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SOCIO-ECONOMIC INDEXES IN SURVEYS FOR COMPARISONS BETWEEN COUNTRIES

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ABSTRACT. The study of socio-economic inequalities from a cross-national perspective has been hampered by the lack of adequate common indices of socio-economic status that can be used in a self-report survey instrument. This paper examines the construction and the properties of global social indexes in general, and of the Family Affluence Scale (henceforth FAS) in particular. The paper proposes a new strategy for making comparisons of the global index with stratified data, building a revised FAS based on Adapted Canonical Variate Analysis (henceforth ACVA). This alternative strategy for constructing a global index is available in standard software, and the new proposal for stratified data only requires a simple program, which is justified, explained and provided in the text. Data come from the 1998 Health Behaviour in School-Aged Children (HBSC), a WHO Cross-National Study using cluster sampling of schoolchildren from five countries: Denmark, Latvia, Portugal, Scotland and the USA. The results reveal that in every country we would have had a completely different evaluation of the three indicators of Family Affluence if we had used either linear or non linear approaches to compute the global indexes. Moreover, Family Affluence comparisons among countries shows that the relative contribution of the three indicators to the overall FAS, changes from country to country. We conclude that separate indicators of Family Affluence are not equally relevant in each country and, as a consequence, do not contribute equally to the global index. For cross-cultural studies, the strategy for constructing an index should be country specific. The methodological developments presented in the paper open up opportunities to study socio-economic patterning of health among young people in the developed world, since self completed surveys can now employ a common measure of family material wealth. The findings show that the RFAS (Revised FAS) is a useful index of socio-economic status for use in national and cross-national surveys of adolescent health and health behaviour. The new strategy for weighting observed indicators in the index gives it enhanced power to detect inequalities.

KEY WORDS: canonical variate analysis, health-behaviour, optimal scaling, socio-economic indexes, social inequalities, summated rating scale



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INTRODUCTION

Social science researchers generally use multiple indicators to measure an underlying assumed quantitative construct, such as socio-economic status or family affluence. The responses to those indicators are subsequently combined to properly define a composite construct by combining observable variables in a global index (See the overview and evaluation of composite indices of development by Booysen, 2002). This increases measurement reliability by averaging out the random errors of measurement in the single indicators, improves precision and discrimination as the composite index global range is larger, and achieves parsimony when making comparisons between different groups. The methods used to combine these indicators differ greatly, and their effects on the resultant composite index are not always understood by their users (Fowlell, 1995).

Methods of combination vary from simple addition (Spector, 1992) to measures based on exploratory (Shen and Lai, 1998; Batista-Foguet et al., 2000) or confirmatory (Little et al., 2002) multivariate statistical techniques. When the aim of the research concerns comparisons between groups, or over time, there are changes involved in the composite index, since these comparisons depend on the relationship between the variables on which the index is based. As this relationship usually varies between groups – different countries or population subgroups –, or from one point in time to another, it is necessary to use appropriate weighting procedures for these different groups before the global index is computed.

Specifically, as studies into the determinants of adolescent health develop, greater interest is put on their cultural and socio-economic determinants. Since wide international variations exist in the distribution of the determinants of health during adolescence, there is a growing interest in understanding their causes (Currie and Klocke, 1998; Currie et al., 2000; Currie et al., 1997, Currie, 2001). To facilitate this investigation, the World Health Organisation sponsored a wide international study (the Health Behaviour in School-Aged Children, HBSC), which nowadays includes more than 140 researchers from 36 countries. A common questionnaire was used in repeated cross-sectional surveys (1986, 1990, 1994,

1998, 2002) of adolescent health and its determinants, based on self reporting by representative samples of schoolchildren. Further, to allow for the control of socio-economic status in such cross national comparisons (Currie, 2001) an instrument to measure family wealth, the FAS (see Currie et al., 1997), was included in the questionnaire. This scale is based in objective indicators reportable by adolescents themselves, to avoid errors due to perceptions or opinions on the relative wealth of the family. These include three objective components: family car ownership, bedroom sharing and travel on holidays. Over the last years, it has been used in this study and been a fundamental part of many of its publications.

