0.82	0.84	0.83	15.36					
LVA	0.82	0.83	0.81	0.73	0.71	0.82	0.81	0.81	0.83	0.82	9.52				
LTU	0.83	0.83	0.82	0.72	0.71	0.82	0.81	0.81	0.84	0.83	0.82	9.38			
IRL	0.75	0.76	0.76	0.82	0.81	0.76	0.76	0.75	0.70	0.74	0.72	0.74	5.51		
NLD	0.87	0.92	0.85	0.69	0.69	0.84	0.90	0.92	0.81	0.82	0.82	0.82	0.78	26.09	
CAM	0.89	0.89	0.93	0.76	0.79	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.83	0.89	11.56

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SIM mil

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	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	554.62											
DEA	0.87	509.99										
FRM	0.96	0.86	613.66									
ITA	0.83	0.80	0.81	532.58								
SVN	0.83	0.81	0.83	0.81	8.68							
FRA	0.92	0.89	0.89	0.86	0.82	669.13						
HUN	0.85	0.82	0.89	0.87	0.83	0.87	423.01					
NLD	0.89	0.93	0.89	0.83	0.82	0.89	0.85	745.00				
IRL	0.82	0.73	0.85	0.73	0.74	0.88	0.79	0.80	179.89			
GBR	0.87	0.87	0.86	0.82	0.81	0.86	0.82	0.86	0.78	228.50		
HRV	0.82	0.80	0.88	0.80	0.81	0.81	0.82	0.81	0.73	0.81	10.79	
USA	0.88	0.83	0.83	0.89	0.81	0.91	0.89	0.89	0.80	0.84	0.81	582.34

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SIM fat

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	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	22.19											
DEA	0.87	19.24										
FRM	0.94	0.90	24.13									
ITA	0.82	0.82	0.81	21.40								
SVN	0.83	0.81	0.83	0.81	8.90							
FRA	0.90	0.91	0.89	0.86	0.81	26.93						
HUN	0.81	0.82	0.89	0.87	0.83	0.86	16.33					
NLD	0.88	0.94	0.89	0.82	0.81	0.88	0.82	28.10				
IRL	0.76	0.73	0.81	0.71	0.73	0.84	0.70	0.78	7.88			
GBR	0.91	0.85	0.86	0.82	0.81	0.89	0.81	0.86	0.76	8.21		
HRV	0.82	0.80	0.88	0.80	0.81	0.81	0.83	0.81	0.73	0.81	10.79	
USA	0.86	0.87	0.85	0.90	0.81	0.91	0.89	0.88	0.77	0.86	0.81	20.32

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SIM pro

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	16.41											
DEA	0.85	15.53										
FRM	0.93	0.86	19.02									
ITA	0.82	0.80	0.81	16.83								
SVN	0.83	0.81	0.83	0.81	8.87							
FRA	0.89	0.86	0.88	0.83	0.82	21.25						
HUN	0.83	0.82	0.88	0.85	0.83	0.84	13.65					
NLD	0.84	0.92	0.87	0.81	0.82	0.85	0.81	23.43				
IRL	0.75	0.73	0.81	0.71	0.74	0.80	0.69	0.75	6.37			
GBR	0.85	0.85	0.86	0.81	0.81	0.86	0.80	0.85	0.74	7.09		
HRV	0.82	0.80	0.88	0.80	0.81	0.81	0.83	0.81	0.73	0.81	10.66	
USA	0.84	0.83	0.81	0.86	0.81	0.88	0.86	0.85	0.74	0.83	0.81	16.12

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^LAPPENDIX II. Number of common bulls

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BSW

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common bulls below diagonal

common three quarter sib group above diagonal

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	85	177	135	129	147	51	35	26	67	91
FRA	72	0	120	161	191	216	83	60	22	58	64
USA	165	80	0	318	241	328	81	43	31	95	125
CHE	111	116	296	0	463	593	95	83	27	74	115
ITA	111	148	172	401	0	721	127	103	31	81	121
DEA	124	156	293	488	615	0	146	110	37	79	128
NLD	48	68	73	88	108	142	0	47	26	43	57
SVN	31	58	35	78	102	102	48	0	12	25	30
NZL	24	18	27	21	23	31	19	11	0	21	28
GBR	59	45	79	53	54	52	32	18	18	0	59
AUS	90	48	117	76	88	91	41	23	21	50	0

