

```

1      options ps=256 ls=132 nocenter nodate nonumber;
3      DATA ONE;
4          TITLE1 'EXST7015: Multiple Regression from Snedecor & Cochran (1967)';
5          INPUT X1 X2 X3 Y;
6          **** LABEL Y ='Plant available phosphorus'
7              X1='Inorganic phosphorus'
8              X2='Hydrolized organic phosphorus'
9              X3='Nonhydrolized phosphorus';
10     CARDS;

```

NOTE: The data set WORK.ONE has 18 observations and 4 variables.

NOTE: DATA statement used:

```

real time      0.05 seconds
cpu time       0.05 seconds

```

```

10     !          RUN;

```

```

29     ;

```

```

30     PROC PRINT DATA=ONE; TITLE2 'RAW DATA LISTING'; RUN;

```

NOTE: There were 18 observations read from the data set WORK.ONE.

NOTE: The PROCEDURE PRINT printed page 1.

NOTE: PROCEDURE PRINT used:

```

real time      0.04 seconds
cpu time       0.04 seconds

```

EXST7015: Multiple Regression from Snedecor & Cochran (1967)

RAW DATA LISTING

Obs	X1	X2	X3	Y
1	0.4	53	158	64
2	0.4	23	163	60
3	3.1	19	37	71
4	0.6	34	157	61
5	4.7	24	59	54
6	1.7	65	123	77
7	9.4	44	46	81
8	10.1	31	117	93
9	11.6	29	173	93
10	12.6	58	112	51
11	10.9	37	111	76
12	23.1	46	114	96
13	23.1	50	134	77
14	21.6	44	73	93
15	23.1	56	168	95
16	1.9	36	143	54
17	26.8	58	202	168
18	29.9	51	124	99

```

31     PROC REG DATA=ONE ALL LINEPRINTER; TITLE2 'PROC REG OUTPUT WITH ALL OPTIONS';
32         MODEL Y = X1 X2 X3 / INFLUENCE;
33         TEST X1=2; TEST X1=X2=X3;
34     RUN;

```

NOTE: 18 observations read.

NOTE: 18 observations used in computations.

```

34     !          OPTIONS PS=60 LS=120;
35         MODEL Y = X1 X2 X3 / PARTIAL;
36         PLOT RESIDUAL.*PREDICTED. / VREF=0;
37     RUN;
38     OPTIONS LS=80;

```

NOTE: The PROCEDURE REG printed pages 2-20.

NOTE: PROCEDURE REG used:

```

real time      0.13 seconds
cpu time       0.13 seconds

```

EXST7015: Multiple Regression from Snedecor & Cochran (1967)
 PROC REG OUTPUT WITH ALL OPTIONS

The REG Procedure

Variable	Descriptive Statistics				
	Sum	Mean	Uncorrected SS	Variance	Standard Deviation
Intercept	18.00000	1.00000	18.00000	0	0
X1	215.00000	11.94444	4321.02000	103.11556	10.15458
X2	758.00000	42.11111	35076	185.63399	13.62476
X3	2214.00000	123.00000	307894	2092.47059	45.74353
Y	1463.00000	81.27778	131299	728.80065	26.99631

Variable	Uncorrected Sums of Squares and Crossproducts				
	Intercept	X1	X2	X3	Y
Intercept	18	215	758	2214	1463
X1	215	4321.02	10139.5	27645	20706.2
X2	758	10139.5	35076	96598	63825
X3	2214	27645	96598	307894	187542
Y	1463	20706.2	63825	187542	131299

Variable	Correlation			
	X1	X2	X3	Y
X1	1.0000	0.4616	0.1520	0.6934
X2	0.4616	1.0000	0.3175	0.3545
X3	0.1520	0.3175	1.0000	0.3617
Y	0.6934	0.3545	0.3617	1.0000

Variable	Model Crossproducts X'X X'Y Y'Y				
	Intercept	X1	X2	X3	Y
Intercept	18	215	758	2214	1463
X1	215	4321.02	10139.5	27645	20706.2
X2	758	10139.5	35076	96598	63825
X3	2214	27645	96598	307894	187542
Y	1463	20706.2	63825	187542	131299

