

# Single group models for ordinal variables

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## 1. Introduction

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In practice, many multivariate data sets consist of observations of ordinal variables rather than continuous variables. Most statistical methods for structural equation modeling assume that the data are observations of continuous variables. In practice, this problem is overcome by treating the ordinal variables as if they were continuous variables. Unfortunately, this approach may yield misleading results (see e.g. Jöreskog 1994 and Jöreskog & Sörbom 1999).

LISREL 8.80 for Windows (Jöreskog & Sörbom 2006) includes several statistical methods for the analysis of ordinal data. These methods are logistic regression, PROBIT regression as well as Weighted Least Squares (WLS) and Diagonally Weighted Least Squares (DWLS) for polychoric correlation and covariance matrices. More details about these methods are provided in Jöreskog (2002).

In this note, LISREL 8.80 for Windows is used to fit a Confirmatory Factor Analysis (CFA) model as well as a Multiple Indicator Multiple Indicator Cause (MIMIC) model to a data set of observations on ordinal variables. This data set is described in the next section. The CFA model is described in Section 3. The CFA model is fitted to the ordinal data set in Section 4. The CFA model is also adjusted in Section 4. Section 5 describes the MIMIC model. In Section 6, the MIMIC model is fitted to the ordinal data set.

## 2. The data

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Barnes & Kaase (1979) conducted a cross-national survey to obtain information on conventional and unconventional forms of political participation in industrial societies. This survey is known as the Political Action Survey. This survey included several attitude and perception statements to which the respondents had to respond to as one of agree strongly, agree, disagree, disagree strongly, don't know or no answer. Amongst others, the following statements were administered to each respondent.

*“People like me have no say in what the government does.” (NOSAY)*

*“Sometimes politics and government seem so complicated that a person like me cannot really understand what is going on.” (COMPLEX)*

*“I don't think that public officials care much about what people like me think.” (NOCARE)*

*“Generally speaking, those we elect to Congress in Washington lose touch with people pretty quickly.” (TOUCH)*

*“Parties are only interested in people's votes but not in their opinions. (INTEREST)*

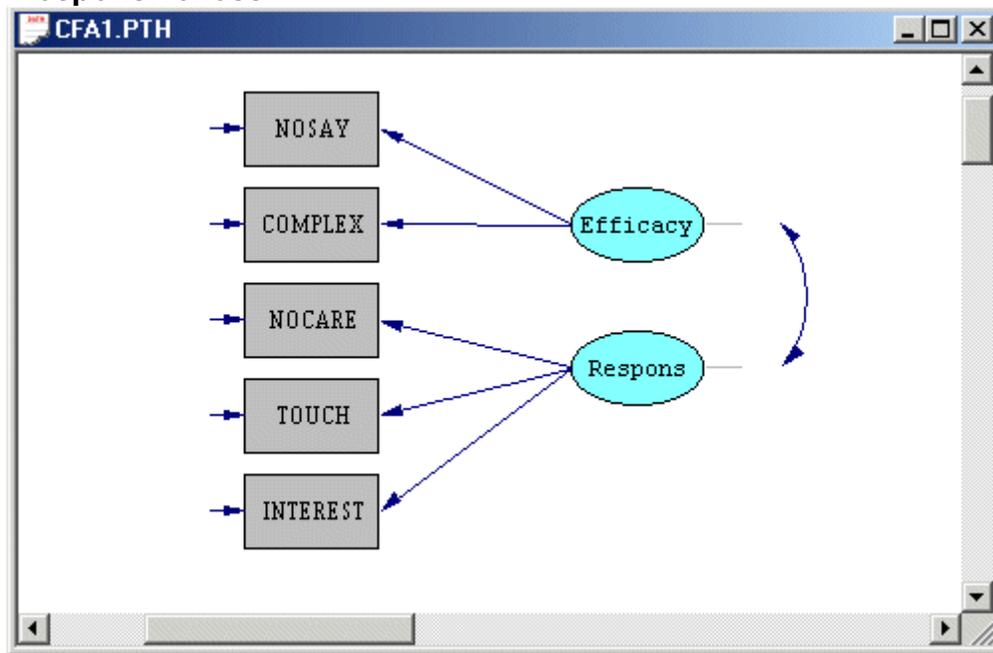
The responses to these statements of a sample of 1076 United States respondents, along with their gender (**GENDER**), education level (**EDUCAT**), age (**AGE**) and left-right score (**LEFTRIGH**), are listed in the PRELIS System File (PSF) **USA.PSF**. This file is located in **C:\LISREL 8.8 Student Examples\WORKSHOP**. A small portion of this file is shown in the following PSF window.

