The assessment of the validity of constructs

1. Introduction

In practice, the construct validity of constructs is a very important aspect of latent variable models. Steenkamp & Van Trijp (1991) claims that the criteria for achieving construct validity are unidimensionality, within-method convergent validity, reliability, stability, across method convergent validity and discriminant validity and nomological validity.

LISREL 8.80 for Windows (Jöreskog & Sörbom 2006) may be used to fit to assess the validity of constructs. Traditional statistical methods such as Maximum Likelihood (ML), Robust Maximum Likelihood (RML), Weighted Least Squares (WLS), Diagonally Weighted Least Squares (DWLS), Generalized Least Squares (GLS) and Un-weighted Least Squares (ULS) are available for complete data while the Full Information Maximum Likelihood (FIML) method is available for incomplete data. The ML, RML, WLS, DWLS, GLS and ULS methods for structural equation modeling are described in Jöreskog & Sörbom (1999) while the FIML method is described in Du Toit & Du Toit (2001).

In this note, the ML estimation method for complete data of LISREL 8.80 for Windows is used to demonstrate the assessment of certain aspects of construct validity. The data are described in the next section. In Sections 3 thru 5, this data set is used to illustrate how LISREL 8.80 for Windows can be used to assess specific aspects of construct validity.

2. The data

The data are the responses of 1686 customers of Clicks stores to scales for merchandise value and store environment. The raw data are listed in the file **CLICKS.PSF** in the location **C:\LISREL 8.8 Student Examples\WORKSHOP**. The first portion of this file is displayed in the following PSF window.

clicks.psf

	MEVAL1	MEVAL2	MEVAL3	MEVAL4	MEVAL5	MEVAL6	MEVAL7	MEVAL8
1	3.00	3.00	2.00	2.00	3.00	1.00	3.00	1.00
2	5.00	6.00	5.00	6.00	5.00	5.00	3.00	5.00
3	5.00	3.00	4.00	4.00	5.00	4.00	5.00	4.00
4	4.00	7.00	7.00	6.00	7.00	7.00	4.00	4.00
5	6.00	3.00	7.00	7.00	7.00	4.00	7.00	4.00
6	6.00	4.00	6.00	4.00	4.00	5.00	4.00	3.00
7	5.00	6.00	5.00	5.00	6.00	5.00	3.00	6.00
8	1.00	6.00	1.00	6.00	4.00	6.00	4.00	5.00
9	3.00	4.00	1.00	7.00	4.00	2.00	4.00	7.00
10	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
11	4.00	6.00	5.00	4.00	5.00	5.00	3.00	5.00
12	2.00	5.00	3.00	5.00	5.00	4.00	5.00	4.00
13	6.00	6.00	7.00	6.00	7.00	7.00	5.00	6.00
14	5.00	4.00	5.00	6.00	6.00	6.00	3.00	6.00
15	6.00	6.00	6.00	5.00	4.00	6.00	5.00	4.00

3. Unidimensionality of the merchandise value scale

A scale is unidimensional if all the items of the scale measure one common latent variable. We assess the unidimensionality of the merchandise value scale as follows.

➢ 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 **MEVAL1.SPL** by clicking on it.
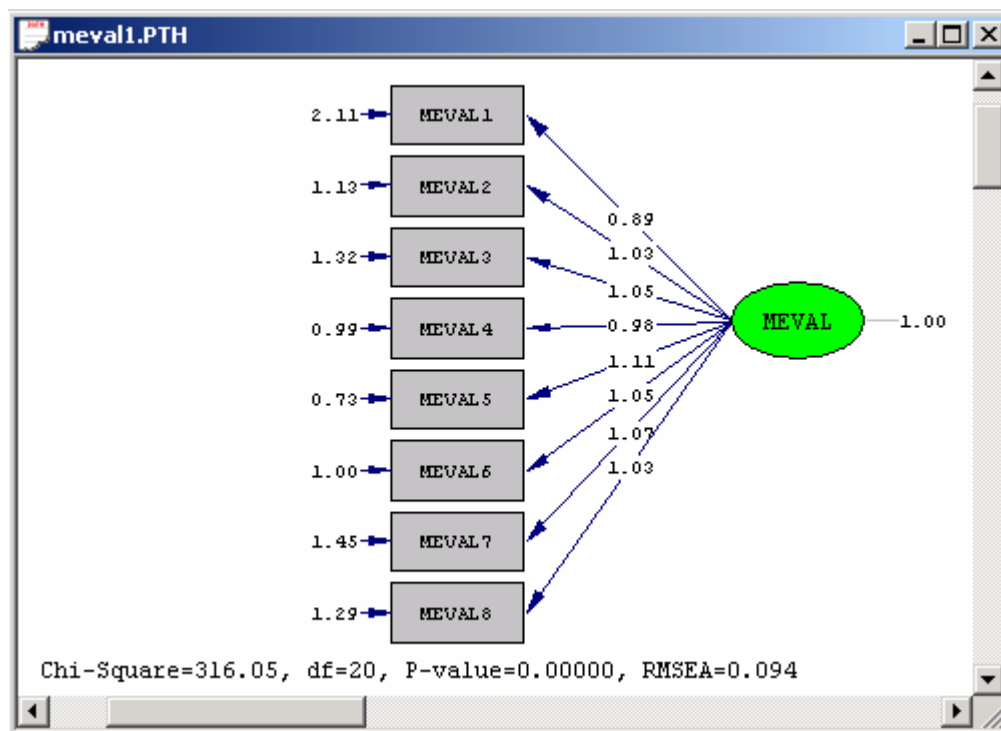➢ Click on the **Open** button to open the following text editor window.