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BSW

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common bulls below diagonal

common three quarter sib group above diagonal

	CAN	FRA	USA	CHE	ITA	DEA	NLD	SVN	NZL	GBR	AUS
CAN	0	85	177	135	129	147	51	35	26	67	91
FRA	72	0	120	161	191	216	83	60	22	58	64
USA	165	80	0	318	241	328	81	43	31	95	125
CHE	111	116	296	0	463	593	95	83	27	74	115
ITA	111	148	172	401	0	721	127	103	31	81	121
DEA	124	156	293	488	615	0	146	110	37	79	128
NLD	48	68	73	88	108	142	0	47	26	43	57
SVN	31	58	35	78	102	102	48	0	12	25	30

NZL	24	18	27	21	23	31	19	11	0	21	28
GBR	59	45	79	53	54	52	32	18	18	0	59
AUS	90	48	117	76	88	91	41	23	21	50	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	85	177	135	129	147	51	35	26	67	91
FRA	72	0	120	161	191	216	83	60	22	58	64
USA	165	80	0	318	241	328	81	43	31	95	125
CHE	111	116	296	0	463	593	95	83	27	74	115
ITA	111	148	172	401	0	721	127	103	31	81	121
DEA	124	156	293	488	615	0	146	110	37	79	128
NLD	48	68	73	88	108	142	0	47	26	43	57
SVN	31	58	35	78	102	102	48	0	12	25	30
NZL	24	18	27	21	23	31	19	11	0	21	28
GBR	59	45	79	53	54	52	32	18	18	0	59
AUS	90	48	117	76	88	91	41	23	21	50	0

GUE

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	USA	AUS	GBR	NZL
CAN	0	71	47	34	14
USA	62	0	63	94	31
AUS	45	59	0	39	27
GBR	27	95	33	0	15
NZL	11	29	27	13	0

GUE

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	USA	AUS	GBR	NZL
CAN	0	71	47	34	14
USA	62	0	63	94	31
AUS	45	59	0	39	27
GBR	27	95	33	0	15
NZL	11	29	27	13	0

GUE

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	USA	AUS	GBR	NZL
CAN	0	71	47	34	14
USA	62	0	63	94	31
AUS	45	59	0	39	27
GBR	27	95	33	0	15
NZL	11	29	27	13	0

HOL

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	2316	1467	1483	1664	1529	3444	901	1689	747	1429	821	554	1310	1198	214	262	135	1038	1382	511	1328	497	432	307	1028	703	500	294	373
DEU	1717	0	2557	2321	2447	3164	3395	1142	2018	936	1613	1211	836	1508	1917	324	418	164	1230	2394	548	1362	766	679	617	1198	625	475	597	346



