BMI Health Study

Naive Regression

```
/********************** bmi1.sas **************************/
options linesize=79 noovp formdlim=' ';
title 'BMI and Health: Read data and analyze ignoring measurement error';

data health;
     infile 'bmihealth2.data';
     input age1 bmi1 fat1 cholest1 diastol1
           age2 bmi2 fat2 cholest2 diastol2;
           /* fat1 and fat2 are percent body fat */
     age = (age1+age2)/2; bmi = (bmi1+bmi2)/2; fat = (fat1+fat2)/2;
     cholest = (cholest1+cholest2)/2 ; diastol = (diastol1+diastol2)/2;

proc means;
     var age1 -- diastol;

proc reg;
     title2 'Regression on average measurements';
     model cholest diastol = age bmi fat;
     BMI: mtest bmi=0; /* Multivariate test */
```

```
       BMI and Health: Read data and analyze ignoring measurement error       1

                                The MEANS Procedure

Variable      N            Mean         Std Dev         Minimum         Maximum
-------------------------------------------------------------------------------
age1        500      44.1300000      12.9561114       3.0000000      80.0000000
bmi1        500      25.4786000       4.6790543      12.8000000      39.4000000
fat1        500      19.4780000       7.7567319               0      44.6000000
cholest1    500     263.8172000      55.7074960     113.4000000     440.3000000
diastol1    500      88.5940000      18.0461767      16.0000000     146.0000000
age2        500      45.5820000      12.4130352       6.0000000      78.0000000
bmi2        500      25.6574000       3.7869522      14.3000000      37.1000000
fat2        500      19.4778000       7.4274451               0      45.8000000
cholest2    500     265.3700000      56.7716240     106.0000000     445.6000000
diastol2    500      89.3420000      13.2834459      52.0000000     131.0000000
age         500      44.8560000      12.4336824       4.5000000      79.0000000
bmi         500      25.5680000       3.9567218      13.9000000      37.2000000
fat         500      19.4779000       7.1693749               0      44.8500000
cholest     500     264.5936000      55.0124311     118.6500000     442.9500000
diastol     500      88.9680000      13.7890628      39.5000000     132.5000000
-------------------------------------------------------------------------------
```

Regression on average measurements

The REG Procedure
Model: MODEL1
Dependent Variable: cholest

Number of Observations Read 500
Number of Observations Used 500

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	146506	48835	17.76	<.0001
Error	496	1363651	2749.29688		
Corrected Total	499	1510157			

Root MSE	52.43374	R-Square	0.0970
Dependent Mean	264.59360	Adj R-Sq	0.0916
Coeff Var	19.81671		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	220.06103	21.01086	10.47	<.0001
age	1	-0.27139	0.20017	-1.36	0.1758
bmi	1	0.51641	1.01541	0.51	0.6113
fat	1	2.23342	0.57920	3.86	0.0001

The REG Procedure
Model: MODEL1
Dependent Variable: diastol

Number of Observations Read	500
Number of Observations Used	500

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	31627	10542	82.67	<.0001
Error	496	63252	127.52449		
Corrected Total	499	94879			

Root MSE	11.29267	R-Square	0.3333
Dependent Mean	88.96800	Adj R-Sq	0.3293
Coeff Var	12.69296		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	49.69194	4.52512	10.98	<.0001
age	1	0.12648	0.04311	2.93	0.0035
bmi	1	0.82627	0.21869	3.78	0.0002
fat	1	0.64056	0.12474	5.14	<.0001

The REG Procedure
Model: MODEL1
Multivariate Test: BMI

Multivariate Statistics and Exact F Statistics

S=1 M=0 N=246.5

Statistic	Value	F Value	Num DF	Den DF	Pr > F
Wilks' Lambda	0.97130971	7.31	2	495	0.0007
Pillai's Trace	0.02869029	7.31	2	495	0.0007
Hotelling-Lawley Trace	0.02953773	7.31	2	495	0.0007
Roy's Greatest Root	0.02953773	7.31	2	495	0.0007