	NOSAY	VOTING	COMPLEX	NOCARE	TOUCH	INTEREST	GENDE
1	2.000	2.000	1.000	1.000	1.000	1.000	2.
2	2.000	3.000	3.000	3.000	2.000	3.000	2.
3	3.000	2.000	2.000	3.000	3.000	3.000	1.
4	2.000	2.000	2.000	2.000	1.000	2.000	2.
5	2.000	1.000	2.000	2.000	1.000	1.000	1.
6	3.000	3.000	2.000	2.000	3.000	3.000	1.
7	2.000	2.000	3.000	1.000	1.000	1.000	1.
8	3.000	2.000	3.000	3.000	2.000	3.000	1.
9	3.000	2.000	1.000	1.000	2.000	2.000	2.
10	1.000	1.000	1.000	1.000	1.000	1.000	2.
11	3.000	3.000	3.000	3.000	3.000	3.000	2.
12	1.000	4.000	4.000	2.000	1.000	1.000	2.
13	3.000	3.000	2.000	2.000	2.000	2.000	1.
14	3.000	3.000	4.000	2.000	1.000	1.000	1.
15	3.000	3.000	3.000	3.000	3.000	3.000	2.
16	2.000	2.000	1.000	2.000	1.000	2.000	1.

### 3. The CFA model

The five political statements, which are listed in Section 2, are regarded as indicators of Political Efficacy and Political Responsiveness. More specifically, **NOSAY** and **COMPLEX** are indicators of Political Efficacy and **NOCARE**, **TOUCH** and **INTEREST** are indicators of Political Responsiveness. A path diagram of the corresponding CFA model is shown in Figure 1.

Figure 1: A path diagram for a CFA model for Political Efficacy and Responsiveness



## 4. Fitting the CFA model

### Generating the matrix files

- Use the **Open** option on the **File** menu to load the **Open** dialog box.
- Select the **PRELIS data (\*.psf)** from the **Files of type:** dropdown list box.
- Browse for the location **C:\LISREL 8.8 Student Examples\WORKSHOP**.
- Select the file **USA.PSF** by clicking on it.
- Click on the **Open** button to open **USA.PSF** in a PSF window.
- Click on the **Output Options** option on the **Statistics** menu to load the **Output** dialog box.
- Select the **Correlations** option from the dropdown list box in the **Moment Matrix** section.
- Check the **Save to File** checkbox in the **Moment Matrix** section.
- Enter the name **USA.PCM** in the string field in the **Moment Matrix** section.
- Check the **Save to File** checkbox in the **Asymptotic Covariance Matrix** section.
- Enter the name **USA.ACC** in the string field in the **Asymptotic Covariance Matrix** section.
- Click on the **OK** button to generate the text editor window for **USA.OUT**.

### Fitting the CFA Model to the ordinal data set

- Use the **Open** option on the **File** menu to load the **Open** dialog box.
- Browse for the location **C:\LISREL 8.8 Student Examples\WORKSHOP**.
- Select the file **CFA1.SPL** by clicking on it.
- Click on the **Open** button to open the following text editor window.

```

CFA1.SPL
CFA Model 1
Observed Variables:
NOSAY VOTING COMPLEX NOCARE TOUCH INTEREST
GENDER LEFTRIGH EDUCAT AGE
Correlation Matrix from File USA.PCM
Asymptotic Covariance Matrix from File USA.ACC
Sample Size: 1076
Latent Variables: Efficacy Respons
Relationships:
NOSAY COMPLEX = Efficacy
NOCARE TOUCH INTEREST = Respons
LISREL Output: ND=3 SC ME=WLS
Path Diagram
End of Problem

```

Line 1 provides a title for the analysis.

Lines 2 to 4 specify labels for the observed variables.

