Test for equal variances with correlated data

```
/* eqvar.sas */
options linesize=79 noovp formdlim='_';
title 'Test equality of variances for repeated measures data';
title2 'With R, got G=5.2728, W=5.431555';
data easy;
     infile 'eqvar.dat.txt';
     input X1-X3;

proc calis  cov vardef=n;
   /*   Analyze the covariance matrix (Default is corr) and divide by n
        rather than (n-1) in covariance matrix, to get pure MLEs  */
     title3 'Fit Reduced (restricted) Model: Full model is saturated';
     var X1-X3;
                    /* no lineqs!  */
     std  X1-X3 = 3 * sigsq;   /* No colon = same value */
     cov  X1-X3 = 3 * kov:;
     bounds 0.0 < sigsq;

/* Now Wald test */

proc calis  cov vardef=n pcoves outest=Abe;  /* Create data set Abe */
     title3 'Fit full model for a Wald Test';
     var X1-X3;
     std  X1-X3 = V1-V3;
     cov  X1-X3 = kov1-kov3;
     bounds 0.0 < V1-V3;

proc print;

data abe2;   /* Extract the asymptotic covariance matrix */
     set abe;
     if _type_='COV';
     keep _type_ _name_ v1 kov1 V2 kov2 kov3 V3;
proc print;

data abe3;   /* Extract the parameter estimates */
     set abe;
     if _type_ ='PARMS';
     keep v1 kov1 V2 kov2 kov3 V3;
proc print;

proc iml;       /* Calculate the Wald Statistic */
     use abe2;
     read all var {v1 kov1 V2 kov2 kov3 V3} into K;
     print "Asymptotic Covariance Matrix"  K;
     use abe3;
     read all var {v1 kov1 V2 kov2 kov3 V3} into T;
     print "Parameter Estimates";
     print T "   v1       kov1       V2    kov2      kov3      V3";
     thetahat = T`; print thetahat;
     C = {1  0 -1  0  0  0,
          0  0  1  0  0 -1};
     W = (C*thetahat)` * inv(C*K*C`) * (C*thetahat);
     pval = 1-probchi(W,2);
     print "Wald Test for equal variances" W pval;
```

This time we're going to skip some output. Note n = 1000.

Optimization Start

Active Constraints	0	Objective Function	0.0078633456
Max Abs Gradient Element	0.0152625974	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	2	0	0.00528	0.00258	0.000765	0	0.965
2	0	3	0	0.00527	7.731E-6	0.000054	0	0.947
3	0	4	0	0.00527	2.95E-8	3.229E-6	0	0.942

Optimization Results

Iterations	3	Function Calls	5
Jacobian Calls	4	Active Constraints	0
Objective Function	0.0052727994	Max Abs Gradient Element	3.2294376E-6
Lambda	0	Actual Over Pred Change	0.9415350065
Radius	0.0007010299		

ABSGCONV convergence criterion satisfied.

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With R, got G=5.2728, W=5.431555
Fit Reduced (restricted) Model: Full model is saturated
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The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation

Fit Function	0.0053
Goodness of Fit Index (GFI)	0.9966
GFI Adjusted for Degrees of Freedom (AGFI)	0.9897
Root Mean Square Residual (RMR)	0.3722
Parsimonious GFI (Mulaik, 1989)	0.6644
Chi-Square	5.2675
Chi-Square DF	2
Pr > Chi-Square	0.0718
Independence Model Chi-Square	751.48
Independence Model Chi-Square DF	3
RMSEA Estimate	0.0404
RMSEA 90% Lower Confidence Limit	.
RMSEA 90% Upper Confidence Limit	0.0843
ECVI Estimate	0.0133
ECVI 90% Lower Confidence Limit	.
ECVI 90% Upper Confidence Limit	0.0243
Probability of Close Fit	0.5670
Bentler's Comparative Fit Index	0.9956

And so on ….