Measurement Error Regression

```
//********************* bmi2.sas *************************/
options linesize=79 pagesize = 500 noovp formdlim='_' ;
title 'BMI and Health: Use the Double Measurement Design';

data health;
     infile 'bmihealth2.data'; /* bmihealth2.data is a big improvement */
     input age1 bmi1 fat1 cholest1 diastol1
           age2 bmi2 fat2 cholest2 diastol2;
           /* fat1 and fat2 are percent body fat */
     age = (age1+age2)/2; bmi = (bmi1+bmi2)/2; fat = (fat1+fat2)/2;
     cholest = (cholest1+cholest2)/2 ; diastol = (diastol1+diastol2)/2;

/* Exclude some output you really don't want to see. */
ods exclude Calis.ML.SqMultCorr (persist);

proc calis pshort nostand pcorr;
           /* Analyze covariance matrix is now default. pshort and
              nostand suppresses some output. pcorr prints
              correlation (or covariance) matrices of observed
              variables -- both sample and predicted.  */

     title2 'Full Model';
     var   /* Name the observed variables */
           age1 bmi1 fat1 cholest1 diastol1
           age2 bmi2 fat2 cholest2 diastol2;

     /* Now give simultaneous equations, separated by commas. Latent
        variables begin with F for factor. Error terms begin with
        E for error or D for disturbance. SAS is not case sensitive.
        You must name all the parameters. Optional starting values in
        parentheses may be given after the parameters. */
     lineqs
          Fcholest = beta11 Fage + beta12 Fbmi + beta13 Ffat + epsilon1,
          Fdiastol = beta21 Fage + beta22 Fbmi + beta23 Ffat + epsilon2,
          age1     = Fage + e11, bmi1 = Fbmi + e12,
          fat1     = Ffat + e13,
          cholest1 = Fcholest + e14, diastol1 = Fdiastol + e15,
          age2     = Fage + e21,bmi2     = Fbmi + e22,
          fat2     = Ffat + e23,
          cholest2 = Fcholest + e24, diastol2 = Fdiastol + e25;
     variance  /* Variances of exogenous vars */
          Fage = phi11, Fbmi = phi22, Ffat = phi33,
          epsilon1 = psi11, epsilon2 = psi22,
          e11 = omega111, e12 = omega122, e13 = omega133,
          e14 = omega144, e15 = omega155,
          e21 = omega211, e22 = omega222, e23 = omega233,
          e24 = omega244, e25 = omega255;
     cov  /* Covariances */
          Fage Fbmi = phi12, Fage Ffat = phi13, Fbmi Ffat = phi23,
          epsilon1 epsilon2 = psi12,
          e11 e12 = omega112, e11 e13 = omega113, e11 e14 = omega114,
          e11 e15 = omega115,
          e12 e13 = omega123, e12 e14 = omega124, e12 e15 = omega125,
          e13 e14 = omega134,  e13 e15 = omega135,
          e14 e15 = omega145,
          e21 e22 = omega212, e21 e23 = omega213, e21 e24 = omega214,
          e21 e25 = omega215,
          e22 e23 = omega223, e22 e24 = omega224, e22 e25 = omega225,
          e23 e24 = omega234,  e23 e25 = omega235,
          e24 e25 = omega245;
```

```
     bounds /* Variances are positive */
          0.0 < phi11 phi22 phi33 psi11 psi22
                omega111 omega122 omega133 omega144 omega155
                omega211 omega222 omega233 omega244 omega255;

/*  Now fit a reduced model to test H0: beta12 = beta22 = 0,
    meaning BMI is unrelated to either cholesterol or blood pressure
    if we allow for age and percent body fat.  Copy the code; only
    the last line is different.  */

proc calis pshort nostand;
     title2 'Reduced Model with beta12=beta22=0';
     var   /* Name the observed variables */
           age1 bmi1 fat1 cholest1 diastol1
           age2 bmi2 fat2 cholest2 diastol2;
     /* Now give simultaneous equations, separated by commas. Latent
        variables begin with F for factor. Error terms begin with
        E for error or D for disturbance. SAS is not case sensitive.
        You must name all the parameters. Optional starting values in
        parentheses may be given after the parameters. */
     lineqs
          Fcholest = beta11 Fage + beta12 Fbmi + beta13 Ffat + epsilon1,
          Fdiastol = beta21 Fage + beta22 Fbmi + beta23 Ffat + epsilon2,
          age1     = Fage + e11, bmi1 = Fbmi + e12,
          fat1     = Ffat + e13,
          cholest1 = Fcholest + e14, diastol1 = Fdiastol + e15,
          age2     = Fage + e21,bmi2     = Fbmi + e22,
          fat2     = Ffat + e23,
          cholest2 = Fcholest + e24, diastol2 = Fdiastol + e25;
     variance  /* Variances of exogenous vars */
          Fage = phi11, Fbmi = phi22, Ffat = phi33,
          epsilon1 = psi11, epsilon2 = psi22,
          e11 = omega111, e12 = omega122, e13 = omega133,
          e14 = omega144, e15 = omega155,
          e21 = omega211, e22 = omega222, e23 = omega233,
          e24 = omega244, e25 = omega255;
     cov  /* Covariances */
          Fage Fbmi = phi12, Fage Ffat = phi13, Fbmi Ffat = phi23,
          epsilon1 epsilon2 = psi12,
          e11 e12 = omega112, e11 e13 = omega113, e11 e14 = omega114,
          e11 e15 = omega115,
          e12 e13 = omega123, e12 e14 = omega124, e12 e15 = omega125,
          e13 e14 = omega134,  e13 e15 = omega135,
          e14 e15 = omega145,
          e21 e22 = omega212, e21 e23 = omega213, e21 e24 = omega214,
          e21 e25 = omega215,
          e22 e23 = omega223, e22 e24 = omega224, e22 e25 = omega225,
          e23 e24 = omega234,  e23 e25 = omega235,
          e24 e25 = omega245;
     bounds                  /* Variances are positive */
          0.0 < phi11 phi22 phi33 psi11 psi22
                omega111 omega122 omega133 omega144 omega155
                omega211 omega222 omega233 omega244 omega255;
     lincon beta12=0, beta22=0;

proc iml;
     title2 'Calculate Likelihood ratio test of H0: beta12=beta22=0';
     G = 500 * (0.0122914464 - 0.0093074908);
     /* Difference between final objective function values */
     pval = 1 - probchi(G,2);
     print G pval;
     print "Or, difference between 'Chi-Square' values";
     diff = 6.1334-4.6444;
     print "6.1334-4.6444 = " diff;
```

