TABLE 5.3 Interfactor Correlations

	1	2	3
1. Union Loyalty	1.00		
2. Willingness to Work for the Union	0.72	1.00	
3. Responsibility to the Union	0.78	0.56	1.00

NOTE: All parameters $p < .01$.

factors [$\chi^2_{difference}(2) = 147.47$, $p < .01$], or one factor [$\chi^2_{difference}(3) = 202.18$, $p < .01$]. Moreover, inspection of the indices of parsimonious fit (i.e., the PNFI and PGFI) suggests that the three-factor model provides the most parsimonious fit to the data.

Standardized parameter estimates for the model are presented in Table 5.2. As shown, model parameters were all significant ($p < .01$) and explained substantial amounts of item variance (R^2 ranged from 0.37 to 0.74). As shown in Table 5.3, the three factors were significantly correlated ($r = .56$, .72, and .78).

CHAPTER 6 *Observed Variable Path Analysis*

Path analysis with observed variables is the "oldest" variety of structural equation modeling. In contrast to the assessment of a measurement model as presented in the previous chapter, the goal of path analysis is to test a "structural" model, that is, a model comprising theoretically based statements of relationships among constructs.

For an example of path analysis, I will use a scaled-down version of the model presented by Kelloway and Barling (1993). The intent of the research was to predict union members' involvement in union activities (attending meetings, serving as officers, reading union literature, voting in elections). The theoretical development of the model relied heavily on Fishbein and Ajzen's (1975) theory of reasoned action. In brief, the theory of reasoned action suggests that the best predictor of actual behavior is an individual's intent to engage in the behavior. In turn, behavioral intentions are predicted by one's attitudes toward the activity and subjective norms. One's beliefs about the activity predict attitudes toward the behavior.

Model Specification

In our study, we had measures of participation in union activities (the behavior), willingness to participate in the union (which we treated as a behavioral intention), union loyalty (attitudes toward the union), and subjective norms (perceptions of family, friends, and important people

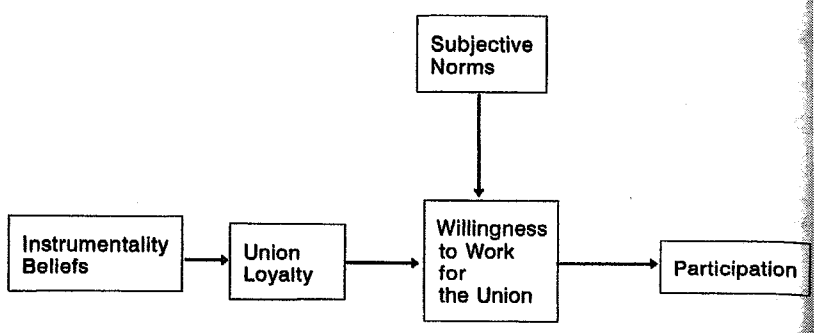

Figure 6.1.

regarding participation). Finally, we constructed a scale assessing individuals' beliefs regarding the instrumentality of participation. The path diagram corresponding to our translation of Fishbein and Ajzen's (1975) theory is shown in Figure 6.1.

Note that in this model we have two exogenous variables (norms and instrumentality) that are allowed to correlate freely. There are three endogenous variables (loyalty, willingness, and actual participation). Attitudes are predicted by instrumentality beliefs. Willingness to work for the union is hypothesized to be totally a function of attitudes and norms. Participation is hypothesized to be predicted by willingness.

Because this is a path analysis using only manifest or observed variables, the LISREL model focuses only on the structural model (matrices BE, GA, and PS). The measurement model is ignored. Note that one of the assumptions of observed variable path analysis is that all variables are measured without error. Although this assumption is untenable in the social sciences, it typically is satisfied by the requirement that all variables manifest high levels of reliability (often defined as alphas > .70; Pedhazur, 1982). This assumption was met in the current example (Kelloway & Barling, 1993).

From Pictures to LISREL

The LISREL matrices corresponding to the path diagram are presented below. As a reminder, in making the translation from path diagrams to LISREL matrices, remember that columns cause rows.


```
BETA (relates endogenous to endogenous)
                Particip        Willingn        Loyalty
                --------        --------        -------
Participation   FIxed           FRee            FIxed
Willingness     FIxed           FIxed           FRee
Loyalty         FIxed           FIxed           FIxed

GAMMA (relates exogenous to endogenous)
                Instrume        Norms
                --------        -----
Participation   FIxed           FIxed
Willingness     FIxed           FRee
Loyalty         FRee            FIxed

PSI (residual variances of endogenous)
Participation   Willingn        Loyalty
                --------        -------
Free            FRee            Free
```

The PSI matrix in this model deserves some comment. PSI contains the residuals of the endogenous variables. Residual variances are represented on the diagonal, with correlated errors of prediction (correlated residuals) in the off-diagonal elements. One of the assumptions of traditional path analysis is that the model contains all relevant causal influences for the endogenous variables (the model is fully specified). Under this assumption, the covariances of the endogenous variables are fully explained by the posited relationships in the model; hence, there are no correlated errors of prediction.

