

CAIQS User's Guide

1. Description

The program computes the adverse impact and the average quality of a (single-stage) **large sample** selection using a weighted predictor combination for either a given set of overall selection ratios or a given set of majority group related selection ratios. By default, the calculation of the adverse impact and the average quality is performed for the following selection ratios: .01, .05, .10, .15, .20, .25, .30, .35, .40, .45, .50, .55, .60, .65, .70, .75, .80, .85, .90, .95 and 1.00. For each selection ratio, the average quality corresponds to the average score of the selected applicants on either the predictor composite or a weighted combination of criterion dimensions. The average quality is computed for (a) all the selected applicants, (b) the selected applicants from the majority group and (c) the selected applicants from the minority group. When the computations refer to the selection of a given **overall** selection ratio, then the results are reported using two different metrics: (a) results standardized with respect to the distribution (metric) of the total applicant population and (b) results standardized with respect to the distribution (metric) of the majority group population. More specifically, using $\mu_a \equiv 0$ and μ_i for the average (composite) criterion (or predictor) score in the majority group and the average (composite) criterion (or predictor) score in the minority group, respectively, assuming that both applicant groups have the same (composite) criterion (predictor) variance, $\sigma \equiv 1$ (see below), and given that the total applicant group consists of a proportion, p_a , of majority group candidates, and a proportion, p_i , of minority group applicants, the average score on the composite criterion (predictor) of the majority and the minority group selected is, according to the first metric, expressed as $\frac{\mu_a^{(s)} - \mu_t}{\sigma_t}$ and $\frac{\mu_i^{(s)} - \mu_t}{\sigma_t}$, respectively. In the above expressions, $\mu_t = p_a\mu_a + p_i\mu_i$ and $\sigma_t^2 = 1 + p_ap_id^2$, where d denotes the effect size of the composite criterion (predictor). In the second metric, only the values $\mu_a^{(s)}$ and $\mu_i^{(s)}$ are reported. In addition to these average scores, the corresponding differences, $\frac{\mu_a^{(s)} - \mu_i^{(s)}}{\sigma_t}$ and $\mu_a^{(s)} - \mu_i^{(s)}$ are presented as well. These differences represent the effect size (expressed in the metric of σ_t and σ , respectively) of the criterion (predictor) composite in the selected subgroup and these measures can therefore be used to gauge the effect of prior selection on the subgroup differences found in the selected group (cf. the paper by Roth et al., 2001).

The option to consider selections where the selection ratio refers to a given proportion of the majority applicant group was added to provide results that cover those computed by Bartram (1995). Also, in that case only the second metric is used to report the average qualities of the majority and the minority selected candidates as well as the difference between the two quantities.

Apart from performing the calculations for the given set of selection ratios, the

program also determines the minimum value of the overall (or majority group related) selection ratio for which the adverse impact ratio of the selection is no less than .800 (cf. the so-called four-fifths rule), and reports the average qualities (total, majority and minority group selected) and the above documented effect sizes. In addition, the user can complete the calculations for a limited number of still other (overall or majority group related) selection ratios.

Finally, when the program is used to focus on a criterion (composite), the user can (a) pre-specify the weights with which the predictors are combined to the predictor composite or (b) let the program compute the regression based weights of the predictors with respect to criterion (composite). Obviously, when the user focuses on the predictor (composite), then only option (a) is available.

2. Assumptional Basis

The calculations are based on the assumption that the predictor and (eventually) the criterion dimensions have a joint multivariate normal distribution with the same variance/covariance matrix but a different mean vector in the two applicant populations. Given this assumption it is, without further restrictions, understood that the joint distribution of the predictors and the criterion dimensions is standard multivariate normal in the majority applicant population.

The method is appropriate for **large sample** selections. The results are exact when the number of applicants (both in the majority and the minority applicant group) tends to infinity. For small(er) samples of applicants, the average quality results are only approximate and typically overestimate the real expected values.

3. Technical Aspects

At present, the program is limited to situations where the total number of predictors and criterion dimensions is not greater than 10. The limitation is easily removed, however.

To safely run the compiled program, a PC running under MS-Windows 95, 98, NT or 2000 and with at least 64 MB RAM memory is required.

