

MEASUREMENT MODEL

Two-step approach

Step 1: Measurement model

Step 2: Structural model

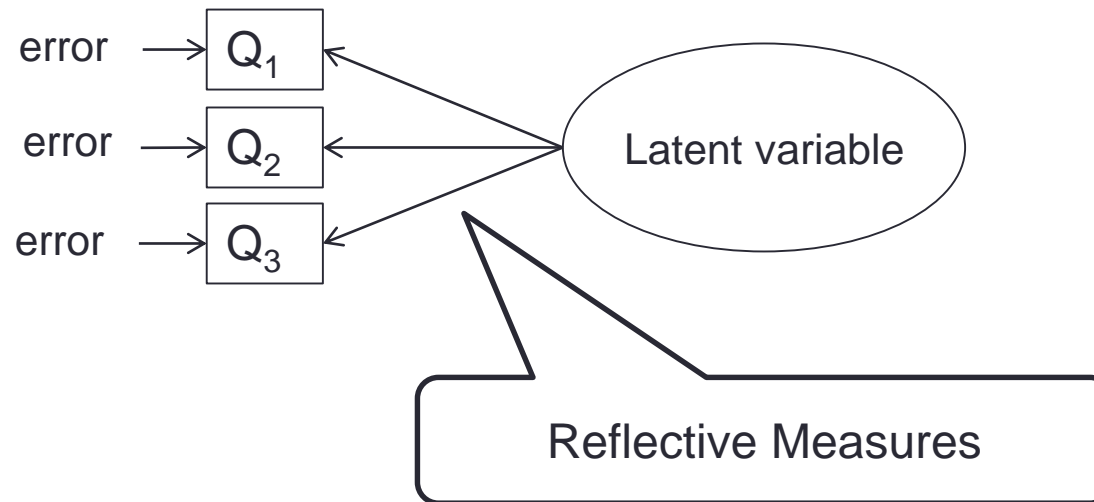
Two-Step Approach

Estimate (and re-specify) the measurement model to assess construct validity before testing theory on the structural model.

- Convergent and discriminant validity
 - Variance extracted and composite reliability
-
- Anderson, James C. and David W. Gerbing (1988), "Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach," *Psychological Bulletin*, 103 (3), 411-23.
 - Fornell, Claes and David F. Larcker (1981), "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error," *Journal of Marketing Research*, 18 (1), 39-50.

Latent variable with 3 measures

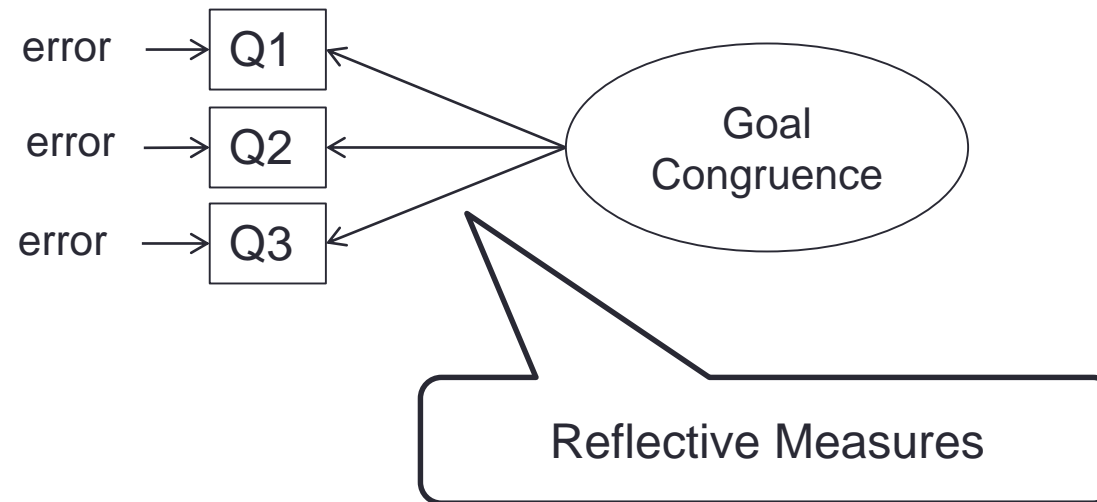
Path Diagram



Bollen, Kenneth and Richard Lennox (1991), "Conventional Wisdom on Measurement: A Structural Equation Perspective," *Psychological Bulletin*, 110 (2), 305-14.

Latent variable with 3 measures

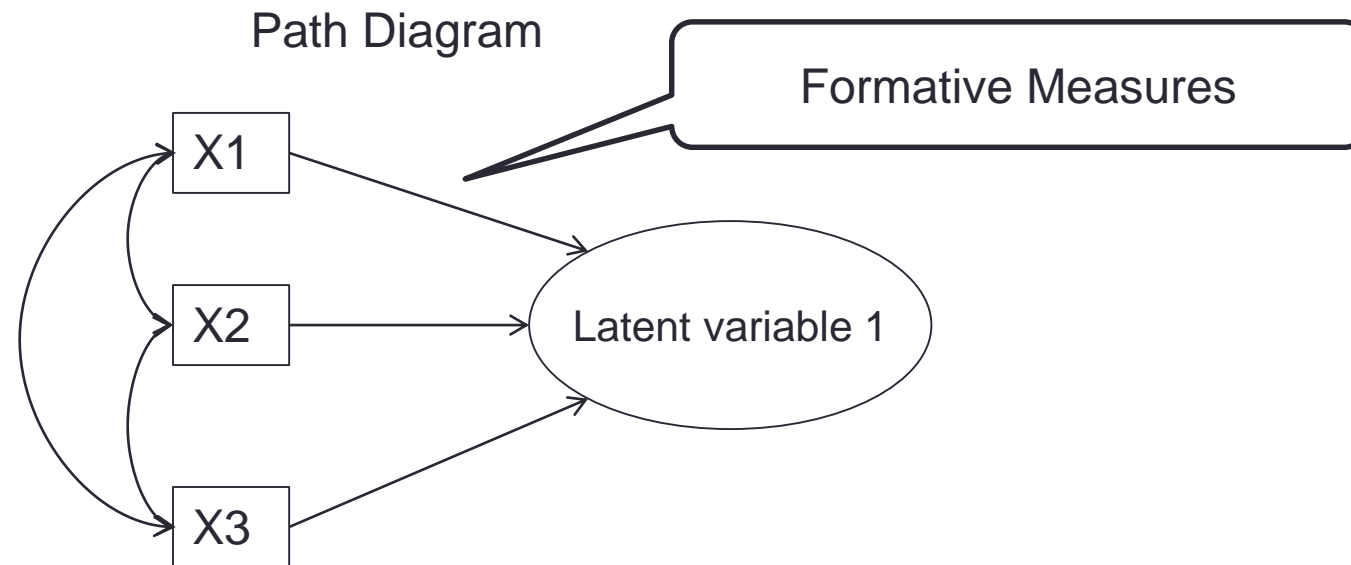
Path Diagram



The three questions in the questionnaire “reflect” goal congruence.