HOL

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	2316	1467	1483	1664	1529	3438	901	1689	747	1429	821	554	1310	1198	214	262	135	1038	1382	511	1323	497	432	307	1028	703	500	294	141
DEU	1717	0	2557	2321	2448	3164	3393	1142	2018	936	1613	1211	836	1508	1917	324	418	164	1230	2394	548	1358	766	679	617	1198	625	475	597	132
DFS	1244	1834	0	1630	1529	2101	2089	731	1553	819	1291	870	719	1035	1328	258	292	150	910	1573	507	951	490	407	371	923	490	418	388	120
FRA	965	1185	842	0	1633	1961	2483	684	1533	792	1269	928	723	1148	1326	210	261	124	947	1630	477	1179	423	422	300	917	527	404	280	123
ITA	1283	1510	1093	815	0	1647	2517	710	1527	694	1158	788	610	1220	1270	236	272	136	996	1558	457	1130	500	383	334	965	583	423	354	118
NLD	1452	2894	1816	1185	1284	0	2498	903	1752	1028	1463	1289	867	1117	1609	272	366	158	982	1823	518	1035	544	539	401	1043	490	429	420	126
USA	3821	2373	1555	1282	1633	2165	0	1023	2247	1065	1905	979	775	1560	1772	249	350	190	1332	2045	642	1922	652	543	417	1292	868	678	366	147
CHE	761	1012	648	587	622	874	907	0	720	402	628	610	394	574	569	145	169	60	445	680	270	468	285	237	182	505	271	218	200	95
GBR	1917	1511	1154	914	1107	1512	1994	649	0	921	1409	868	939	1082	1142	221	254	145	882	1337	514	1023	437	380	316	945	503	445	321	130
NZL	753	713	577	460	489	935	1006	337	791	0	1190	515	699	538	657	132	140	108	504	648	366	555	249	258	186	563	317	360	212	101
AUS	1438	1195	924	834	813	1277	1890	544	1201	1197	0	758	714	903	906	185	217	112	733	1033	481	880	387	310	262	782	455	436	286	118
BEL	819	1252	813	907	749	1482	868	617	862	419	664	0	509	680	722	182	199	83	553	820	337	546	306	302	216	660	303	251	262	105
IRL	518	724	581	556	500	807	688	395	956	600	610	502	0	499	551	118	133	98	438	587	329	432	212	204	157	483	235	267	178	90
ESP	837	963	762	812	845	992	996	453	840	408	629	661	470	0	915	196	207	110	777	1051	450	895	375	316	239	822	484	365	273	119
CZE	901	1514	880	835	889	1476	1402	417	821	489	604	593	437	667	0	231	274	130	983	1396	433	865	461	518	338	839	499	409	355	97
SVN	154	311	207	142	196	234	187	102	159	93	128	146	88	144	172	0	98	46	167	262	100	170	123	87	83	168	101	77	108	36
EST	159	299	175	124	150	264	232	93	144	70	110	126	70	97	174	57	0	48	203	325	108	200	195	117	116	195	119	107	122	29
ISR	95	127	111	64	83	122	176	38	98	89	73	55	73	64	98	36	30	0	114	143	65	103	69	48	58	101	61	69	65	15
HUN	968	962	718	627	832	819	1293	356	759	397	549	476	387	618	913	125	125	80	0	966	399	715	347	319	231	712	461	376	253	110
POL	1161	2125	1251	1029	1154	1671	1916	556	1110	491	772	754	484	730	1167	233	234	109	851	0	418	964	628	453	451	1007	571	422	444	104
ZAF	471	429	384	331	346	436	626	219	447	304	420	287	296	399	306	70	56	43	329	311	0	422	173	183	119	435	269	275	152	103
JPN	644	567	488	398	495	517	802	288	499	280	464	339	266	406	373	91	68	42	382	497	276	0	347	303	221	683	554	388	211	127
LVA	296	629	308	195	319	370	534	147	254	142	197	188	126	203	315	76	123	47	256	510	98	147	0	186	238	404	233	188	248	44
SVK	304	501	214	219	224	376	358	122	216	154	156	188	102	157	446	48	53	21	225	314	100	104	95	0	135	320	210	183	140	58
LTU	162	570	213	107	171	245	279	80	158	84	117	110	78	97	230	45	60	28	140	351	48	73	167	69	0	239	148	123	164	25
PRT	1075	1098	809	762	880	1047	1351	446	862	463	622	667	436	786	707	132	138	74	708	1008	391	396	315	222	152	0	464	396	309	125
KOR	671	419	349	297	460	346	988	188	364	232	330	221	165	338	368	63	60	37	378	476	203	319	139	129	65	391	0	297	137	99
URY	490	352	299	235	315	340	844	162	372	283	330	195	218	292	315	46	66	35	320	362	232	229	112	119	72	359	241	0	138	102
HRV	171	611	293	166	251	376	275	127	227	124	177	214	121	203	262	84	88	45	188	392	99	95	194	68	113	247	58	88	0	45
MEX	175	147	127	127	126	138	191	96	154	100	127	118	100	138	90	30	17	12	117	105	114	128	30	42	6	149	102	107	28	0

JER

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	0	108	441	175	264	161	39	156	70	72	9	37
DFS	101	0	194	147	153	171	119	153	107	111	34	59
USA	463	174	0	360	488	236	86	296	100	123	37	64
NZL	182	126	434	0	446	220	74	203	84	79	102	50
AUS	268	122	531	495	0	223	73	234	85	85	49	52
GBR	157	159	251	215	216	0	87	169	102	96	60	68
NLD	35	121	93	68	64	78	0	73	57	70	24	40
ZAF	151	134	309	208	222	165	69	0	90	83	31	56
ITA	67	108	107	83	79	103	56	83	0	60	19	45
DEU	70	111	125	73	75	91	65	78	61	0	18	48
IRL	6	30	38	113	46	61	22	31	18	18	0	15
CHE	30	58	64	41	43	64	34	49	42	44	11	0