In the current example, I explicitly tell LISREL that there are no covariances or correlations between the endogenous variables (after accounting for the structural relations). Operationally, this means that PSI is a diagonal matrix (a vector containing only the residual variances of the endogenous variables).

Alternative Models

For our purposes, a reasonable alternative to the proposed model is based on the findings of Fullagar and colleagues (1992) and Kelloway and Barling (1993). In both studies, the authors reported that in addition to the paths presented in the Fishbein and Ajzen-based model, subjective

norms was a predictor of union loyalty. Adding this path to the proposed model creates a plausible alternative model that stands in nested sequence with the original model.

When the literature does not offer a plausible rival model specification, alternative models can be generated by considering (a) omitted parameters and (b) indirect effects in structural equation models. I have previously noted (Kelloway, 1996) that most researchers build models from the "bottom up," offering a theoretic or empirical rationale for the inclusion of certain parameters in their models.

In contrast to this procedure, I also have suggested (Kelloway, 1995) that there is some advantage in developing models from the top down, that is, providing justification for the omission of parameters from the model. The rationale for this suggestion is that tests of model fit are, in essence, tests of omitted parameters (Brannick, 1995; Kelloway, 1995). That is, because the just-identified or saturated model always provides a perfect fit to the data, testing an overidentified model for fit is, in essence, testing whether the overidentifying restrictions (e.g., omitted paths) are necessary.

Thus, although researchers should continue to justify the inclusion of specific parameters in their model, I suggest that there is considerable merit in paying equal attention to the parameters omitted from the model. When researchers have no particular justification for the inclusion or omission of a particular parameter, an opportunity is created to formulate and test competing models.

In particular, researchers need to consider the implications of indirect relationships posited in their models. The indirect relationship of X on Z (through Y) can be diagrammed as $X \rightarrow Y \rightarrow Z$. There are at least two interpretations of such relationships. First, Y may be viewed as a mediator of the $X \rightarrow Z$ relationship such that the effects of X on Z are completely mediated by Y. The rationale and sequence for mediator tests is presented by Baron and Kenny (1986). The first condition of such a test is that X and Z are significantly related. In many applications of structural models containing an indirect relationship, however, there is no significant relationship between X and Z, and the indirect relationship may be more appropriately thought of as one of sequential causation. Considering the interpretation of indirect relationships a priori would assist in the identification of alternative models for analyses (Kelloway, 1995) and assist researchers in formulating more precise hypotheses in their models.

In the current example, there are several mediated relationships posited: Willingness to work for the union mediates the relationship

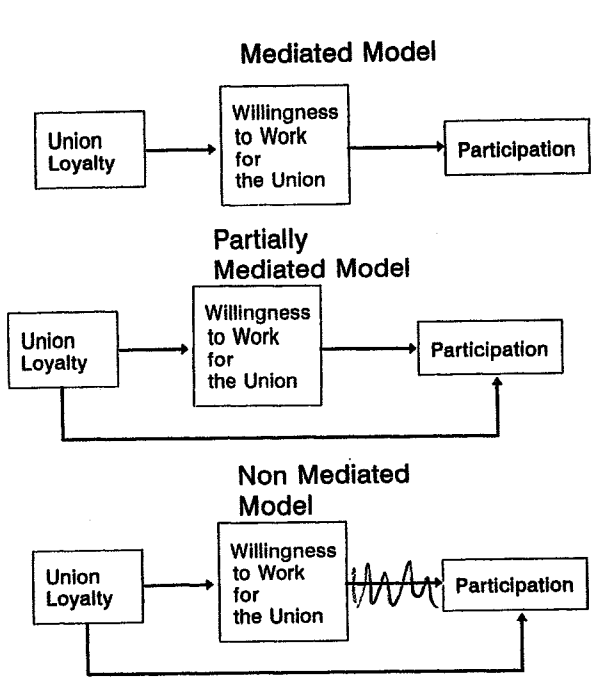

Figure 6.2.

between loyalty and participation as well as the link between subjective norms and participation. Similarly, loyalty mediates the relationship between instrumentality beliefs and willingness. Each of these mediational relationships provides an opportunity to generate plausible rival specifications within a nesting sequence.