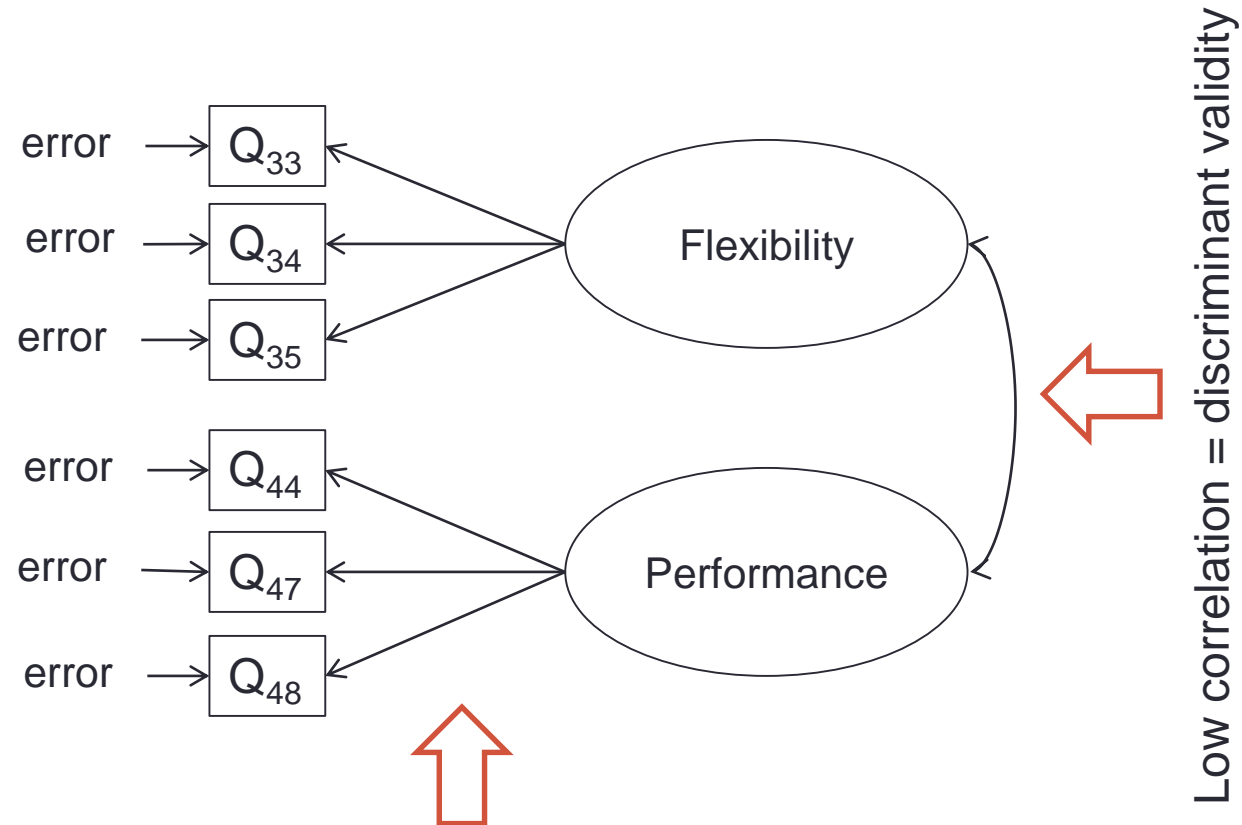
GOALS	Low				High		
	1	2	3	4	5	6	7
1 To what degree do you discuss company goals with the other party in this relationship?							
2 To what degree are these goals developed through joint analysis of potentials?							
3 To what degree are these goals formalized in a joint agreement or contract?							

Causal (formative) Indicators



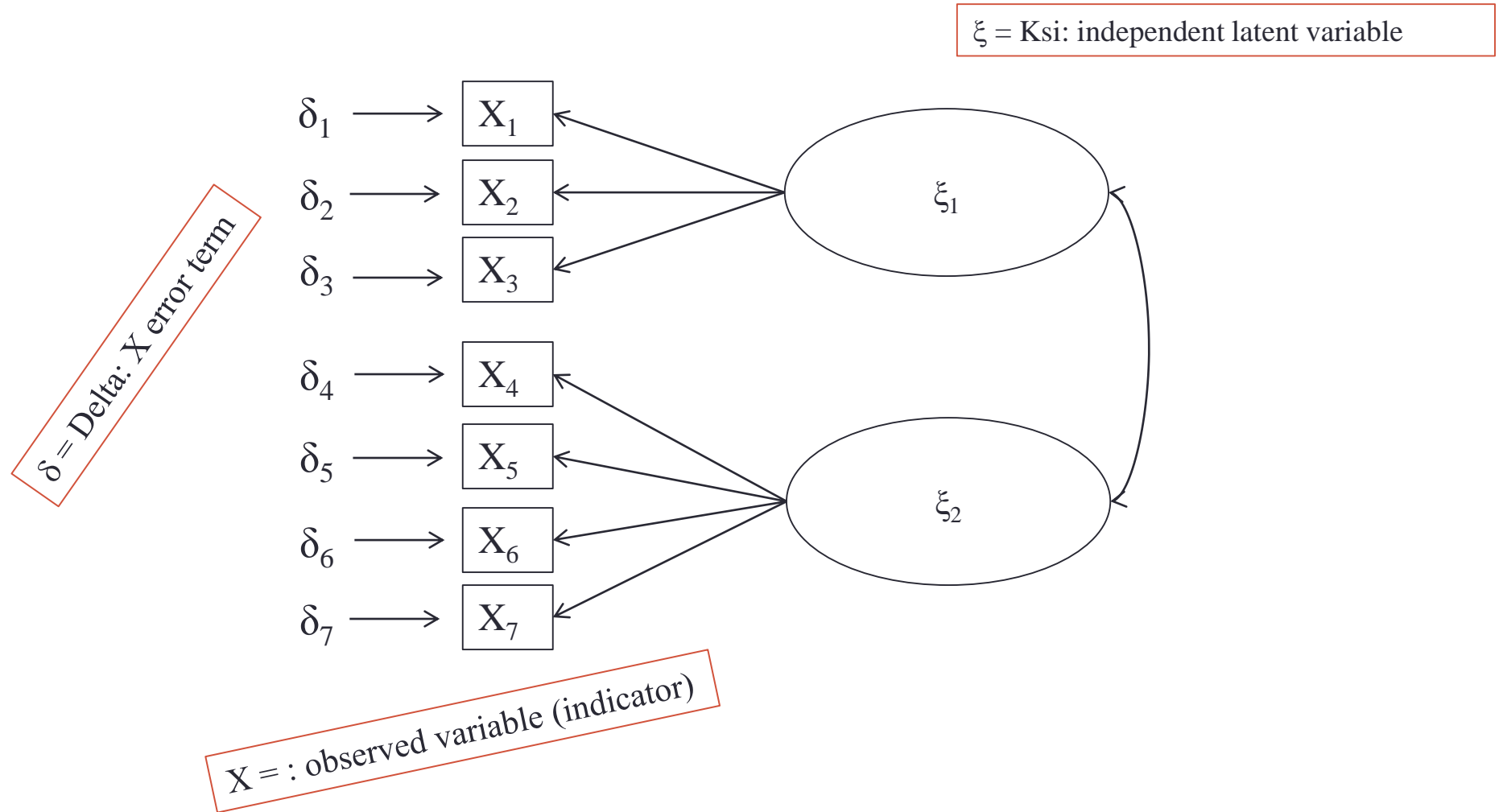
Example: Unemployment (X1), death in family (X2) and divorce (X3) cause stress

