Multiple groups and ordinal data

Contents

1. Introduction

This example is the fourth of a set of examples extracted from a note by K.G. Jöreskog first posted on the SSI website in 2005 with the title "*Structural Equation Modeling with Ordinal Variables using LISREL*".

In the second example in this set I explained how one can analyze ordinal variables in longitudinal studies. This section considers the situation where data on the same ordinal variables have been collected in several groups. These groups may be different nations, states or regions, culturally or socioeconomically different groups, groups of individuals selected on the basis of some known selection variables, groups receiving different treatments, etc. In fact, they may be any set of mutually exclusive groups of individuals which are clearly defined. It is assumed that the data is a random sample of individuals from each group. The objective is to compare different characteristics across groups. In particular, the procedure to be described can be used for testing factorial invariance and for estimating differences in factor means. For information and examples on how to do this with continuous variables see Chapters 9 and 10 in Jöreskog & Sörbom (1999c) and Chapter 2 in Jöreskog & Sörbom (1999b). Just as in the cases of analysis of cross-sectional data, described in Section 2, and analysis of longitudinal data, described in Section 3, the analysis of ordinal variables in multiple groups requires a PRELIS step before one can proceed to analyze models with LISREL. For further information about PRELIS, see Jöreskog & Sörbom (1999a).

In this section I continue the analysis of the efficacy variables in the Political Action Survey which was carried out in eight countries. For information about this survey and the efficacy variables, see Section 1. In examples two and three I analyzed only data from the USA. Here I will analyze the data from all eight countries. The procedure to be described here makes it possible to answer questions like these:

- Do the efficacy items measure the same latent variables in all countries?
- If so, are the factor loadings invariant over countries?
- Are the intercepts invariant over countries?

If these conditions are satisfied one can estimate differences in means, variances, and covariances of the latent variables *Efficacy* and *Respons* between countries. Recall from the second example that *Efficacy* and *Respons* are two different components of *Political Efficacy*, where *Efficacy* indicates *individuals' self-perceptions that they are capable of understanding politics and competent enough to participate in political acts such as voting*, and *Respons* (short for *Responsiveness*) indicates *the belief that the public cannot influence political outcomes because government leaders and institutions are unresponsive*. People who are low on *Efficacy* or low on *Respons* are expected to agree or agree strongly with the items. Hence, the items measure these components from low to high.
Complete factorial invariance over all eight countries should not be expected to hold for the following reasons:

- The items are stated in different languages.
- Words may have different connotations in different languages.

Other cultural differences between countries may lead to different response styles or response patterns in different countries.

These reasons may imply that the items are interpreted differently in different countries. The procedure to study factorial invariance with ordinal variables is as follows:

PRELIS Step Define a set of thresholds for each variable to be the same in each country. Since the underlying variables are only determined up to a monotonic transformation, one can simply choose these as 0, 1, 2, … for all variables. Alternatively, one can use PRELIS to estimate a set of thresholds from the total sample by pooling the data from all groups into one data file. Either way, these thresholds define a scale for the underlying variables common to all groups. Using the thresholds as *fixed thresholds*, PRELIS can estimate the mean vector, the covariance matrix, and the asymptotic covariance matrix of the underlying variables for each group.

LISREL Step These mean vectors, covariance matrices, and asymptotic covariance matrices can be used in a multigroup analysis in LISREL as if the underlying variables had been observed.

2. Data Screening

The data for all countries is in the datafile **EFFITOT.RAW** in free format. The first variable is COUNTRY coded as 1 = USA (USA), 2 = Germany (GER), 3 = The Netherlands (NET), 4 = Austria (AUS), 5 = Britain (BTN), 6 = Italy (ITY), 7 = Switzerland (SWI), and 8 = Finland (FIN). The other variables are the six efficacy variables described in the very first example. The item VOTING is included here but will be eliminated in the LISREL step. The response categories and their codings are those described in the first example, but in Italy there was an additional response category *Don't Understand* (DU) coded as 6.

A data screening of all the data can be obtained by running the following PRELIS command file (file **ORD41.PRL**):

```
!Data Screening of EFFITOT.RAW
Data Ninputvariables = 7
Labels
COUNTRY NOSAY VOTING COMPLEX NOCARE TOUCH INTEREST
Rawdata = EFFITOT.RAW
Clables COUNTRY 1=USA 2=GER 3=NET 4=AUS 5=BTN 6=ITY 7=SWI 8=FIN
Clables NOSAY - INTEREST 1=AS 2=A 3=D 4=DS 6=DU 8=DK 9=NA
Output
```

The output gives the numbers in the right and bottom margins of Tables 6 and 7. Just like in the USA sample, there are more people in the *Don't Know* than in the *No answer* categories.