The CALIS Procedure
Covariance Structure Analysis: Model and Initial Values

Modeling Information

Data Set	WORK.HEALTH
N Records Read	500
N Records Used	500
N Obs	500
Model Type	LINEQS
Analysis	Covariances

The CALIS Procedure
Covariance Structure Analysis: Descriptive Statistics

Covariance Matrix (DF = 499)

	age1	bmi1	fat1	cholest1	diastol1
age1	167.86082	8.93946	26.05437	19.08533	48.31741
bmi1	8.93946	21.89355	29.77223	56.71544	35.65743
fat1	26.05437	29.77223	60.16689	124.49070	54.39786
cholest1	19.08533	56.71544	124.49070	3103.3251	123.97594
diastol1	48.31741	35.65743	54.39786	123.97594	325.66449
age2	148.22078	5.03573	23.54229	21.03486	37.65761
bmi2	3.62158	13.19402	20.61349	61.58983	25.59028
fat2	25.29808	21.42201	45.13296	130.30870	57.56051
cholest2	8.13778	54.87651	110.89557	2889.5639	120.65613
diastol2	34.64884	24.38168	55.62858	104.79631	129.21929

Covariance Matrix (DF = 499)

	age2	bmi2	fat2	cholest2	diastol2
age1	148.22078	3.62158	25.29808	8.13778	34.64884
bmi1	5.03573	13.19402	21.42201	54.87651	24.38168
fat1	23.54229	20.61349	45.13296	110.89557	55.62858
cholest1	21.03486	61.58983	130.30870	2889.5639	104.79631
diastol1	37.65761	25.59028	57.56051	120.65613	129.21929
age2	154.08344	3.10881	22.26445	11.60828	36.93282
bmi2	3.10881	14.34101	19.30298	57.02692	27.09416
fat2	22.26445	19.30298	55.16694	114.17915	51.68196
cholest2	11.60828	57.02692	114.17915	3223.0173	91.06699
diastol2	36.93282	27.09416	51.68196	91.06699	176.44994