meval1.spl

```
Raw Data from File CLICKS.PSF
Latent Variables
MEVAL
Relationships
MEVAL1 MEVAL2 MEVAL3 MEVAL4 MEVAL5 MEVAL6 MEVAL7 MEVAL8=MEVAL
LISREL Output: ND=3 SC RS
Path Diagram
End of Problem
```

Line 1 specifies the raw data source.
Lines 2 and 3 specifies label for the latent variable.
Lines 4 and 5 specify the model.

Line 6 specifies that the results should be printed in terms of the LISREL model for the model, requests results with three decimal places, the completely standardized solution and an analysis of the residuals.
Line 7 requests a path diagram.
Line 8 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.

The significant Chi-square test statistic value above implies that there is sufficient evidence that the 8-item merchandise value scale is not unidimensional. The corresponding standardized residuals are shown in the text editor window below.

```
meval1.OUT                                                          _□×
        Standardized Residuals
              MEVAL1      MEVAL2      MEVAL3      MEVAL4      MEVAL5      MEVAL6
            --------    --------    --------    --------    --------    --------
   MEVAL1      - -
   MEVAL2    -1.353        - -
   MEVAL3    11.469       1.198        - -
   MEVAL4    -3.997       1.389      -3.777        - -
   MEVAL5    -0.660       3.167       5.441      -1.187        - -
   MEVAL6     0.660      -3.804      -3.088       2.164      -2.061        - -
   MEVAL7    -4.414      -3.475      -5.618       1.237      -1.184       7.449
   MEVAL8    -1.383       1.847      -3.418       3.078      -3.634      -0.345


              MEVAL7      MEVAL8
            --------    --------
   MEVAL7      - -
   MEVAL8     4.350        - -
```

The results above indicate that the item MEVAL3 is involved in several significant standardized residuals. As a result, we delete MEVAL3 from the scale and then assess the unidimensionality of the resulting 7-item scale as follows.

➢ 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 **MEVAL1A.SPL** by clicking on it.
➢ Click on the **Open** button to open the following text editor window.

```
meval1a.spl                                             _□×
  Raw Data from File CLICKS.PSF
  Latent Variables
  MEVAL
  Relationships
  MEVAL1 MEVAL2 MEVAL4 MEVAL5 MEVAL6 MEVAL7 MEVAL8=MEVAL
  LISREL Output: ND=3 SC RS
  Path Diagram
  End of Problem
```