Measurement Model

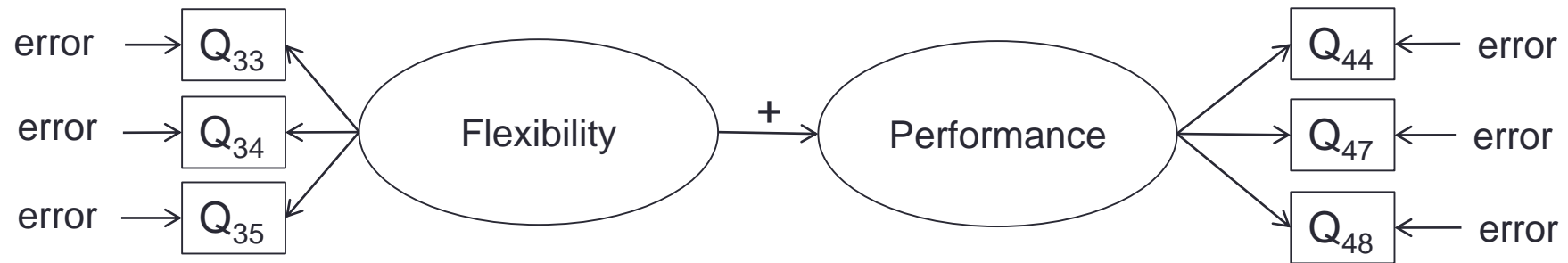


Significant loadings and good fit = convergent validity

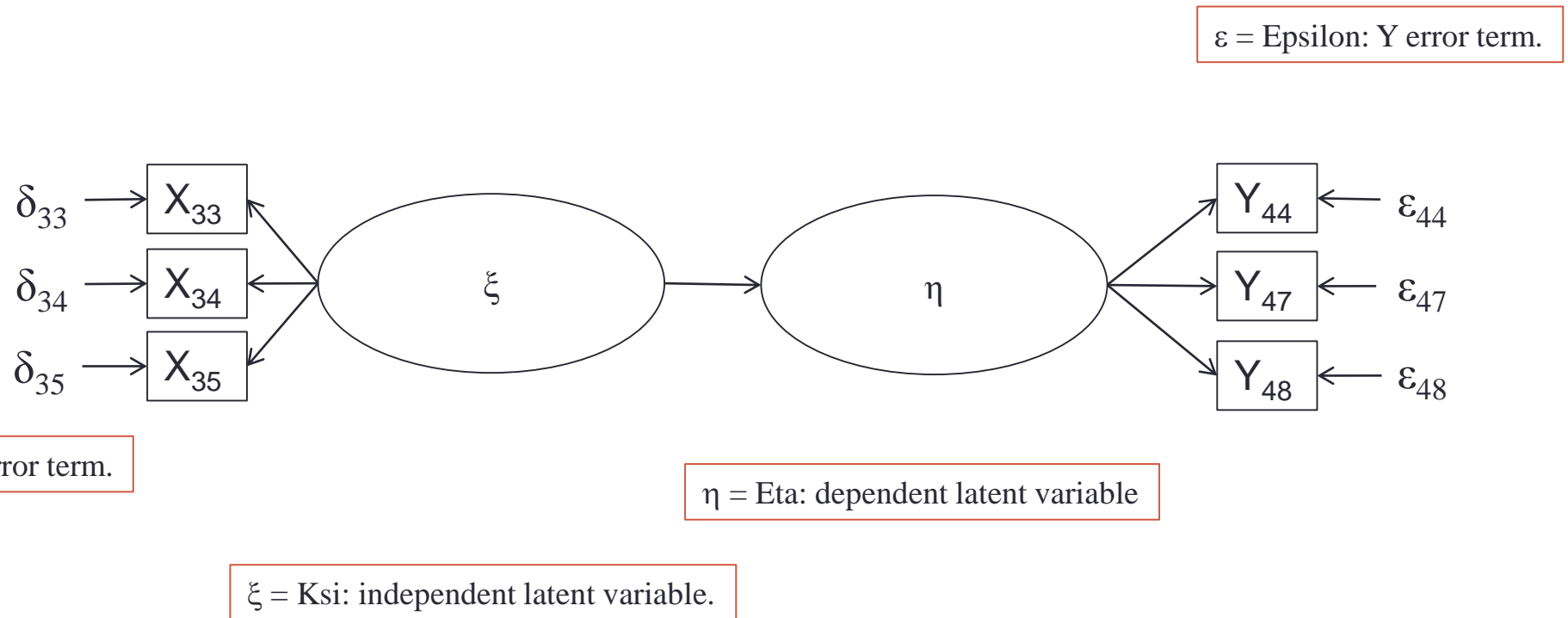
Measurement Model - Greek



Structural Model - Path diagram



Structural Model - Greek

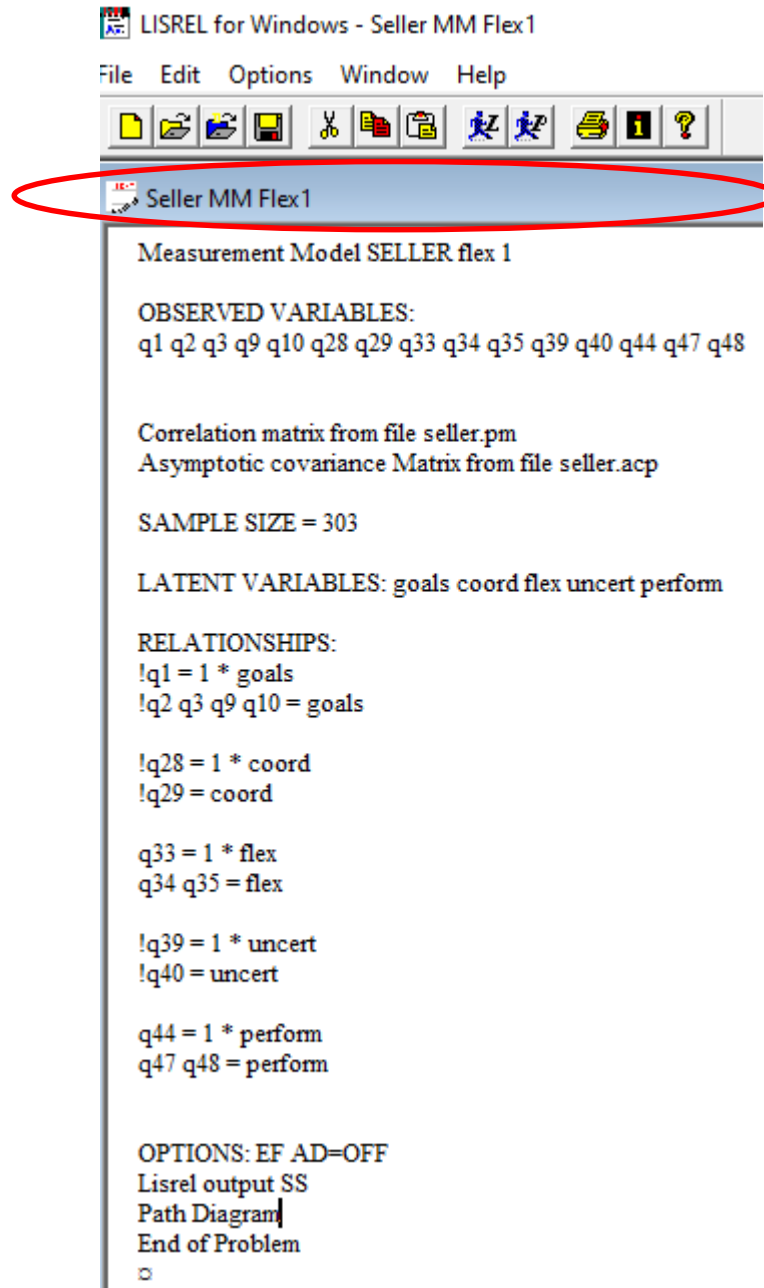


SIMPLIS Syntax Example

One way (I think the easiest) to start a LISREL analysis is to use an existing syntax file.

- Two languages: SIMPLIS and LISREL
