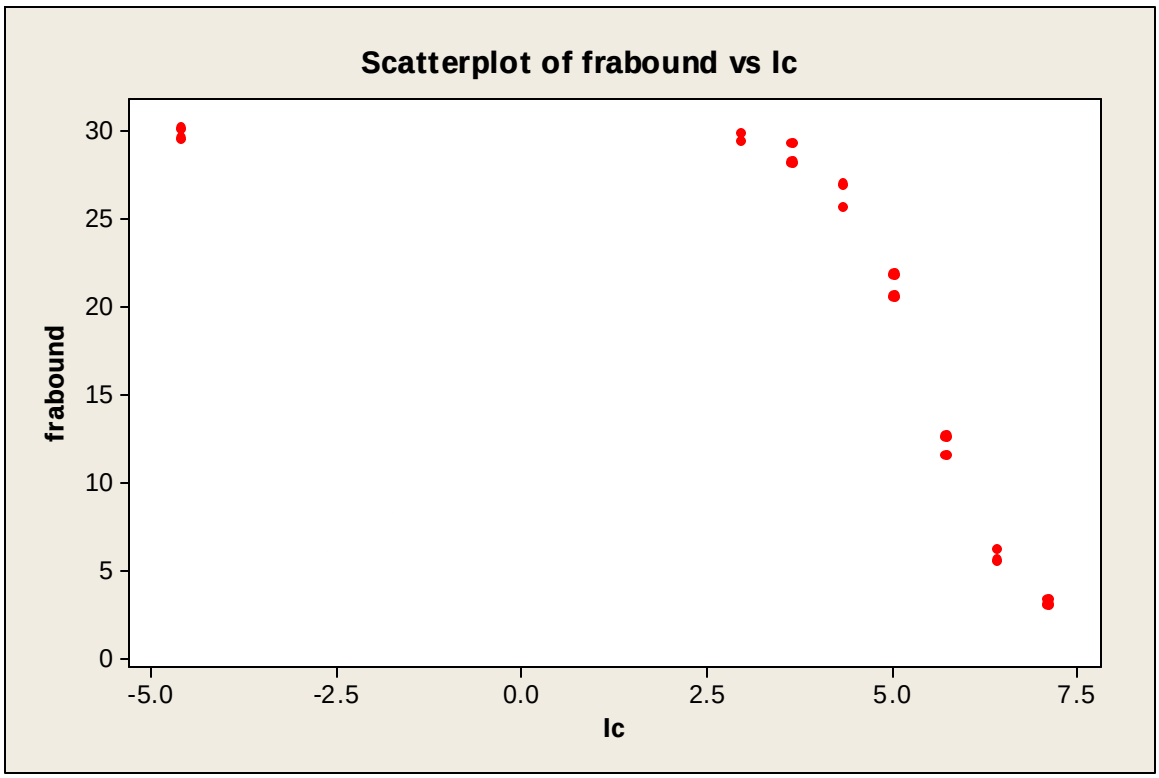


conc	frabound	lc
0.0	30.16	-4.60517
0.0	29.58	-4.60517
19.4	29.87	2.96579
19.4	29.43	2.96579
38.8	28.19	3.65868
38.8	29.33	3.65868
77.5	26.96	4.35041
77.5	25.72	4.35041
155.0	21.82	5.04349
155.0	20.59	5.04349
310.0	12.62	5.73660
310.0	11.57	5.73660
620.0	5.56	6.42974
620.0	6.17	6.42974
1240.0	3.33	7.12287
1240.0	3.07	7.12287

```
proc nlin data=one;
  parms th1=30 th2=0 th3=300 th4=2;
  if conc=0 then do;
    rhs=th1;
  end;
  else do;
    t=(conc/th3)**th4;
    rhs=th2+(th1-th2)/(1+t);
  end;
  model frabound=rhs;
  output out=two r=r p=p;
run;
proc print noobs; var r p; run;
```

The NLIN Procedure

Dependent Variable frabound

Method: Gauss-Newton

Iterative Phase

Iter	th1	th2	th3	th4	Sum of Squares
0	30.0000	0	300.0	2.0000	39.5202
1	29.7547	1.7626	236.1	1.7641	4.1840
2	29.8066	2.0042	232.1	1.8567	3.6505
3	29.8038	1.9915	232.4	1.8615	3.6471
4	29.8033	1.9928	232.4	1.8619	3.6471
5	29.8033	1.9929	232.4	1.8619	3.6471

NOTE: Convergence criterion met.