4. Input

- # 1: **NP, NC, NVERH, NREG, NCR, NRSR** (6i3) with
 - **NP**: the number of predictors
 - **NC**: the number of criterion dimensions
 - **NVERH**: when NVERH is set equal to 1, the calculations are performed for **overall** selection ratios; whereas for $NVERH = 0$, the calculations pertain to selection ratios for the **majority** applicant group

- **NREG**: when NREG is equal to 0, the weights with which the predictors are combined to the predictor composite is specified by the user. When NREG = 1, the program computes the regression based weights for the predictors with respect to the criterion composite. Observe that the latter option is only feasible when NC is at least equal to 1.
 - **NCR**: when NCR is set equal to 1, then the computed average qualities pertain to the criterion composite; whereas for NCR equal to 0 the average qualities refer to the predictor composite.
 - **NRSR**: the number of additional selection ratios for which the user requests the computation of adverse impact and average quality
- # 2: **Optional** only required when NVERH = 1. **VERH** (f7.3)
VERH indicates the ratio between the size of the majority applicant group and that of the minority applicant group.
 - # 3: **Optional** only required when NREG = 0. **WEP(I)** with I = 1, ..., NP (10f7.3)
The element WEP(I) indicates the weight with which the Ith predictor is used in the predictor composite.
 - # 4: **Optional** only required when NC \neq 0. **WEC(I)** with I = 1, ..., NC (10f7.3)
The element WEC(I) indicates the weight with which the Ith criterion dimension is used in the criterion composite.
 - # 5 and following: **CORIN(I,J)** with both I and J ranging from 1 to NP + NC. (7f7.3)
CORIN specifies the **full** correlation matrix between the predictors (first NP rows and columns of the matrix) and the criterion dimensions (final NC rows and columns of the matrix)
 - # 6: **DIFP(I)** with I ranging from 1 to NP (10f7.3)
The element DIFP(I) specifies the effect size of the Ith predictor. As the program presumes that the average score of the predictors is zero in the majority applicant population, the elements of the vector DIFP have typically a negative value. For example, suppose that the difference between the average score on predictor 2 of the majority and the minority population (expressed relative to the common standard deviation of the predictor in both populations) is 0.450, then the second element of DIFP, DIFP(2) is set equal to -0.450.

- # 7: **Optional** only required when $NC \neq 0$ **DIFC(I)** with I ranging from 1 to NC (10f7.3)

The element DIFC(I) specifies the effect size of the Ith predictor. As the program presumes that the average score of the predictors is zero in the majority applicant population, the elements of the vector DIFC also have typically a negative value.

- # 8: **Optional** only required when $NRSR \neq 0$ **RSR(I)** with I ranging from 1 to NRSR (10f7.3)

The elements of RSR specify the selection ratios for which the user wants the calculation of the adverse impact and the average quality in addition to the selection ratios that are analyzed by default.

5. Sample Input File

Important: in preparing the input file, use a simple text editor such as Notepad, Wordpad or any other standard ASCII producing editor. DO NOT USE TEXT PROCESSING PROGRAMS SUCH AS MS-WORD or WORDPERFECT. Also, when saving the input file in Notepad, use the option "All Files" in the "Save as type" box. When saving in Wordpad, use the "Text Document-MS-DOS Format" option in the "Save as type" box, and be **aware that Wordpad has the nasty habit of adding the extension .txt to the file name that you specify**. Thus, with Wordpad, if you specify the name of the input file as "MINPUT", the file will in fact be saved as "MINPUT.TXT"; and this is the name that you have to use in the command to run the present programs. Here is a sample input file, for the caiqs program.

```

4 2 1 1 1 3
4.000
6.000 2.000
1.000 0.170 0.000 0.100 0.290 0.160
0.170 1.000 0.120 0.160 0.300 0.260
0.000 0.120 1.000 0.470 0.120 0.200
0.100 0.160 0.470 1.000 0.240 0.250
0.290 0.300 0.120 0.240 1.000 0.170
0.160 0.260 0.200 0.250 0.170 1.000
-1.000 -0.090 -0.090 -0.200
-0.450 0.000
0.075 0.250 0.320

```

6. Running the Program

Suppose you copied the executable source of the program to the d:publik directory on your machine. In that case, the input file must also be saved in the d:publik

directory. Next, to run the program, you have to open an MS-DOS Command window. The way to do this varies from one operating system (i.e., Windows 95, 98, NT a.s.o.) to the other, and you should use your local "HELP" button when in doubt about this feature.