Various formulations of the FAS scale have been used so far in analyses of HBSC data to explore health inequalities among adolescents across countries (Currie and Klocke, 1998; Currie, 2001; Williams et al., 1997). The global FAS index has been computed by simply adding the responses to the items, a strategy known as Summated Rating Scale (SRS) and widely used (Jolly et al., 1993, Carstairs, 1995; Roos et al., 1998; Morrison et al., 1999; Currie, 2001; Batista-Foguet et al., 2000). Subsequently, this additive global index is used to make comparisons among different groups or strata. While yielding evidence of gradients in health outcome measures and in risk or health promoting behaviours, the FAS scale has not been subject to methodological scrutiny in terms of its scaling properties.

In this paper we examine this global index based on the addition of ordinal indicators and its subsequent use for comparisons between populations. We will show that methodology available in standard packages and based on non-linear statistical techniques can generally be used to improve the value of any global index based on ordinal or nominal indicators. We propose a simple strategy for making proper comparisons between-groups of this global social index, which involves only a simple computation to be made prior to the application of standard procedures. Specifically, a method is proposed to improve the value of any global index to be used as a cross-national indicator; we will apply it to the FAS scale to provide a revised and improved FAS which can become a better standard for the estimation of family affluence in such studies.

METHODS

Data and Measurement Instrument

Data are from the 1997–98 round of the HBSC. In this study, over 200 variables were measured on school children from 28 countries. For this study, $g = 5$, countries (Denmark, Latvia, Portugal, Scotland and USA) were selected. The distribution of the schoolchildren involved were as follows: $N_{\text{Denmark}} = 4957$ (104 missing), $N_{\text{Latvia}} = 3698$ (71 missing), $N_{\text{Portugal}} = 3678$ (41 missing), $N_{\text{Scotland}} = 5581$ (321 missing) and $N_{\text{USA}} = 5169$ (182 missing).

Adolescents describe their family affluence on the basis of $p = 3$ variables which constitute the three objective indicators of the Family Affluence Scale (FAS).

- Does your family have a car or van? (no car,1/one car,2/two or more cars,3): *Familycar*
- Do you have your own bedroom? (no,1/yes, 2, own bedroom): *Ownbedroom*
- During the past year, did you go away on holiday (vacation) with your family? (No,1/Once,2/Twice,3/More than twice,4): *Holidays*

So each schoolchild has 3 co-ordinates response pattern (from a total of $k = \sum k_j = 3 + 2 + 4 = 9$ response categories) corresponding to their particular combination of the $p = 3$ indicators.

Constructing a Global Index for FAS

The FAS is constructed by adding up these 3 values for each individual. The resulting SRS is subsequently re-coded to set the scale ranges from 1 to 7. Notice that actually FAS is an example of global indexes built on the assumptions that (1) each indicator, Y_j , has metric properties, even though it was expressed on an ordinal scale and (2) that the three indicators are equally reliable in every country, so they are simply added.

This common strategy of assigning discrete numerical values to consecutive ordinal responses has been criticised by other authors (Booyesen, 2002; Shen and Lai, 1998; Batista-Foguet et al., 1990) in this journal. The arbitrary quantification in the scale leads to order categories describing only relative levels, with the distances among

TABLE I
Indicator matrix for stratified data into g populations

Group-Strata	G_1	...	G_j	...	G_p	
group 1	1	0	0 1 0 ...	$G_{1.}$
...	n_1		...			
...			
group α	1					$G_{\alpha.}$
...	n_{α}					
...			
group g	1	0 0 1 ...				$G_{g.}$
...	n_g		
		$G_{.1}$		$G_{.j}$		$G_{.p}$

them not necessarily being equal. As a consequence, neither SRS nor Factor Analysis (Boelhouwer and Stoop, 1998) should be used directly. It should be noted that Boelhouwer, J. (2002) subsequently use a more appropriate approach – Nonlinear Correlation Analysis (OVERALS in SPSS package).

Let us assume that our data consist of g groups for each of which we are given p (observable) variables, measured in a nominal/ordinal categorical scale. Let k_j be the number of categories or states of variable j ($1 \leq j \leq p$), and let $k = \sum k_j$, be the sum of the k_j , for $1 \leq j \leq p$.