Determinant 4.5765674E18 Ln 42.967481

The CALIS Procedure
Covariance Structure Analysis: Optimization

Levenberg-Marquardt Optimization

Scaling Update of More (1978)

Parameter Estimates	45
Functions (Observations)	55
Lower Bounds	15
Upper Bounds	0

Optimization Start

Active Constraints	0	Objective Function	0.2768223813
Max Abs Gradient Element	0.1013655982	Radius	1

Iter	Rest arts	Func Calls	Act Con	Objective Function	Obj Fun Change	Max Abs Gradient Element	Lambda	Actual Over Pred Change
1	0	6	0	0.10492	0.1719	0.0424	0	0.674
2	0	8	0	0.01737	0.0875	0.00443	0	1.073
3	0	10	0	0.00932	0.00805	0.000201	0	1.093
4	0	12	0	0.00931	0.000013	0.000164	0	1.019
5	0	14	0	0.00931	5.719E-8	1.441E-6	0	1.025

Optimization Results

Iterations	5	Function Calls	17
Jacobian Calls	7	Active Constraints	0
Objective Function	0.0093074908	Max Abs Gradient Element	1.4407197E-6
Lambda	0	Actual Over Pred Change	1.0254675652
Radius	0.0018060845		

Convergence criterion (ABSGCONV=0.00001) satisfied.

Full Model

The CALIS Procedure

Covariance Structure Analysis: Maximum Likelihood Estimation

Fit Summary

Modeling Info	N Observations	500
	N Variables	10
	N Moments	55
	N Parameters	45
	N Active Constraints	0
	Baseline Model Function Value	8.1272
	Baseline Model Chi-Square	4055.4515
	Baseline Model Chi-Square DF	45
	Pr > Baseline Model Chi-Square	<.0001
Absolute Index	Fit Function	0.0093
	Chi-Square	4.6444
	Chi-Square DF	10
	Pr > Chi-Square	0.9136
	Z-Test of Wilson & Hilferty	-1.3642
	Hoelter Critical N	1967
	Root Mean Square Residual (RMSR)	5.7999
	Standardized RMSR (SRMSR)	0.0114
	Goodness of Fit Index (GFI)	0.9982

Parsimony Index	Adjusted GFI (AGFI)	0.9899
	Parsimonious GFI	0.2218
	RMSEA Estimate	0.0000
	RMSEA Lower 90% Confidence Limit	0.0000
	RMSEA Upper 90% Confidence Limit	0.0184
	Probability of Close Fit	0.9987
	ECVI Estimate	0.1937
	ECVI Lower 90% Confidence Limit	0.2049
	ECVI Upper 90% Confidence Limit	0.2079
	Akaike Information Criterion	94.6444
	Bozdogan CAIC	329.3018
	Schwarz Bayesian Criterion	284.3018
	McDonald Centrality	1.0054
Incremental Index	Bentler Comparative Fit Index	1.0000
	Bentler-Bonett NFI	0.9989
	Bentler-Bonett Non-normed Index	1.0060
	Bollen Normed Index Rho1	0.9948
	Bollen Non-normed Index Delta2	1.0013
	James et al. Parsimonious NFI	0.2220

Predicted Covariances

	age1	bmi1	fat1	cholest1	diastol1
age1	166.24694	8.17463	25.76119	21.96533	46.18388
bmi1	8.17463	22.04955	30.00458	61.34375	34.86877
fat1	25.76119	30.00458	60.73126	132.38341	53.44883
cholest1	21.96533	61.34375	132.38341	3103.6215	108.72072
diastol1	46.18388	34.86877	53.44883	108.72072	324.01763
age2	147.62538	4.16880	23.36704	19.25674	35.60086
bmi2	4.16880	13.36758	21.01792	62.22916	24.78849
fat2	23.36704	21.01792	44.57431	124.44423	56.38255
cholest2	19.25674	62.22916	124.44423	2903.1136	108.81759
diastol2	35.60086	24.78849	56.38255	108.81759	128.58644