Table 6: Observed Frequency Distributions

NOSAY

Response Category	USA	GER	NET	AUS	BTN	ITY	SWI	FIN	Total
Agree Strongly	175	721	171	804	211	306	347	295	3030
Agree	518	907	479	432	693	797	463	413	4702
Disagree	857	464	460	215	488	365	314	425	3588
Disagree Strongly	130	133	49	50	33	57	137	50	639
Don't Understand	-	-	-	-	-	74	-	-	74
Don't Know	29	27	40	82	42	173	26	35	454
No Answer	10	3	2	2	16	7	3	6	49
All Responses	1719	2255	1201	1585	1483	1779	1290	1224	12536

VOTING

Response Category	USA	GER	NET	AUS	BTN	ITY	SWI	FIN	Total
Agree Strongly	283	790	195	903	218	341	371	429	3530
Agree	710	861	634	431	884	902	403	512	5337
Disagree	609	448	285	135	289	271	310	234	2581
Disagree Strongly	80	103	38	28	19	45	150	18	481
Don't Understand	-	-	-	-	-	57	-	-	57
Don't Know	26	49	43	85	57	159	53	26	498
No Answer	11	4	6	3	16	4	3	5	52
All Responses	1719	2255	1201	1585	1483	1779	1290	1224	12536

COMPLEX

Response Category	USA	GER	NET	AUS	BTN	ITY	SWI	FIN	Total
Agree Strongly	343	688	262	531	312	484	495	386	3483
Agree	969	801	592	557	777	858	394	588	5536
Disagree	323	516	273	283	310	225	267	198	2395
Disagree Strongly	63	214	45	125	40	55	112	37	691
Don't Understand	-	-	-	-	-	39	-	-	39
Don't Know	9	30	25	86	28	114	18	28	338
No Answer	12	6	4	3	16	4	4	5	54
All Responses	1719	2255	1201	1585	1483	1779	1290	1224	12536

Table 7: Observed Frequency Distributions

NOCARE

Response Category	USA	GER	NET	AUS	BTN	ITY	SWI	FIN	Total
Agree Strongly	250	569	156	590	205	402	354	226	2752
Agree	701	880	487	474	756	853	418	552	5121
Disagree	674	638	421	334	404	286	364	354	3475
Disagree Strongly	57	103	36	86	33	24	82	26	467
Don't Understand	-	-	-	-	-	45	-	-	25
Don't Know	20	57	95	98	68	184	48	60	630
No Answer	17	8	6	3	17	5	8	6	66
All Responses	1719	2255	1201	1585	1483	1779	1290	1224	12536

TOUCH

Response Category	USA	GER	NET	AUS	BTN	ITY	SWI	FIN	Total
Agree Strongly	273	697	197	602	276	481	325	319	3170
Agree	881	978	575	533	737	869	523	578	5674
Disagree	462	425	267	257	347	167	262	230	2417
Disagree Strongly	26	49	25	49	18	15	56	21	259
Don't Understand	-	-	-	-	-	45	-	-	45
Don't Know	60	101	133	140	88	198	116	68	904
No Answer	17	5	4	4	17	4	8	8	67
All Responses	1719	2255	1201	1585	1483	1779	1290	1224	12536

INTEREST

Response Category	USA	GER	NET	AUS	BTN	ITY	SWI	FIN	Total
Agree Strongly	264	541	147	629	280	469	343	331	3004
Agree	762	792	443	458	709	834	432	519	4949
Disagree	581	698	443	309	377	247	318	280	3253
Disagree Strongly	31	149	44	76	24	26	93	28	471
Don't Understand	-	-	-	-	-	24	-	-	24
Don't Know	62	66	120	110	76	172	96	58	760
No Answer	19	9	4	3	17	7	8	8	75
All Responses	1719	2255	1201	1585	1483	1779	1290	1224	12536