- I usually use SIMPLIS because it is more intuitive.

SIMPLIS FILE



The syntax file I am using.

Unstandardized estimates

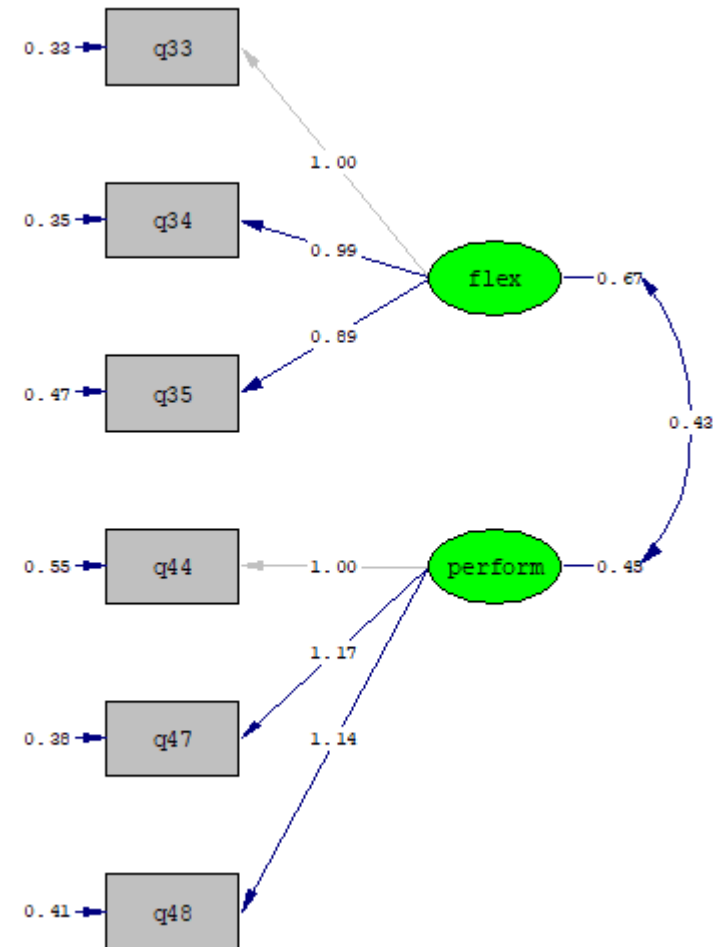
Normed chi2

Chi2 / df should be less than 2

$11.35/8 < 2$, means good model fit

An insignificant p-value (greater than .05), indicates good model fit. .182>.05, so good model fit. NOTE: sensitive to sample size so often misleading.

An RMSEA less than .08 indicates good model fit. .037<.08, so good model fit.