Variable	X'X Inverse, Parameter Estimates, and SSE				
	Intercept	X1	X2	X3	Y
Intercept	0.8133156545	0.0019185269	-0.011398244	-0.002444578	43.652197791
X1	0.0019185269	0.0007249271	-0.000248347	-9.690816E-7	1.7847796802
X2	-0.011398244	-0.000248347	0.0004374839	-0.000032994	-0.083397057
X3	-0.002444578	-9.690816E-7	-0.000032994	0.0000312649	0.161132691
Y	43.652197791	1.7847796802	-0.083397057	0.161132691	5583.4996578

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	6806.11145	2268.70382	5.69	0.0092
Error	14	5583.49966	398.82140		
Corrected Total	17	12390			

Root MSE	19.97051	R-Square	0.5493
Dependent Mean	81.27778	Adj R-Sq	0.4528
Coeff Var	24.57069		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t	Type I SS	Type II SS	Standardized Estimate	Squared Semi-partial Corr Type I	Squared Partial Corr Type I
Intercept	1	43.65220	18.01021	2.42	0.0295	118909	2342.89647	0	.	.
X1	1	1.78478	0.53770	3.32	0.0051	5957.02249	4394.14983	0.67134	0.48081	0.48081
X2	1	-0.08340	0.41771	-0.20	0.8446	18.64604	15.89789	-0.04209	0.00150	0.00290
X3	1	0.16113	0.11167	1.44	0.1710	830.44292	830.44292	0.27303	0.06703	0.12947

Parameter Estimates

Variable	DF	Squared Semi-partial Corr Type II	Squared Partial Corr Type II	Tolerance	Variance Inflation	95% Confidence Limits
Intercept	1	.	.	.	0	5.02414 82.28026
X1	1	0.35466	0.44040	0.78692	1.27077	0.63154 2.93802
X2	1	0.00128	0.00284	0.72432	1.38060	-0.97929 0.81249
X3	1	0.06703	0.12947	0.89915	1.11216	-0.07837 0.40063

Covariance of Estimates

Variable	Intercept	X1	X2	X3
Intercept	324.36769134	0.7651495821	-4.545863489	-0.974950169
X1	0.7651495821	0.2891164632	-0.09904623	-0.00038649
X2	-4.545863489	-0.09904623	0.1744779464	-0.013158898
X3	-0.974950169	-0.00038649	-0.013158898	0.0124691254

Correlation of Estimates

Variable	Intercept	X1	X2	X3
Intercept	1.0000	0.0790	-0.6043	-0.4848
X1	0.0790	1.0000	-0.4410	-0.0064
X2	-0.6043	-0.4410	1.0000	-0.2821
X3	-0.4848	-0.0064	-0.2821	1.0000

Sequential Parameter Estimates

	Intercept	X1	X2	X3
	81.277778	0	0	0
	59.258959	1.843436	0	0
	56.251024	1.789774	0.086649	0
	43.652198	1.784780	-0.083397	0.161133

Output Statistics														
Obs	Dep Var	Predicted Value	Std Error Mean	95% CL Mean	95% CL Predict	Residual	Std Error Residual	Student Residual						
	Y		Predict						-2	-1	0	1	2	
1	64.0000	65.4050	10.5752	42.7235	88.0865	16.9378	113.8723	-1.4050	16.941	-0.0829				
2	60.0000	68.7126	11.0062	45.1068	92.3185	19.8060	117.6192	-8.7126	16.664	-0.523	*			
3	71.0000	53.5624	11.6962	28.4766	78.6481	3.9245	103.2002	17.4376	16.187	1.077		**		
4	61.0000	67.1854	8.6364	48.6623	85.7085	20.5193	113.8515	-6.1854	18.007	-0.344				
5	54.0000	59.5460	9.4223	39.3371	79.7548	12.1854	106.9065	-5.5460	17.608	-0.315				
6	77.0000	61.0848	13.7970	31.4932	90.6765	9.0244	113.1453	15.9152	14.438	1.102		**		
7	81.0000	64.1718	10.1592	42.3825	85.9610	16.1156	112.2279	16.8282	17.193	0.979		*		
8	93.0000	77.9457	6.2695	64.4989	91.3925	33.0521	122.8393	15.0543	18.961	0.794		*		
9	93.0000	89.8131	9.9864	68.3944	111.2318	41.9238	137.7024	3.1869	17.294	0.184				
10	51.0000	79.3503	8.3893	61.3571	97.3435	32.8919	125.8086	-28.3503	18.123	-1.564	***			
11	76.0000	77.9063	5.1132	66.9397	88.8730	33.6922	122.1205	-1.9063	19.305	-0.0987				
12	96.0000	99.4135	7.3614	83.6249	115.2021	53.7637	145.0632	-3.4135	18.564	-0.184				
13	77.0000	102.3025	7.1198	87.0320	117.5730	56.8294	147.7757	-25.3025	18.658	-1.356	**			
14	93.0000	90.2967	8.9528	71.0949	109.4985	43.3570	137.2363	2.7033	17.851	0.151				
15	95.0000	107.2807	8.3375	89.3984	125.1629	60.8652	153.6961	-12.2807	18.147	-0.677	*			
16	54.0000	67.0830	7.3513	51.3159	82.8500	21.4406	112.7253	-13.0830	18.568	-0.705	*			
17	168.0000	119.1961	11.2752	95.0132	143.3789	70.0083	168.3838	48.8039	16.483	2.961	*****			
18	99.0000	112.7443	9.8642	91.5877	133.9009	64.9717	160.5169	-13.7443	17.364	-0.792	*			