To screen the data for one country, use the following PRELIS command file, here illustrated with the USA (file **ORD42.PRL**):

```
!Data Screening of EFFITOT.RAW for Country USA
Data Ninputvariables = 7
Labels
COUNTRY NOSAY VOTING COMPLEX NOCARE TOUCH INTEREST
Rawdata = EFFITOT.RAW
Clables COUNTRY 1=BTN 2=GER 3=NET 4=AUS 5=USA 6=ITY 7=SWI 8=FIN
Clables NOSAY - INTEREST 1=AS 2=A 3=D 4=DS 6=DU 8=DK 9=NA
Sdelete COUNTRY = 1
Output
```

To repeat this for another country, just change the line

```
Sdelete Country = 1
```

The Sdelete line (short for Select and Delete) first selects all cases with COUNTRY = 1 and then deletes the variable COUNTRY (it is no use to keep the variable COUNTRY after selection of cases since all cases have the same value 1 on this variable).

One can screen the data for each and all countries simultaneously by running a file with stacked input, see file **ORD42A.PRL**. Collecting the results from this output gives the results shown in Tables 6 and 7.

It is seen in Tables 6 and 7 that there are considerable differences between countries in the univariate marginal distribution of these variables but these distributions are rather similar across variables. Countries like the USA and Britain which use the same language (English) are rather similar. Germany and Austria, where the German language was used, are also rather similar. But there is a considerable difference between these two pairs of countries. Most notably is the distribution in Austria where many people respond in the Agree Strongly category. We shall see that these manifest differences may be viewed as reflections of differences in the means of the latent variables between countries.

3. PRELIS Step

Write a text file of thresholds called **EFFITOT.THR**, say, as follows

```
0  1  2
0  1  2
0  1  2
0  1  2
0  1  2
0  1  2
```

The first line gives the thresholds for NOSAY, the second for VOTING, etc. After listwise deletion of all responses in the *Don't Understand*, *Don't Know*, and *No Answer* categories, there are four categories on the ordinal scale. Thus there should be three thresholds for each variable. Any set of monotonically increasing thresholds will do, and they do not have to be the same for all variables. But they must be the same for all countries.

In the PRELIS step we compute the mean vector, the covariance matrix, and the asymptotic covariance matrix of the underlying variables for each country. For the USA this can be done with the following PRELIS command file (file **ORD43.PRL**):

```
Computing mean vector, covariance matrix and asymptotic covariance matrix
for country USA
Data Ninputvariables = 7
Labels
COUNTRY NOSAY VOTING COMPLEX NOCARE TOUCH INTEREST
Rawdata=EFFITOT.RAW
SD COUNTRY = 1
Missing 6,8,9 NOSAY - INTEREST
CLabels NOSAY - INTEREST 1=AS 2=A 3=D 4=DS
FT=EFFITOT.THR NOSAY
FT VOTING
FT COMPLEX
FT NOCARE
FT TOUCH
FT INTEREST
Output MA=CM ME=EFFUSA.ME CM=EFFUSA.CM AC=EFFUSA.ACC
```

In the same way one can obtain the three matrices for all the other countries by changing the country code on the Sdelete line and changing the three file names on the output line. File **ORD43A.PRL**, not listed here, shows how this can be done for all countries in one single run.

The listwise sample sizes are given in Table 8. The estimated means and standard deviations of the underlying variables are given in Table 9.

Table 8: Listwise Sample Sizes

USA	GER	NET	AUS	BTN	ITY	SWI	FIN
1554	2062	945	1318	1266	1237	1085	1066

Table 9: Means and Standard Deviations

Means

	USA	GER	NET	AUS	BTN	ITY	SWI	FIN
NOSAY	1.018	0.458	0.823	-0.024	0.716	0.609	0.677	0.659
VOTING	0.758	0.361	0.640	-0.292	0.587	0.494	0.640	0.301
COMPLEX	0.586	0.553	0.605	0.452	0.569	0.388	0.425	0.383
NOCARE	0.781	0.589	0.789	0.337	0.686	0.416	0.638	0.633
TOUCH	0.637	0.367	0.601	0.206	0.557	0.245	0.508	0.425
INTEREST	0.691	0.661	0.822	0.222	0.580	0.308	0.578	0.462

Standard Deviations

	USA	GER	NET	AUS	BTN	ITY	SWI	FIN
NOSAY	0.729	0.986	0.742	1.112	0.654	0.770	1.082	0.811
VOTING	0.760	0.989	0.731	1.081	0.628	0.744	1.187	0.788
COMPLEX	0.755	1.102	0.803	1.122	0.736	0.841	1.207	0.839
NOCARE	0.700	0.858	0.691	1.097	0.669	0.704	0.994	0.691
TOUCH	0.642	0.815	0.697	0.994	0.666	0.721	0.880	0.739
INTEREST	0.649	0.926	0.705	1.115	0.690	0.791	1.016	0.790

Table 9 shows that there are considerable differences in the means between countries. Note particularly the large differences between the USA and Austria on NOSAY and VOTING.