For each mediated relationship in a model, there are two plausible rival specifications: a partially mediated model and a nonmediated model. To illustrate these models, consider the diagrams presented in Figure 6.2. Each diagram gives a plausible account of how loyalty is related to participation. First, the mediated model suggests that loyalty causes willingness, which in turn causes participation. Second, the partially mediated model suggests that loyalty causes both willingness and participation directly. In the partially mediated model, willingness also is hypothesized as a cause of participation. Finally, the nonmediated model suggests that loyalty causes both willingness and participation but there is no direct relationship between willingness and participation.

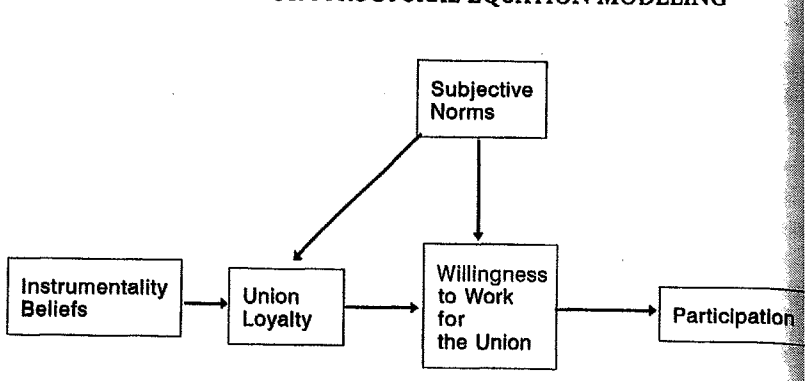

Figure 6.3.

As was the case for confirmatory path analysis, another source o alternative models is the research literature. With reference to th current example, Fullagar and colleagues (1992) found that subjectiv norms were a predictor of union loyalty as well as willingness to wor for the union. Adding this path to the original model gives the mode depicted in Figure 6.3.

Identification

Bollen (1989) cites four rules for the identification of structural models the *t* rule (see Chapter 5), the null B rule, the recursive rule, and rank and order conditions.[1] The null B rule states that a model is identifiec if there are no predictive relationships between the endogenous vari ables (in LISREL terminology, leading to the definition of the beta matrix as a null matrix). The null B rule is a sufficient condition for mode identification, and its most common example is the estimation of a multiple regression equation. Note that the null B rule is a sufficient but not necessary condition for the identification of a structural model.

The recursive rule states that recursive models, incorporating only one-way causal flow, are identified; again, recursion is a sufficient condition for identification of structural models. Again, recursion is a sufficient but not necessary condition for identification. Although we shall not deal with nonrecursive models, it is possible to estimate identified models allowing for bidirectional causality. Given our focus on recursive models, the models described earlier are, by definition, identified.

Estimation

The code used to estimate the model is given below, with explanatory comments. Following the code, the annotated output from the LISREL job is presented, followed by an edited output from a second run incorporating the effect of subjective norms on loyalty.

```
TI Reasoned action model of union participation
DA NI = 5 NO = 202 MA = CM
```

Note: There are five input variables, based on 202 observations, and I want LISREL to analyze the covariance matrix.

```
CM SY
  2.637
  3.071    15.972
  3.550    16.014    31.921
  2.615    10.719    19.247    31.002
  5.495    24.191    33.299    25.070    132.315
```

Note: This time I am reading in a lower diagonal covariance matrix (variances on the diagonal, covariances on the off-diagonal).

```
LA
  'Participation' 'Willingness' 'Loyalty'
  'Instrumentality' 'Sub. Norms'
```

Note: These are the variable labels.

```
MO NX = 2 NY = 3 PS = DI,FR BE = FU,FI GA = FU,FI
```

Note: I have specified that there are two exogenous (NX) and three endogenous (NY) variables. I have declared PSI to be a diagonal matrix (no off-diagonal elements) that is freely estimated. This tells LISREL to estimate the residual variances (but not covariances) for the endogenous variables. As a matter of habit, I always declare that both GAmma and BEta are full (rectangular) and fixed. This procedure allows me to ensure that the only elements to be estimated in this model are the ones I explicitly tell LISREL to free.

```
FR BE(1,2) BE(2,3)
```

Note: This code tells LISREL to estimate the path from willingness (2) to participation (1) and the path from loyalty (3) to willingness (2).

```
FR GA(3,1) GA(2,2)
```

Note: This code tells LISREL to estimate the paths from both exogenous variables, beliefs (1) and norms (2), to loyalty (3) and willingness (2).

```
OU ML TO MI SS TV EF
```

