

## Multiple group analysis with SIMPLIS

An interesting example of multi-sample analyses is given by Mare & Mason (1981) in a study of the reliabilities of son's and parents' reports on father's and mother's education and occupation. They report the covariance matrices given in Table 1 below for six variables and three populations. The sample size is 80 for each group.

**Table 1: Covariance matrices for SAT Verbal and Math sections**

Covariance matrix for

Sixth grade						
Tests	'Sons father educ'	'Sons mother educ'	'Son Father Occup'	'Father Own Educ'	'Mother Own Educ'	'Father Own Occup'
'Sons father educ'	5.86					
'Sons mother educ'	3.12	3.32				
'Son Father Occup'	35.28	23.85	622.09			
'Father Own Educ'	4.02	2.14	29.42	5.33		
'Mother Own Educ'	2.99	2.55	19.20	3.17	4.64	
'Father Own Occup'	35.30	26.91	465.62	31.22	23.38	546.01

Ninth grade						
Tests	'Sons father educ'	'Sons mother educ'	'Son Father Occup'	'Father Own Educ'	'Mother Own Educ'	'Father Own Occup'
'Sons father educ'	8.20					
'Sons mother educ'	3.47	4.36				
'Son Father Occup'	45.65	22.58	611.63			
'Father Own Educ'	6.39	3.16	44.62	7.32		
'Mother Own Educ'	3.22	3.77	23.47	3.33	4.02	
'Father Own Occup'	45.58	22.01	548.00	40.99	21.43	585.14

Twelfth grade						
Tests	'Sons father educ'	'Sons mother educ'	'Son Father Occup'	'Father Own Educ'	'Mother Own Educ'	'Father Own Occup'
'Sons father educ'	5.74					
'Sons mother educ'	1.35	2.49				
'Son Father Occup'	39.24	12.73	535.30			
'Father Own Educ'	4.94	1.65	37.36	5.39		
'Mother Own Educ'	1.67	2.32	15.71	1.85	3.06	
'Father Own Occup'	40.11	12.94	496.86	38.09	14.91	538.76

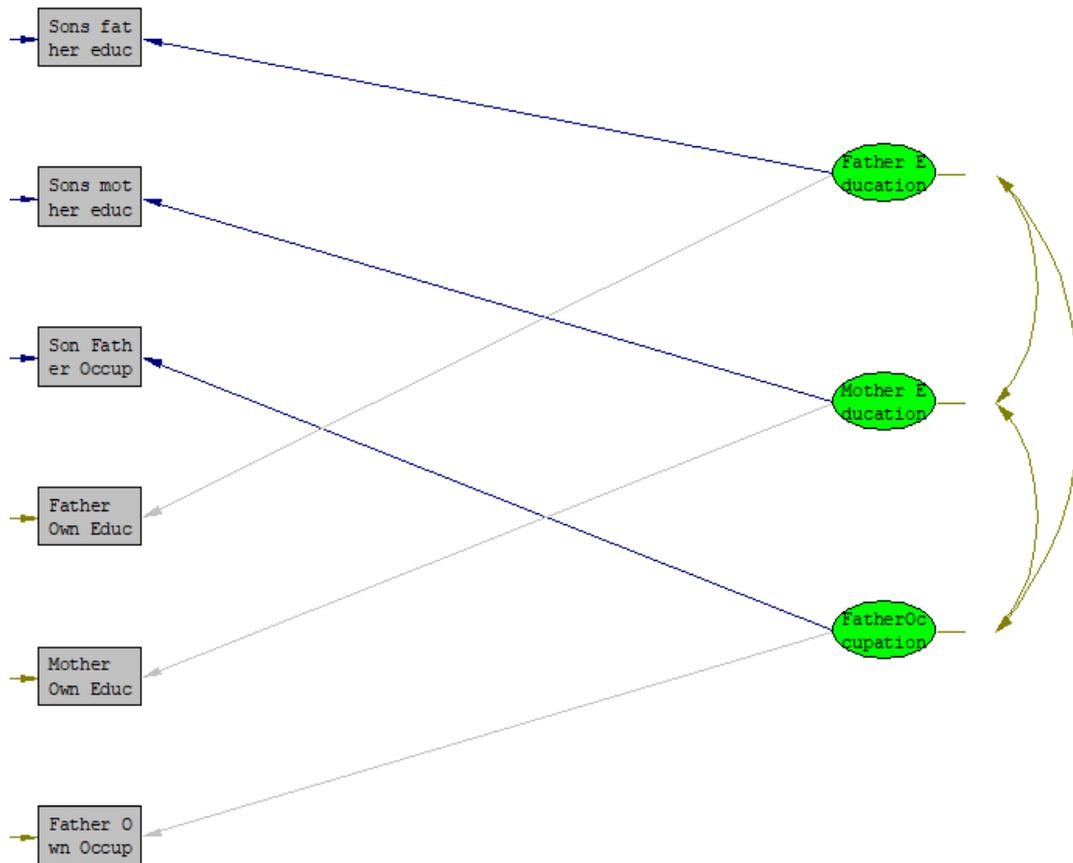
The variables are:

- 'Sons father educ' = Son's report of father's education,
- 'Sons mother educ' = Son's report of mother's education,
- 'Son Father Occup' = Son's report of father's occupation,
- 'Father Own Educ' = Father's report of his own education,
- 'Mother Own Educ' = Mother's report of her own education, and
- 'Father Own Occup' = Father's report of his own occupation.