4. LISREL Step

The model is the same as the one considered in the second example. The VOTING item is not included for reasons explained in that example. This was found to fit the cross-sectional data for the USA very well. A path diagram is shown in the figure below.

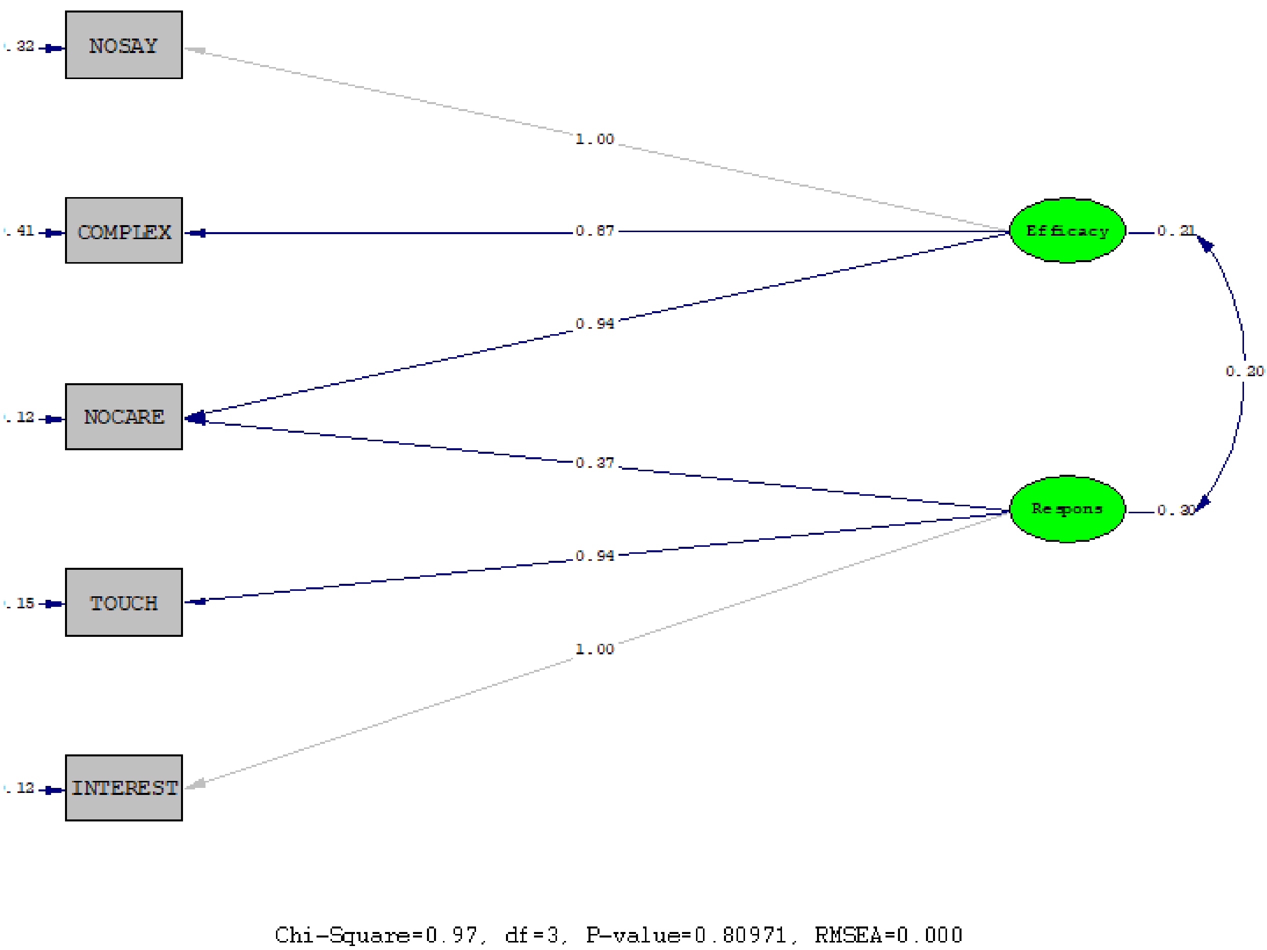
In standard LISREL notation the model is