Note: This code specifies that I want maximum likelihood estimation (ML), with the printout to be 80 columns wide (TO). I also have specified that I would like to see the modification indices (MI), the standardized solution (SS), the *t* values for parameters (TV), and the estimates for all effects (both direct and indirect) in the model (EF).

```
ANNOTATED OUTPUT
NUMBER OF INPUT VARIABLES 5
NUMBER OF Y - VARIABLES   3
NUMBER OF X - VARIABLES   2
NUMBER OF ETA - VARIABLES 3
NUMBER OF KSI - VARIABLES 2
NUMBER OF OBSERVATIONS  202

TI REASONED ACTION MODEL OF UNION PARTICIPATION
COVARIANCE MATRIX TO BE ANALYZED
            Particip   Willingn   Loyalty   Instrume   Subjecti
            --------   --------   -------   --------   --------
Particip      2.64
Willingn      3.07      15.97
 Loyalty      3.55      16.01      31.92
Instrume      2.62      10.72      19.25      31.00
Subjecti      5.50      24.19      33.30      25.07     132.32

TI REASONED ACTION MODEL OF UNION PARTICIPATION PARAMETER
SPECIFICATIONS
BETA
```



```
            Particip   Willingn   Loyalty
            --------   --------   -------
Particip       0          1         0
Willingn       0          0         2
 Loyalty       0          0         0

GAMMA
            Instrume   Subjecti
            --------   --------
Particip       0          0
Willingn       0          3
 Loyalty       4          0

PHI
            Instrume   Subjecti
            --------   --------
Instrume       5
Subjecti       6          7

PSI
            Particip   Willingn   Loyalty
            --------   --------   -------
               8          9         10
```

Note: Once again, the LISREL output begins by repeating the model specification. This information always should be scanned to ensure that the model you think you are testing is the one that the program actually is working with.

```
TI REASONED ACTION MODEL OF UNION PARTICIPATION
Number of Iterations = 6
LISREL ESTIMATES (MAXIMUM LIKELIHOOD)
BETA
            Particip   Willingn   Loyalty
            --------   --------   -------
Particip      - -        0.19       - -
                        (0.03)
                         7.30
Willingn      - -        - -        0.42
                                    (0.04)
                                    12.02
Loyalty       - -        - -        - -
```

GAMMA

	Instrume	Subjecti
Particip	- -	- -
Willingn	- -	0.08
		(0.02)
		4.45
Loyalty	0.62	- -
	(0.06)	
	10.91	

Note: These are the maximum likelihood estimates of the parame ters, followed by the standard errors (in parentheses) and the *t* value (parameter/standard error). In regression terms, these are the unstan dardized regression weights.

COVARIANCE MATRIX OF Y AND X

	Particip	Willingn	Loyalty	Instrume	Subjecti
Particip	2.59				
Willingn	2.85	14.82			
Loyalty	2.82	14.65	31.92		
Instrume	1.93	10.04	19.25	31.00	
Subjecti	3.21	16.71	15.56	25.07	132.32

PHI

	Instrume	Subjecti
Instrume	31.00	
Subjecti	25.07	132.32

PSI

Particip	Willingn	Loyalty
2.05	7.36	19.97
(0.21)	(0.74)	(2.00)
9.97	9.97	9.97

SQUARED MULTIPLE CORRELATIONS FOR STRUCTURAL EQUATIONS

Particip	Willingn	Loyalty
0.21	.50	0.37

Note: For each endogenous variable in the model, LISREL calculates the R^2 value, which is interpreted exactly the same as R^2 values in regression. In the current case, the model is able to explain 21% of the variance in participation, 50% of the variance in willingness to work for the union, and 37% of the variance in union loyalty.

GOODNESS OF FIT STATISTICS

CHI-SQUARE WITH 5 DEGREES OF FREEDOM	=	33.24 (P = 0.0000034)
ESTIMATED NON-CENTRALITY PARAMETER (NCP)	=	28.24
MINIMUM FIT FUNCTION VALUE	=	0.17
POPULATION DISCREPANCY FUNCTION VALUE (F0)	=	0.14
ROOT MEAN SQUARE ERROR OF APPROXIMATION (RMSEA)	=	0.17
P-VALUE FOR TEST OF CLOSE FIT (RMSEA < 0.05)	=	0.00018
EXPECTED CROSS-VALIDATION INDEX (ECVI)	=	0.27
ECVI FOR SATURATED MODEL	=	0.15
ECVI FOR INDEPENDENCE MODEL	=	1.90
CHI-SQUARE FOR INDEPENDENCE MODEL WITH 10 DEGREES OF FREEDOM	=	367.51
INDEPENDENCE AIC	=	377.51
MODEL AIC	=	53.24
SATURATED AIC	=	30.00
INDEPENDENCE CAIC	=	399.05
MODEL CAIC	=	96.33
SATURATED CAIC	=	94.62
ROOT MEAN SQUARE RESIDUAL (RMR)	=	5.04
STANDARDIZED RMR	=	0.098
GOODNESS OF FIT INDEX (GFI)	=	0.94
ADJUSTED GOODNESS OF FIT INDEX (AGFI)	=	0.83
PARSIMONY GOODNESS OF FIT INDEX (PGFI)	=	0.31
NORMED FIT INDEX (NFI)	=	0.91
NON-NORMED FIT INDEX (NNFI)	=	0.84
PARSIMONY NORMED FIT INDEX (PNFI)	=	0.45
COMPARATIVE FIT INDEX (CFI)	=	0.92
INCREMENTAL FIT INDEX (IFI)	=	0.92
RELATIVE FIT INDEX (RFI)	=	0.82
CRITICAL N (CN)	=	92.23