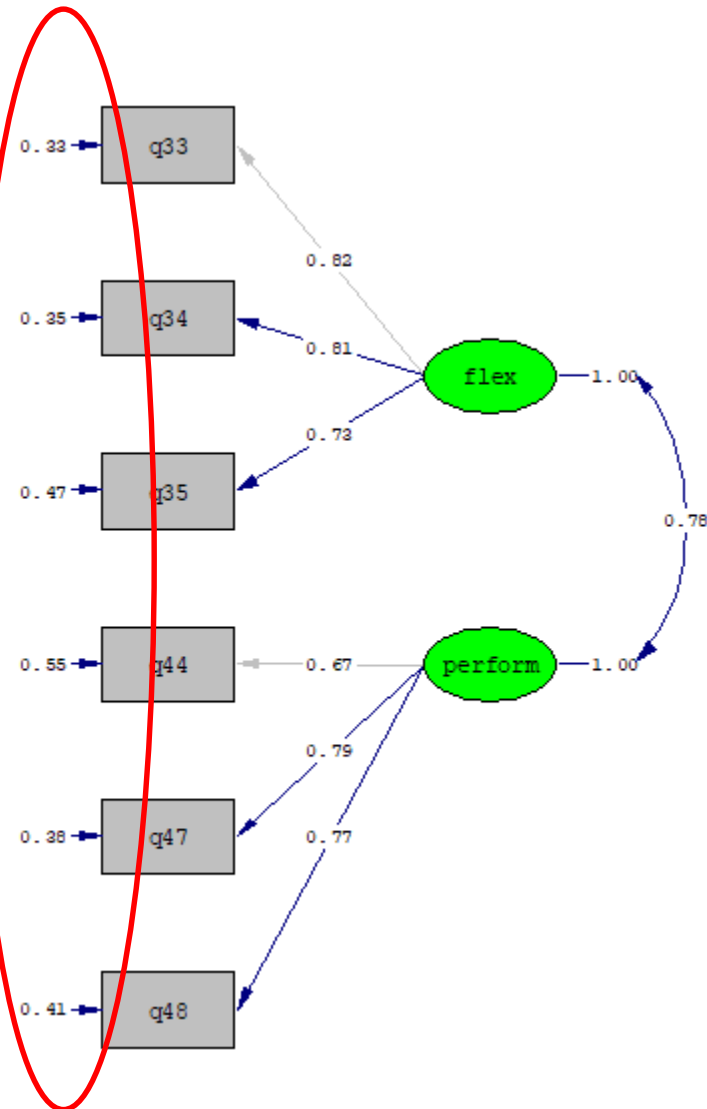


Chi-Square=11.35, df=8, P-value=0.18260, RMSEA=0.037

Standardized solution

Look for negative error terms (Heywood case). If you find one, then you need to specify the error in your syntax. Either a very small error, or approximately what you think the error should be.

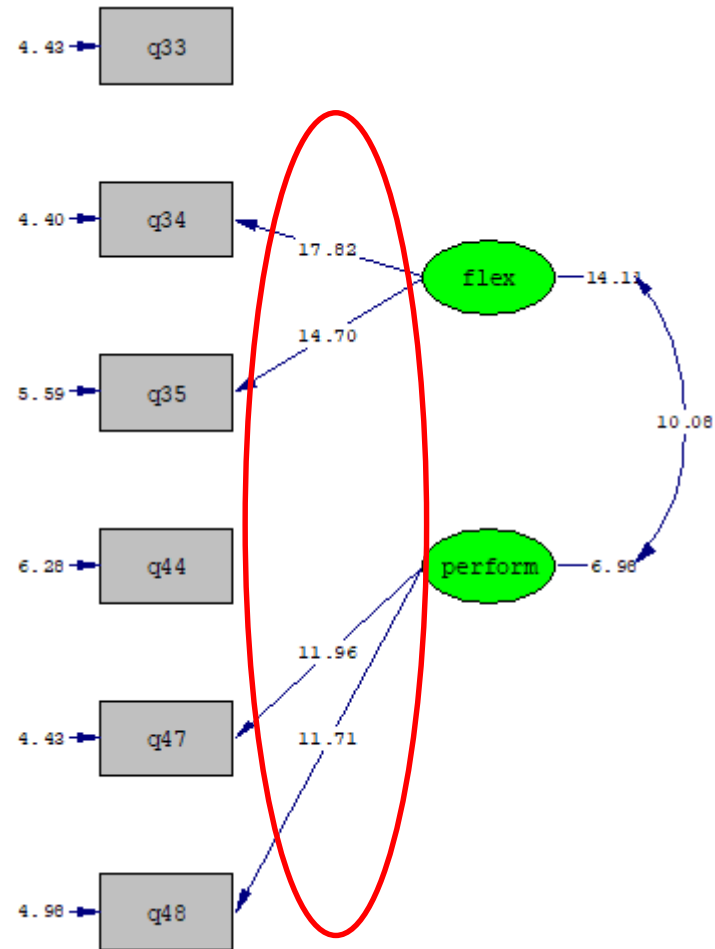
Look for large error terms (above .5). It means that there is more error variance in the indicator than what the factor loading is explaining. Consider removing them.



Chi-Square=11.35, df=8, P-value=0.18260, RMSEA=0.037

t-values

Check the t-values for the factor loadings. The default cutoff is a two-sided test, which is 1.96. A one-sided test cutoff is 1.645. If the value is below 1.96, it will be red.