$$\mathbf{x}^{(g)} = \boldsymbol{\tau}_x + \boldsymbol{\Lambda}_x \boldsymbol{\xi}^{(g)} + \boldsymbol{\delta}^{(g)},$$

where $\mathbf{x}^{(g)}$ is a vector of the underlying variables of NOSAY, COMPLEX, NOCARE, TOUCH, and INTEREST in group g, $\boldsymbol{\tau}_x$ is a vector of intercepts, $\boldsymbol{\Lambda}_x$ is the matrix

$$\begin{pmatrix} 1 & 0 \\ \lambda_{21}^{(x)} & 0 \\ \lambda_{31}^{(x)} & \lambda_{32}^{(x)} \\ 0 & \lambda_{42}^{(x)} \\ 0 & 1 \end{pmatrix},$$

$\boldsymbol{\xi}^{(g)}$ is a vector of the latent variables *Efficacy* and *Respons* in group g, and $\boldsymbol{\delta}^{(g)}$ is a vector of measurement errors in group g.



The parameter matrices $\boldsymbol{\tau}_x$ and $\boldsymbol{\Lambda}_x$ are regarded as attributes of the variables and are therefore assumed to be invariant over groups. The unit of measurement in the latent variables are defined by the two elements 1 in $\boldsymbol{\Lambda}_x$. This makes these units the same across groups which makes it possible to compare the variances and covariances of the latent variables across groups. The fact that $\boldsymbol{\tau}_x$ is also invariant over groups makes it possible to estimate differences in the means of the latent variables between groups. To do so, it is convenient to fix the mean of ξ to 0 in the first group and estimate the mean of ξ in the other groups. Any group can be chosen as the first group.

4.1 USA vs Britain

I begin with the comparison of the two countries USA and Britain where the same language, English, was used in the survey. The same wording was used in these countries, except the USA had *Congress in Washington* whereas Britain had *Parliament* in the TOUCH item.

A SIMPLIS command file for analysis of these two samples is (file **ORD44.SPL**)

```
Group USA
Observed Variables: NOSAY VOTING COMPLEX NOCARE TOUCH INTEREST
Means from File EFFUSA.ME
Covariance Matrix from File EFFUSA.CM
Asymptotic Covariance Matrix from File EFFUSA.ACC
Sample Size: 1554
Latent Variables: Efficacy Respons
```

```
Relationships:
   NOSAY = CONST 1*Efficacy
   COMPLEX = CONST Efficacy
   NOCARE = CONST Efficacy Respons
   TOUCH = CONST Respons
   INTEREST = CONST 1*Respons

Group BTN
Observed Variables: NOSAY VOTING COMPLEX NOCARE TOUCH INTEREST
Means from File EFFBTN.ME
Covariance Matrix from File EFFBTN.CM
Asymptotic Covariance Matrix from File EFFBTN.ACC
Sample Size: 1266
Latent Variables: Efficacy Respons
Relationships:
   Efficacy  Respons = CONST
Set the error variance of NOSAY free
Set the error variances of COMPLEX - INTEREST free
Set the variances of Efficacy - Respons free
Set the covariance between Efficacy and Respons free
Method of Estimation: Weighted Least Squares
End of Problem
```

The general rule in SIMPLIS is that everything is the same as in the previous group unless otherwise stated. The model is specified as relationships. Note that VOTING is not included in the relationships. As a consequence, VOTING is automatically excluded in the model although it is included in the data, *i.e.*, it is included in the mean vector, the covariance matrix, and the asymptotic covariance matrix. Since the relationships are the same in group 2 they are not repeated in that group. The mean vector of ξ is zero in group 1 by default. The line

```
Efficacy      Respons = CONST
```

in group 2 means that we want to estimate that mean vector in that group. The two lines

```
Set the error variance of NOSAY free
Set the error variances of COMPLEX - INTEREST free
```

specify that we want to estimate the measurement error variances as free parameters in group 2. Note that it is *not* possible to specify this with the single line

```
Set the error variances of NOSAY - INTEREST free
```

because this will include VOTING. The two lines

```
Set the variances of Efficacy - Respons free
Set the covariance between Efficacy and Respons free
```

specify that we do not want to constrain the covariance matrix of ξ to be the same in the two groups.