Line 1 specifies the raw data source.
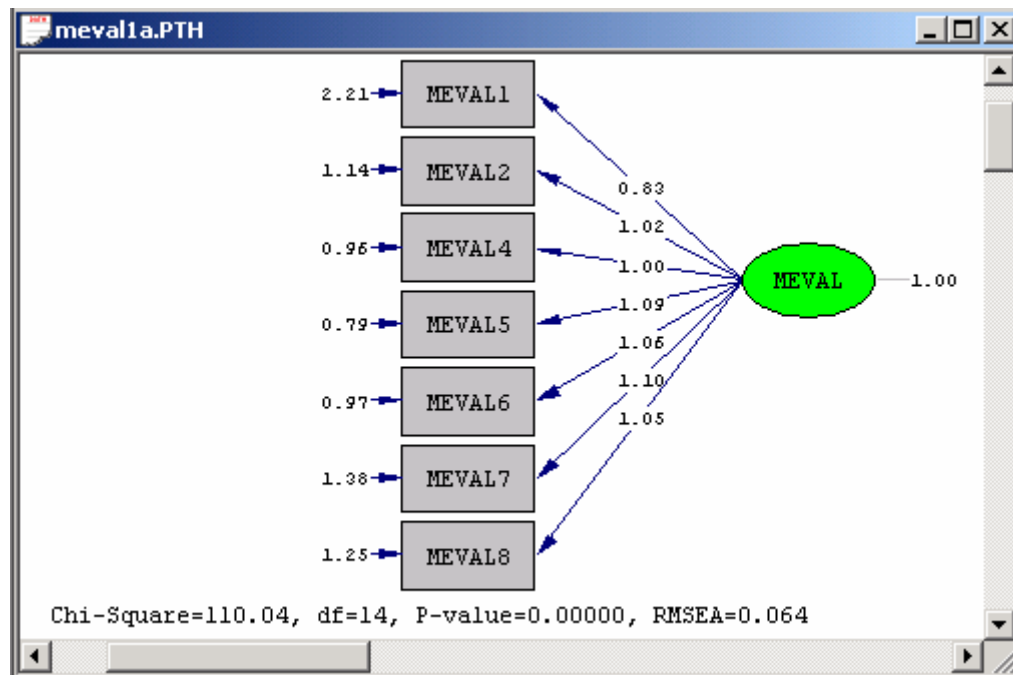Lines 2 and 3 specifies label for the latent variable.
Lines 4 and 5 specify the model.
Line 6 specifies that the results should be printed in terms of the LISREL model for the model, requests results with three decimal places, the completely standardized solution and an analysis of the residuals.
Line 7 requests a path diagram.
Line 8 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.

Chi-Square=110.04, df=14, P-value=0.00000, RMSEA=0.064

The significant Chi-square test statistic value above implies that there is sufficient evidence that the 7-item merchandise value scale is not unidimensional. The corresponding standardized residuals are shown in the text editor window below.

Standardized Residuals

	MEVAL1	MEVAL2	MEVAL4	MEVAL5	MEVAL6	MEVAL7
MEVAL1	- -					
MEVAL2	0.662	- -				
MEVAL4	-2.630	1.043	- -			
MEVAL5	2.653	5.202	-0.731	- -		
MEVAL6	2.246	-4.316	0.548	-1.404	- -	
MEVAL7	-3.492	-4.511	-0.791	-1.479	6.006	- -
MEVAL8	-0.119	1.543	1.693	-3.237	-2.015	2.792

	MEVAL8
MEVAL8	- -

The results above indicate that the item MEVAL7 is involved in several significant standardized residuals. As a result, we delete MEVAL7 from the scale and then assess the unidimensionality of the resulting 6-item scale as follows.
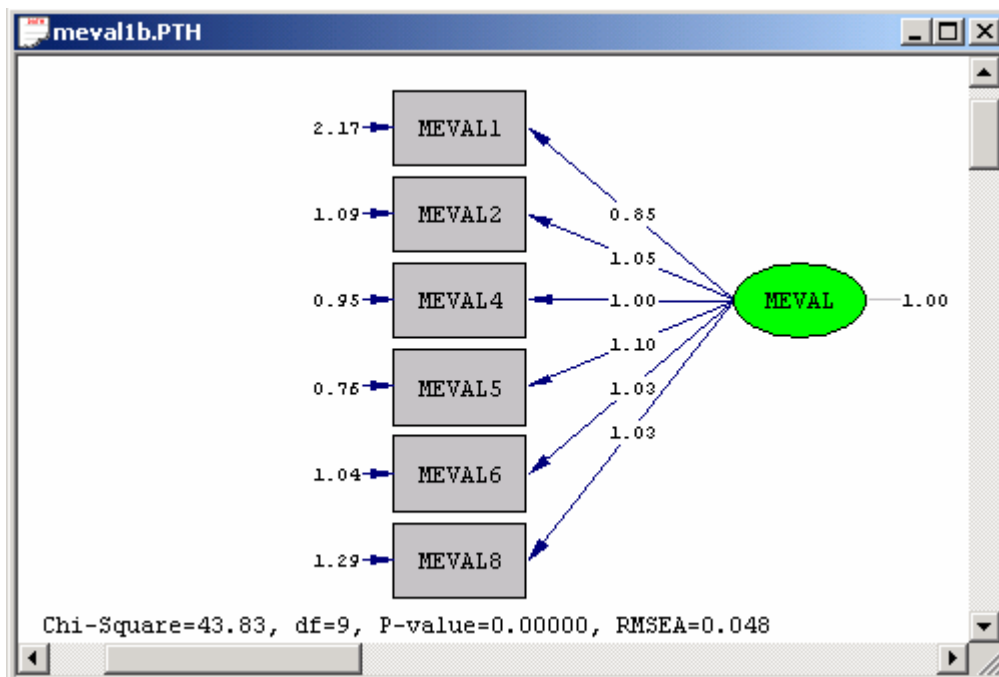
- ➢ Use the **Open** option on the **File** menu to load the **Open** dialog box.
- ➢ Browse for the location **C:\LISREL 8.8 Student Examples\WORKSHOP**.
- ➢ Select the file **MEVAL1B.SPL** by clicking on it.
- ➢ Click on the **Open** button to open the following text editor window.