In the MS-DOS Command window you type d:, followed by RETURN or ENTER, and your computer will return the D:\> command prompt. Next, you type cd publik after the D:\> command prompt, again followed by RETURN or ENTER, and your computer will respond with the D:\publik> command prompt. Now, you can execute the program by typing caiqs < minput > moutput where "minput" is the name of the input file and "moutput" is the name of the output file. At the end of the execution, the PC will return the command prompt D:\publik>. You can then inspect the output by editing the output file with either Notepad, Wordpad or any other simple editor program.

7. Sample Output

```
Computing adverse impact and average quality of the selected subjects
(with respect to either a criterion or a predictor composite)
of a selection using a weighted predictor combination
for a given overall or majority group related selection ratio
```

Program written by Anonymous

The program uses routines from the Slatec library (see <http://www.geocities.com/Athens/Olympus/5564>) and a couple of algorithms from StatLib (see <http://lib.stat.cmu.edu/apstat/>)

Problem specification

Number of predictors: 4

Number of criteria: 2

Computation for overall selection ratio: Yes

Use regression based weights: Yes

Expected scores on (composite) criterion: Yes

Ratio number of majority vs number of minority applicants: 4.000

Predictor weights (from predictor one to the last):

0.244 0.270 0.039 0.206

(Regression based weights!)

Criterion weights (from criterion one to the last):

6.000 2.000

Effect sizes (i.e., standardized difference between the minority and the majority group) of the predictors

-1.000 -0.090 -0.090 -0.200

Effect sizes (i.e., standardized difference between the minority and the majority group) of the criteria

-0.450 0.000

Correlation matrix of the predictors (first 4 rows and columns) and the criteria (final 2 rows and columns)

Row 1	1.000	0.170	0.000	0.100	0.290	0.160
Row 2	0.170	1.000	0.120	0.160	0.300	0.260
Row 3	0.000	0.120	1.000	0.470	0.120	0.200
Row 4	0.100	0.160	0.470	1.000	0.240	0.250
Row 5	0.290	0.300	0.120	0.240	1.000	0.170
Row 6	0.160	0.260	0.200	0.250	0.170	1.000

Correlation between weighted predictor and weighted criterion combinations: 0.487

Squared correlation: 0.237

Effect size predictor composite -0.643

Effect size criterion composite -0.407

Minimum overall selection ratio without AI 4/5th rule is 0.846 with selection ratio majority and minority group equal to 0.881 0.705 , respectively

For each overall selection ratio (SR): the majority group SR (SRA) the minority group SR (SRI), the adverse impact (AI), the overall average quality of the selected individuals (with respect to the majority group distribution: wrtmgd) (M), the average quality of the majority group selected {wrtmgd) (MA) and the minority group selected (again wrtmgd) (MI), and the difference between MA and MI.

On the second line: the globally standardized (gs) overall average quality of the selected individuals (SM), the (gs) average quality of the majority selected individuals (SMA), the (gs) average quality of the minority selected (SMI) and the difference between SMA and SMI (SDIF)

