Exploring the (Inverse of the) International Genetic Correlation Matrix

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Superior dairy bulls are used worldwide. Before a superior bull is identified, he is usually tested within a single country. Breeding values of both test and proven bulls are estimated within country. So within countries superior bulls can be identified, but to identify superior bulls among countries, estimated breeding values have to be made comparable internationally. Interbull facilitates international comparison through the MACE methodology. MACE combines information from several countries to obtain an estimated breeding value for each combination of country and bull participating in the analysis.

A critical assumption of MACE is that milk production is a separate trait in each country. Therefore, for each bull a breeding value is computed for each country, and the ranking of bulls can vary among countries. The users of the MACE EBVs are often globally orientated enterprises that have to use for one bull the EBVs from several countries. Those users can only make optimal use of the available information if they understand and accept the differences among the sire rankings for the various countries.

In the MACE analysis a separate trait is defined for each country; the ranking of a sire can therefore be different for each country. Information of different countries is linked through the genetic correlation structure among countries. This genetic correlation structure determines how information from one country is used to estimate EBVs in other countries. When a bull has daughter information in one country only, the impact of this daughter information in other countries is simply related to the genetic correlation between the two countries. When a bull has daughter information in several countries, then his EBV in a particular country is a weighted average of the daughter information from the different countries. How these weights depend on the international genetic correlation structure has not been quantified until now.

The present study quantifies the relative impact on various information sources on the MACE EBV in a certain country, and investigates the effect that the genetic correlation structure among countries has on the relative importance of country information.

Approach

The May 1999 Interbull genetic correlation matrix among countries for milk yield for Holstein was used. For simplicity, the genetic variance in each country was set to one, and the heritability in each country to 0.30.

To improve the understanding of the genetic correlation matrix, it was decomposed by computing eigen values and eigen vectors.

Selection index theory was used the study the impact of across country information on the across country evaluation. For hypothetical and existing bulls, an index was constructed where daughter information from 1 to all countries was available. For the bull, only information on his daughters was used, i.e., no information on other relatives was used. For each country, an index was constructed that was a weighted average of the daughters averages available. The matrix containing the weights for the daughter groups were computed as $\mathbf{W} = \mathbf{C'}\ \mathbf{V}^{-1}$ where $\mathbf{C}$ is a $n_i \times 23$ matrix with genetic correlations between the n_i countries in which the bull has daughter information and the 23 countries for which an index is to be computed, $\mathbf{V}$ is an $n_i \times n_i$ matrix with covariances between the daughter group averages. Diagonal elements of $\mathbf{V}$ are equal to $(1/h^2 + ¼\ (n_{di}-1))/n_{di}$ where n_{di} is the number of daughters in country i, and off-diagonal elements are equal to a quarter times the genetic correlation between two countries.

Matrix **W** is standardised to **Ws** by dividing each element in a row by the row-sum.

The decomposed matrix

Table 1 shows the five largest eigen values of the genetic correlation matrix and the eigenvectors belonging to these eigen values. The largest eigen value is very dominant. One trait defined by the largest eigen vector can explain 88% of all the variance. The eigen vector for the largest eigen value shows that this trait is, up to a scaling factor, almost equal to the average of all countries. The weights in this vector vary from 0.19 for NZL and AUS to 0.22 for NLD. This vector can be denoted as the global vector. The second eigen vector explains two percent of the variance. The second vector is the Southern Hemisphere vector, or the grazing vector. NZL and AUS have largest effects on this vector. The third vector explains 1.5 % of the variance. This vector is difficult to explain, but might be linked to the process of holsteinization in the respective countries scoring for this vector.

The universal bull

The universal bull was assumed to have 50 daughters in each of the 23 countries. Table 2 gives the resulting selection index weights. In the first row you see the weights for the selection index to compute a breeding value for Canada. The daughter average from Canada is weighted by a factor of 0.25, the daughter average from Germany by a factor of 0.05 and so on. In Canada, Canadian information of course gets most weight, followed by information from USA, and then from Spain and France. Some countries have an almost zero weight, and Australia, Austria and Israel even have a negative weight, i.e., the better the daughters perform in Australia, the lower the Canadian index. The contrast between NZL and AUS is interesting: although both countries have a relatively low genetic correlation with CAN, the information from NZL weights positive with factor 0.05, and the information from AUS weights negative with a factor of -0.01.