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

The significant Chi-square test statistic value above implies that there is sufficient evidence that the 6-item merchandise value scale is not unidimensional. The corresponding standardized residuals are shown in the text editor window below.

```
meval1b.OUT                                                    _ □ ×

        Standardized Residuals

             MEVAL1       MEVAL2       MEVAL4       MEVAL5       MEVAL6       MEVAL8
            --------     --------     --------     --------     --------     --------
MEVAL1        - -
MEVAL2      -0.575         - -
MEVAL4      -3.420       -0.317         - -
MEVAL5       1.664        3.468       -1.711         - -
MEVAL6       2.418       -4.199        2.195        0.161         - -
MEVAL8      -0.334        1.141        2.370       -3.182        0.236         - -
```

The results above indicate that the item MEVAL6 is involved in several significant standardized residuals. As a result, we delete MEVAL6 from the scale and then assess the unidimensionality of the resulting 5-item scale as follows.

➢ 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 **MEVAL1C.SPL** by clicking on it.
➢ Click on the **Open** button to open the following text editor window.

```
meval1c.spl                                  _ □ ×

Raw Data from File CLICKS.PSF
Latent Variables
MEVAL
Relationships
MEVAL1 MEVAL2 MEVAL4 MEVAL5 MEVAL8 = MEVAL
LISREL Output: ND=3 SC RS
Path Diagram
End of Problem
```

Line 1 specifies the raw data source.
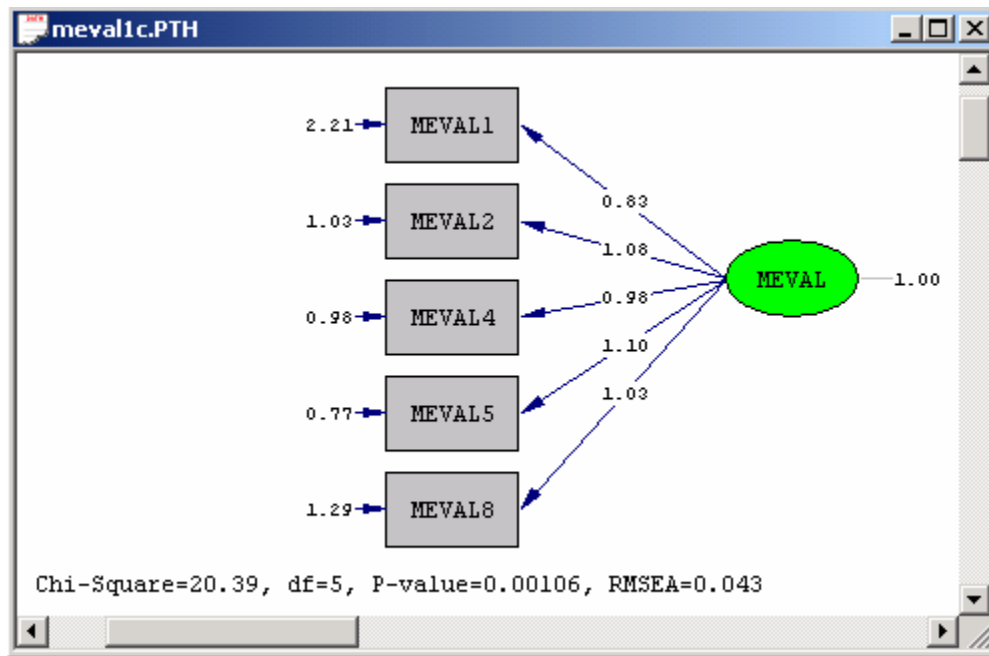Lines 2 and 3 specifies label for the latent variable.
Lines 4 and 5 specify the model.
Line 6 specifies that the results should be printed in terms of the LISREL model for the model, requests results with three decimal places, the completely standardized solution and an analysis of the residuals.
Line 7 requests a path diagram.
Line 8 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.

```
meval1c.PTH                                              _ □ X

              2.21 →  MEVAL1
                                            0.83
              1.03 →  MEVAL2
                                        1.08
                                             0.98
              0.98 →  MEVAL4                          MEVAL  — 1.00
                                        1.10
                                        1.03
              0.77 →  MEVAL5

              1.29 →  MEVAL8

    Chi-Square=20.39, df=5, P-value=0.00106, RMSEA=0.043
```