Let n_{α} be the number of cases or individuals in group α , ($1 \leq \alpha \leq g$), so that the total number of cases is: $n = \sum n_{\alpha}$, for $1 \leq \alpha \leq g$.

The data matrix can be coded as an $n \times k$ indicator matrix G. In Table I, G can be thought of as being subdivided in $g \times p = m$ sub-matrices, where the sub-matrix $G_{\alpha,j}$, of order $n_{\alpha} \times k_j$ matrix corresponds to the indicators of the categories of variable j for cases in group α .

This table may be analysed by considering two perspectives, the within group or the between group structure. The former, would be based on the $n_\alpha \times k$ matrix of G_α indicators (rows-subdivision per country), obtained concatenating the p sub-matrices $G_{\alpha,j}$ ($1 < j < p$). This within group analysis would aim to achieve proper quantifications for the k categories of the p indicator-variables, and n_α factor scores (Giffi, 1990) for the elements of each group α ($1 \leq \alpha \leq g$). Appropriate techniques are available in standard packages for obtaining the “within factor structure”, such as Homogeneity Analysis (HOMALS in the SPSS package) or, in the case of ordinal data, Categorical Principal Component Analysis (CATPCA in the SPSS package). However, researchers (Currie et al., 1997; Williams et al., 1997; Samdal, 1998; Currie and Klocke, 1998; Currie, 2001) persist in using SRS uniquely to obtain those factor scores.

The latter perspective, the between group analysis, coincides with the main aim of this paper, that is to make a comparison among groups. This involves considering the rows of the G matrix partitioned in sub-matrices corresponding to these groups. The average of the columns in each country would represent the proportion of individuals in the categories of the variables in that country, i.e., the marginals (entries of the diagonal matrices in the Burt table).

We now have a new $g \times k$ matrix M , whose entries in row α , ($1 \leq \alpha \leq g$) are the averages of the G_α columns defined in Table I. Each row α of M is thus computed as:

$$M_\alpha = (1'_{(n_\alpha)} * G_\alpha) / n_\alpha, = G_\alpha / n_\alpha, \quad (1)$$

where $1_{(n_\alpha)}$ is the $n_\alpha \times 1$ (unity vector). In other words, M is the matrix of percentages (or proportions, to be more exact) in each group of the variable categories.

This M matrix is similar to G , since it can be subdivided into p sub-matrices M_j (columns-subdivision per indicator like G_j), of order $g \times k_j$. M can be described as a fuzzy indicator matrix of groups by categories of the variables: its entries are not zeros or ones, but amounts (proportions) between 0 and 1, and their sum in each row of each M_j indicator sub-matrix still equals one.

In these circumstances, we propose performing a non-metric interdependence analysis (HOMALS or CATPCA in SPSS package)

on this generalised indicator matrix in order to describe the between-groups structure of the data and to obtain the scores for each group. Given the huge sample size and its randomness in each country, we did not consider weighting the countries (although in other applications it would be advisable to do so).

This procedure can be considered as a sort of Canonical Variate Analysis,¹ in which each group is represented by the vector of proportions of the categories of the ordinal variables, rather than by the group means of quantitative variables. We will refer to this in future as Adapted Canonical Variate Analysis (ACVA). Notes 1 and 2 show how this procedure is justified and the simplicity of its implementation with a standard package.

RESULTS

Within-group Analysis Results

Let us assume that we summarise how well the FAS score captures the information of the $p = 3$ original indicators in each country, that is in each G_α matrix, by calculating the correlation of the three variables with the global FAS scores. The average of the squared correlation of these three variables with FAS (last column in Table IIa) is interpreted as the percentage of variance of each indicator explained by FAS. If the average squared correlation was 1, for example, then all 3 quantified variables would be perfectly correlated and could be replaced without loss of information by the single FAS score.

What we see from these findings is that *Holidays*, which actually has the widest range, seems to be the most relevant indicator in the construction of the FAS for every country, while *Ownbedroom*, which actually has the narrowest range, is the least important, since these show the highest and the lowest correlations with the underlying factor.