Output Statistics

Obs	Cook's		Hat Diag		Cov		-----DFBETAS-----			
	D	RStudent	H	Ratio	DFFITs	Intercept	X1	X2	X3	
1	0.001	-0.0799	0.2804	1.8655	-0.0499	0.0184	0.0389	-0.0292	-0.0126	
2	0.030	-0.5088	0.3037	1.7853	-0.3361	-0.1038	0.0829	0.1986	-0.2064	
3	0.151	1.0840	0.3430	1.4483	0.7832	0.7596	-0.0292	-0.3246	-0.4587	
4	0.007	-0.3324	0.1870	1.5994	-0.1594	-0.0176	0.0855	0.0327	-0.0885	
5	0.007	-0.3046	0.2226	1.6817	-0.1630	-0.1550	0.0089	0.0663	0.0863	
6	0.277	1.1115	0.4773	1.7897	1.0622	-0.3836	-0.7486	0.9230	-0.2049	
7	0.084	0.9772	0.2588	1.3667	0.5774	0.2736	-0.0944	0.2170	-0.5008	
8	0.017	0.7829	0.0986	1.2410	0.2589	0.1768	0.0437	-0.1658	0.0267	
9	0.003	0.1778	0.2501	1.7762	0.1027	0.0187	0.0226	-0.0717	0.0733	
10	0.131	-1.6594	0.1765	0.7574	-0.7682	0.1975	0.2350	-0.6252	0.2841	
11	0.000	-0.0952	0.0656	1.4354	-0.0252	-0.0154	-0.0019	0.0074	0.0036	
12	0.001	-0.1774	0.1359	1.5416	-0.0703	-0.0116	-0.0505	0.0070	0.0144	
13	0.067	-1.4021	0.1271	0.8773	-0.5350	0.0663	-0.3410	-0.0228	-0.0195	
14	0.001	0.1460	0.2010	1.6724	0.0732	0.0317	0.0399	0.0006	-0.0478	
15	0.024	-0.6631	0.1743	1.4261	-0.3046	0.1548	-0.1245	-0.0635	-0.1224	
16	0.019	-0.6913	0.1355	1.3467	-0.2737	-0.0470	0.1597	0.0298	-0.1113	
17	1.026	4.6666	0.3188	0.0386	3.1922	-1.8192	1.4167	0.1771	1.9528	
18	0.051	-0.7804	0.2440	1.4814	-0.4433	0.0137	-0.3603	0.0259	0.0449	

Sum of Residuals 0
 Sum of Squared Residuals 5583.49966
 Predicted Residual SS (PRESS) 10683

EXST7015: Multiple Regression from Snedecor & Cochran (1967)
 PROC REG OUTPUT WITH ALL OPTIONS

The REG Procedure
 Model: MODEL1

Test 1 Results for Dependent Variable Y

Source	DF	Mean Square	F Value	Pr > F
Numerator	1	63.89578	0.16	0.6950
Denominator	14	398.82140		