Estimation Summary

Method	Gauss-Newton
Iterations	5
R	2.794E-6
PPC(th2)	1.471E-6
RPC(th2)	0.000025
Object	2.965E-9
Objective	3.647137
Observations Read	16
Observations Used	16
Observations Missing	0

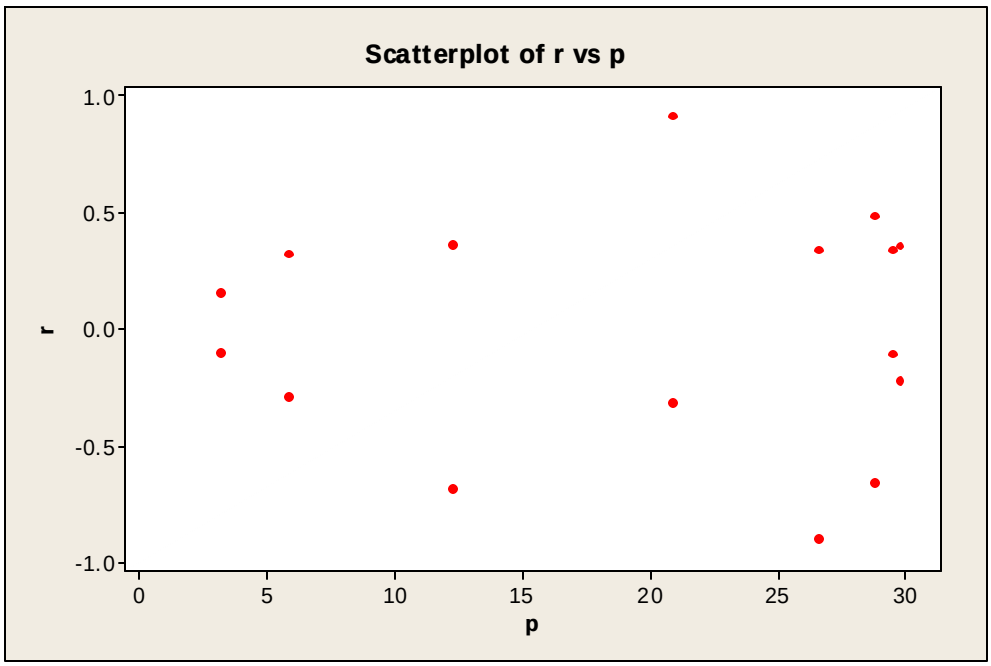
Source	DF	Sum of Squares	Mean Square	F Value	Approx Pr > F
Model	3	1704.2	568.1	1869.08	<.0001
Error	12	3.6471	0.3039		
Corrected Total	15	1707.8			

Parameter	Estimate	Approx Std Error	Approximate 95% Confidence Limits	
th1	29.8033	0.2658	29.2242	30.3823
th2	1.9929	0.5667	0.7582	3.2276
th3	232.4	8.6272	213.6	251.2
th4	1.8619	0.1122	1.6174	2.1065