This situation is similar to the one we have in Principal Component Analysis when there is an underlying global factor (size factor). Correlations among variables are then usually all positive and similar in magnitude, and the variable with the highest dispersion is also the variable which contributes the most to the

TABLE II

(a) Squared correlations of each indicator with the global FAS scores derived from the simple SRS quantification, (b) percentage of variance accounted for by each indicator using CATPCA, and (c) comparison of the global indicator reliability from SRS and CATPCA

	Familycar	Ownbedroom	Holidays	
(a) SRS strategy: Squared correlations				Average
Denmark	0.339	0.072	0.726	0.379
Latvia	0.372	0.161	0.712	0.415
Portugal	0.352	0.162	0.709	0.407
Scotland	0.410	0.187	0.640	0.412
USA	0.345	0.084	0.723	0.384
(b) CATPCA strategy: Squared factor loadings				Average
Denmark	0.470	0.351	0.391	0.400
Latvia	0.564	0.223	0.500	0.426
Portugal	0.518	0.248	0.504	0.422
Scotland	0.548	0.372	0.348	0.423
USA	0.474	0.373	0.381	0.409
(c) Ratio of squared factor loadings				Difference of averages
Denmark	1.39	4.88	0.54	0.021
Latvia	1.52	1.39	0.70	0.011
Portugal	1.48	1.53	0.71	0.015
Scotland	1.34	1.99	0.54	0.011
USA	1.37	4.44	0.53	0.025

factor construction (definition), that is, the variable which shows the highest correlation (loading) with the underlying factor.

However, results in Table IIIb reveal that we could have had a completely different evaluation of these indicators if we had used CATPCA instead of SRS. Notice, that the mentioned percentage of variance of each indicator explained by FAS, in the last column of Table IIb, actually is the first principal inertia – Highest Eigenvalue, obtained with Multiple Correspondence Analysis (see Greenacre, 1993).

Table IIc illustrates these differences by giving ratios between square factor loadings (obtained by optimal scaling, using CATPCA), and those obtained with the original arbitrary quantification, using the usual SRS methodology. In Table IIc we can see that these differences are especially significant for *Ownbedroom*, where the indicator reliability can be double or even five times larger than it was with SRS, or for *Holidays* where reliability is only half of what was shown with SRS.

The difference between the averages of the squared loadings in Table IIc (which indicates that there is only slight global improvement per country when the results of CATPCA are compared with those of SRS) is rather misleading. Actually when we have summarised the level of agreement between both strategies by correlating the scores obtained within each country from the SRS and the optimal scores from CATPCA, these correlations ranged from 0.725 for USA to 0.919 for Latvia. Such diversity tells us that SRS scores may be far removed from CATPCA ones but also that SRS's performance is very patchy, depending on the country to which the technique is applied.

We interpret these differences as meaning that the indicators' contribution to the global score varied considerably from country to country. When an intrinsic procedure such as optimal scaling is used (CATPCA), data show that each indicator of Family Affluence is not equally relevant in different countries and, as a consequence, it does not contribute equally to the global index as it would be assumed by the SRS.

So far, we have shown how the usual SRS methodology for obtaining the FAS scores in each country can lead to mistaken results, and that this problem can be easily overcome simply by using HOMALS or CATPCA instead. The following section will discuss the strategy for making comparisons among countries.

Between-groups Analysis Results

The Optimal Scaling module in SPSS does not allow the user to input a matrix of indicators, thus we cannot adapt it directly for our purposes. Instead, we first compute the fuzzy indicator matrix M (Table III), that with percentages. Then, following the procedure explained in Note 2 below, in order to get the Family Affluence

TABLE III

Generalised indicator matrix, M , which includes the marginal of the categories (computed as in equation 1) of each three family affluence indicators by country, i.e., the percentages of each indicator's category of FAS

Country	Famcar0	Famcar1	Famcar2	Ownbed0	Ownbed1	Holid0	Holid1	Holid2	Holid3
Denmark	12.90	61.20	25.90	5.50	94.50	17.00	35.50	25.90	21.60
Latvia	38.40	47.10	14.50	41.10	58.90	32.10	26.40	14.90	26.60
Portugal	8.40	44.70	46.90	31.90	68.10	20.20	30.70	20.90	28.10
Scotland	14.10	46.90	39.00	26.70	73.30	15.20	34.00	26.70	24.10
USA	13.40	61.10	25.50	6.20	93.80	17.20	35.50	25.90	21.40

TABLE IV

Comparison of SRS and ACVA strategies to estimate the affluence mean by country (stratum)

	SRS		ACVA
	Mean	S.D.	Mean
Denmark	4.59	1.27	0.5273
Latvia	3.70	1.62	-0.5888
Portugal	4.54	1.49	-0.2750
Scotland	4.58	1.44	-0.1804
USA	4.57	1.29	0.5168

mean scores per each country, we apply a simple macro file we have developed for MATLAB/Octave, Splus/R.