Test 1 Results using
 ACOV estimates

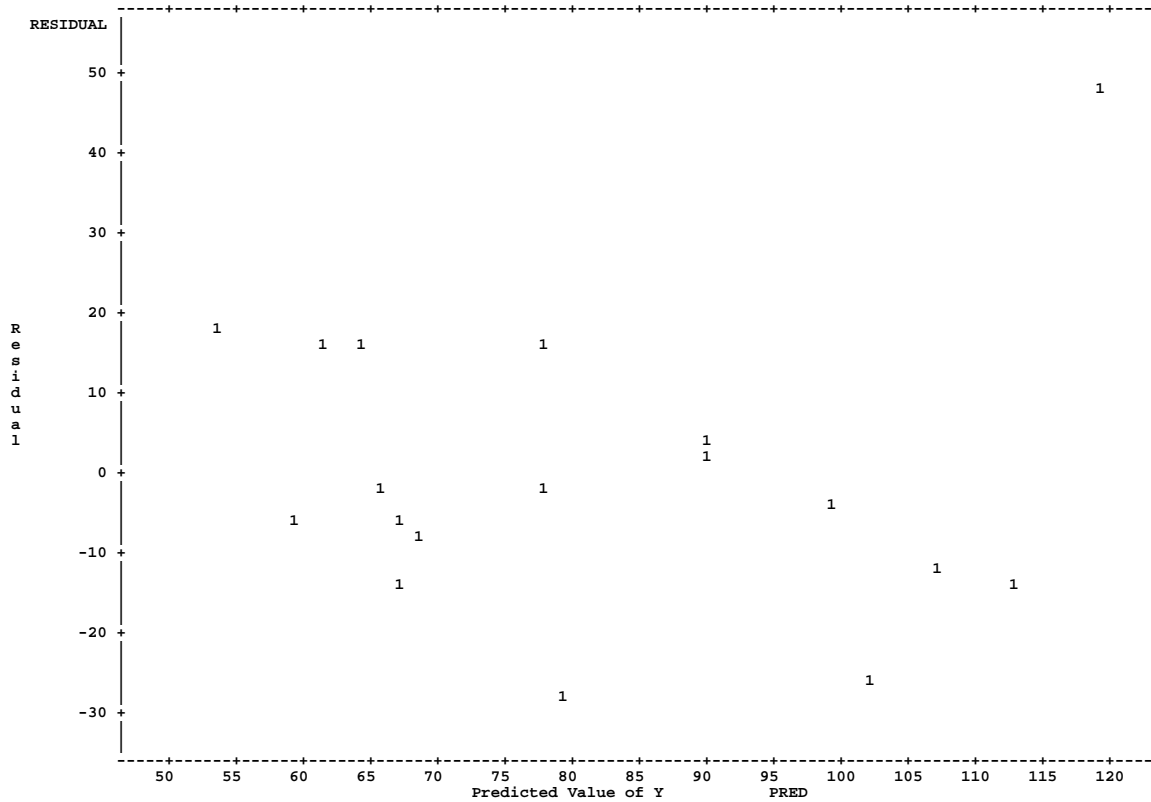
DF	Chi-Square	Pr > ChiSq
1	0.21	0.6480

Test 2 Results for Dependent Variable Y

Source	DF	Mean Square	F Value	Pr > F
Numerator	2	1760.86020	4.42	0.0326
Denominator	14	398.82140		