Lines 5 and 6 specify the matrix files for the polychoric correlation matrix and the estimated asymptotic covariance matrix of the polychoric correlations respectively.

Line 7 specifies the number of observations in USA.PSF.

Line 8 specifies labels for the latent variables.

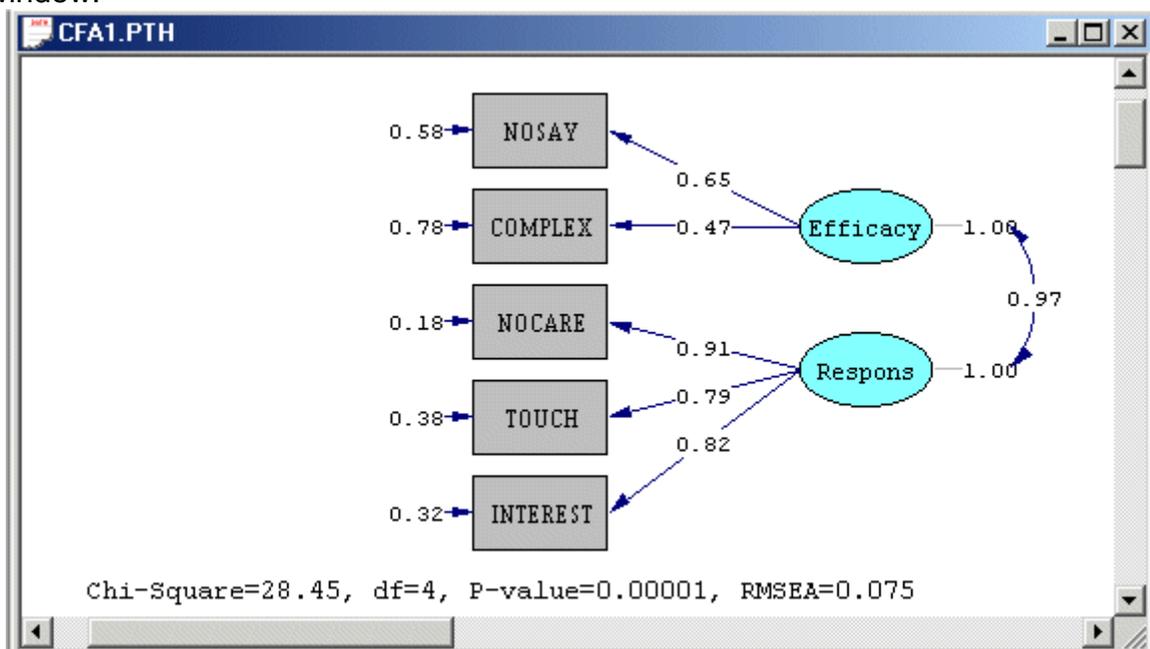
Lines 9 to 11 specify the CFA model to be fitted to the data.

Line 12 specifies the Weighted Least Squares (WLS) method for ordinal variables and that the results should be printed in terms of the LISREL model for the CFA model in Figure 1.

Line 13 requests a path diagram.