Table IV shows means and standard deviations for Family Affluence measurements in each country using SRS, and our proposed ACVA procedure to obtain a solution with ordinal data. The two results cannot be directly compared since SRS scores range from 1 to 7, while our proposed ACVA procedure leads to a standardised solution (standard deviation equal to one) and provides a relative comparison between the five countries. The Family Affluence mean for Portugal or Scotland seems to be as high as the mean of USA or Denmark when SRS is used, while Portugal's or Scotland's Family Affluence is actually below the mean when the comparison is made with the proposed ACVA procedure. Figure 1 illustrates clearly these differences between the two strategies. Departures from the straight line reveal how misleading equal weighting from SRS can be with respect to the proposed ACVA in making comparisons between countries.

DISCUSSION

This paper has a twofold aim, methodological and substantive. Regarding the methodological aim, this paper provides an improved method to research in cross-national comparisons of health behaviour surveys of adolescent health using family affluence indicators.

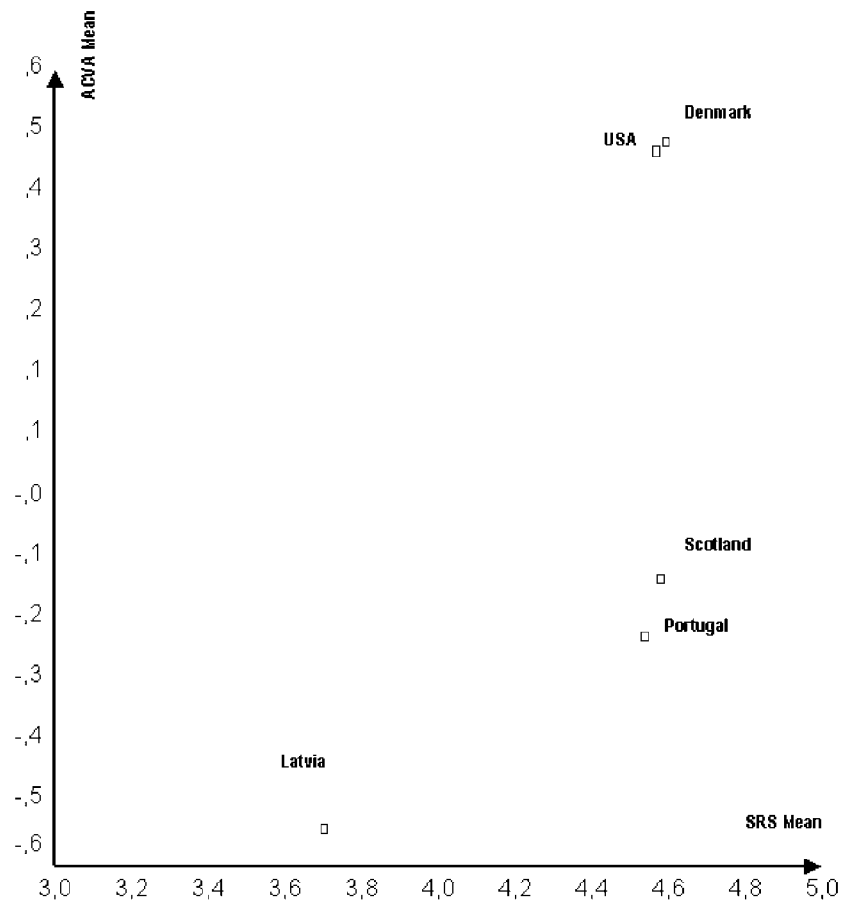


Figure 1. Comparison of the SRS-FAS mean scores and ACVA-FAS mean score by country.