Test 2 Results using
 ACOV estimates

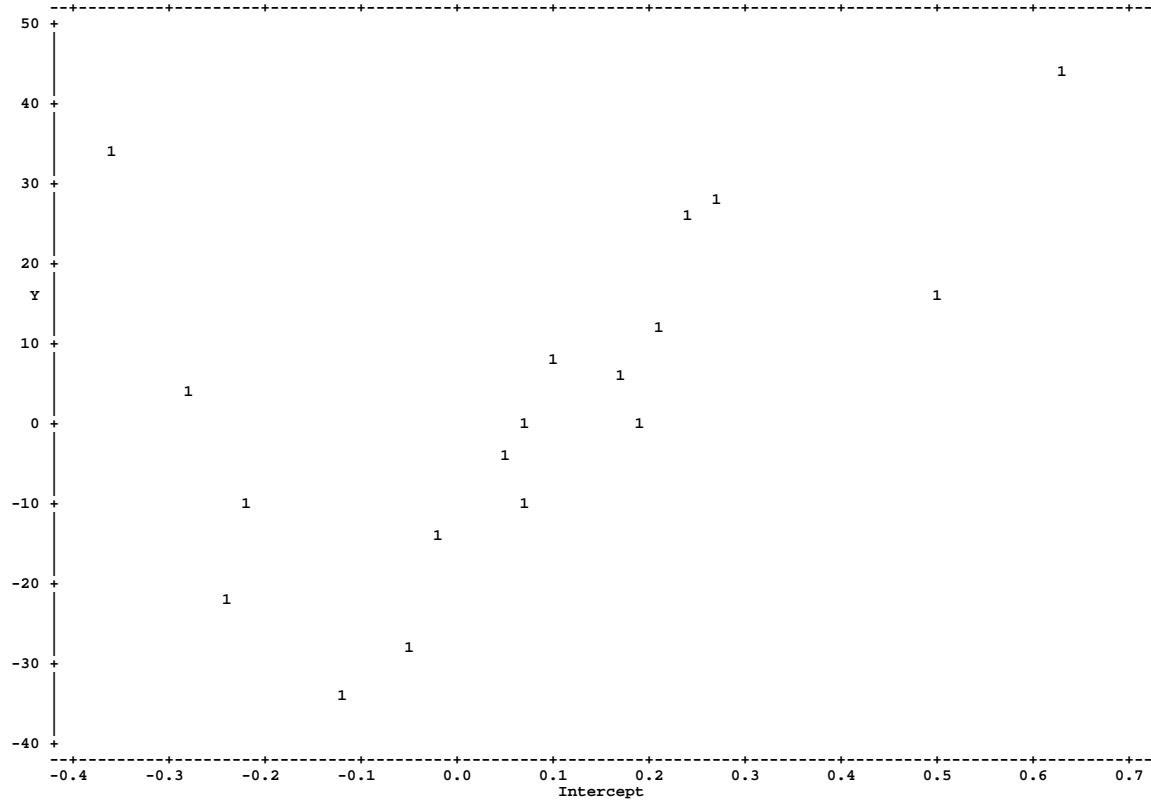
DF	Chi-Square	Pr > ChiSq
2	18.15	0.0001



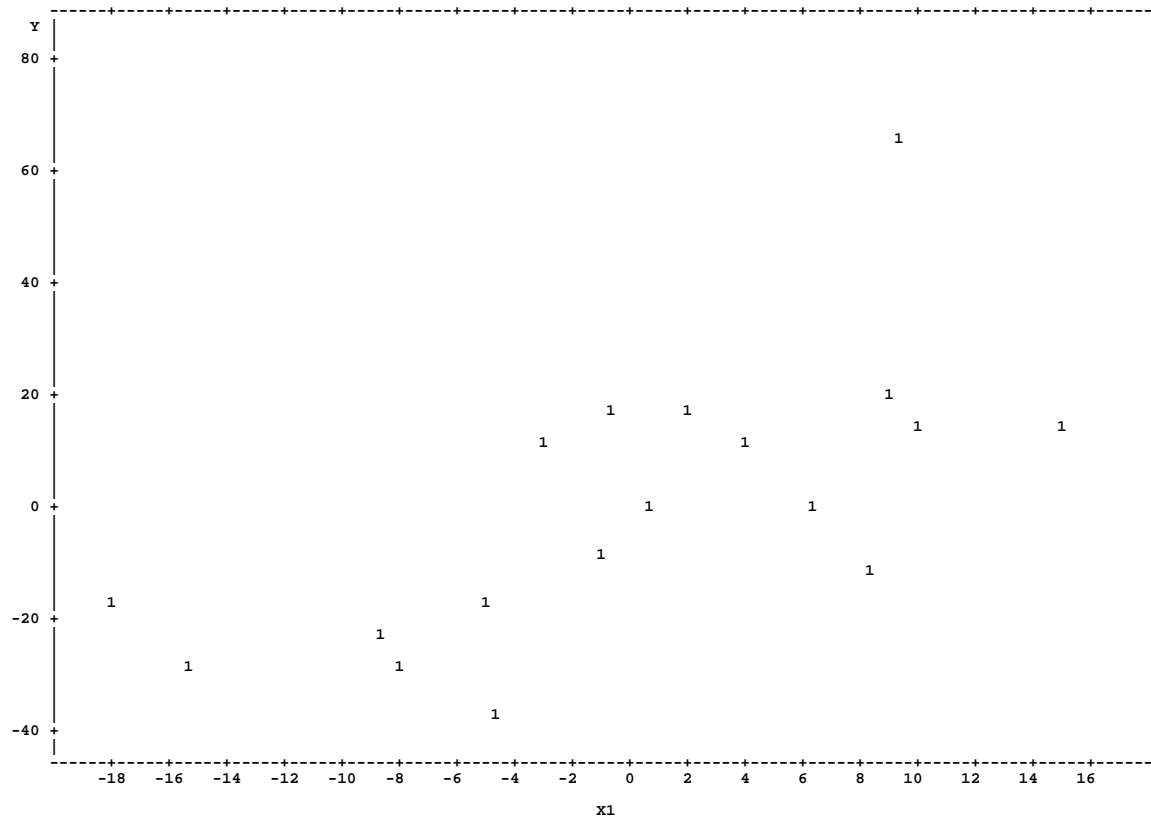
EXST7015: Multiple Regression from Snedecor & Cochran (1967)
PROC REG OUTPUT WITH ALL OPTIONS