Note: Again, these are the fit indices described in Chapter 2. Note that the model falls in the awkward category of a "reasonable but not outstanding" fit to the data. That is, the NFI, GFI, CFI, and IFI all indicate an acceptable fit to the data; however, the χ^2, RMSEA, stand-

ardized RMR, AGFI, and RFI and NNFI all indicate that the model i
not a good fit to the data.

```
 CONFIDENCE LIMITS COULD NOT BE COMPUTED DUE TO TOO SMALL
 P-VALUE FOR CHI-SQUARE
 TI REASONED ACTION MODEL OF UNION PARTICIPATION SUMMARY
 STATISTICS FOR FITTED RESIDUALS
 SMALLEST FITTED RESIDUAL =    0.00
 MEDIAN FITTED RESIDUAL   =    0.68
 LARGEST FITTED RESIDUAL  =   17.73
 STEMLEAF PLOT
  0|0000000111112
  0|7
  1|
  1|8
 SUMMARY STATISTICS FOR STANDARDIZED RESIDUALS
 SMALLEST STANDARDIZED RESIDUAL =    0.00
 MEDIAN STANDARDIZED RESIDUAL   =    1.65
 LARGEST STANDARDIZED RESIDUAL  =    3.93
 STEMLEAF PLOT
  0|000005
  1|2699
  2|666
  3|19
 LARGEST POSITIVE STANDARDIZED RESIDUALS
 RESIDUAL FOR Subjecti AND Willingn    3.05
 RESIDUAL FOR Subjecti AND  Loyalty    3.93
 TI REASONED ACTION MODEL OF UNION PARTICIPATION
 MODIFICATION INDICES AND EXPECTED CHANGE

 MODIFICATION INDICES FOR BETA
             Particip   Willingn  Loyalty
             --------   --------  -------
Particip       - -        - -      1.25
Willingn       1.84       - -      - -
Loyalty        0.57       2.83     - -
```



```
 EXPECTED CHANGE FOR BETA
             Particip   Willingn  Loyalty
             --------   --------  -------
Particip       - -        - -      0.03
Willingn      -0.26       - -      - -
Loyalty        0.18       0.30     - -

 STANDARDIZED EXPECTED CHANGE FOR BETA
             Particip   Willingn  Loyalty
             --------   --------  -------
Particip       - -        - -      0.00
Willingn      -0.04       - -      - -
Loyalty        0.02       0.01     - -

 MODIFICATION INDICES FOR GAMMA
             Instrume   Subjecti
             --------   --------
Particip       1.25       0.62
Willingn       0.72       - -
Loyalty        - -       28.25

 EXPECTED CHANGE FOR GAMMA
             Instrume   Subjecti
             --------   --------
Particip       0.02       0.01
Willingn       0.04       - -
Loyalty        - -        0.16

 STANDARDIZED EXPECTED CHANGE FOR GAMMA
             Instrume   Subjecti
             --------   --------
Particip       0.08       0.05
Willingn       0.06       - -
Loyalty        - -        0.32

 MODIFICATION INDICES FOR PSI
             Particip   Willingn  Loyalty
             --------   --------  -------
Particip       - -
Willingn       1.84       - -
Loyalty        0.10       0.72     - -
```

EXPECTED CHANGE FOR PSI

	Particip	Willingn	Loyalty
Particip	- -		
Willingn	-0.52	- -	
Loyalty	0.17	-1.26	- -

STANDARDIZED EXPECTED CHANGE FOR PSI

	Particip	Willingn	Loyalty
Particip	- -		
Willingn	-0.08	- -	
Loyalty	0.02	-0.06	- -

MAXIMUM MODIFICATION INDEX IS 28.25 FOR ELEMENT (3, 2) OF GAMMA

Note: The residuals, modification indices, expected changes, an standardized expected changes provide information about the source of the model's lack of fit. They converge in suggesting that the fit of th model would be improved substantially by allowing a path betwee subjective norms and union loyalty, Gamma (3, 2).

