

```

data insect;
do type='DDT ' 'gBHC';
do deposit=2,2.64,3.48,4.59,6.06,8;
  ldep=log(deposit); dd=(type='DDT '); dg=(type='gBHC');
  input y n @@; output;
end; end; datalines;
3 50 5 49 19 47 19 38 24 49 35 50
2 50 14 49 20 50 27 50 41 50 40 50
;
proc sort; by type; run;
proc nlmixed;
parms bet=2.5 gam=1;
eta=bet*(ldep-log(gam));
expeta=exp(eta);
p=expeta/(1+expeta);
model y~binomial(n,p);
by type;
run;

```

First NLMixed

The NLMIXED Procedure Specifications

Data Set	WORK.INSECT
Dependent Variable	y
Distribution for Dependent Variable	Binomial
Optimization Technique	Dual Quasi-Newton
Integration Method	None

----- type=DDT -----

The NLMIXED Procedure Dimensions

Observations Used	6
Observations Not Used	0
Total Observations	6
Parameters	2

Parameters

bet	gam	NegLogLike
2.5	1	416.03576

Iteration History

Iter	Calls	NegLogLike	Diff	MaxGrad	Slope
1	3	102.564578	313.4712	82.7474	-2532.41
2	5	47.8553472	54.70923	21.29345	-36.046
3	7	37.4773597	10.37799	15.25714	-5.69886
4	9	31.3603422	6.117017	17.30058	-6.46413
5	10	20.8812123	10.47913	4.740603	-31.1141
6	12	18.6311778	2.250035	4.517671	-4.1283
7	15	17.9103999	0.720778	7.213801	-0.9354
8	16	16.8778268	1.032573	3.104732	-0.73744
9	17	16.4674615	0.410365	2.628793	-1.05518
10	18	16.0158884	0.451573	0.303515	-1.30892
11	20	16.0096329	0.006255	0.024832	-0.01262
12	22	16.0095708	0.000062	0.001178	-0.0001
13	24	16.0095707	7.964E-8	3.772E-6	-1.58E-7

NOTE: GCONV convergence criterion satisfied.

Fit Statistics

-2 Log Likelihood	32.0
AIC (smaller is better)	36.0
AICC (smaller is better)	40.0

BIC (smaller is better)						35.6			
Parameter Estimates									
Parameter	Estimate	Standard Error	DF	t Value	Pr > t	Alpha	Lower	Upper	Gradient
bet	2.2824	0.3190	6	7.16	0.0004	0.05	1.5019	3.0629	3.772E-6
gam	5.3569	0.3505	6	15.28	<.0001	0.05	4.4993	6.2145	-1.14E-6
----- type=gBHC -----									
The NLMIXED Procedure									
Dimensions									
Observations Used							6		
Observations Not Used							0		
Total Observations							6		
Parameters							2		
Parameters									
bet			gam			NegLogLike			
2.5			1			315.327115			
Iteration History									
Iter	Calls	NegLogLike		Diff	MaxGrad		Slope		
1	3	69.6343928		245.6927	67.9755		-2118.97		
2	5	32.6585765		36.97582	18.38442		-23.0892		
3	7	19.7707462		12.88783	9.070433		-6.82388		
4	9	17.8804383		1.890308	6.436566		-1.08876		
5	11	15.8282969		2.052141	2.38946		-2.15176		
6	13	15.7019341		0.126363	0.433908		-0.29391		
7	15	15.6881118		0.013822	0.02003		-0.02471		
8	17	15.688085		0.000027	0.000488		-0.00005		
9	19	15.688085		5.247E-9	9.171E-6		-1.07E-8		
NOTE: GCONV convergence criterion satisfied.									
Fit Statistics									
-2 Log Likelihood						31.4			
AIC (smaller is better)						35.4			
AICC (smaller is better)						39.4			
BIC (smaller is better)						35.0			
Parameter Estimates									
Parameter	Estimate	Standard Error	DF	t Value	Pr > t	Alpha	Lower	Upper	Gradient
bet	2.8381	0.3392	6	8.37	0.0002	0.05	2.0080	3.6681	2.072E-6
gam	4.1558	0.2021	6	20.57	<.0001	0.05	3.6613	4.6502	9.171E-6

```
proc nlmixed;
  title 'Second NLMixed';
  parms betd=2 betg=3 gamd=5 gamg=4;
  bet=betd*dd+betg*dg; gam=gamd*dd+gamg*dg;
  t=(deposit/gam)**bet;
  p=t/(1+t);
  model y~binomial(n,p);
run;
```