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With R, got G=5.2728, W=5.431555

Fit **full model** for a Wald Test

Optimization Start

Active Constraints	0	Objective Function	0
Max Abs Gradient Element	9.443802E-17	Radius	1

Optimization Results

Iterations	0	Function Calls	2
Jacobian Calls	1	Active Constraints	0
Objective Function	0	Max Abs Gradient Element	9.443802E-17
Lambda	0	Actual Over Pred Change	0
Radius	1		

ABSGCONV convergence criterion satisfied.

Of course the objective function is always zero for a saturated model. Now showing just the stuff that's different from the usual output …

Approximate Covariance Matrix of Parameter Estimates

	V1	kov1	V2
V1	0.225862768	0.1182508241	0.0619104137
kov1	0.1182508241	0.1316519537	0.1054398952
V2	0.0619104137	0.1054398952	0.1795751448
kov2	0.1131049383	0.081385004	0.0542157266
kov3	0.0592162767	0.0775336127	0.0923350401
V3	0.0566393796	0.051856437	0.0474773925

Approximate Covariance Matrix of Parameter Estimates

	kov2	kov3	V3
V1	0.1131049383	0.0592162767	0.0566393796
kov1	0.081385004	0.0775336127	0.051856437
V2	0.0542157266	0.0923350401	0.0474773925
kov2	0.1390159148	0.0838834094	0.1108663442
kov3	0.0838834094	0.1224424343	0.1015041766
V3	0.1108663442	0.1015041766	0.2170106093

Factor sigm = 0.002002002

Determinant = 4.7785189E-7

Approximate Correlation Matrix of Parameter Estimates

	V1	kov1	V2
V1	1	0.6857537622	0.3074101978
kov1	0.6857537622	1	0.6857537622
V2	0.3074101978	0.6857537622	1
kov2	0.638303143	0.6015870436	0.3431388639
kov3	0.3560842758	0.6106753481	0.6226979729
V3	0.2558324804	0.3067951828	0.2405045313

Approximate Correlation Matrix of Parameter Estimates

	kov2	kov3	V3
V1	0.638303143	0.3560842758	0.2558324804
kov1	0.6015870436	0.6106753481	0.3067951828
V2	0.3431388639	0.6226979729	0.2405045313
kov2	1	0.6429509393	0.638303143
kov3	0.6429509393	1	0.6226979729
V3	0.638303143	0.6226979729	1

Determinant = 0.0242268911

Matrix has Only Positive Eigenvalues

Information (Cross Product Jacobian) Matrix

	V1	kov1	V2
V1	0.0230170905	-0.019666973	0.0042011155
kov1	-0.019666973	0.058987627	-0.021611368
V2	0.0042011155	-0.021611368	0.0277932857
kov2	-0.014318938	-0.007495854	0.0058159343
kov3	0.0061174145	-0.00991866	-0.014959157
V3	0.0022269538	0.0042344088	0.0020128637

Information (Cross Product Jacobian) Matrix

	kov2	kov3	V3
V1	-0.014318938	0.0061174145	0.0022269538
kov1	-0.007495854	-0.00991866	0.0042344088
V2	0.0058159343	-0.014959157	0.0020128637
kov2	0.047280465	-0.014062186	-0.013321206
kov3	-0.014062186	0.0510863751	-0.012664707
V3	-0.013321206	-0.012664707	0.0199212193

Now the proc print of the data set Abe, created by the outset option

Obs	_TYPE_	_NAME_	_RHS_	_ITER_	V1	kov1
1	INITIAL	ML	0.00000	0	10.62	5.56
2	GRAD	ML	.	0	0.00	-0.00
3	TERMINAT	ABSGTOL	3.00000	.	.	.
4	PARMS	ML	0.00000	.	10.62	5.56
5	GRAD	ML	.	.	0.00	-0.00
6	STDERR	ML	.	.	0.48	0.36
7	_NOBS_	ML	.	.	1000.00	1000.00
8	LOWERBD	ML	.	.	0.00	.
9	NACTBC	ML	.	.	0.00	0.00
10	COV	V1	1.00000	.	0.23	0.12
11	COV	kov1	2.00000	.	0.12	0.13
12	COV	V2	3.00000	.	0.06	0.11
13	COV	kov2	4.00000	.	0.11	0.08
14	COV	kov3	5.00000	.	0.06	0.08
15	COV	V3	6.00000	.	0.06	0.05
16	COVRANK	COV	6.00000	.	.	.
17	SIGSQ	COV	0.00200	.	.	.
18	INFORMAT	V1	0.00200	.	0.02	-0.02
19	INFORMAT	kov1	0.00200	.	-0.02	0.06
20	INFORMAT	V2	0.00200	.	0.00	-0.02
21	INFORMAT	kov2	0.00200	.	-0.01	-0.01
22	INFORMAT	kov3	0.00200	.	0.01	-0.01
23	INFORMAT	V3	0.00200	.	0.00	0.00