TI REASONED ACTION MODEL OF UNION PARTICIPATION
STANDARDIZED SOLUTION
BETA

	Particip	Willingn	Loyalty
Particip	- -	0.46	- -
Willingn	- -	- -	0.62
Loyalty	- -	- -	- -

GAMMA

	Instrume	Subjecti
Particip	- -	- -
Willingn	- -	0.23
Loyalty	0.61	- -

Note: These are the standardized parameter estimates (in regressior terms, the βs). These are the values that typically would be reported i a results section.

CORRELATION MATRIX OF Y AND X

	Particip	Willingn	Loyalty	Instrume	Subjecti
Particip	1.00				
Willingn	0.46	1.00			
Loyalty	0.31	0.67	1.00		
Instrume	0.22	0.47	0.61	1.00	
Subjecti	0.17	0.38	0.24	0.39	1.00

PSI

Particip	Willingn	Loyalty
0.79	0.50	0.63

REGRESSION MATRIX Y ON X (STANDARDIZED)

	Instrume	Subjecti
Particip	0.17	0.11
Willingn	0.38	0.23
Loyalty	0.61	- -

Note: LISREL reports the regression equation for each endogenous (Y) variable predicted by each exogenous (X) variable.

TI REASONED ACTION MODEL OF UNION PARTICIPATION TOTAL AND INDIRECT EFFECTS
TOTAL EFFECTS OF X ON Y

	Instrume	Subjecti
Particip	0.05	0.01
	(0.01)	(0.00)
	5.42	3.80
Willingn	0.26	0.08
	(0.03)	(0.02)
	8.08	4.45
Loyalty	0.62	- -
	(0.06)	
	10.91	

Note: The total effect of an exogenous variable on an endogenous variable is the sum of the direct (simple paths) and indirect (compound paths) linking the two variables. LISREL reports the total effects, followed by the standard error of the effects and a significance test of the total effect (effect/standard error).

INDIRECT EFFECTS OF X ON Y

	Instrume	Subjecti
Particip	0.05	0.01
	(0.01)	(0.00)
	5.42	3.80
Willingn	0.26	- -
	(0.03)	
	8.08	
Loyalty	- -	- -

Note: LISREL then decomposes the total effect and presents separate information on the indirect effects. (Recall that the direct effects are the parameters estimated in the model; therefore, they have been presented previously.)

TOTAL EFFECTS OF Y ON Y

	Particip	Willingn	Loyalty
Particip	- -	0.19	0.08
		(0.03)	(0.01)
		7.30	6.24
Willingn	- -	- -	0.42
			(0.04)
			12.02
Loyalty	- -	- -	- -

Note: This is the same information as presented above (total effect, standard errors, and significance test). This time the effects under consideration are the effects of the endogenous (Y) variables on other endogenous (Y) variables.

LARGEST EIGENVALUE OF B*B' (STABILITY INDEX) IS 0.178

Note: The stability index is rarely reported and is most useful when estimating nonrecursive models.

INDIRECT EFFECTS OF Y ON Y

	Particip	Willingn	Loyalty
Particip	- -	- -	0.08
			(0.01)
			6.24
Willingn	- -	- -	- -
Loyalty	- -	- -	- -

Note: Again, the indirect effects of the endogenous variables on the endogenous variables are presented. In the model, there is only one compound path linking endogenous variables (from loyalty to willingness to participation). Thus, only the indirect effect of loyalty on participation is reported.

TI REASONED ACTION MODEL OF UNION PARTICIPATION
STANDARDIZED TOTAL AND INDIRECT EFFECTS
STANDARDIZED TOTAL EFFECTS OF X ON Y

	Instrume	Subjecti
Particip	0.17	0.11
Willingn	0.38	0.23
Loyalty	0.61	- -

STANDARDIZED INDIRECT EFFECTS OF X ON Y

	Instrume	Subjecti
Particip	0.17	0.11
Willingn	0.38	- -
Loyalty	- -	- -

STANDARDIZED TOTAL EFFECTS OF Y ON Y

	Particip	Willingn	Loyalty
Particip	- -	0.46	0.28
Willingn	- -	- -	0.62
Loyalty	- -	- -	- -

```
STANDARDIZED INDIRECT EFFECTS OF Y ON Y
              Particip  Willingn  Loyalty
              --------  --------  -------
Particip        - -       - -      0.28
Willingn        - -       - -      - -
Loyalty         - -       - -      - -
```

Note: The same information about effects reported in standardize form. The standardized estimates allow the direct comparison of effe sizes.

```
Second Run (Adding subjective norms - loyalty)
TI      REASONED ACTION MODEL OF UNION PARTICIPATION
DA      NI = 5 NO = 202 MA = CM
CM      SY
 2.637
 3.071    15.972
 3.550    16.014    31.921
 2.615    10.719    19.247    31.002
 5.495    24.191    33.299    25.070   132.315
LA
'Participation' 'Willingness' 'Loyalty'
'Instrumentality' 'Subjective Norms'
MO NX = 2 NY = 3 BE = FU,FI GA = FU,FI PS = DI,FR
FR BE(1,2) BE(2,3)
FR GA(3,1) GA(2,2) GA(3,2)
```