For all countries you see a pattern of some countries having more influence than others do, and that some countries even have negative weight. Australia and New-Zealand have large effects on each other, Italy has large effects on USA and ESP, and vice versa. The impact of own country information varies widely (diagonal of Table 3). The weight of owns country information ranges from 0.19 (NLD) to 0.49 (NZL), and is for instance twice as high in DEU as in neighbouring country NLD.

Real bulls

For the Dutch bull Cash and the French bull Esquimau, the indices were computed based on the actual number of daughters they had in the Interbull May 99 evaluation. The weights the daughter averages from the different countries have are in Tables 3 and 4. In Table 3, in the first seven rows the weights are given for the countries in which Cash has daughters. In rows 8 to 23 the weights are given for the countries in which Cash has zero daughters. Rows 8 to 23 are sorted based on the weight information from NLD has. NLD is the country in which Cash is originally tested and where he has his most daughters. The weight NLD information gets varies from 0.75 for CHE to 0.09 for ESP. In CHE, the information from BEL gets a weight of -0.14, although NLD and BEL have a genetic correlation of 0.97. The GBR daughters of Cash have a large influence on the breeding values in NZL, AUS and IRL. The ITA daughters of Cash have a large influence on the breeding values in USA and ESP.

In Table 4, the first 8 rows give the weights for the countries in which Esquimau has daughters. Esquimau originates from FRA and rows 9-23 are sorted based on the weight information from FRA has. Information from FRA has most weight in NZL (0.54) and least weight in CHE (0.03). In NZL, also daughters from GBR and IRL have much influence, and further, the daughters from DNK have a large negative effect on the breeding value in NZL.

Hypothetical bulls

The first hypothetical bull has 1000 daughters in each of the countries CAN, DEU, FRA, ITA, NLD and USA. The weighting of the daughter averages varies widely. The weight of CAN information ranges from -0.11 for EST and +0.44 for NZL, the weight of DEU information ranges from +0.03 for ESP till +0.37 for AUT, the weight for FRA information ranges from -0.01 for CHE till +0.65 for NZL, the weight of ITA information ranges from -0.26 for FRR till +0.47 for ESP, the weight for NLD ranges from +0.03 for ESP till +0.56 for CHE, and the weight for USA information ranges from -0.33 for NZL till +0.36 for CSK. Information from DEU and NLD weighs positive in all 17 countries in which the hypothetical bull has no daughters. Information from ITA weighs negative in 11 out of the 17 countries. The overall lowest weight is -0.33 for USA information in NZL. The weights of ITA and USA have mostly opposite signs, although the genetic correlation between ITA and USA is 0.96.

The second hypothetical bull represents a bull that has many daughters in one country, and relatively few in other countries. In this case, the bull has 10,000 daughters in NLD and 100 in DNK, ITA, GBR and ESP. In Table 6, the other countries are ranked based on the weight of NLD information. The weight of NLD information varies from 0.73 for CHE till 0.30 for IRL. In IRL, the 100 daughters from GBR carry more weight than the 10,000 from NLD. ITA has low or negative weight for many countries, and a very high weight for USA. GBR has a high value for NZL, AUS and IRL. ESP has a relatively high weight for AUT.

Discussion

Milk production in various countries is highly correlated. However, the relative impact of information from two highly correlated countries can be very different. This was clearly illustrated by the hypothetical bull with 1000 daughters in CAN, DEU, FRA, ITA, NLD and USA. We saw that the MACE EBV of this bull in CHE was dominated by NLD (relative impact of 0.56), whereas CAN had even a negative weight of -0.04. The correlation between CAN and NLD is 0.94, the correlation between CAN and CHE is 0.89, and the correlation between NLD and CHE is 0.93. So, because the correlation between NLD and CHE is 0.04 higher than the correlation between CAN and CHE, the MACE EBV in CHE is completely dominated by information from NLD. For the MACE EBV of ESP of same hypothetical bull, the relative effect of ITA was 0.47, and the relative effect of USA was -0.01. The correlation between ITA and ESP is 0.94, the correlation between USA and ESP is 0.92, and the correlation between ITA and USA is 0.96. So it is clear that the computation of the MACE EBV of a bull that has no daughters in country X, can be completely different from the computation of the MACE EBV for country Y where he also has no daughters. In theory this is of course not a problem. If we take the ESP-ITA-USA example again: ITA and USA have a correlation of 0.96. So, it should not really matter if you take USA daughter information or ITA daughter information. Therefore, for most bulls the MACE EBV for ESP should be insensitive to the relative weight of ITA and USA information. However, in some cases the ranking of a bull in USA is different from the ranking in ITA. For those instances it is better to rely on ITA information since the correlation between ITA and ESP is 0.02 higher than the correlation between USA and ESP.