The significant Chi-square test statistic value above implies that there is sufficient evidence that the 5-item merchandise value scale is not unidimensional. The corresponding standardized residuals are shown in the text editor window below.


```
meval1c.OUT                                                         _ □ X

        Standardized Residuals

              MEVAL1      MEVAL2      MEVAL4      MEVAL5      MEVAL8
            --------    --------    --------    --------    --------
MEVAL1        - -
MEVAL2      -0.811        - -
MEVAL4      -2.413      -1.197        - -
MEVAL5       2.663       1.790      -0.464        - -
MEVAL8       0.267      -0.077       3.475      -3.371        - -
```

The results above indicate that the item MEVAL8 is involved in several significant standardized residuals. As a result, we delete MEVAL8 from the scale and then assess the unidimensionality of the resulting 4-item scale as follows.

➢ 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 **MEVAL1D.SPL** by clicking on it.
➢ Click on the **Open** button to open the following text editor window.

```
meval1d.spl                                    _ □ X

Raw Data from File CLICKS.PSF
Latent Variables
MEVAL
Relationships
MEVAL1 MEVAL2 MEVAL4 MEVAL5 = MEVAL
LISREL Output: ND=3 SC RS
Path Diagram
End of Problem
```

Line 1 specifies the raw data source.
Lines 2 and 3 specifies label for the latent variable.
Lines 4 and 5 specify the model.
Line 6 specifies that the results should be printed in terms of the LISREL model for the model, requests results with three decimal places, the completely standardized solution and an analysis of the residuals.
Line 7 requests a path diagram.