In such studies, rather than generalising a procedure such as SRS, the strategy for constructing an index should be country specific. Indeed, we have seen that the reliability of each indicator depends heavily on the country. As a consequence, indicators should be evaluated and weighted accordingly, letting the data speak for themselves. This means that items should not be weighted equally across countries “in each country the data speak in their own language”. See Table IIb for the relative importance of each indicator in each country.

These considerations for within group analysis are also valid when the aim is to make a comparison over strata. Since HOMALS

and CATPCA versions implemented in the SPSS package do not allow us to enter data in the form of a generalised indicator matrix as our paper proposes, we have presented a simple adaptation of Canonical Variate Analysis for handling between-groups comparisons with categorical or ordinal data.

Regarding the FAS in particular, the paper has shown the weaknesses in use of the traditional SRS procedure: 1st the three variables are not equally associated with the underlying construct as imposed by the SRS construction. As a consequence, the quality of each indicator should not be considered equivalent, and 2nd the suggested ACVA procedure has clearly shown that comparisons among countries made with the SRS were incorrect. We have proposed a simple approach for performing within-groups and between-groups Homogeneity Analysis for stratified data.

As far as the substantive aim is concerned, the revised FAS may improve cross-national comparisons of relationships between family material wealth and adolescent health behaviours and health outcomes. However, its original conceptualisation from a methodological point of view was somewhat simplistic. This paper has demonstrated that, through various straightforward statistical manipulations, the accuracy of representation of the material wealth experiences of children differs in different countries and therefore the value of the FAS can be improved.

With the ACVA procedure, we found that the relative contribution of the three indicators (car ownership, bedroom sharing and family holidays) to the overall FAS, changes from country to country in a logical fashion. The comparison of SRS and CATPCA results shows that the number of cars that a family has makes the largest contribution to FAS and also that there is least inter-country variation in the extent of its contribution, compared to the other two indicators. This finding suggests that in all countries the financial resources needed to buy a car place a similar burden on the family income. In contrast, there may be variation between countries for the other two indicators in terms of their relationship to material resources of the family. For example, whether a child has his/her own bedroom may depend on available housing in countries and be less strongly linked to its actual cost (and therefore its affordability to a family). This may explain why *Ownbedroom* variable

makes a smaller contribution to the overall FAS. Family holidays may be determined not only by the financial resources of the family but also by the amount of time the parents have available to take holidays. This may vary from country to country, according to the extension of vacations or the number of public holidays. Therefore, FAS indicators may partly reflect other structural differences among countries, besides family affluence (compare for instance the number of official holidays in Europe and the USA). Similarly the role of *Ownbedroom* as an affluence indicator in Western countries is not the same as in the former socialist countries like Latvia, where crowding is common (compare the availability of land for housing or urban development in a large young country as the USA with most European countries). FAS indicators are not equally understood, and thus are not equally applicable to every country. We could say that data speak their own language in each country.

The methodological developments presented in the paper open up opportunities to study socioeconomic patterning of health among young people in the developed world, since self completed surveys can now employ a common measure of family material wealth. Despite the above mentioned considerations about structural differences, the FAS avoids the complications of different national systems for classifying parental occupation or parental educational achievement which hinder the development of a common coding system in adolescent surveys. Furthermore, response rates on FAS are higher than for questions on parental occupation, since they are less sensitive and personal.

The current HBSC survey 2002, in which 37 countries are participating, includes four items for the calculation of the revised FAS. We hope that the application of the procedures devised in this paper will lead to improved interpretation and a better understanding of cross-national patterns of health inequalities among adolescents.

Meanwhile further refinement of the methodology will continue, as several concerns remain, leading us to develop additional theory on these aspects. First, we have observed that results from SRS and ACVA coincide for cases with extreme ACVA scores (this being the case for Latvia, USA and Denmark). However, results are clearly different for other cases where ACVA scores are closer to the mean (as in Portugal or Scotland's case). This aspect requires

further study. Second, the within-group analyses are unrelated to one other and to the between-groups structure. This can clearly be improved (Flury, 1988). Likewise, the between-groups structure does not take any information from the within-groups structure. In this respect ACVA is analogous to the classical Canonical Variate Analysis for quantitative variables. Finally, Structural Equation Models for ordinal variables could also be used with our data, based on polychoric correlations and multiple comparisons between groups (Bechger et al., 1999; Batista-Foguet et al., 2001, see also the discussion in Little et al., 2002). We intend to pursue work in these directions.