Approximate Correlation Matrix

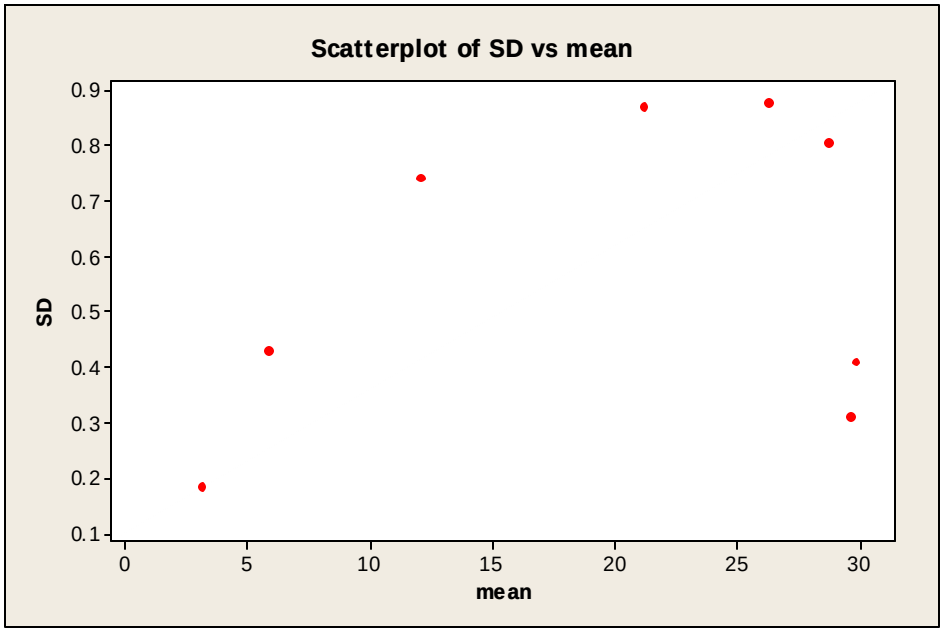
	th1	th2	th3	th4
th1	1.0000000	-0.3033530	-0.1517961	-0.5459955
th2	-0.3033530	1.0000000	-0.7268311	0.7460833
th3	-0.1517961	-0.7268311	1.0000000	-0.4125604
th4	-0.5459955	0.7460833	-0.4125604	1.0000000

r	p
0.35675	29.8033
-0.22325	29.8033
0.33705	29.5329
-0.10295	29.5329
-0.65525	28.8452
0.48475	28.8452
0.34247	26.6175
-0.89753	26.6175
0.91179	20.9082
-0.31821	20.9082
0.36251	12.2575
-0.68749	12.2575
-0.28828	5.8483
0.32172	5.8483
0.15796	3.1720
-0.10204	3.1720




```
proc sort data=one; by conc; run;
proc means noprint; var frabound; by conc; output out=three mean=m stddev=s; run;
data three; set three; drop _TYPE_ _FREQ_;
proc print; run;
```

Obs	conc	m	s
1	0.0	29.870	0.41012
2	19.4	29.650	0.31113
3	38.8	28.760	0.80610
4	77.5	26.340	0.87681
5	155.0	21.205	0.86974
6	310.0	12.095	0.74246
7	620.0	5.865	0.43134
8	1240.0	3.200	0.18385



```
proc nlmixed data=one; *** NLMIXED # 1 ***;
  parms th1=30 th2=0 th3=300 th4=2 se=1;
  if conc=0 then do;
    rhs=th1;
  end;
  else do;
    t=(conc/th3)**th4; den=1+t;
    rhs=th2+(th1-th2)/den;
  end;
  var=se*se;
  model frabound ~ normal(rhs,var);
run;
```

The NLMIXED Procedure

Iteration History

Iter	Calls	NegLogLike	Diff	MaxGrad	Slope
22	39	10.8738466	0.000103	0.004516	-0.00021
23	41	10.8738465	1.446E-7	0.000804	-3.4E-7
24	43	10.8738465	3.317E-9	7.301E-6	-6.64E-9

NOTE: GCONV convergence criterion satisfied.