The results showed that the information from a country can be negatively weighted in the EBV of another country. Although correct, this might be hard to explain to a practical breeder. Put yourself in the place of an AI representative who knows that the national EBV of her bull in the country of first test has improved, and then learns that the MACE EBV of this bull has decreased in her main export market. It is a challenge to find for this phenomenon a logical explanation that is accepted throughout the AI industry.

The eigen vector analysis showed that one eigenvector can explain almost 90% of all variance among countries, and that this vector is almost equal to the average of all countries. This largest eigen vector might be the base for a global sire ranking: just define a phantom country that is the average of all countries, and in which no bull has daughter information. Most countries will have a correlation with this country of around 0.95. In this phantom country bulls from all countries will have a more even chance to rank in the top. For a farmer the ranking in this phantom country probably is as good or better than the national ranking in his home country (say NLD), because why would an independent farmer from NLD thrust the national ranking from NLD more than the one from a neighbouring country with an equal farming system. This global ranking would be a first step towards a more transparent international genetic evaluation system that serves the needs of the global dairy genetics industry.

Table 1. Eigen vectors of the genetic correlation matrix belonging to the five largest eigen values

Country	Eigen vectors				
CAN	0.21	-0.05	-0.29	0.08	0.05
DEU	0.21	-0.13	0.04	0.29	-0.39
DNK	0.21	-0.08	-0.12	-0.30	-0.05
FIN	0.21	-0.13	-0.04	-0.40	0.15
FRA	0.21	0.01	-0.28	0.00	0.02
ITA	0.21	-0.12	-0.28	0.43	0.17
NLD	0.22	-0.09	-0.17	-0.07	-0.20
SWE	0.21	-0.07	0.04	-0.40	0.07
USA	0.21	-0.16	-0.21	0.19	0.04
CHE	0.21	-0.15	0.12	0.00	-0.21
GBR	0.21	0.05	-0.08	-0.17	0.00
NZL	0.19	**0.66**	-0.05	0.27	0.04
AUS	0.19	**0.62**	0.00	-0.18	-0.12
AUT	0.21	-0.02	0.43	-0.02	0.00
BEL	0.21	-0.06	-0.20	-0.10	-0.12
IRL	0.21	0.13	0.05	-0.18	0.14
ESP	0.21	-0.10	-0.14	0.11	0.42
CSK	0.20	-0.06	0.40	0.00	0.25
SLO	0.21	-0.06	0.28	0.12	0.24
EST	0.20	-0.07	0.32	0.15	-0.39
ISR	0.20	0.01	0.25	0.20	0.32
CHR	0.21	-0.09	0.06	0.07	-0.29
FRR	0.21	0.09	-0.06	-0.06	-0.13
Eigen values	20.30	0.50	0.32	0.21	0.18

Table 2. The universal bull: the weight of daughter average from countries in the columns on the index in the countries given in the rows