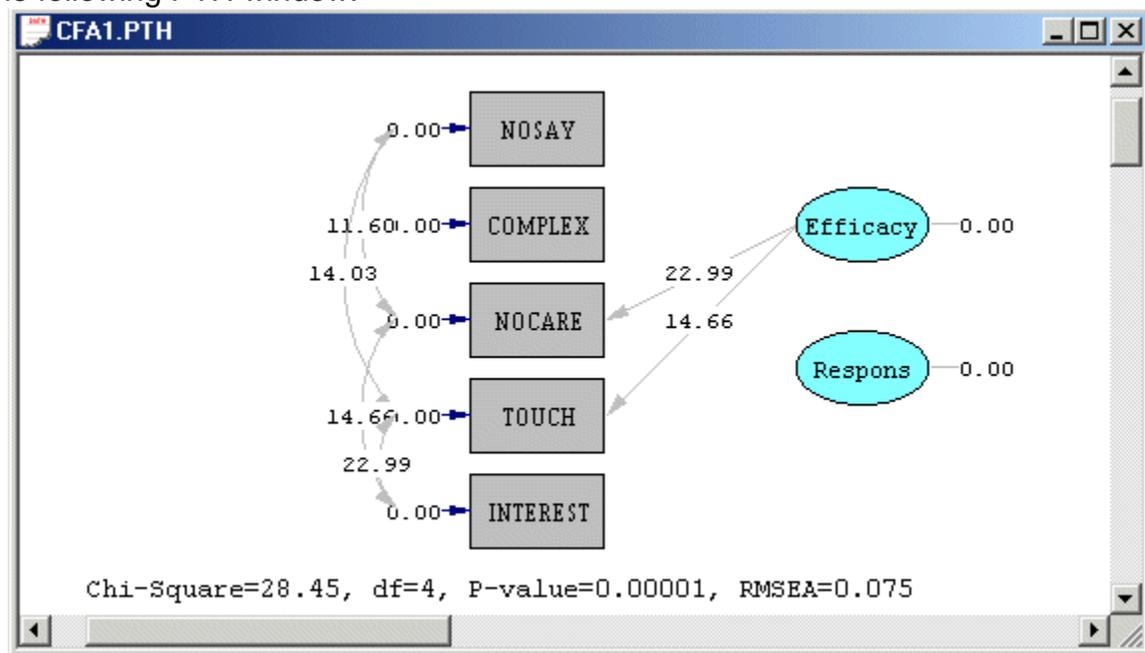
Line 14 indicates no more SIMPLIS commands are to be processed.

- Click on the **Run LISREL** icon  on the main toolbar to produce the following PTH window.



## Adjusting the CFA model

- Select the **Modification Indices** option from the **Estimates** dropdown list box to open the following PTH window.



From the results above, it is evident that the largest modification index is that of the factor loading of the variable **NOCARE** as an indicator of the latent variable **Efficacy**. The wording of this statement supports the suggestion that NOCARE is an indicator of the latent variable **Efficacy** rather than the latent variable **Respons**. In other words, this modification makes sense from a theoretical point of view.