Obs	V2	kov2	kov3	V3
1	9.47	5.32	4.87	10.41
2	0.00	-0.00	-0.00	0.00
3	.	.	.	.
4	9.47	5.32	4.87	10.41
5	0.00	-0.00	-0.00	0.00
6	0.42	0.37	0.35	0.47
7	1000.00	1000.00	1000.00	1000.00
8	0.00	.	.	0.00
9	0.00	0.00	0.00	0.00
10	0.06	0.11	0.06	0.06
11	0.11	0.08	0.08	0.05
12	0.18	0.05	0.09	0.05
13	0.05	0.14	0.08	0.11
14	0.09	0.08	0.12	0.10
15	0.05	0.11	0.10	0.22
16	.	.	.	.
17	.	.	.	.
18	0.00	-0.01	0.01	0.00
19	-0.02	-0.01	-0.01	0.00
20	0.03	0.01	-0.01	0.00
21	0.01	0.05	-0.01	-0.01
22	-0.01	-0.01	0.05	-0.01
23	0.00	-0.01	-0.01	0.02

Now proc print of Abe2, in which we extract the asymptotic covariance matrix

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With R, got G=5.2728, W=5.431555
Fit full model for a Wald Test
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Obs	_TYPE_	_NAME_	V1	kov1	V2	kov2	kov3	V3
1	COV	V1	0.22586	0.11825	0.06191	0.11310	0.05922	0.05664
2	COV	kov1	0.11825	0.13165	0.10544	0.08139	0.07753	0.05186
3	COV	V2	0.06191	0.10544	0.17958	0.05422	0.09234	0.04748
4	COV	kov2	0.11310	0.08139	0.05422	0.13902	0.08388	0.11087
5	COV	kov3	0.05922	0.07753	0.09234	0.08388	0.12244	0.10150
6	COV	V3	0.05664	0.05186	0.04748	0.11087	0.10150	0.21701

Now proc print of Abe3, in which we extract the parameter estimates

Test equality of variances for repeated measures data 16
With R, got G=5.2728, W=5.431555
Fit full model for a Wald Test
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Obs	V1	kov1	V2	kov2	kov3	V3
1	10.6216	5.56096	9.47089	5.31896	4.86980	10.4114

Now proc iml output

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With R, got G=5.2728, W=5.431555
Fit full model for a Wald Test
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Asymptotic Covariance Matrix
K

0.2258628	0.1182508	0.0619104	0.1131049	0.0592163	0.0566394
0.1182508	0.131652	0.1054399	0.081385	0.0775336	0.0518564
0.0619104	0.1054399	0.1795751	0.0542157	0.092335	0.0474774
0.1131049	0.081385	0.0542157	0.1390159	0.0838834	0.1108663
0.0592163	0.0775336	0.092335	0.0838834	0.1224424	0.1015042
0.0566394	0.0518564	0.0474774	0.1108663	0.1015042	0.2170106

Parameter Estimates

T

10.621603	5.5609578	9.4708914	5.3189633	4.8698006	10.411378
v1	kov1	V2	kov2	kov3	V3

THETAHAT

10.621603
5.5609578
9.4708914
5.3189633
4.8698006
10.411378

	W	PVAL
Wald Test for equal variances	5.4311288	0.0661676

With R, got G=5.2728, W=5.431555