JER

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	DFS	USA	NZL	AUS	GBR	NLD	ZAF	ITA	DEU	IRL	CHE
CAN	0	108	441	175	264	161	39	156	70	72	9	37
DFS	101	0	194	147	153	171	119	152	107	111	34	59
USA	463	174	0	360	488	236	86	296	100	123	37	64
NZL	182	126	434	0	446	219	74	203	84	79	102	51

AUS	268	122	531	495	0	222	73	233	85	85	49	52
GBR	157	159	251	215	216	0	87	168	102	96	60	68
NLD	35	121	93	68	64	78	0	72	57	70	24	40
ZAF	151	133	309	208	221	164	68	0	90	82	31	56
ITA	67	108	107	83	79	103	56	83	0	60	19	45
DEU	70	111	125	73	75	91	65	77	61	0	18	48
IRL	6	30	38	113	46	61	22	31	18	18	0	15
CHE	30	58	64	41	43	64	34	49	42	44	11	0

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	CHE
CAN	0	108	441	175	264	161	39	156	70	72	9	37
DFS	101	0	194	147	153	171	119	152	107	111	34	59
USA	463	174	0	360	488	236	86	296	100	123	37	64
NZL	182	126	434	0	446	219	74	203	84	79	102	50
AUS	268	122	531	495	0	222	73	233	85	85	49	52
GBR	157	159	251	215	216	0	87	168	102	96	60	68
NLD	35	121	93	68	64	78	0	72	57	70	24	40
ZAF	151	133	309	208	221	164	68	0	90	82	31	56
ITA	67	108	107	83	79	103	56	83	0	60	19	45
DEU	70	111	125	73	75	91	65	77	61	0	18	48
IRL	6	30	38	113	46	61	22	31	18	18	0	15
CHE	30	58	64	41	43	64	34	49	42	44	11	0

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RDC

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common bulls below diagonal

	common	three	quarter	sib	group	above	diagonal								
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	0	7	209	86	100	82	168	13	75	2	10	17	2	6	0
NOR	6	0	73	40	68	52	129	14	0	23	19	25	48	43	0
USA	193	75	0	121	129	108	190	20	64	19	23	34	24	41	24
NZL	85	40	122	0	139	81	170	16	39	9	17	27	9	20	12
AUS	100	58	130	139	0	82	180	38	38	34	35	42	14	32	11
GBR	78	55	98	75	81	0	100	14	40	8	17	26	18	33	0
DFS	171	103	186	168	154	92	0	49	52	109	121	104	14	49	0
DEU	12	13	20	16	38	14	40	0	1	21	34	29	4	14	0
ZAF	77	0	58	34	38	35	49	1	0	0	2	5	2	3	0
EST	2	23	18	8	31	7	97	21	0	0	50	25	0	18	0
LVA	10	17	20	14	33	16	82	28	2	43	0	52	2	13	0
LTU	16	22	29	25	42	24	99	28	5	25	48	0	4	15	0
IRL	2	47	24	9	13	17	11	4	2	0	2	4	0	9	0
NLD	6	43	40	20	30	32	47	14	3	17	12	13	9	0	0
CAM	0	0	24	12	11	0	0	0	0	0	0	0	0	0	0

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RDC

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common bulls below diagonal

	common	three	quarter	sib	group	above	diagonal								
	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	0	7	209	86	100	82	168	13	75	2	10	17	2	6	0
NOR	6	0	73	40	68	52	129	14	0	23	19	25	48	43	0
USA	193	75	0	121	129	108	190	20	64	19	23	34	24	41	24
NZL	85	40	122	0	139	81	170	16	39	9	17	27	9	20	12
AUS	100	58	130	139	0	82	180	38	38	34	35	42	14	32	11
GBR	78	55	98	75	81	0	100	14	40	8	17	26	18	33	0
DFS	171	103	186	168	154	92	0	49	52	109	121	104	14	49	0
DEU	12	13	20	16	38	14	40	0	1	21	34	29	4	14	0
ZAF	77	0	58	34	38	35	49	1	0	0	2	5	2	3	0
EST	2	23	18	8	31	7	97	21	0	0	50	25	0	18	0

LVA	10	17	20	14	33	16	82	28	2	43	0	52	2	13	0
LTU	16	22	29	25	42	24	99	28	5	25	48	0	4	15	0
IRL	2	47	24	9	13	17	11	4	2	0	2	4	0	9	0
NLD	6	43	40	20	30	32	47	14	3	17	12	13	9	0	0
CAM	0	0	24	12	11	0	0	0	0	0	0	0	0	0	0