Note: I have now added the path from subjective norms to loyalty GA(3, 2).

```
OU ML SC TV EF
TI REASONED ACTION MODEL OF UNION PARTICIPATION
Number of Iterations = 5
LISREL ESTIMATES (MAXIMUM LIKELIHOOD)
BETA
              Particip  Willingn  Loyalty
              --------  --------  -------
Particip        - -       0.19      - -
                          (0.03)
                           7.58
```



```
Willingn        - -       - -      0.42
                                   (0.04)
                                   10.63
 Loyalty        - -       - -      - -
GAMMA
              Instrume  Subjecti
              --------  --------
Particip        - -       - -
Willingn        - -       0.08
                          (0.02)
                           3.94
 Loyalty        0.49      0.16
               (0.06)    (0.03)
                8.60      5.70
```

Note: All parameters are significant.

```
SQUARED MULTIPLE CORRELATIONS FOR STRUCTURAL EQUATIONS
              Particip  Willingn  Loyalty
              --------  --------  -------
                0.22      0.54      0.46
GOODNESS OF FIT STATISTICS
          CHI-SQUARE WITH 4 DEGREES OF FREEDOM =  2.80 (P = 0.59)
    ESTIMATED NON-CENTRALITY PARAMETER (NCP) =  0.0
     90 PERCENT CONFIDENCE INTERVAL FOR NCP = (0.0 ; 6.59)
                MINIMUM FIT FUNCTION VALUE =  0.014
  POPULATION DISCREPANCY FUNCTION VALUE (F0) =  0.0
      90 PERCENT CONFIDENCE INTERVAL FOR F0 = (0.0 ; 0.033)
ROOT MEAN SQUARE ERROR OF APPROXIMATION (RMSEA) =  0.0
    90 PERCENT CONFIDENCE INTERVAL FOR RMSEA = (0.0 ; 0.091)
 P-VALUE FOR TEST OF CLOSE FIT (RMSEA < 0.05) =  0.78
          EXPECTED CROSS-VALIDATION INDEX (ECVI) =  0.12
    90 PERCENT CONFIDENCE INTERVAL FOR ECVI = (0.13 ; 0.16)
                ECVI FOR SATURATED MODEL =  0.15
           ECVI FOR INDEPENDENCE MODEL =  1.90
CHI-SQUARE FOR INDEPENDENCE MODEL WITH 10
                DEGREES OF FREEDOM =367.51
                  INDEPENDENCE AIC =377.51
                         MODEL AIC =  24.80
                       SATURATED AIC =  30.00
                  INDEPENDENCE CAIC =399.05
                         MODEL CAIC =  72.19
                       SATURATED CAIC =  94.62
```

```
ROOT MEAN SQUARE RESIDUAL (RMR) =    0.35
              STANDARDIZED RMR  =   0.028
    GOODNESS OF FIT INDEX (GFI) =    0.99
ADJUSTED GOODNESS OF FIT INDEX (AGFI) =  0.98
PARSIMONY GOODNESS OF FIT INDEX (PGFI) =  0.27
          NORMED FIT INDEX (NFI) =    0.99
    NON-NORMED FIT INDEX (NNFI) =    1.01
PARSIMONY NORMED FIT INDEX (PNFI) =   0.40
    COMPARATIVE FIT INDEX (CFI) =    1.00
    INCREMENTAL FIT INDEX (IFI) =    1.00
      RELATIVE FIT INDEX (RFI) =    0.98
              CRITICAL N (CN) =  954.97
```

Note: The model now provides an acceptable fit to the data.

```
MODIFICATION INDICES FOR BETA
            Particip  Willingn   Loyalty
            --------  --------  --------
Particip      - -       - -      1.37
Willingn      1.72      - -      - -
Loyalty       - -       0.66     - -

MODIFICATION INDICES FOR GAMMA
            Instrume  Subjecti
            --------  --------
Particip      1.22      0.73
Willingn      0.66      - -
Loyalty       - -       - -

MODIFICATION INDICES FOR PSI
            Particip  Willingn   Loyalty
            --------  --------  --------
Particip      - -
Willingn      1.72      - -
Loyalty       0.03      0.66      - -
MAXIMUM MODIFICATION INDEX IS 1.72 FOR ELEMENT (2, 1) OF
BETA
```

Note: The modification indices suggest no further changes to the model.


```
TI REASONED ACTION MODEL OF UNION PARTICIPATION
STANDARDIZED SOLUTION
BETA
            Particip  Willingn   Loyalty
            --------  --------  --------
Particip      - -       0.47      - -
Willingn      - -       - -       0.60
Loyalty       - -       - -       - -

GAMMA
            Instrume  Subjecti
            --------  --------
Particip      - -       - -
Willingn      - -       0.22
Loyalty       0.49      0.32
```

Fit and Model Modification

The original model provided only a modest fit to the data. Adding the path from subjective norms to union loyalty substantially improved the fit of the model, $\chi^2_{\text{difference}}(1) = 30.44$, $p < .01$, and the revised model provided an acceptable fit to the data. After the initial, and specified a priori, addition to the model, there were no modifications suggested by the results.