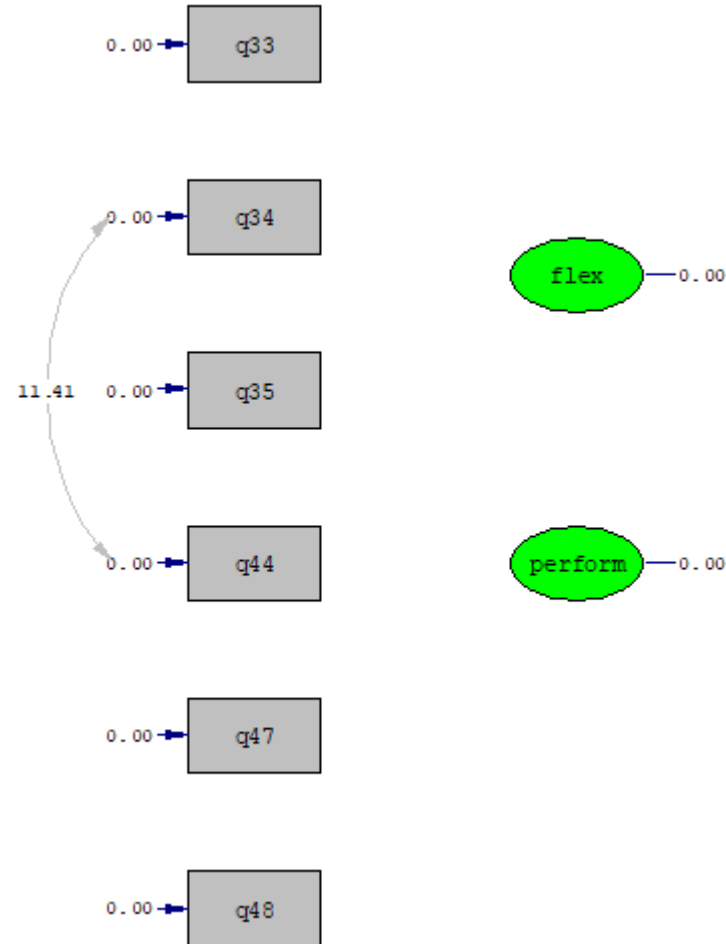


Chi-Square=11.35, df=8, P-value=0.18260, RMSEA=0.027

Modification indices

Modification indices suggest how you could improve model fit. If it suggests an indicator load onto the wrong latent construct, it could indicate cross-loading problems. Maybe remove the indicator.

As a rule, do not improve the model by letting error terms correlate, as suggested in this example. Only do it if you have a strong theoretical rational for it. (e.g. the same thing measured at two times).



Chi-Square=11.35, df=8, P-value=0.18260, RMSEA=0.037

In the example, model fit was good and all measured indicators had significant factor loadings. You can conclude that the model has convergent validity. To check discriminant validity you check the standardized correlation between latent constructs (the phi matrix).

PHI			Standardized Solution		
	flex	perform		flex	perform
flex	0.67 (0.05)		flex	1.00	
perform	0.43 (0.04)	0.45 (0.07)	perform	0.78	1.00
Standard error	10.08	6.98	Standardized loading		

Anderson and Gerbing (1988)

In the standardized phi matrix the loading $\pm 2(\text{std. error})$ does not include 1.

Flex to Perform

$.78 + 2(.04) = .86$ does not include 1 (is below an absolute value of 1).

Full measurement model syntax (no exclamation marks)

➤ Seller MM Flex1

Measurement Model SELLER flex 1

OBSERVED VARIABLES:

q1 q2 q3 q9 q10 q28 q29 q33 q34 q35 q39 q40 q44 q47 q48

Correlation matrix from file seller.pm

Asymptotic covariance Matrix from file seller.acp

SAMPLE SIZE = 303

LATENT VARIABLES: goals coord flex uncert perform

RELATIONSHIPS:

q1 = 1 * goals

q2 q3 q9 q10 = goals

q28 = 1 * coord

q29 = coord

q33 = 1 * flex

q34 q35 = flex

q39 = 1 * uncert

q40 = uncert

q44 = 1 * perform

q47 q48 = perform

OPTIONS: EF AD=OFF

Lisrel output SS

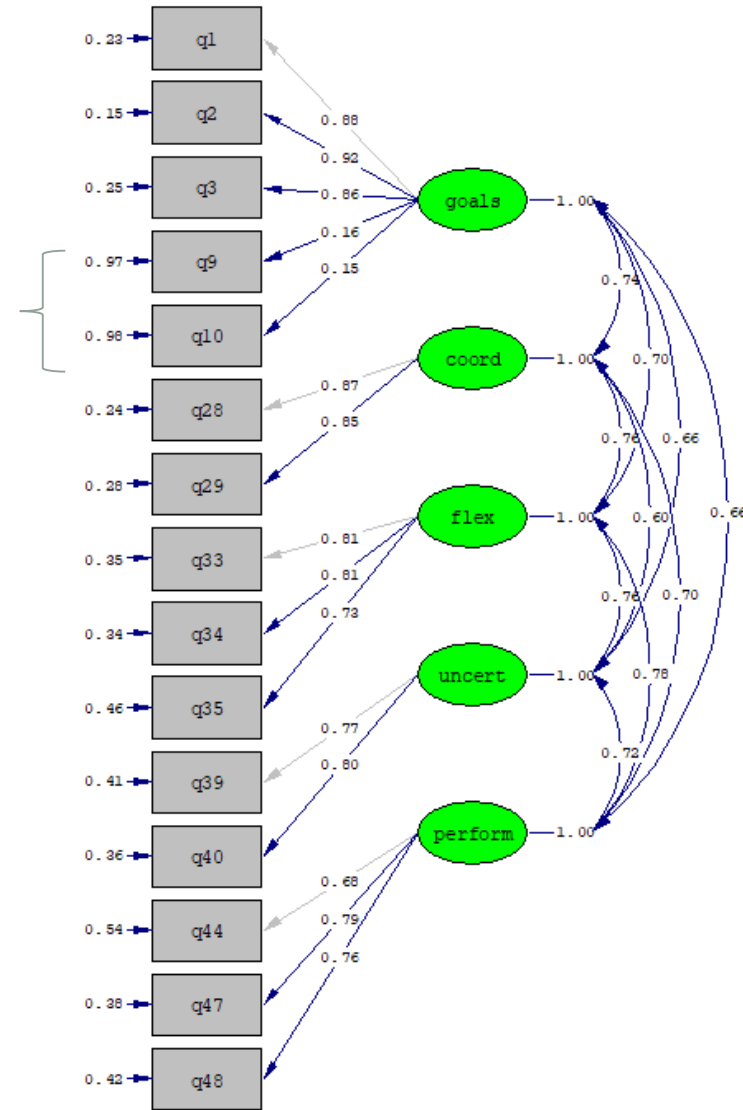
Path Diagram

End of Problem

□

Standardized solution

Large error



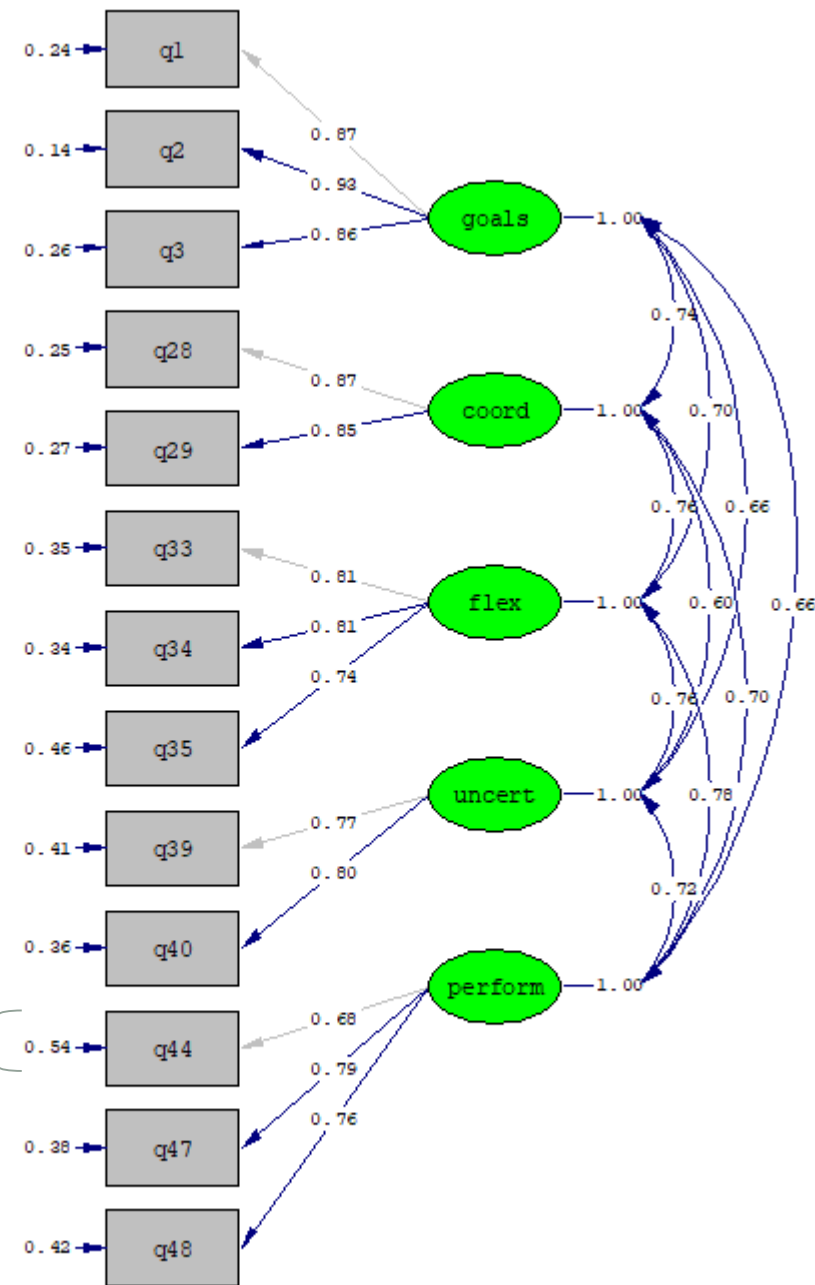
Poor fit

Chi-Square=192.65, df=80, P-value=0.00000, RMSEA=0.068

Standardized solution

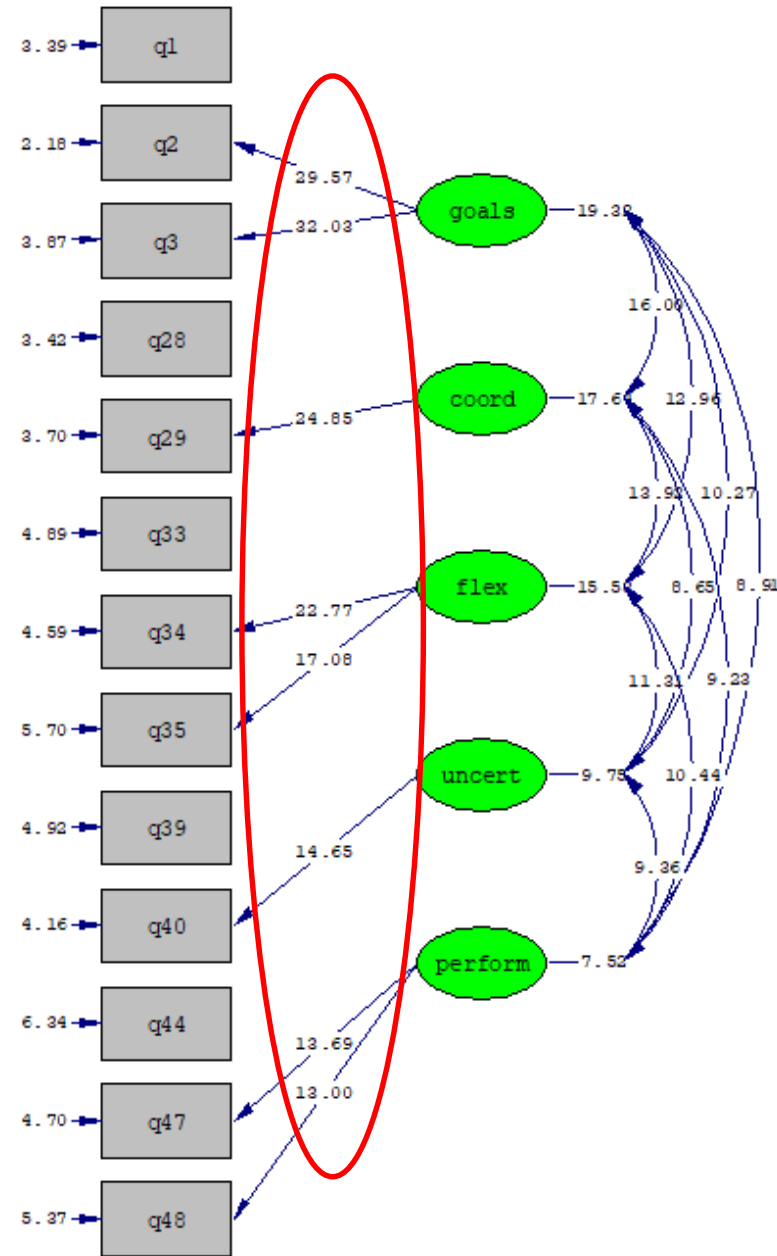
Slightly large error

Excellent fit



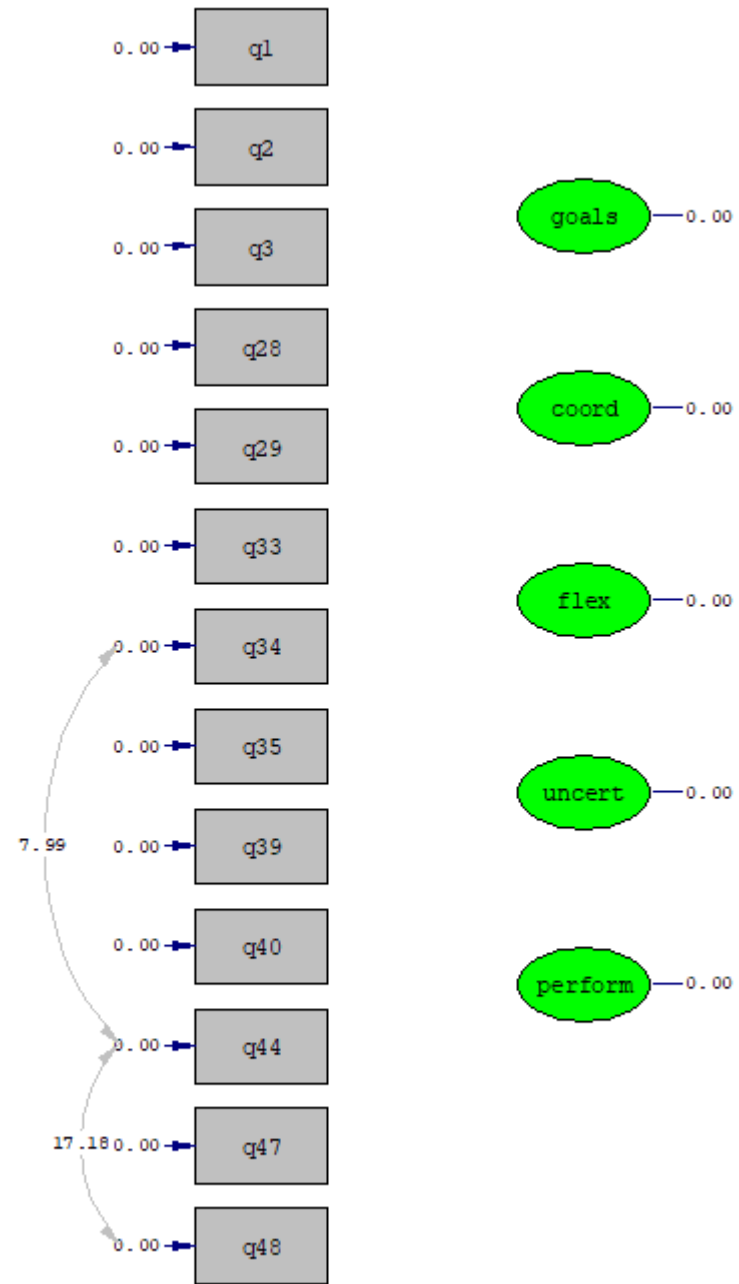
Chi-Square=44.17, df=55, P-value=0.85196, RMSEA=0.000

T-values are all over 1.96,
So all factor loadings are significant.



Chi-Square=44.17, df=55, P-value=0.85196, RMSEA=0.000

Modification indices
No cross-loadings



Chi-Square=44.17, df=55, P-value=0.85196, RMSEA=0.000

PHI					
	goals	coord	flex	uncert	perform
goals	0.76 (0.04) 19.32				
coord	0.56 (0.03) 16.00	0.75 (0.04)			
flex	0.49 (0.04) 12.96	0.53 (0.04)	0.65 (0.04)		
uncert	0.44 (0.04) 10.27	0.40 (0.05)	0.47 (0.04)	0.59 (0.06)	
perform	0.39 (0.04) 8.91	0.42 (0.05) 9.23	0.43 (0.04) 10.44	0.37 (0.04) 9.36	0.46 (0.06) 7.52

Standardized Solution

PHI					
	goals	coord	flex	uncert	perform
goals	1.00				
coord	0.74	1.00			
flex	0.70	0.76	1.00		
uncert	0.66	0.60	0.76	1.00	
perform	0.66	0.70	0.78	0.72	1.00

The standardized loadings + 2 times the standard errors do not include 1.
The model has discriminant validity.

By several fit indices we have excellent fit. See Hair et al. appendix.