Line 8 indicates no more SIMPLIS commands are to be processed.
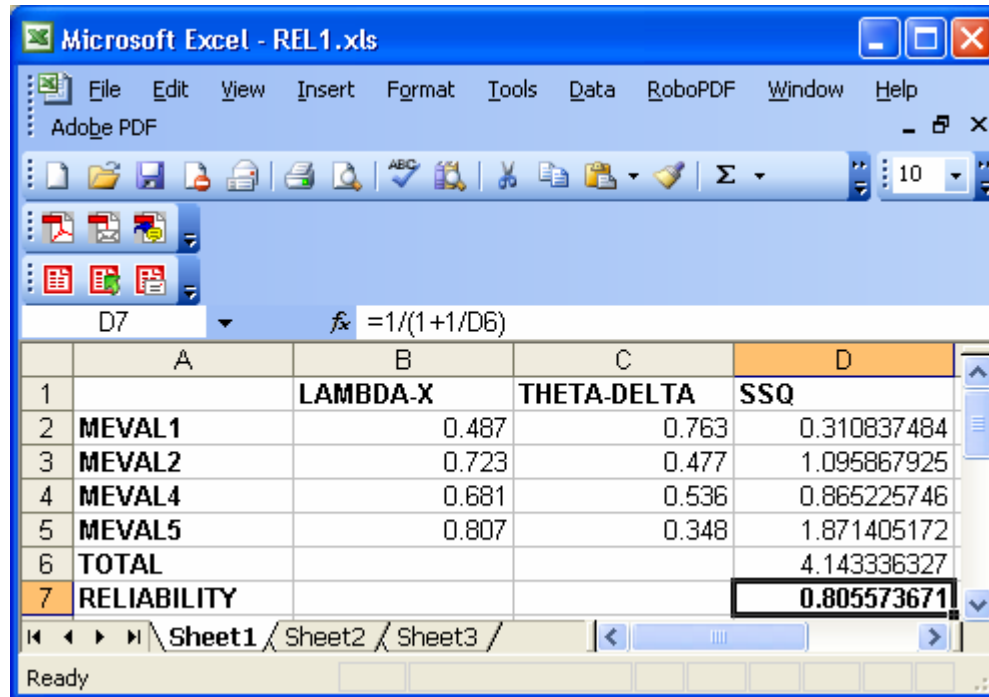
➢ Click on the **Run LISREL** icon on the main toolbar to produce the following PTH window.
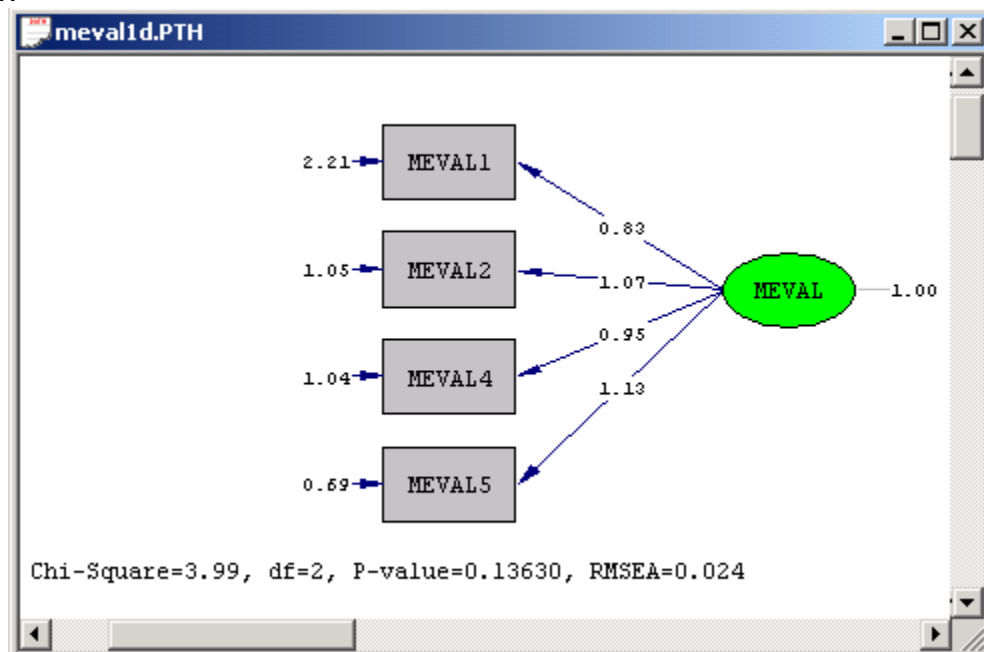
The nonsignificant Chi-square test statistic value above implies that there is insufficient evidence that the 4-item merchandise value scale is not unidimensional.

4. Reliability of the merchandise value scale

The reliability of the linear composite of the four item scores for the merchandize value scale can be computed from the results listed in the output file **MEVAL1D.OUT** by using, for example, Microsoft Excel. The corresponding Microsoft Excel workbook is shown below.

These results imply that although the 4-item merchandise value scale seems to be unidimensional, the reliability of the 4 item scores seems adequate.

5. The discriminant validity of the merchandise value scale

The discriminant validity of a scale is assessed with respect to another scale(s). We will now use the data in **CLICKS.PSF** to illustrate how LISREL 8.80 for Windows may be used to assess discriminant validity of the merchandise value scale with respect to the store environment scale.

Fitting the two factor 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 *MEVALDV.SPL* by clicking on it.
➢ Click on the *Open* button to open the following text editor window.

```
mevalDV.spl                                    _ □ X
    Raw Data from File CLICKS.PSF
    Latent Variables
    MEVAL STENV
    Relationships
    MEVAL1 MEVAL2 MEVAL4 MEVAL5 = MEVAL
    STENV1 STENV3 STENV4 STENV5 = STENV
    LISREL Output: ND=3 SC RS
    Path Diagram
    End of Problem
```