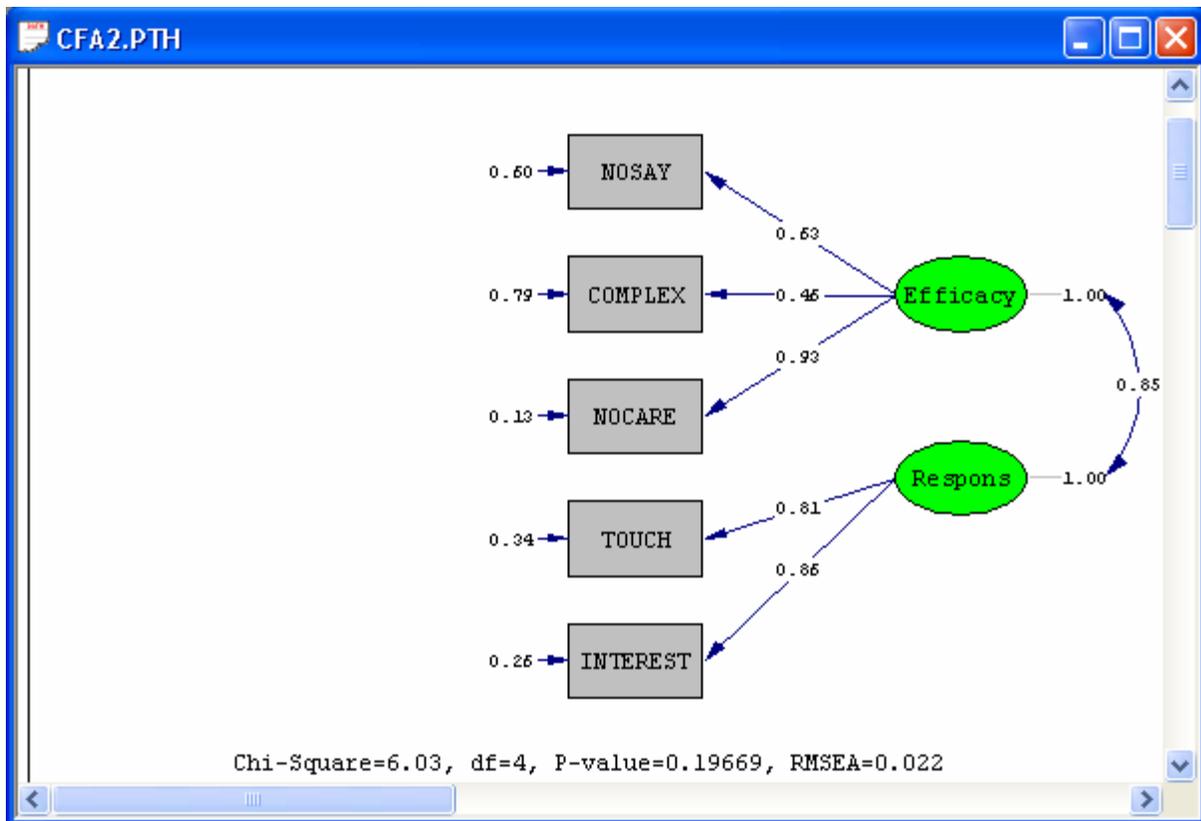
- Use the **Open** option on the **File** menu to load the **Open** dialog box.
- Browse for the location **C:\LISREL 8.8 Student Examples\WORKSHOP**.
- Select the file **CFA1.SPL** by clicking on it.
- Click on the **Open** button to open the text editor window for **CFA1.SPL**.
- Change line 10 from **NOSAY COMPLEX = Efficacy** to **NOSAY COMPLEX NOCARE = Efficacy**.
- Change line 11 from **NOSAY COMPLEX NOCARE = Respons** to **NOSAY COMPLEX = Respons**.
- Select the **Save As** option on the **File** menu to load the **Save As** dialog box.
- Enter the name **CFA2.SPL** in the **File name** string field.
- Click on the **Save** button to create the following text editor window.

```

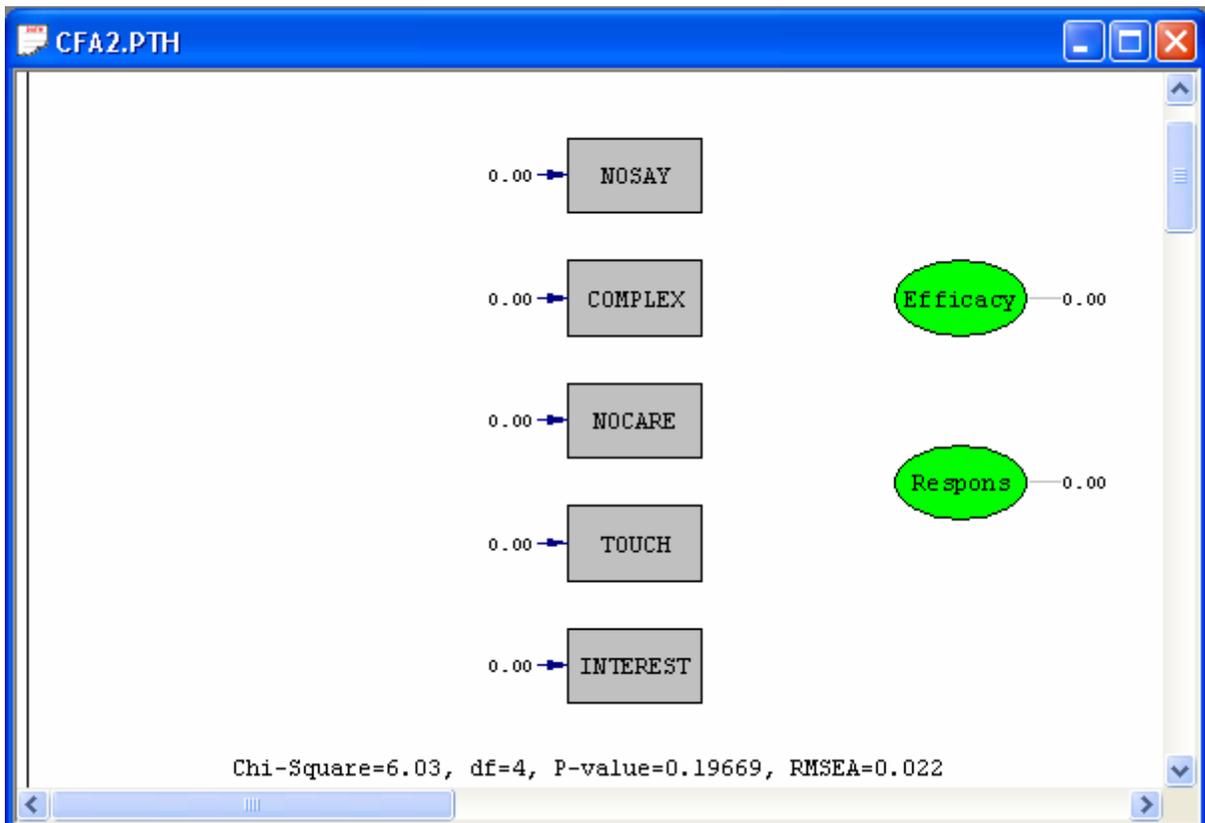
CFA2.SPL
CFA Model 2
Observed Variables:
NOSAY VOTING COMPLEX NOCARE TOUCH INTEREST
GENDER LEFTRIGH EDUCAT AGE
Correlation Matrix from File USA.PCM
Asymptotic Covariance Matrix from File USA.ACC
Sample Size: 1076
Latent Variables: Efficacy Respons
Relationships:
NOSAY COMPLEX NOCARE = Efficacy
TOUCH INTEREST = Respons
LISREL Output: ND=3 SC ME=WLS
Path Diagram
End of Problem