Predicted Covariances

	age2	bmi2	fat2	cholest2	diastol2
age1	147.62538	4.16880	23.36704	19.25674	35.60086
bmi1	4.16880	13.36758	21.01792	62.22916	24.78849
fat1	23.36704	21.01792	44.57431	124.44423	56.38255
cholest1	19.25674	62.22916	124.44423	2903.1136	108.81759
diastol1	35.60086	24.78849	56.38255	108.81759	128.58644
age2	154.50002	3.50674	20.65811	17.28984	37.87862
bmi2	3.50674	14.45915	19.16469	59.57095	27.44593
fat2	20.65811	19.16469	53.92456	113.04535	51.53445
cholest2	17.28984	59.57095	113.04535	3248.2548	99.82594
diastol2	37.87862	27.44593	51.53445	99.82594	177.03207

Determinant 4.6193627E18 Ln 42.976788

The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation

Linear Equations

Fcholest =	-0.3197*Fage	+	0.3935*Fbmi	+	2.7739*Ffat		
Std Err	0.2280 beta11		1.7096 beta12		0.9814 beta13		
t Value	-1.4024		0.2302		2.8264		

+ 1.0000 epsilon1

Linear Equations

Fdiastol =	0.0204*Fage	+	-0.4795*Fbmi	+	1.4803*Ffat		
Std Err	0.0501 beta21		0.4192 beta22		0.2348 beta23		
t Value	0.4066		-1.1440		6.3059		

+ 1.0000 epsilon2

Linear Equations

age1 = 1.0000 Fage + 1.0000 e11

Linear Equations

bmi1 = 1.0000 Fbmi + 1.0000 e12

Linear Equations

fat1 = 1.0000 Ffat + 1.0000 e13

Linear Equations

cholest1 = 1.0000 Fcholest + 1.0000 e14

Linear Equations

diastol1 = 1.0000 Fdiastol + 1.0000 e15

Linear Equations

age2 = 1.0000 Fage + 1.0000 e21

Linear Equations

bmi2 = 1.0000 Fbmi + 1.0000 e22

Linear Equations

fat2 = 1.0000 Ffat + 1.0000 e23

Linear Equations

cholest2 = 1.0000 Fcholest + 1.0000 e24

Linear Equations

diastol2 = 1.0000 Fdiastol + 1.0000 e25

Estimates for Variances of Exogenous Variables

Variable Type	Variable	Parameter	Estimate	Standard Error	t Value
Latent	Fage	phi11	147.62538	9.72823	15.17495
	Fbmi	phi22	13.36758	0.98913	13.51443
	Ffat	phi33	44.57431	3.11040	14.33072
Disturbance	epsilon1	psi11	2540	171.77281	14.78457
	epsilon2	psi22	56.28249	9.24845	6.08561
Error	e11	omega111	18.62155	2.92259	6.37158
	e12	omega122	8.68196	0.71007	12.22696
	e13	omega133	16.15695	1.66444	9.70712
	e14	omega144	200.50786	57.59459	3.48137
	e15	omega155	195.43119	14.36626	13.60348
	e21	omega211	6.87464	2.70919	2.53753
	e22	omega222	1.09156	0.49224	2.21755
	e23	omega233	9.35025	1.54338	6.05828
	e24	omega244	345.14117	60.47109	5.70754
	e25	omega255	48.44563	8.27042	5.85770

Covariances Among Exogenous Variables

Var1	Var2	Parameter	Estimate	Standard Error	t Value
Fage	Fbmi	phi12	4.16880	2.14702	1.94166
Fage	Ffat	phi13	23.36704	3.99758	5.84529
Fbmi	Ffat	phi23	21.01792	1.58854	13.23095
epsilon1	epsilon2	psi12	-45.95363	25.04350	-1.83495
e11	e12	omega112	4.00583	0.94772	4.22683
e11	e13	omega113	2.39415	1.50990	1.58564
e11	e14	omega114	2.70859	9.11878	0.29703
e11	e15	omega115	10.58302	3.83545	2.75927
e12	e13	omega123	8.98666	0.95884	9.37242
e12	e14	omega124	-0.88540	4.19082	-0.21127
e12	e15	omega125	10.08028	2.28090	4.41944
e13	e14	omega134	7.93918	6.76172	1.17414
e13	e15	omega135	-2.93372	3.41941	-0.85796