Line 1 specifies the raw data source.
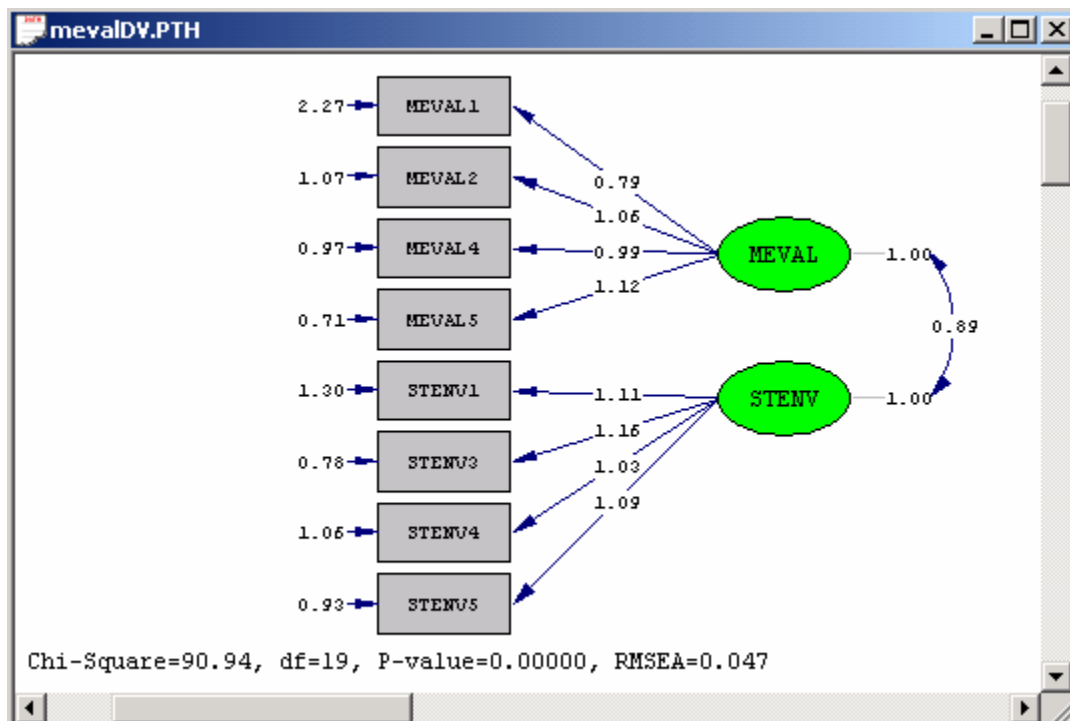Lines 2 and 3 specify labels for the latent variables.
Lines 4 thru 6 specify the model.
Line 7 specifies that the results should be printed in terms of the LISREL model for the model, requests results with three decimal places, the completely standardized solution and an analysis of the residuals.
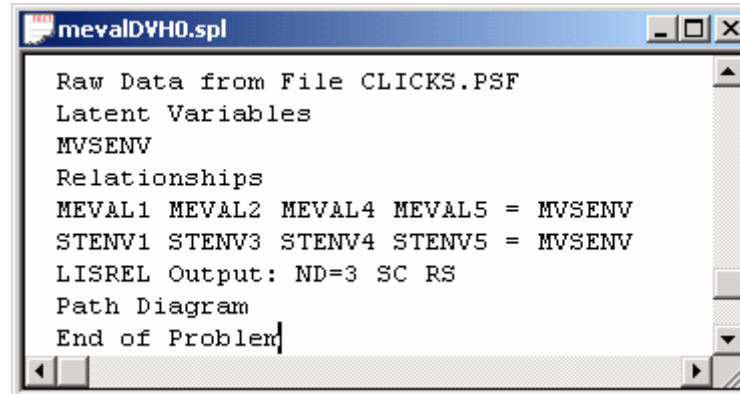Line 8 requests a path diagram.
Line 9 indicates no more SIMPLIS commands are to be processed.

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

Fitting the one factor 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 **MEVALDVH0.SPL** by clicking on it.
➢ Click on the **Open** button to open the following text editor window.

```
mevalDVH0.spl                                    _ □ ×

Raw Data from File CLICKS.PSF
Latent Variables
MVSENV
Relationships
MEVAL1 MEVAL2 MEVAL4 MEVAL5 = MVSENV
STENV1 STENV3 STENV4 STENV5 = MVSENV
LISREL Output: ND=3 SC RS
Path Diagram
End of Problem
```