Sample Results Section

As in the previous chapter, a sample results section based on the preceding analyses is presented below.

Results

Descriptive statistics and intercorrelations for all study variables are presented in Table 6.1. All model tests were based on the covariance matrix and used maximum likelihood estimation as implemented in LISREL VIII (Jöreskog & Sörbom, 1992).

The original model provided an adequate but not outstanding fit to the data [$\chi^2(5) = 33.24$, $p < .01$; GFI = .94; AGFI = .83; RMSEA = .17; NFI = .91; CFI = .92; PNFI = .45]. The revised model provided

TABLE 6.1 Descriptive Statistics and Intercorrelations (n = 202)

	Mean	SD	*1*	*2*	*3*	*4*
1. Participation	2.62	1.71	1.00			
2. Willingness to work for the union	10.32	3.88	0.47	1.00		
3. Union loyalty	20.00	5.55	0.39	0.71	1.00	
4. Instrumentality beliefs	19.87	5.60	0.29	0.48	0.61	1.00
5. Subjective norms	18.09	9.99	0.29	0.53	0.51	0.39

a better fit to the data than did the original model, $\chi^2_{difference}(1) = 30.44$, $p < .01$; $\chi^2(4) = 2.80$, ns; GFI = .99; AGFI = .98; RMSEA = .00; NFI = .99; CFI = 1.00; PNFI = .40.

Standardized parameter estimates for the revised model are presented in Figure 6.4. As shown, participation in union activities was predicted by willingness to work for the union ($\beta = .47$, $p < .01$), which in turn was predicted by both union loyalty ($\beta = .60$, $p < .01$) and subjective norms ($\beta = .22$, $p < .01$). Union loyalty was predicted by both perceptions of instrumentality ($\beta = .49$, $p < .01$) and subjective norms ($\beta = .32$, $p < .01$). The model explained 22% of the variance in participation, 54% of the variance in willingness to work for the union, and 46% of the variance in union loyalty.

Note

1. Rank and order conditions refer to the identification of nonrecursive structural models and will not be dealt with further.

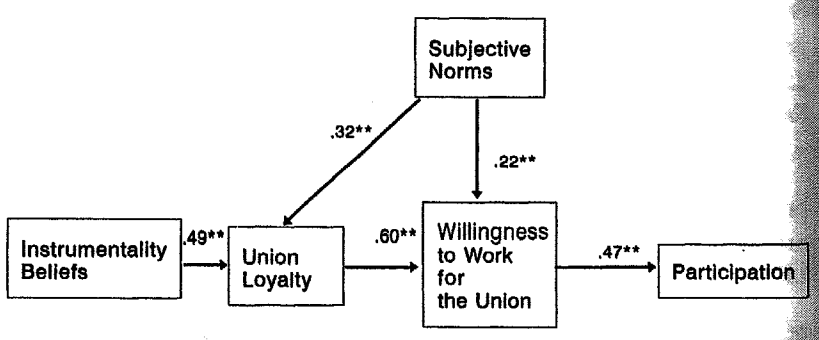

Figure 6.4.

CHAPTER 7

Latent Variable Path Analysis

The true power of structural equation modeling is the ability to estimate a complete model incorporating both measurement and structural considerations. In this chapter, we consider such a latent variable path analysis. Latent variable path analysis uses the full LISREL model (all eight matrices) to combine measurement and structural considerations. Thus, in conducting the analysis we will be equally concerned with assessing the proposed measurement relations (i.e., through confirmatory factor analysis) and the proposed structural relations (i.e., through path analysis).

Model Specification

To illustrate the use of latent variable path analysis, we will consider a reduced form of the model of perceived risk and participation in occupational health and safety programs presented by Cree and Kelloway (in press). There are two components to the model. First, the structural model specifies the predictive relationships among the latent variables. Second, the measurement model defines how the latent variables are measured (i.e., represented by indicators).

The structural model we were interested in was based on the hypotheses that two factors, perceived health and safety climate and accident history, predicted perceived risk in the workplace, which in turn predicted willingness to participate in health and safety programs (see Figure 7.1).