```

- Click on the **Run LISREL** icon  on the main toolbar to produce the following PTH window.



- Select the **Modification Indices** option from the **Estimates** dropdown list box to open the following PTH window.

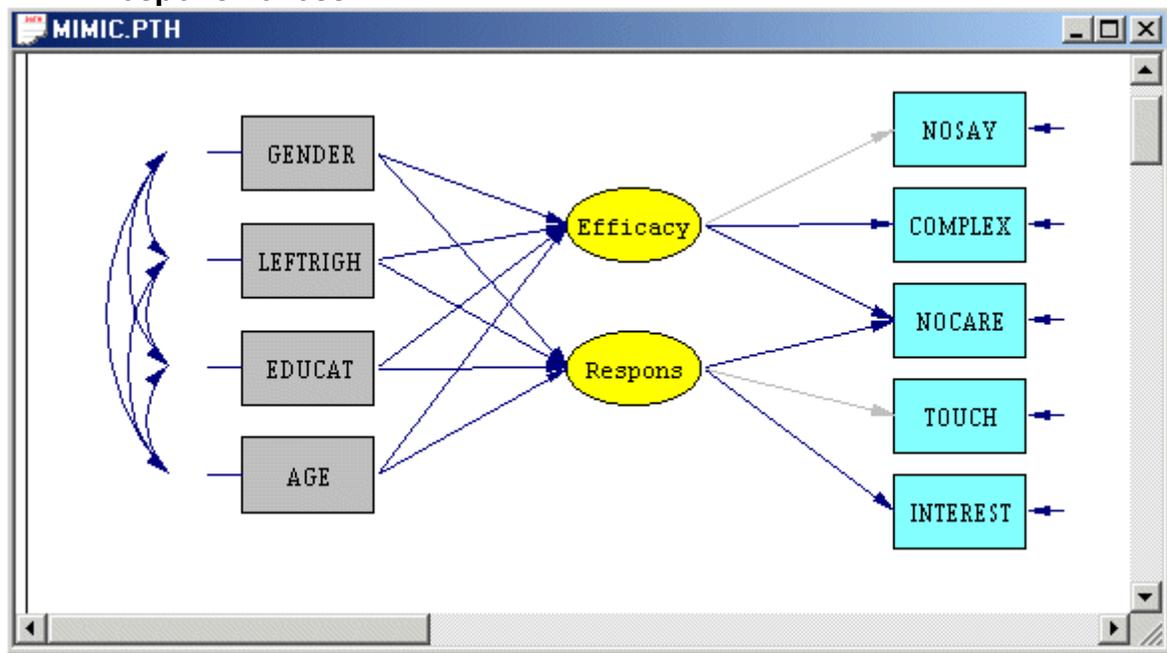


From the results above, it is evident that none of the modification indices suggests further refining of the CFA model.