e14	e15	omega145	-0.09687	16.95779	-0.00571
e21	e22	omega212	-0.66206	0.73717	-0.89811
e21	e23	omega213	-2.70893	1.37336	-1.97248
e21	e24	omega214	-1.96690	8.98900	-0.21881
e21	e25	omega215	2.27776	2.71807	0.83801
e22	e23	omega223	-1.85323	0.70700	-2.62127
e22	e24	omega224	-2.65821	3.48688	-0.76234
e22	e25	omega225	2.65744	1.49113	1.78216
e23	e24	omega234	-11.39888	6.56616	-1.73600
e23	e25	omega235	-4.84810	2.54402	-1.90568
e24	e25	omega245	-8.99165	12.64259	-0.71122

The CALIS Procedure
Covariance Structure Analysis: Model and Initial Values

Modeling Information

Data Set	WORK.HEALTH
N Records Read	500
N Records Used	500
N Obs	500
Model Type	LINEQS
Analysis	Covariances

The CALIS Procedure
Covariance Structure Analysis: Optimization

Levenberg-Marquardt Optimization

Scaling Update of More (1978)

Parameter Estimates	45
Functions (Observations)	55
Lower Bounds	15
Upper Bounds	0
Linear Constraints	2

Optimization Start

Active Constraints	2	Objective Function	0.4178440369
Max Abs Gradient Element	0.3660107658	Radius	1

Iter	Rest arts	Func Calls	Act Con	Objective Function	Obj Fun Change	Max Abs Gradient Element	Lambda	Actual Over Pred Change
1	0	4	2	0.02411	0.3937	0.0180	0	0.983
2	0	6	2	0.01233	0.0118	0.00354	0	1.088
3	0	8	2	0.01229	0.000037	0.000266	0	1.032
4	0	10	2	0.01229	2.904E-7	0.000035	0	1.043
5	0	12	2	0.01229	2.601E-9	2.183E-6	0	1.047

Optimization Results

Iterations	5	Function Calls	15
Jacobian Calls	7	Active Constraints	2
Objective Function	0.0122914464	Max Abs Gradient Element	2.183169E-6
Lambda	0	Actual Over Pred Change	1.0474386893
Radius	0.0002628856		

Convergence criterion (ABSGCONV=0.00001) satisfied.

The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation

Fit Summary

Modeling Info	N Observations	500
	N Variables	10
	N Moments	55
	N Parameters	43
	N Active Constraints	0
	Baseline Model Function Value	8.1272
	Baseline Model Chi-Square	4055.4515
	Baseline Model Chi-Square DF	45
	Pr > Baseline Model Chi-Square	<.0001
Absolute Index	Fit Function	0.0123
	Chi-Square	6.1334
	Chi-Square DF	12
	Pr > Chi-Square	0.9092
	Z-Test of Wilson & Hilferty	-1.3370
	Hoelter Critical N	1711
	Root Mean Square Residual (RMSR)	6.0164
	Standardized RMSR (SRMSR)	0.0117
	Goodness of Fit Index (GFI)	0.9975
Parsimony Index	Adjusted GFI (AGFI)	0.9887
	Parsimonious GFI	0.2660
	RMSEA Estimate	0.0000

Skipping the rest ...