The output file gives the following fit statistics of overall fit (here I have selected the only fit statistics you need to consider).

```
Degrees  of  Freedom  = 13
Minimum  Fit  Function  Chi-Square  =  19.47  (P  =  0.11) Root Mean Square Error of
Approximation (RMSEA) = 0.019
90 Percent Confidence Interval for RMSEA = (0.0 0.035)
```

As judged by the χ^2-value for exact fit, the model fits very well. Some people might say that I should test whether $\boldsymbol{\tau}_x$ and $\boldsymbol{\Lambda}_x$ are invariant over groups and not just assume that. However, since the model fits well and makes good sense, I do not need to do that.

The results concerning the distribution of the latent variables is summarized in Table 10. This gives the estimated means, variances, and covariances of the latent variables, with their standard errors and *t*-values (The standard error is given in parenthesis and the *t*-value follows after the standard errors).

Table 10: USA vs Britain: Estimated Means and Covariance Matrices

USA

	Efficacy	Respons	Means
Efficacy	0.19		0.00
	(0.02)		
	9.85		
Respons	0.20	0.31	0.00
	(0.01)	(0.02)	
	17.09	20.08	

Britain

	Efficacy	Respons	Means
Efficacy	0.15		-0.13
	(0.01)		(0.03)
	10.09		-4.00
Respons	0.18	0.38	-0.09
	(0.01)	(0.02)	(0.04)
	14.57	21.42	-2.14

The *t*-values for the means suggest that there is a significant mean difference between the two countries for both *Efficacy* and *Respons*. The means are larger in the USA than in Britain. One might say that "the USA is ahead of Britain on Efficacy" or that "people in the USA are more efficacious than in Britain".

The *t*-values for the variances and covariances are not useful. The only hypothesis of any interest is whether the covariance matrix of the latent variables is the same in both countries. This can be tested formally by omitting the two lines

```
Set the variances of Efficacy - Respons free
Set the covariance between Efficacy and Respons free
```

in the second group. However, for most purposes, it does not matter if this hypothesis holds or not. It is more important to consider the interpretation of differences in variances and covariances. If the variance of *Efficacy*, say, is noticeably smaller in one country than in another country, it can be interpreted as "People in the first country are more homogeneous with regard to their feeling of efficacy" in the first country compared to the other country. If the differences between the variances are small but the difference between the covariances is large, such that the correlation between the latent variables are different in the two countries, this might suggest that "there is more confusion about the distinction between *Efficacy* and *Respons*" in the country with the smaller covariance than in the country with the larger covariance. In my example, the differences in variances and covariances are rather small, even if some difference may be statistically significant.

Two other countries with the same language are Germany and Austria. I leave it as an exercise for anyone interested to carry out the same analysis for these two countries and to verify that the same model also fits well in these two countries. I now turn to the analysis of the USA and Germany.

4.2 USA vs Germany

Fitting the model of factorial invariance (in the sense of equal intercepts and equal factor loadings) to the USA and Germany gives a chi-square of 140.17 with 13 degrees of freedom and a RMSEA of 0.074 indicating that the model does not fit well (Since I do not believe that the model holds exactly in the population, I use RMSEA and the guidelines of Browne & Cudeck (1993) to judge whether the model fits approximately in the population.) There are large modification indices for the two loadings of NOCARE indicating that these are different in the two countries (they are larger in Germany). Allowing these two loadings to be free in each country gives a chi-square of 72.47 with 11 degrees of freedom and a RMSEA of 0.056. Note that it is still possible to compare the variances and covariances of the two latent variables across countries since they are still measured in the same units (because they are measured in the units of the underlying variables of NOSAY and INTEREST which themselves are in the same units by the construction in the PRELIS step). The fit is still not adequate. There are large modification indices for the intercepts of NOSAY and COMPLEX. This indicates that the large differences between the mean vectors of the underlying variables between the two countries cannot be entirely accounted for by the mean differences in the latent variables.