## 5. The MIMIC model

We consider a MIMIC model that suggests that the five political statements, which are described in Section 2, represent indicators of the latent variables Political Efficacy and Political Responsiveness. In addition, the model suggests that a respondent's age, gender, education level and left-right score determines his/her political efficacy and political responsiveness. A path diagram for the corresponding MIMIC model for Political Efficacy and Political Responsiveness is shown in Figure 2.

Figure 2: A path diagram for a MIMIC model for Political Efficacy and Responsiveness



## 6. Fitting the MIMIC model

### Generating the matrix files

- Use the **Open** option on the **File** menu to load the **Open** dialog box.
- Browse for the location **C:\LISREL 8.8 Student Examples\WORKSHOP**.
- Select the file **MIMIC.PR2** by clicking on it.
- Click on the **Open** button to open the following text editor window.

```
Computing Covariance Matrix
SY=USA.PSF
Fixedvariables: GENDER - AGE
Output MA=CM CM=USA.COV AC=USA.ACM WP
```

Line 1 provides a title for the computation.

Line 2 specifies the raw data source.

Line 3 specifies the variables **GENDER**, **EDUCAT**, **LEFTRIGH** and **AGE** as covariates.

Line 4 specifies that the covariance matrix should be computed and written to the text file **USA.COV** and that the estimated asymptotic covariance matrix of the variances and covariances should be computed and written to the binary file **USA.ACM**.

➤ Click on the **Run PRELIS** icon to produce the text editor window for **USA.OUT**.

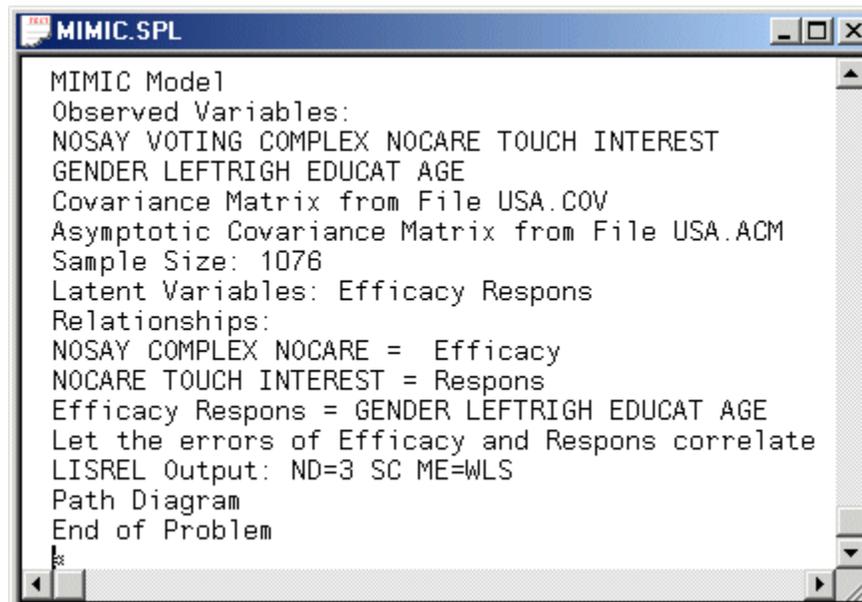
### Fitting the MIMIC model

➤ Use the **Open** option on the **File** menu to load the **Open** dialog box.

➤ Browse for the location **C:\LISREL 8.8 Student Examples\WORKSHOP**.

➤ Select the file **MIMIC.SPL** by clicking on it.

➤ Click on the **Open** button to open the following text editor window.



```
MIMIC Model
Observed Variables:
NOSAY VOTING COMPLEX NOCARE TOUCH INTEREST
GENDER LEFTRIGH EDUCAT AGE
Covariance Matrix from File USA.COV
Asymptotic Covariance Matrix from File USA.ACM
Sample Size: 1076
Latent Variables: Efficacy Respons
Relationships:
NOSAY COMPLEX NOCARE = Efficacy
NOCARE TOUCH INTEREST = Respons
Efficacy Respons = GENDER LEFTRIGH EDUCAT AGE
Let the errors of Efficacy and Respons correlate
LISREL Output: ND=3 SC ME=WLS
Path Diagram
End of Problem
```

Line 1 provides a title for the analysis.