Calculate Likelihood ratio test of H0: beta12=beta22=0

G	pval
1.4919778	0.4742651

Or, difference between 'Chi-Square' values

	diff
6.1334-4.6444 =	1.489

```
/********************* bmi3.sas *************************/
options linesize=79 pagesize = 500 noovp formdlim='_' ;
title 'BMI and Health: Like bmi2.sas, but try to make it shorter';
title2 'Also Try Wald Test: Compare G2 = 1.49, df=2, p = 0.47';

data health;
     infile 'bmihealth2.data';
     input age1 bmi1 fat1 cholest1 diastol1
           age2 bmi2 fat2 cholest2 diastol2;
           /* fat1 and fat2 are percent body fat */
     age = (age1+age2)/2; bmi = (bmi1+bmi2)/2; fat = (fat1+fat2)/2;
     cholest = (cholest1+cholest2)/2 ; diastol = (diastol1+diastol2)/2;

/* Exclude some output you really don't want to see. */
ods exclude Calis.ML.SqMultCorr (persist);

proc calis pshort nostand pcorr;
     title2 'Full Model';
    var   /* Name the observed variables */
           age1 bmi1 fat1 cholest1 diastol1
           age2 bmi2 fat2 cholest2 diastol2;
     lineqs
          Fcholest = beta11 Fage + beta12 Fbmi + beta13 Ffat + epsilon1,
          Fdiastol = beta21 Fage + beta22 Fbmi + beta23 Ffat + epsilon2,
          age1     = Fage + e11, bmi1 = Fbmi + e12,
          fat1     = Ffat + e13,
          cholest1 = Fcholest + e14, diastol1 = Fdiastol + e15,
          age2     = Fage + e21,bmi2     = Fbmi + e22,
          fat2     = Ffat + e23,
          cholest2 = Fcholest + e24, diastol2 = Fdiastol + e25;
     variance  /* Variances of exogenous vars will be
               called v-something. __ means fill in the numbers. */
          Fage Fbmi Ffat epsilon1 epsilon2 e11-e15 e21-e25 = 15 * v__ ;
     cov   /* Covariances: If not mentioned, it's zero.  */
          Fage Ffat Fbmi = 3 * phi__ , epsilon1 epsilon2 = psi12 ,
          e11-e15 = 10 * omega1__ , e21-e25 = 10 * omega2__ ;
     /* If you don't count the variances and covariances you get a warning.
        It's better to count them.  */
     bounds 0.0 < v01-v15;  /* Variances are positive */
     /* Wald test of H0: beta12=beta22=0 */
     simtests BMI = [f1 f2];
              f1 = beta12;
              f2 = beta22;
```

Output is the same except for things like

Estimates for Variances of Exogenous Variables

Variable Type	Variable	Parameter	Estimate	Standard Error	t Value
Latent	Fage	v01	147.62538	9.72823	15.17495
	Fbmi	v02	13.36758	0.98913	13.51443
	Ffat	v03	44.57431	3.11040	14.33072
Disturbance	epsilon1	v04	2540	171.77281	14.78457
	epsilon2	v05	56.28249	9.24845	6.08561
Error	e11	v06	18.62155	2.92259	6.37158
	e12	v07	8.68196	0.71007	12.22696
	e13	v08	16.15695	1.66444	9.70712
	e14	v09	200.50786	57.59459	3.48137
	e15	v10	195.43119	14.36626	13.60348
	e21	v11	6.87464	2.70919	2.53753
	e22	v12	1.09156	0.49224	2.21755
	e23	v13	9.35025	1.54338	6.05828

e24	v14	345.14117	60.47109	5.70754
e25	v15	48.44563	8.27042	5.85770

Covariances Among Exogenous Variables

Var1	Var2	Parameter	Estimate	Standard Error	t Value
Fage	Ffat	phi1	23.36704	3.99758	5.84529
Fage	Fbmi	phi2	4.16880	2.14702	1.94166
Ffat	Fbmi	phi3	21.01792	1.58854	13.23095
epsilon1	epsilon2	psi12	-45.95363	25.04350	-1.83495
e11	e12	omega101	4.00583	0.94772	4.22683
e11	e13	omega102	2.39415	1.50990	1.58564
e12	e13	omega103	8.98666	0.95884	9.37242
e11	e14	omega104	2.70859	9.11878	0.29703

Skipping ...

Simultaneous Tests

Simultaneous Test	Parametric Function	Function Value	DF	Chi-Square	p Value
BMI			2	1.35941	0.5068
	f1	0.39355	1	0.05299	0.8179
	f2	-0.47951	1	1.30863	0.2526

Repeating output from above ...

Full Model

The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation

Linear Equations

Fcholest =	-0.3197*Fage	+	0.3935*Fbmi	+	2.7739*Ffat	
Std Err	0.2280 beta11		1.7096 beta12		0.9814 beta13	
t Value	-1.4024		0.2302		2.8264	

\+ 1.0000 epsilon1

Linear Equations

Fdiastol =	0.0204*Fage	+	-0.4795*Fbmi	+	1.4803*Ffat	
Std Err	0.0501 beta21		0.4192 beta22		0.2348 beta23	
t Value	0.4066		-1.1440		6.3059	

\+ 1.0000 epsilon2

```
> 1.1440^2
[1] 1.308736
```