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NOTES

¹ **CVA or canonical discriminant analysis** can be briefly described as a “Principal Component Analysis for groups”, where several groups or populations are represented along principal axes as geometrical points in such a way that their Euclidean interdistances correspond to Mahalanobis distances between the original groups (See Krzanowski and Marriott, 1994).

² **Implementing ACVA in a standard package.** As it was mentioned in Note 1 ACVA can be described as a between-groups HOMALS or CATPCA, hence it would seem that we could rely on standard implementations of these modules such as those in the CATEGORIES package of SPSS 10.0 for Windows. It turns out, however, that this version does not allow us to enter the indicator matrix, which, in our case, should be replaced with the fuzzy indicator matrix **M** described above.

This is not a great inconvenience since any mathematical or statistical environment with a capability for matrix operations can be used for the actual computation. More precisely, ACVA involves performing a Singular Value Decomposition (SVD) of $\mathbf{M}\Lambda^{-1/2}$, where $\Lambda = \mathbf{Diag}(\mathbf{M}'\mathbf{M})$ is a block-diagonal matrix, where

block j of order $k_j * k_j$ ($1 \leq j \leq p$), is a matrix of cross products $M_j' * M_j$, where M_j is the block j of M , including the k_j columns corresponding to variable j .

Notice, that in HOMALS, these cross products matrices are diagonal. However, if M includes proportions instead of zeros and ones, $M_j' * M_j$ is not diagonal anymore. Macro files for MATLAB/Octave is adjoined bellow:

```
% Input variables:
% p = Number of (categorical) variables
% g = Number of groups
% K = a [1,p] vector. K(j) = number of categories in variable j
%   k=sum(K) is the total number of categories.
% M = a [g,k] fuzzy indicator matrix.
function [x,y]=ACVA2(M,K)
% In a future version there should be some parameter checking
p=length(K);
k=sum(K);
[g,k1]=size(M);
% We build the list of p cross-product matrices, one for each
variable.
% III and JJJ are auxiliary vectors, containing the first and
last indexes
% in each variable.
% Lambda is the block-diagonal matrix containing the inverse
square roots
% of these cross-product matrices.
% A=M*Lambda
III=zeros(1,p);
JJJ=zeros(1,p);
s=0;
for j=1:p,
    s=s+1;
    III(j)=s;
    s=s+K(j)-1;
    JJJ(j)=s;
end
A=zeros(g,k);
Lambda=zeros(k,k);
for j=1:p,
    Q=M(:,(III(j):JJJ(j)));
    R=pinv(sqrtm(Q'*Q));
    A(:,(III(j):JJJ(j)))=Q*R;
    Lambda((III(j):JJJ(j)),(III(j):JJJ(j)))=R;
end
[x,s,v]=svd(A,0);
y=Lambda*v;
```