The REG Procedure
Model: MODEL2

Partial Regression Residual Plot



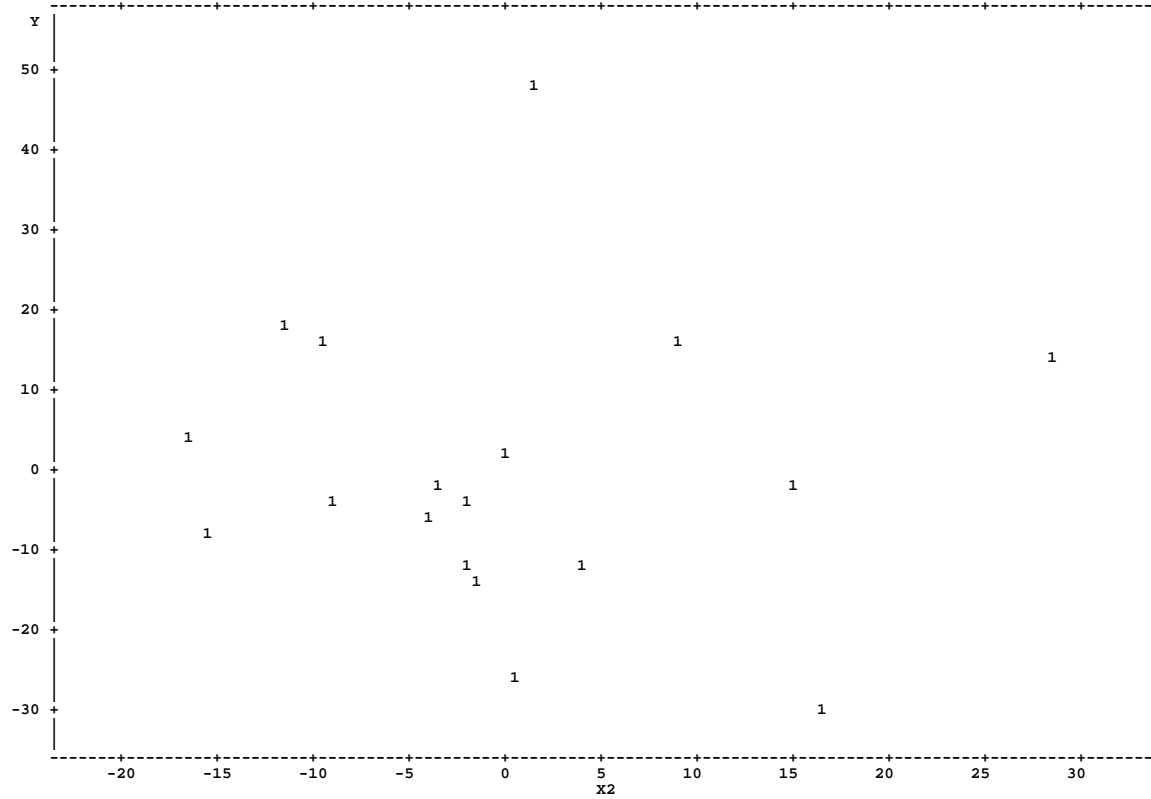
Partial Regression Residual Plot



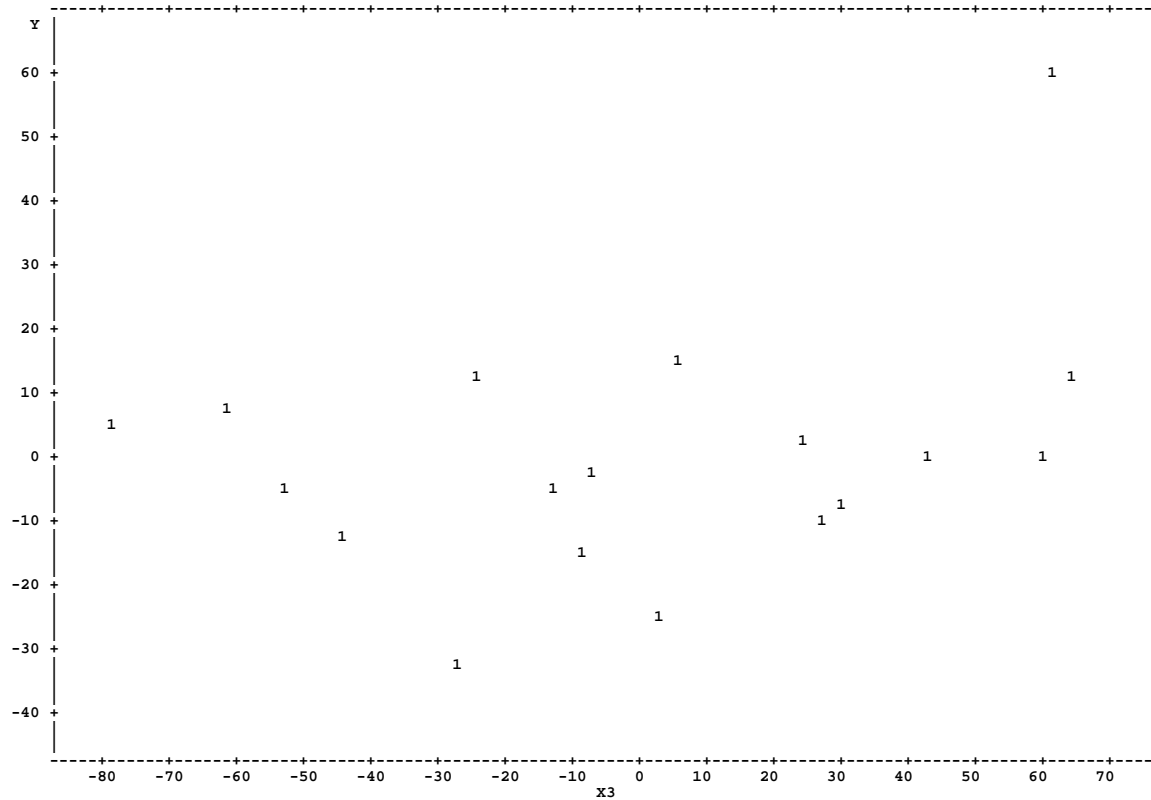
EXST7015: Multiple Regression from Snedecor & Cochran (1967)
PROC REG OUTPUT WITH ALL OPTIONS

The REG Procedure
Model: MODEL2

Partial Regression Residual Plot



Partial Regression Residual Plot



```
39      PROC GLM;  TITLE2 'PROC GLM OUTPUT WITH CONFIDENCE LIMITS FOR THE MEAN';
40      MODEL Y = X1 X2 X3 / XPX I CLI ALPHA=0.01;      RUN;
41      OPTIONS LS=120;
```

NOTE: The PROCEDURE GLM printed pages 21-25.