SR	SRA	SRI	AI	M	MA	MI	DIF
SM	SMA	SMI	SDIF				
0.010	0.012	0.002	0.156	1.262	1.267	1.147	0.120
1.326	1.331	1.212	0.119				
0.050	0.059	0.014	0.232	0.962	0.969	0.837	0.132
1.030	1.037	0.907	0.131				
0.100	0.117	0.033	0.285	0.809	0.818	0.678	0.141
0.879	0.888	0.749	0.139				
0.150	0.173	0.057	0.327	0.708	0.720	0.572	0.148
0.779	0.791	0.645	0.146				
0.200	0.229	0.083	0.363	0.631	0.644	0.489	0.154
0.703	0.715	0.563	0.152				
0.250	0.284	0.113	0.396	0.566	0.581	0.420	0.161
0.639	0.653	0.495	0.159				
0.300	0.339	0.145	0.428	0.510	0.526	0.359	0.167
0.583	0.599	0.434	0.165				
0.350	0.393	0.180	0.459	0.459	0.477	0.303	0.174
0.533	0.551	0.379	0.171				
0.400	0.446	0.218	0.489	0.412	0.432	0.251	0.181
0.487	0.506	0.328	0.178				
0.450	0.498	0.259	0.519	0.368	0.390	0.202	0.188
0.444	0.465	0.280	0.185				
0.500	0.549	0.302	0.550	0.327	0.351	0.155	0.195
0.403	0.426	0.234	0.193				
0.550	0.600	0.349	0.581	0.287	0.313	0.110	0.204
0.364	0.389	0.188	0.201				
0.600	0.650	0.399	0.613	0.249	0.277	0.065	0.213
0.326	0.354	0.144	0.210				
0.650	0.699	0.452	0.647	0.211	0.242	0.020	0.223
0.289	0.319	0.100	0.220				
0.700	0.748	0.510	0.682	0.174	0.208	-0.026	0.234
0.252	0.286	0.055	0.231				
0.750	0.795	0.571	0.719	0.137	0.174	-0.072	0.247
0.215	0.252	0.009	0.243				
0.800	0.840	0.638	0.759	0.099	0.141	-0.121	0.262
0.178	0.219	-0.039	0.258				
0.850	0.885	0.711	0.804	0.060	0.107	-0.173	0.280

0.140	0.186	-0.090	0.276				
0.900	0.927	0.792	0.854	0.019	0.073	-0.230	0.303
0.099	0.152	-0.147	0.299				
0.950	0.967	0.883	0.914	-0.025	0.037	-0.299	0.336
0.056	0.117	-0.214	0.332				
1.000	1.000	1.000	1.000	-0.081	0.000	-0.407	0.407
0.000	0.080	-0.321	0.401				

Details for minimum possible overall SR without AI

0.846	0.881	0.705	0.800	0.063	0.110	-0.168	0.278
0.143	0.188	-0.086	0.274				

Details for requested overall selection ratios

0.075	0.088	0.023	0.261	0.875	0.883	0.746	0.137
0.944	0.952	0.817	0.135				
0.250	0.284	0.113	0.396	0.566	0.581	0.420	0.161
0.639	0.653	0.495	0.159				
0.320	0.360	0.159	0.440	0.489	0.506	0.336	0.170
0.563	0.579	0.412	0.168				

8. Description of Output

The output is largely self-explanatory. Suffice it to restate that the average qualities labeled as SM, SMA, SMI and the difference SDIF refer to the solution values that correspond to the earlier discussed metric of global standardization; whereas the quantities M, MA, MI and DIF represent the average scores and the difference as obtained for the standardization with respect to the majority applicant group.

9. Dependencies and Acknowledgment

The present program is written in Fortran77. It was compiled to an executable code for WIN32 PCs (ie, Windows 95/98/ME or NT/2000) with the GNU Fortran G77 compiler (cf. <http://www.geocities.com/Athens/Olympus/5564/>). The program uses routines from the SLATEC program library (cf. Fong et al., 1993; <http://www.geocities.com/Athens/Olympus/5564/>) and a couple of algorithms from StatLib (<http://lib.stat.cmu.edu/apstat/>).

When the user reports results obtained by the present program, due reference should be made to De Corte (2003), and De Corte & Lievens (2003).

11. References

De Corte, W. (2003). Caiqs User's Guide. <http://allserv.rug.ac.be/~wdecorte/software.html>

- De Corte, W., & Lievens, F. (2003). A practical procedure to estimate the quality and the adverse impact of single-stage selection decisions. *International Journal of Selection and Assessment*, 11, 89–97.
- Bartram, D. (1995). Predicting adverse impact in selection testing. *International Journal of Selection and Assessment*, 3, 52–61.
- Fong, K. W., Jefferson, T. H., Suyehiro, & Walton, L. (1993). Guide to the SLATEC common mathematical library (<http://www.netlib.org/slatec/>).
- Roth, P. L., Bobko, P., Switzer, F. S. III, & Dean, M. A. (2001). Prior selection causes biased estimates of standardized ethnic group differences: simulation and analysis. *Personnel Psychology*, 54, 591–617.