	CAN	DEU	DNK	FIN	FRA	ITA	NLD	SWE	USA	CHE	GBR	NZL	AUS	AUT	BEL	IRL	ESP	CSK	SLO	EST	ISR	CHR	FRR
CAN	**0.25**	0.05	0.06	0.03	0.07	0.06	0.04	0.03	0.10	0.01	0.05	0.05	-0.01	-0.02	0.05	0.02	0.07	0.03	0.01	0.00	-0.01	0.02	0.04
DEU	0.05	**0.38**	0.04	0.01	0.02	0.05	0.04	0.00	0.02	0.03	0.03	0.01	-0.01	0.03	0.03	0.02	0.01	0.04	0.03	0.05	0.03	0.07	0.02
DNK	0.06	0.04	**0.22**	0.08	0.07	0.00	0.06	0.05	0.02	0.04	0.08	-0.04	0.03	0.02	0.06	0.07	0.04	0.03	-0.01	0.03	0.01	0.00	0.03
FIN	0.03	0.01	0.08	**0.29**	0.06	-0.01	0.08	0.12	0.04	0.02	0.02	-0.01	-0.02	0.04	0.03	0.04	0.05	0.05	0.01	0.01	0.02	0.02	0.02
FRA	0.07	0.01	0.07	0.06	**0.26**	0.09	0.05	0.01	0.03	0.00	0.00	0.03	0.05	0.01	0.09	0.00	0.05	-0.01	0.02	0.01	0.01	0.03	0.04
ITA	0.06	0.05	0.00	-0.01	0.09	**0.28**	0.06	0.02	0.15	0.04	0.02	0.05	-0.02	-0.01	0.01	0.01	0.12	-0.01	0.03	0.02	0.03	0.03	-0.02
NLD	0.04	0.04	0.06	0.07	0.05	0.06	**0.19**	0.04	0.04	0.08	0.05	0.02	0.00	-0.01	0.11	0.01	0.00	0.00	0.00	0.03	0.02	0.06	0.04
SWE	0.03	0.00	0.05	0.12	0.01	0.02	0.04	**0.33**	0.03	0.04	0.04	-0.02	0.05	0.03	0.00	0.02	0.02	0.01	0.05	0.04	0.03	0.03	0.03
USA	0.10	0.02	0.02	0.03	0.03	0.14	0.04	0.03	**0.25**	0.05	0.04	-0.01	-0.01	0.00	0.07	0.01	0.04	0.03	0.02	0.04	0.01	0.02	0.03
CHE	0.01	0.03	0.04	0.02	0.00	0.04	0.08	0.04	0.05	**0.34**	0.00	-0.02	-0.01	0.05	-0.01	0.07	0.01	0.04	0.03	0.05	0.03	0.05	0.05
GBR	0.05	0.03	0.08	0.02	0.00	0.02	0.05	0.04	0.04	0.00	**0.24**	0.04	0.04	0.01	0.08	0.11	0.01	0.01	0.04	0.01	0.03	0.04	0.01
NZL	0.05	0.01	-0.04	-0.01	0.03	0.05	0.02	-0.02	-0.01	-0.02	0.04	**0.49**	0.21	0.03	-0.01	0.06	-0.01	0.02	0.00	0.00	0.05	0.00	0.06
AUS	-0.01	-0.02	0.04	-0.02	0.05	-0.03	0.00	0.05	-0.01	-0.01	0.04	0.21	**0.45**	0.03	0.03	0.07	0.01	0.01	0.01	0.03	-0.01	0.01	0.06
AUT	-0.02	0.03	0.02	0.04	0.01	-0.01	-0.01	0.03	0.00	0.05	0.01	0.03	0.03	**0.39**	0.03	0.00	0.05	0.09	0.04	0.07	0.05	0.05	0.03
BEL	0.05	0.03	0.06	0.03	0.09	0.01	0.11	0.00	0.07	-0.01	0.08	-0.01	0.02	0.03	**0.21**	0.03	0.04	0.01	0.01	0.00	0.01	0.07	0.05
IRL	0.02	0.02	0.07	0.04	0.00	0.01	0.01	0.02	0.01	0.06	0.11	0.06	0.07	0.00	0.03	**0.29**	0.02	0.05	0.04	0.01	0.05	0.00	0.00
ESP	0.07	0.01	0.04	0.05	0.05	0.12	0.00	0.02	0.04	0.01	0.01	-0.01	0.01	0.05	0.04	0.02	**0.30**	0.03	0.04	-0.01	0.04	0.00	0.05
CSK	0.03	0.04	0.03	0.05	-0.01	-0.01	0.00	0.01	0.03	0.04	0.01	0.02	0.01	0.09	0.01	0.05	0.03	**0.40**	0.07	0.04	0.04	0.03	0.00
SLO	0.01	0.03	-0.01	0.01	0.02	0.03	0.00	0.05	0.02	0.03	0.04	0.00	0.01	0.04	0.01	0.04	0.04	0.07	**0.39**	0.05	0.04	0.04	0.03
EST	0.00	0.05	0.03	0.01	0.01	0.02	0.04	0.04	0.04	0.05	0.01	0.00	0.03	0.07	0.00	0.01	-0.01	0.04	0.05	**0.41**	0.04	0.03	0.02
ISR	-0.02	0.03	0.01	0.02	0.01	0.03	0.02	0.03	0.01	0.03	0.03	0.04	-0.01	0.05	0.01	0.05	0.04	0.04	0.04	0.04	**0.42**	0.04	0.03
CHR	0.02	0.07	0.00	0.02	0.03	0.03	0.06	0.03	0.02	0.05	0.04	0.00	0.01	0.05	0.07	0.00	0.00	0.03	0.04	0.03	0.04	**0.33**	0.03
FRR	0.04	0.02	0.03	0.02	0.04	-0.02	0.04	0.03	0.03	0.05	0.01	0.05	0.06	0.03	0.05	0.00	0.05	0.00	0.03	0.02	0.03	0.03	**0.33**