NOTE: PROCEDURE GLM used:

```
real time      0.09 seconds
cpu time       0.09 seconds
```

NOTE: SAS Institute Inc., SAS Campus Drive, Cary, NC USA 27513-2414

NOTE: used:

```
real time      0.99 seconds
cpu time       0.63 seconds
```

EXST7015: Multiple Regression from Snedecor & Cochran (1967)
 PROC GLM OUTPUT WITH CONFIDENCE LIMITS FOR THE MEAN

The GLM Procedure

Number of observations 18

The X'X Matrix

	Intercept	X1	X2	X3	Y
Intercept	18	215	758	2214	1463
X1	215	4321.02	10139.5	27645	20706.2
X2	758	10139.5	35076	96598	63825
X3	2214	27645	96598	307894	187542
Y	1463	20706.2	63825	187542	131299

X'X Inverse Matrix

	Intercept	X1	X2	X3	Y
Intercept	0.8133156545	0.0019185269	-0.011398244	-0.002444578	43.652197791
X1	0.0019185269	0.0007249271	-0.000248347	-9.690816E-7	1.7847796802
X2	-0.011398244	-0.000248347	0.0004374839	-0.000032994	-0.083397057
X3	-0.002444578	-9.690816E-7	-0.000032994	0.0000312649	0.161132691
Y	43.652197791	1.7847796802	-0.083397057	0.161132691	5583.4996578

The GLM Procedure

Dependent Variable: Y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	6806.11145	2268.70382	5.69	0.0092
Error	14	5583.49966	398.82140		
Corrected Total	17	12389.61111			

R-Square 0.549340 Coeff Var 24.57069 Root MSE 19.97051 Y Mean 81.27778

Source	DF	Type I SS	Mean Square	F Value	Pr > F
X1	1	5957.022495	5957.022495	14.94	0.0017
X2	1	18.646037	18.646037	0.05	0.8319
X3	1	830.442921	830.442921	2.08	0.1710

Source	DF	Type III SS	Mean Square	F Value	Pr > F
X1	1	4394.149832	4394.149832	11.02	0.0051
X2	1	15.897886	15.897886	0.04	0.8446
X3	1	830.442921	830.442921	2.08	0.1710

Parameter	Estimate	Standard Error	t Value	Pr > t
Intercept	43.65219779	18.01021075	2.42	0.0295
X1	1.78477968	0.53769551	3.32	0.0051
X2	-0.08339706	0.41770557	-0.20	0.8446
X3	0.16113269	0.11166524	1.44	0.1710

EXST7015: Multiple Regression from Snedecor & Cochran (1967)
 PROC GLM OUTPUT WITH CONFIDENCE LIMITS FOR THE MEAN

The GLM Procedure

Observation	Observed	Predicted	Residual
1	64.0000000	65.4050308	-1.4050308
2	60.0000000	68.7126060	-8.7126060
3	71.0000000	53.5623803	17.4376197
4	61.0000000	67.1853981	-6.1853981
5	54.0000000	59.5459617	-5.5459617
6	77.0000000	61.0848355	15.9151645
7	81.0000000	64.1717601	16.8282399
8	93.0000000	77.9456886	15.0543114
9	93.0000000	89.8130830	3.1869170
10	51.0000000	79.3502538	-28.3502538
11	76.0000000	77.9063339	-1.9063339
12	96.0000000	99.4134705	-3.4134705
13	77.0000000	102.3025361	-25.3025361
14	93.0000000	90.2966548	2.7033452
15	95.0000000	107.2806653	-12.2806653
16	54.0000000	67.0829599	-13.0829599
17	168.0000000	119.1960675	48.8039325
18	99.0000000	112.7443140	-13.7443140

Observation	99% Confidence Limits for Individual Predicted Value	
1	-1.8647549	132.6748166
2	0.8329702	136.5922418
3	-15.3321646	122.4569252
4	2.4154319	131.9553644
5	-6.1877991	125.2797225
6	-11.1721120	133.3417830
7	-2.5274762	130.8709963
8	15.6358585	140.2555187
9	23.3454618	156.2807041
10	14.8686997	143.8318080
11	16.5396224	139.2730454
12	36.0541644	162.7727767
13	39.1883302	165.4167421
14	25.1470643	155.4462453
15	42.8586051	171.7027255
16	3.7339941	130.4319258
17	50.9262662	187.4658688
18	46.4385986	179.0500294

Sum of Residuals	0.00000
Sum of Squared Residuals	5583.49966
Sum of Squared Residuals - Error SS	0.00000
PRESS Statistic	10682.74523
First Order Autocorrelation	-0.16585
Durbin-Watson D	2.29751