Line 1 specifies the raw data source.
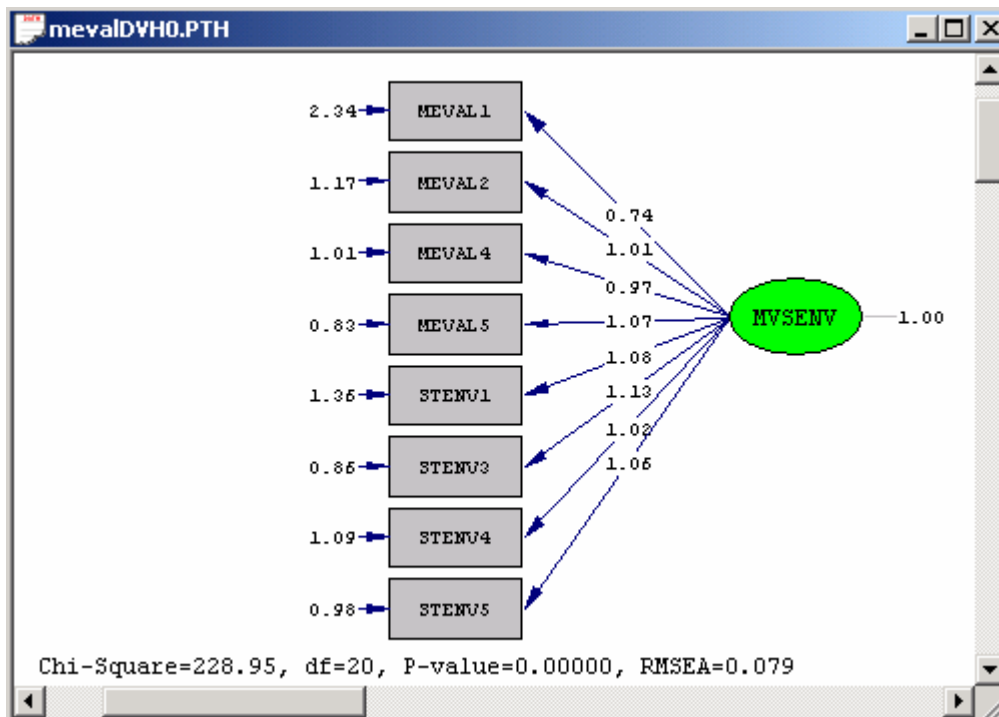Lines 2 and 3 specify labels for the latent variables.
Lines 4 thru 6 specify the model.
Line 7 specifies that the results should be printed in terms of the LISREL model for the model, requests results with three decimal places, the completely standardized solution and an analysis of the residuals.
Line 8 requests a path diagram.
Line 9 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.

```
mevalDVH0.PTH

    2.34  MEVAL1
    1.17  MEVAL2
                        0.74
    1.01  MEVAL4        1.01
                        0.97
    0.83  MEVAL5        1.07      MVSENV  1.00
                        1.08
    1.36  STENV1        1.13
                        1.02
    0.86  STENV3        1.06
    1.09  STENV4
    0.98  STENV5

Chi-Square=228.95, df=20, P-value=0.00000, RMSEA=0.079
```

Performing the Chi-square difference test

A Chi-square difference test is used to assess the discriminant validity of the merchandise value scale with respect to the store environment scale. In other words, a Chi-square difference test is used to test the null and alternative hypotheses. The test statistic value for the Chi-square difference test is merely the difference between the goodness-of-fit Chi-square test statistic values of the multiple group measurement models under the null and the alternative hypotheses. The associated degrees of freedom are merely the difference between the degrees of freedom of the measurement models under the null and the alternative hypotheses. The Chi-square difference test results for the assessment of the discriminant validity of the merchandise value scale with respect to the store environment scale are summarized in the MS-Excel workbook **DV.XLS**. The contents of this file are shown below.

DV.xls

	A	B	C	D
1	HYPOTHESIS	CHISQ	DF	P VALUE
2	1 FACTOR MODEL(H0)	209.077	20	1.78611E-33
3	2 FACTOR MODEL(H1)	91.152	19	2.07188E-11
4	DIFFERENCE	117.925	1	1.8007E-27

The small P-value suggests that there is sufficient evidence that the null hypothesis should be rejected. In other words, there is sufficient evidence that the discriminant validity of the merchandise value scale with respect to the store environment scale is acceptable.

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References

Du Toit, M. & Du Toit, S.H.C. (2001).
   Interactive LISREL: User's Guide. Lincolnwood, IL: Scientific Software International, Inc.
Jöreskog, K.G. & Sörbom, D. (1999).
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   Lincolnwood, IL: Scientific Software International, Inc.
Steenkamp, J.E.M. & Van Trijp, H.C.M. (1991).
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   North-Holland: Elsevier Science Publishers B.V.