Fit Statistics

-2 Log Likelihood	21.7
AIC (smaller is better)	31.7
AICC (smaller is better)	37.7
BIC (smaller is better)	35.6

Parameter Estimates

Parameter	Estimate	Standard Error	DF	t Value	Pr > |t|	Alpha	Lower	Upper	Gradient
th1	29.8033	0.2329	16	127.97	<.0001	0.05	29.3095	30.2970	1.531E-7
th2	1.9929	0.4927	16	4.04	0.0009	0.05	0.9484	3.0374	-1.97E-6
th3	232.44	7.4175	16	31.34	<.0001	0.05	216.72	248.17	-7.76E-8
th4	1.8619	0.09942	16	18.73	<.0001	0.05	1.6512	2.0727	7.301E-6
se	0.4774	0.08440	16	5.66	<.0001	0.05	0.2985	0.6564	2.854E-7

```
proc nlmixed data=one; *** NLMIXED # 2 ***;
  parms th1=30 th2=0 th3=300 th4=2 se=.01 rho=0;
  if conc=0 then do;
    rhs=th1;
  end;
  else do;
    t=(conc/th3)**th4; den=1+t;
    rhs=th2+(th1-th2)/den;
  end;
  var=se*se*(rhs)**rho;
  model frabound ~ normal(rhs,var);
run;
```

The NLMIXED Procedure

Iteration History

Iter	Calls	NegLogLike	Diff	MaxGrad	Slope
84	198	9.68738811	1.119E-9	0.0002	-1.8E-6
85	201	9.68738811	1.36E-10	0.000189	-2.11E-7
86	202	9.68738811	1.79E-10	0.000129	-1.07E-9

```
NOTE: GCONV convergence criterion satisfied.

                    Fit Statistics
-2 Log Likelihood                 19.4
AIC (smaller is better)           31.4
AICC (smaller is better)          40.7
BIC (smaller is better)           36.0

                    Parameter Estimates
                 Standard
Parameter  Estimate     Error    DF  t Value  Pr > |t|   Alpha     Lower     Upper  Gradient
th1         29.7840    0.2777    16   107.24    <.0001    0.05   29.1952   30.3728  -2.57E-6
th2          2.0618    0.2811    16     7.33    <.0001    0.05    1.4659    2.6577  0.000037
th3          231.74    5.6829    16    40.78    <.0001    0.05    219.69    243.79  6.445E-7
th4          1.8784   0.08705    16    21.58    <.0001    0.05    1.6939    2.0629  -0.00013
se           0.1223   0.09460    16     1.29    0.2144    0.05  -0.07822    0.3229  0.000046
rho          0.9410    0.5501    16     1.71    0.1065    0.05   -0.2252    2.1071  7.497E-6
```

```
proc nlmixed data=one;  *** NLMIXED # 3 ***;
  parms th1=30 th2=2 th3=250 th4=2 se=.01 rho1=5 rho2=4;
  if conc=0 then do;
    rhs=th1;
  end;
  else do;
    t=(conc/th3)**th4; den=1+t;
    rhs=th2+(th1-th2)/den;
  end;
  var=.00001*se*se*((rhs)**rho1)*((1.1*th1-rhs)**rho2);
  model frabound ~ normal(rhs,var);
run;
```

```
                    The NLMIXED Procedure
                    Iteration History
    Iter     Calls    NegLogLike        Diff     MaxGrad       Slope
      44        90    7.71820293    3.782E-8    0.027773    -6.64E-8
NOTE: GCONV convergence criterion satisfied.

                    Fit Statistics
-2 Log Likelihood                 15.4
AIC (smaller is better)           29.4
AICC (smaller is better)          43.4
BIC (smaller is better)           34.8

                    Parameter Estimates
                 Standard
Parameter  Estimate     Error    DF  t Value  Pr > |t|   Alpha     Lower     Upper  Gradient
th1         29.8710    0.1771    16   168.64    <.0001    0.05   29.4955   30.2464  -0.00012
th2          1.9814    0.2295    16     8.63    <.0001    0.05    1.4948    2.4680   0.00012
th3          230.04    6.7797    16    33.93    <.0001    0.05    215.67    244.42  -0.00032
th4          1.8332   0.08383    16    21.87    <.0001    0.05    1.6555    2.0109  -0.00032
se           0.2476    0.6171    16     0.40    0.6936    0.05   -1.0606    1.5557  -0.02777
rho1         2.9106    1.0545    16     2.76    0.0139    0.05    0.6751    5.1461  -0.00009
rho2         2.0161    0.9914    16     2.03    0.0589    0.05  -0.08554    4.1176  -0.00011
```