Lines 2 to 4 specify labels for the observed variables.

Lines 5 and 6 specify the matrix files for the covariance matrix and the estimated asymptotic covariance matrix of the variances and covariances respectively.

Line 7 specifies the number of observations in USA.PSF.

Line 8 specifies labels for the latent variables.

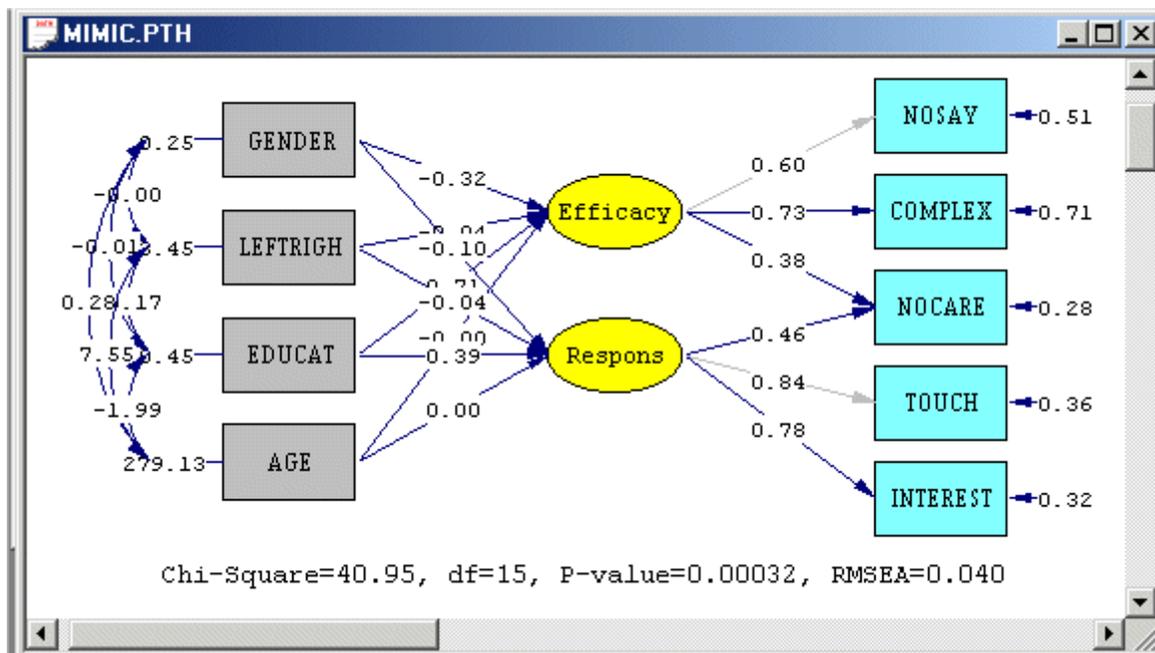
Lines 9 to 13 specify the MIMIC model to be fitted to the data.

Line 14 specifies the Weighted Least Squares (WLS) method for ordinal variables and that the results should be printed in terms of the LISREL model for the MIMIC model in Figure 2.

Line 15 requests a path diagram.

Line 16 indicates no more SIMPLIS commands are to be processed.

➤ Click on the **Run LISREL** icon  on the main toolbar to produce the following PTH window.



## References

- Barnes, S.H. & Kaase, M. (Eds.). (1979). *Political Action: Mass Participation in Five Western Democracies*. Beverley Hills and London: Sage Publications.
- Jöreskog, K.G. (1994). On the Estimation of Polychoric Correlations and their Asymptotic Covariance Matrix. *Psychometrika*, **59**, 381-389.
- Jöreskog, K.G. (2002). *Structural Equation Modeling with Ordinal Variables using LISREL*. Available at <http://www.ssicentral.com/lisrel/ordinal.htm>.
- Jöreskog, K.G. & Sörbom, D. (1999). *PRELIS 2: User's Reference Guide*. Lincolnwood, IL: Scientific Software International, Inc.
- Jöreskog, K.G. & Sörbom, D. (2006). *LISREL 8.80 for Windows [Computer Software]*. Lincolnwood, IL: Scientific Software International, Inc.