One must be careful in relaxing the assumption of equal intercepts, however. It is this assumption that makes it possible to estimate the means of the latent variables on a scale with the same origin. In this case, if we allow the intercepts of NOSAY, COMPLEX, and NOCARE to be different, one will not be able to estimate the mean difference in Efficacy. One can, however, allow one of these intercepts to be different. Relaxing the intercept of NOCARE will not improve the fit much. In choosing between NOSAY and COMPLEX, it is best to choose COMPLEX, because the mean difference of Efficacy is well defined by the mean difference in NOSAY. Thus, in the next model, I will allow the intercept of COMPLEX to be different in the two countries but assume that all the other intercepts are the same. This gives a chi-square of 20.21 with 10 degrees of freedom and a RMSEA of 0.024. Thus, this model fits well. Note that chi-square decreased from 72.47 to 20.21 only by adding one single parameter.

The SIMPLIS command file for the last model is not listed here but is given in file **ORD45.SPL**. The estimated means, variances, and covariances of the latent variables, with their standard errors and *t*-values, are given in Table 11.

Table 11: USA vs Germany: Estimated Means and Covariance Matrices

USA

	Efficacy	Respons	Means
Efficacy	0.19 (0.02) 9.823		0.00
Respons	0.21 (0.01) 17.05	0.32 (0.01) 21.52	0.00

Germany

	Efficacy	Respons	Means
Efficacy	0.62 (0.03) 20.76		-0.52 (0.05) -11.25
Respons	0.44 (0.02) 24.80	0.61 (0.02) 27.91	-0.12 (0.03) -3.87

4.3 All Countries

I will now analyze the data from all countries simultaneously. There are several ways to do this and several models that can be considered. In line with the previous sections my objective is to achieve maximum factorial invariance over countries in the sense that intercepts and factor loadings should be invariant over countries. But the model must also fit the data reasonably well and all estimated parameters should be statistically significant and meaningful. In particular, I want to estimate the mean vector (relative to the USA) and the covariance matrix of the latent variables in each country.

I know from the previous analysis of the USA and Germany that I will not be able to fit the model of complete factorial invariance over all eight countries. If I do, I get a chi-square of 473.32 with 73 degrees of freedom and a RMSEA of 0.059. This is not a satisfactory fit.

My guess is that I can fit the model of complete factorial invariance over the USA, The Netherlands, Britain, Italy, Switzerland, and Finland but not with Germany and Austria. I can also fit complete factorial invariance over Germany and Austria, but the model in Germany and Austria differs slightly from that of the other countries. The only differences are that (i) the two loadings of NOCARE are different and (ii) the intercept of COMPLEX is different. To estimate this model with SIMPLIS it is convenient to order the countries in the command file such that Germany and Austria are the last two countries. The SIMPLIS command file is not listed here but is given in file **ORD46.SPL**.

Note the following

- The measurement relations are not repeated in The Netherlands, Britain, Italy, Switzerland, and Finland. Hence the intercepts and factor loadings in these countries are the same as in the USA.
- The lines

```
Set the error variance of NOSAY free
Set the error variances of COMPLEX - INTEREST free Set the variances of
Efficacy - Respons free
Set the covariance between Efficacy and Respons free
```

are repeated in each country to allow the error variances and the covariance matrix of the latent variables to be free in each country.

- The line

```
Efficacy Respons = CONST
```

is included in each country except the USA to specify that the means of the latent variables are to be estimated in these countries. These means are zero in the USA.

- The two lines

```
COMPLEX = CONST
NOCARE = Efficacy Respons
```

are added in Germany to specify that the two loadings of NOCARE are different and that the intercept of COMPLEX is different in Germany. Note that these lines are not repeated in Austria, which makes these quantities equal in Germany and Austria.

The output gives the following set of fit statistics.

```
Degrees of Freedom = 70
Minimum Fit Function Chi-Square = 236.51 (P = 0.0) Root Mean Square Error of
Approximation (RMSEA) = 0.043
90 Percent Confidence Interval for RMSEA = (0.037 0.049)
```

The hypothesis that the model holds exactly in the population is rejected. But, following the guidelines of Browne & Cudeck (1993), since RMSEA is below 0.05 and its upper confidence limit is below 0.08, I judge that the fit represents a reasonable degree of approximation in the population.