Table 3. Weight of Cash daughters from various countries in the EBV of Cash for all Interbull participants

	# dau	CAN	DEU	DNK	ITA	NLD	GBR	BEL
CAN	15	0.10	0.08	0.09	0.17	0.26	0.21	0.10
DEU	109	0.01	0.59	0.04	0.07	0.19	0.08	0.03
DNK	75	0.02	0.05	0.30	0.01	0.28	0.27	0.07
ITA	113	0.02	0.06	0.01	0.55	0.29	0.07	0.00
NLD	2842	0.00	0.01	0.01	0.01	0.94	0.01	0.02
GBR	742	0.00	0.01	0.03	0.01	0.06	0.85	0.04
BEL	161	0.01	0.02	0.03	0.00	0.38	0.17	0.39
CHE	0	0.01	0.11	0.09	0.09	0.75	0.10	-0.14
FIN	0	0.02	0.02	0.16	0.00	0.65	0.15	0.00
SWE	0	0.02	0.03	0.12	0.07	0.51	0.31	-0.05
EST	0	0.00	0.19	0.08	0.09	0.48	0.19	-0.03
FRR	0	0.03	0.08	0.08	0.02	0.46	0.18	0.14
CHR	0	0.01	0.16	-0.01	0.06	0.44	0.20	0.15
ISR	0	-0.01	0.12	0.04	0.13	0.34	0.37	0.01
FRA	0	0.03	0.02	0.14	0.21	0.33	0.03	0.24
USA	0	0.04	0.04	0.03	0.32	0.28	0.15	0.14
NZL	0	0.04	0.05	-0.10	0.16	0.28	0.61	-0.04
CSK	0	0.03	0.20	0.12	0.06	0.23	0.29	0.08
SLO	0	0.01	0.14	0.01	0.16	0.19	0.42	0.07
AUT	0	0.00	0.20	0.12	0.06	0.18	0.27	0.17
AUS	0	0.01	0.00	0.08	0.01	0.17	0.63	0.11
IRL	0	0.01	0.05	0.10	0.06	0.12	0.67	-0.01
ESP	0	0.04	0.05	0.13	0.35	0.09	0.15	0.18

Table 4. Weight of Esquimau daughters from various countries in the EBV of Esquimau for all Interbull participants

	# dau	DEU	DNK	FRA	NLD	SWE	GBR	BEL	IRL
DEU	806	0.92	0.01	0.01	0.03	0.00	0.02	0.00	0.01
DNK	169	0.05	0.44	0.17	0.07	0.04	0.16	0.01	0.07
FRAU	11828	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00
NLD	337	0.06	0.04	0.11	0.62	0.04	0.08	0.06	0.00
SWE	95	0.03	0.08	0.07	0.14	0.52	0.13	-0.01	0.05
GBR	1370	0.01	0.02	0.00	0.02	0.01	0.88	0.01	0.05
BEL	79	0.04	0.03	0.26	0.24	-0.02	0.25	0.22	-0.03
IRL	339	0.02	0.03	0.02	0.00	0.01	0.18	-0.01	0.73
NZL	0	0.05	-0.35	0.54	0.06	-0.03	0.39	-0.09	0.43
ITA	0	0.20	-0.10	0.52	0.23	0.04	0.12	-0.05	0.05
AUS	0	-0.08	-0.08	0.47	-0.10	0.10	0.31	-0.01	0.39
ESP	0	0.10	0.10	0.42	0.03	0.10	0.06	0.06	0.13
CAN	0	0.15	0.07	0.39	0.11	0.04	0.23	0.02	0.00
FRR	0	0.11	0.04	0.33	0.18	0.10	0.12	0.06	0.06
USA	0	0.14	0.00	0.26	0.23	0.08	0.21	0.07	0.01
FIN	0	0.01	0.16	0.24	0.25	0.23	-0.01	-0.01	0.11
SLO	0	0.21	-0.10	0.23	0.02	0.16	0.27	0.01	0.19
AUT	0	0.27	0.08	0.17	-0.01	0.17	0.11	0.07	0.14
ISR	0	0.18	-0.03	0.17	0.14	0.10	0.18	-0.01	0.27
CHR	0	0.27	-0.07	0.17	0.23	0.09	0.21	0.09	0.01
EST	0	0.30	0.06	0.11	0.21	0.14	0.07	-0.02	0.13
CSK	0	0.28	0.10	0.07	0.05	0.12	0.03	0.04	0.31
CHE	0	0.19	0.10	0.03	0.43	0.11	-0.09	-0.04	0.28