The three populations are:

- Group 1: Sixth graders
- Group 2: Ninth graders
- Group 3: twelfth graders

The model is shown in the figure below, where the latent variables 'Father Education', 'Mother Education' and FatherOccupation represent the true father's education, mother's education, and father's occupation, respectively. The use of single quotes with these variable names is necessary as the names have blank spaces in them.



It seems reasonable to assume that the covariance matrix of the latent variables 'Father Education', 'Mother Education' and FatherOccupation are the same in all groups and that the error variances of variables 'Father Education', 'Mother Education' and FatherOccupation should be the same in all groups but that the error variances of 'Sons father educ', 'Sons mother educ' and 'Son Father Occup' should vary over groups. Such a model may be specified as follows (**EX11A\_16.SPL**):

Group 1: Reports of Parental Socioeconomic Characteristics - Grade 6

Observed Variables: 'Sons father educ' 'Sons mother educ' 'Son Father Occup' 'Father Own Educ' 'Mother Own Educ' 'Father Own Occup'

Covariance Matrix

5.86 3.12 3.32 35.28 23.85 622.09 4.02 2.14 29.42 5.33

2.99 2.55 19.20 3.17 4.64 35.30 26.91 465.62 31.22 23.38 546.01

Sample Size: 80

Latent Variables: 'Father Education' 'Mother Education' FatherOccupation

'Sons father educ' = 'Father Education'

'Sons mother educ' = 'Mother Education'

'Son Father Occup' = FatherOccupation

'Father Own Educ' = 1\*'Father Education'

'Mother Own Educ' = 1\*'Mother Education'

'Father Own Occup' = 1\*FatherOccupation

Group 2: Reports of Parental Socioeconomic Characteristics - Grade 9

Covariance Matrix

8.20 3.47 4.36 45.65 22.58 611.63 6.39 3.16 44.62 7.32

3.22 3.77 23.47 3.33 4.02 45.58 22.01 548.00 40.99 21.43 585.14

'Sons father educ' = 'Father Education'

'Sons mother educ' = 'Mother Education'

'Son Father Occup' = FatherOccupation

Let the Error Variances of 'Sons father educ' - 'Son Father Occup' be free

Group 3: Reports of Parental Socioeconomic Characteristics - Grade 12

Covariance Matrix

5.74 1.35 2.49 39.24 12.73 535.30 4.94 1.65 37.36 5.39

1.67 2.32 15.71 1.85 3.06 40.11 12.94 496.86 38.09 14.91 538.76

'Sons father educ' = 'Father Education'

'Sons mother educ' = 'Mother Education'

'Son Father Occup' = FatherOccupation

Let the Error Variances of 'Sons father educ' - 'Son Father Occup' be free

Path Diagram

End of Problem

Note the following:

- Since the sample size is the same for all groups, it need only be specified for the first group.
- The units of measurements of the latent variables 'Father Education', 'Mother Education' and FatherOccupation are defined in the first group by using 'Sons father educ', 'Sons mother educ' and 'Son Father Occup' as reference variables. Since this is not repeated in the second and third group, it stays the same. This defines the units of the latent variables to be the same in all groups, which is essential. Otherwise, it would not make sense to postulate equal variances and covariances for the latent variables.
- Since nothing is specified about the variances and covariances of the latent variables, their covariance matrix will be the same in all groups.

- The inclusion of the line

Let the Error Variances of 'Sons father educ' 'Sons mother educ' 'Son Father Occup' be free for the second and third group makes the error variances 'Sons father educ', 'Sons mother educ' and 'Son Father Occup' free in all groups.

The chi-square for this model is

Degrees of Freedom for (C1)-(C2) 36  
 Maximum Likelihood Ratio Chi-Square (C1) 78.368 (P = 0.0001)

Mare & Mason (1981) considered another model in which the error terms of 'Sons mother educ' and 'Sons father educ' were allowed to correlate in the first two groups but not in the third. To specify this, add the line

Set the Error Covariance between 'Sons mother educ' and 'Sons father educ' free

in the first two groups, and add the line

Set the Error Covariance between 'Sons mother educ' and 'Sons father educ' equal to 0

in the third group. The last line is needed, otherwise the error covariance between 'Sons mother educ' and 'Sons father educ' in the third group would be estimated to be equal to that of the second group. The chi-square for this model is

Degrees of Freedom for (C1)-(C2) 34  
 Maximum Likelihood Ratio Chi-Square (C1) 52.728 (P = 0.0212)

The output file gives the reliabilities (squared multiple correlations) shown in the table below. This is a somewhat remarkable result because in grade 12, the sons' reports of their fathers' education and occupation are more reliable than the fathers' reports of their own education and occupation. In the earlier ages, however, the sons' reports are less reliable than their parents' reports, as expected.

**Table 2: Estimated reliabilities of son's and parents' reports of parental socioeconomic characteristics**

	'Sons father educ'	'Sons mother educ'	'Son Father Occup'	'Father Education'	'Mother Education'	FatherOccupation
Grade 6	0.62	0.38	0.71	0.87	0.93	0.90
Grade 9	0.76	0.86	0.92	0.87	0.93	0.90
Grade 12	0.91	0.81	0.95	0.87	0.93	0.90