REFERENCES

- Batista-Foguet, J.M., G. Coenders and A. Artés: 2001, 'Using structural equation models to evaluate the magnitude of measurement error in blood pressure', *Statistics in Medicine* V20(15), pp. 2351–2368.
- Batista-Foguet, J.M., R. Mendoza, M. Pérez and R. Rius: 2000, 'Life-styles of Spanish school-aged children: Their evolution over time. Use of Multiple Correspondence Analysis to determine overall trends over time in a sequential, cross-sectional', in A. Ferligoj (ed.) *Advances in Methodology, Data Analysis and Statistics, Metodološki zvezki* (Ljubljana), pp. 173–210.
- Batista-Foguet, J.M., W.E. Saris and X. Tort-Martorell: 1990, 'Design of experimental studies for measurement and evaluation of the determinants of job-satisfaction', *Social Indicators Research* 22, pp. 49–67.
- Bechger, T.M., G. van den Wittenboer, J.J. Hox and C. de Glopper: 1999, 'The validity of comparative educational studies', *Educational Measurement: Issues and Practice* 18, pp. 18–26.
- Boelhouwer, J. and I. Stoop: 1998, 'Measuring well-being in the Netherlands. The SCP index from 1974 to 1997', *Social Indicators Research* 48, pp. 51–75.
- Boelhouwer, J.: 2002, 'Quality of live and living conditions in the Netherlands', *Social Indicators Research* 58, pp. 115–140.
- Booyens, F.: 2002, 'An overview and evaluation of composite indices of development', *Social Indicators Research* 59(2), pp. 115–151.
- Carstairs, V.: 1995, 'Deprivation indices: their interpretation and use in relation to health', *Journal of Epidemiology and Community Health* 49(suppl 2), pp. S3–8.
- Currie, C.: 2001, 'Socio-economic circumstances among school-aged children in Europe and North America', in K. Vleminckx and T.M. Smeeding (eds.), *Child Well Being, Child Poverty and Child Policy in Modern Nations: What Do We Know?* Bristol (The Policy Press), pp. 347–364.
- Currie, C., R.A. Elton, J. Todd and S. Platt: 1997, 'Indicators of socio-economic status for adolescents: the WHO health behaviour in school-aged children survey', *Health Education Research* 12(3), pp. 385–397.
- Currie, C., K. Hurrelmann, W. Settertobulte, R. Smith and J. Todd (eds.): 2000, 'Health and health behaviour among young people: Health behaviour in school-aged children: A WHO Cross-National Study (HBSC) international report'. WHO Policy Series Health policy for children and adolescents Issue 1, WHO Copenhagen; available from <http://www.HBSC.org>, p. 132.
- Currie, C. and A. Klocke: 1998, 'Rationale for social inequalities', in C. Currie et al. (eds.), 'Health behaviour in school-aged children: A WHO Cross-National Survey (HBSC): Research protocol for the 1997/98 survey. Edinburgh: Research unit in health and behavioural change, University of Edinburgh; available from <http://www.HBSC.org>, pp. 64–72.
- Flury, B.: 1988, *Common Principal Components and Related Multivariate Methods*. New York: J. Wiley & Sons.
- Fowlell, K.: 1995, 'Single measures of deprivation', *Journal of Epidemiology and Community Health* 49(Suppl 2), pp. 51–56.

- Gifi, A.: 1990, *Nonlinear Multivariate Analysis*. New York: J. Wiley & Sons.
- Greenacre, M.J.: 1993, *Correspondence Analysis in Practice* (Academic Press).
- Jolly, D.L., J.N. Moller and R.E. Volkmer: 1993, 'The socio-economic context of child injury in Australia', *Journal of Paediatric Child Health* 29, pp. 438–444.
- Krzanowski, W.J. and F.H.C. Marriott: 1994, *Multivariate Analysis, Part I. Distributions, Ordination and Inference* (Edward Arnold, London).
- Little, T.D., W.A. Cunningham and G. Shahar: 2002, 'To parcel or not to parcel: Exploring the question, weighing the merits', *Structural Equation Modeling* 9(2), pp. 151–173.
- Morrison, M.A., G. Todd, G. Morrison, A. Pope and B.D. Zumbo: 1999, 'An investigation of measures of modern and old-fashioned sexism', *Social Indicators Research* 48, pp. 39–50.
- Roos, E., E. Lahelma, M. Virtanen, R. Prattala and P. Pietinen: 1998, 'Gender, socio-economic status and family status as determinants of food behaviour', *Social Science and Medicine* 46(12), pp. 1519–1529.
- Samdal, O. (1998). *The School Environment as a Risk or Resource for Students' Health-Related Behaviours and Subjective Well-being*. PhD. Dissertation, RCHP, University of Bergen.
- Shen, S.M. and Y.L. Lai: 1998, 'Optimally scaled quality-of-life indicators', *Social Indicators Research*, pp. 225–254.
- Spector, P.E.: 1992, 'Summated rating scale construction', *Quantitative applications to Social Sciences* (Sage Pub), p. 70.
- Williams, J., C. Currie, P. Wright, R. Elton and T. Beattie: 1997, 'Socio-economic status and adolescent injuries', *Social Science and Medicine* 44, pp. 1881–1891.

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