Goodness of Fit Statistics

Degrees of Freedom = 55
Minimum Fit Function Chi-Square = 74.31 (P = 0.042)
Normal Theory Weighted Least Squares Chi-Square = 75.45 (P = 0.035)
Satorra-Bentler Scaled Chi-Square = 44.17 (P = 0.85)
Chi-Square Corrected for Non-Normality = 48.41 (P = 0.72)
Estimated Non-centrality Parameter (NCP) = 0.0
90 Percent Confidence Interval for NCP = (0.0 ; 7.22)

Minimum Fit Function Value = 0.25
Population Discrepancy Function Value (F0) = 0.0
90 Percent Confidence Interval for F0 = (0.0 ; 0.024)
Root Mean Square Error of Approximation (RMSEA) = 0.0
90 Percent Confidence Interval for RMSEA = (0.0 ; 0.021)
P-Value for Test of Close Fit (RMSEA < 0.05) = 1.00

Expected Cross-Validation Index (ECVI) = 0.42
90 Percent Confidence Interval for ECVI = (0.42 ; 0.44)
ECVI for Saturated Model = 0.60
ECVI for Independence Model = 19.76

Chi-Square for Independence Model with 78 Degrees of Freedom = 5941.19
Independence AIC = 5967.19
Model AIC = 116.17
Saturated AIC = 182.00
Independence CAIC = 6028.46
Model CAIC = 285.86
Saturated CAIC = 610.95

Normed Fit Index (NFI) = 0.99
Non-Normed Fit Index (NNFI) = 1.00
Parsimony Normed Fit Index (PNFI) = 0.70
Comparative Fit Index (CFI) = 1.00
Incremental Fit Index (IFI) = 1.00
Relative Fit Index (RFI) = 0.99

Critical N (CN) = 563.68

Root Mean Square Residual (RMR) = 0.028
Standardized RMR = 0.028
Goodness of Fit Index (GFI) = 0.96
Adjusted Goodness of Fit Index (AGFI) = 0.94
Parsimony Goodness of Fit Index (PGFI) = 0.58