Table 5. Weight of daughter information from countries listed in the columns for a bull with 1000 daughters in each of seven countries

	CAN	DEU	FRA	ITA	NLD	USA
CAN	0.85	0.02	0.05	0.00	0.02	0.06
DEU	0.02	0.93	0.00	0.02	0.03	0.00
FRA	0.05	0.00	0.88	0.04	0.05	-0.01
ITA	0.00	0.02	0.04	0.85	0.01	0.09
NLD	0.02	0.03	0.05	0.01	0.85	0.04
USA	0.06	0.00	-0.01	0.09	0.04	0.82
DNK	0.23	0.14	0.32	-0.17	0.37	0.12
FIN	0.05	0.06	0.33	-0.25	0.51	0.29
SWE	0.15	0.07	0.12	-0.05	0.47	0.23
CHE	-0.04	0.18	-0.01	0.01	0.56	0.32
GBR	0.26	0.12	0.08	-0.06	0.41	0.17
NZL	0.44	0.07	0.32	0.27	0.22	-0.33
AUS	0.12	0.09	0.65	-0.19	0.28	0.06
AUT	-0.08	0.37	0.31	-0.14	0.22	0.32
BEL	0.05	0.07	0.33	-0.24	0.50	0.29
IRL	0.21	0.17	0.15	0.02	0.35	0.11
ESP	0.32	0.03	0.18	0.47	0.03	-0.01
CSK	0.18	0.33	0.12	-0.18	0.19	0.36
SLO	0.02	0.25	0.21	0.07	0.17	0.27
EST	-0.11	0.32	0.13	-0.05	0.34	0.36
ISR	-0.08	0.25	0.20	0.14	0.36	0.14
CHR	0.02	0.28	0.15	-0.01	0.43	0.12
FRR	0.18	0.13	0.33	-0.26	0.35	0.27

Table 6. Weight of within country daughter information for a bull with 10,000 daughters in NLD and 100 in DNK, ITA, GBR and ESP

	DNK	ITA	NLD	GBR	ESP
DNK	0.39	-0.01	0.38	0.13	0.10
ITA	-0.01	0.47	0.33	0.03	0.17
NLD	0.00	0.00	0.99	0.00	0.00
GBR	0.13	0.03	0.33	0.45	0.05
ESP	0.10	0.17	0.16	0.05	0.52
CHE	0.10	0.07	0.73	0.03	0.08
BEL	0.08	-0.02	0.71	0.13	0.10
CHR	0.02	0.06	0.70	0.13	0.08
FIN	0.17	-0.05	0.66	0.05	0.17
FRR	0.10	-0.03	0.62	0.10	0.20
EST	0.12	0.09	0.60	0.10	0.08
DEU	0.12	0.14	0.57	0.10	0.07
SWE	0.15	0.03	0.55	0.14	0.13
FRA	0.17	0.16	0.50	0.03	0.14
NZL	-0.06	0.16	0.49	0.32	0.09
ISR	0.07	0.09	0.47	0.18	0.19
USA	0.05	0.29	0.45	0.09	0.11
CAN	0.14	0.14	0.43	0.12	0.17
CSK	0.17	0.02	0.42	0.16	0.23
AUT	0.16	0.01	0.40	0.15	0.28
SLO	0.05	0.12	0.40	0.22	0.21
AUS	0.15	-0.01	0.39	0.33	0.14
IRL	0.19	0.05	0.30	0.34	0.12