RDC

common bulls below diagonal  
common three quarter sib group above diagonal

	CAN	NOR	USA	NZL	AUS	GBR	DFS	DEU	ZAF	EST	LVA	LTU	IRL	NLD	CAM
CAN	0	7	209	86	100	82	168	13	75	2	10	17	2	6	0
NOR	6	0	73	40	68	52	129	14	0	23	19	25	48	43	0
USA	193	75	0	121	129	108	190	20	64	19	23	34	24	41	24
NZL	85	40	122	0	139	81	170	16	39	9	17	27	9	20	12
AUS	100	58	130	139	0	82	180	38	38	34	35	42	14	32	11
GBR	78	55	98	75	81	0	100	14	40	8	17	26	18	33	0
DFS	171	103	186	168	154	92	0	49	52	109	121	103	14	49	0
DEU	12	13	20	16	38	14	40	0	1	21	34	29	4	14	0
ZAF	77	0	58	34	38	35	49	1	0	0	2	5	2	3	0
EST	2	23	18	8	31	7	97	21	0	0	50	25	0	18	0
LVA	10	17	20	14	33	16	82	28	2	43	0	52	2	13	0
LTU	16	22	29	25	42	24	98	28	5	25	48	0	4	15	0
IRL	2	47	24	9	13	17	11	4	2	0	2	4	0	9	0
NLD	6	43	40	20	30	32	47	14	3	17	12	13	9	0	0
CAM	0	0	24	12	11	0	0	0	0	0	0	0	0	0	0

SIM

common bulls below diagonal  
common three quarter sib group above diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	0	351	204	93	6	12	2	90	56	55	2	28
DEA	308	0	268	963	212	268	49	327	64	54	549	26
FRM	256	303	0	171	17	3	3	121	71	72	2	52
ITA	96	869	204	0	127	155	23	216	62	47	244	28
SVN	6	197	17	122	0	59	14	62	4	0	80	0
FRA	9	228	1	140	56	0	12	72	4	0	93	1
HUN	1	35	1	19	12	9	0	7	2	0	22	0
NLD	92	336	143	209	60	69	7	0	55	52	108	22
IRL	53	58	76	60	4	4	2	50	0	39	7	17
GBR	63	57	93	53	0	0	0	53	34	0	0	19
HRV	2	573	1	228	67	83	20	104	6	0	0	2
USA	27	28	67	33	0	1	0	24	16	27	2	0

SIM

common bulls below diagonal  
common three quarter sib group above diagonal

	CHE	DEA	FRM	ITA	SVN	FRA	HUN	NLD	IRL	GBR	HRV	USA
CHE	0	350	204	93	6	12	2	90	56	55	2	28
DEA	308	0	268	963	212	268	49	327	64	54	547	26
FRM	256	303	0	171	17	3	3	121	71	72	2	52
ITA	96	869	204	0	127	155	23	216	62	47	242	28
SVN	6	197	17	122	0	59	14	62	4	0	80	0
FRA	9	228	1	140	56	0	12	72	4	0	93	1
HUN	1	35	1	19	12	9	0	7	2	0	22	0
NLD	92	336	143	209	60	69	7	0	55	52	108	22
IRL	53	58	76	60	4	4	2	50	0	39	7	17
GBR	63	57	93	53	0	0	0	53	34	0	0	19
HRV	2	571	1	226	67	83	20	104	6	0	0	2
USA	27	28	67	33	0	1	0	24	16	27	2	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	GBR	HRV	USA
CHE	0	350	204	93	6	12	2	90	56	55	2	28
DEA	308	0	268	963	212	268	49	327	64	54	548	26
FRM	256	303	0	171	17	3	3	121	71	72	2	52
ITA	96	869	204	0	127	155	23	216	62	47	243	28
SVN	6	197	17	122	0	59	14	62	4	0	80	0
FRA	9	228	1	140	56	0	12	72	4	0	93	1
HUN	1	35	1	19	12	9	0	7	2	0	22	0
NLD	92	336	143	209	60	69	7	0	55	52	108	22
IRL	53	58	76	60	4	4	2	50	0	39	7	17
GBR	63	57	93	53	0	0	0	53	34	0	0	19
HRV	2	572	1	227	67	83	20	104	6	0	0	2
USA	27	28	67	33	0	1	0	24	16	27	2	0

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