If one includes the line

```
LISREL Output
```

the set of factor loadings common to the USA, The Netherlands, Britain, Italy, Switzerland, and Finland is given in the output as

```
          Efficacy    Respons
          --------   --------
   NOSAY     1.000        - -

 COMPLEX     1.037        - -
           (0.024)
            43.265

  NOCARE     0.971      0.263
           (0.074)    (0.047)
            13.038      5.575

   TOUCH       - -      0.884
                      (0.013)
                       70.291

INTEREST       - -      1.000
```

The loadings for Germany and Austria differ from these only for NOCARE. For Germany and Austria these loadings are

```
NOCARE      0.427      0.613
          (0.044)    (0.041)
            9.741     15.025
```

The loading on *Efficacy* is noticeably smaller and the loading on *Respons* is noticeably larger. Thus, the item NOCARE functions differently in these two groups of countries. In the USA, The Netherlands, Britain, Italy, Switzerland, and Finland, NOCARE is mainly a measure of *Efficacy*, whereas in Germany and Austria, NOCARE is more of a measure of *Respons* than of *Efficacy*.

In the USA, The Netherlands, Britain, Italy, Switzerland, and Finland the intercepts in the measurement equations are estimated as

```
   NOSAY    COMPLEX     NOCARE      TOUCH   INTEREST
--------   --------   --------   --------   --------
   0.910      0.658      0.886      0.553      0.688
 (0.026)    (0.025)    (0.022)    (0.028)    (0.030)
  35.586     26.202     40.207     19.633     22.837
```

In Germany and Austria these intercepts are estimated as

```
   NOSAY    COMPLEX     NOCARE      TOUCH   INTEREST
--------   --------   --------   --------   --------
   0.910      1.210      0.886      0.553      0.688
 (0.026)    (0.044)    (0.022)    (0.028)    (0.030)
  35.586     27.480     40.207     19.633     22.837
```

The only difference is for COMPLEX but this difference is highly significant.

The estimated means of *Efficacy* and *Respons* are given in Table 12. All these means are statistically significant except for the mean of *Respons* in Britain. Note that all estimated means are negative except for *Respons* in The Netherlands. Hence, the USA is "ahead" of all countries on *Efficacy* and "ahead" of all countries except The Netherlands on *Respons*. Note also that Germany and Austria are "way below" the USA on *Efficacy* and that Austria is "way below" the USA on *Respons* as well. If we rank the countries in order of decreasing *Efficacy*, the order is the USA, The Netherlands, Britain, Switzerland, Finland, Italy, Germany and Austria.

A command file in LISREL syntax for doing exactly the same thing as in **ORD46.SPL** is given in **ORD46A.LIS**.

Table 12: Estimated Means of Efficacy and Respons

	USA	GER	NET	AUS	BTN	ITY	SWI	FIN
Efficacy	0.000	-0.55	-0.08	-0.82	-0.15	-0.30	-0.23	-0.25
Respons	0.000	-0.10	0.08	-0.41	-0.07	-0.39	-0.09	-0.18

5. Conclusion

In this section I have examined the factorial invariance of the five efficacy items NOSAY, COMPLEX, NOCARE, TOUCH, and INTEREST in the eight countries USA, The Netherlands, Britain, Italy, Switzer- land, Finland, Germany, and Austria using data from the Political Action Survey. The conclusions are

- The five efficacy items measure the same two latent variables *Efficacy* and *Respons* in all countries.
- NOSAY, TOUCH, and INTEREST are functionally equivalent in all eight countries, in the sense that the intercepts and slopes (factor loadings) are the same in all eight countries. COMPLEX and NOCARE are functionally equivalent in the six countries USA, The Netherlands, Britain, Italy, Switzerland, and Finland. They are also functionally equivalent in Germany and Austria, but these countries differ from the other six countries in two respects.
    - The loadings of NOCARE on *Efficacy* and *Respons* are different. In Germany and Austria the loading on *Efficacy* is much smaller and the loading on *Respons* is much larger than in the other six countries. Thus, the item NOCARE functions differently in these two groups of countries. In the USA, The Netherlands, Britain, Italy, Switzerland, and Finland, NOCARE is mainly a measure of Efficacy, whereas in Germany and Austria, NOCARE is more of a measure of *Respons* than of *Efficacy*.
    - COMPLEX measures *Efficacy* at a higher level in the sense that the intercept is much larger in Germany and Austria than in the other six countries.
- The means of *Efficacy* and *Respons* are considerably different among the eight countries, with the USA being the most efficacious and Germany and Austria the least efficacious.