Second NLMixed

The NLMIXED Procedure	
Specifications	
Data Set	WORK.INSECT
Dependent Variable	y
Distribution for Dependent Variable	Binomial

Optimization Technique				Dual Quasi-Newton					
Integration Method				None					
Dimensions									
Observations Used				12					
Observations Not Used				0					
Total Observations				12					
Parameters				4					
Parameters									
betd		betg		gamd		gamg		NegLogLike	
2		3		5		4		33.5095283	
Iteration History									
Iter	Calls	NegLogLike		Diff		MaxGrad		Slope	
1	3	31.920406		1.589122		2.385246		-65.4072	
2	5	31.7104028		0.210003		0.406192		-9.35406	
3	7	31.7000375		0.010365		0.257504		-0.19118	
4	9	31.6991427		0.000895		0.204831		-0.00847	
5	10	31.6977469		0.001396		0.051084		-0.00542	
6	12	31.6976557		0.000091		0.000121		-0.00018	
7	14	31.6976557		1.58E-9		2.016E-6		-3.18E-9	
NOTE: GCONV convergence criterion satisfied.									
Fit Statistics									
-2 Log Likelihood						63.4			
AIC (smaller is better)						71.4			
AICC (smaller is better)						77.1			
BIC (smaller is better)						73.3			
Parameter Estimates									
Standard									
Parameter	Estimate	Error	DF	t Value	Pr > t	Alpha	Lower	Upper	Gradient
betd	2.2824	0.3190	12	7.16	<.0001	0.05	1.5874	2.9774	-1.81E-6
betg	2.8381	0.3392	12	8.37	<.0001	0.05	2.0990	3.5772	-1.7E-7
gamd	5.3569	0.3505	12	15.28	<.0001	0.05	4.5932	6.1206	-9.29E-7
gamg	4.1558	0.2021	12	20.57	<.0001	0.05	3.7155	4.5961	2.016E-6

```
proc nlmixed;
  parms bet=2.5 gamd=5 gamg=4;
  gam=gamd*dd+gamg*dg;
  t=(deposit/gam)**bet;
  p=t/(1+t);
  model y~binomial(n,p);
run;
```

Third NLMixed

The NLMIXED Procedure		
Specifications		
Data Set	WORK.INSECT	
Dependent Variable	y	
Distribution for Dependent Variable	Binomial	
Optimization Technique	Dual Quasi-Newton	
Integration Method	None	
Dimensions		
Observations Used	12	
Observations Not Used	0	
Total Observations	12	
Parameters	3	

Parameters									
	bet	gamd	gamg	NegLogLike					
	2.5	5	4	33.1943149					
Iteration History									
Iter	Calls	NegLogLike	Diff	MaxGrad	Slope				
1	3	32.4611226	0.733192	0.859125	-38.4815				
2	6	32.4129924	0.04813	0.144567	-1.78525				
3	9	32.4123667	0.000626	0.06799	-0.03425				
4	10	32.4121859	0.000181	0.00052	-0.00036				
5	11	32.4121859	2.497E-8	0.000026	-4.81E-8				
NOTE: GCONV convergence criterion satisfied.									
Fit Statistics									
-2 Log Likelihood				64.8					
AIC (smaller is better)				70.8					
AICC (smaller is better)				73.8					
BIC (smaller is better)				72.3					
Parameter Estimates									
	Standard								
Parameter	Estimate	Error	DF	t Value	Pr > t	Alpha	Lower	Upper	Gradient
bet	2.5576	0.2322	12	11.02	<.0001	0.05	2.0518	3.0635	8.113E-6
gamd	5.2621	0.3009	12	17.49	<.0001	0.05	4.6065	5.9176	-0.00003
gamg	4.1635	0.2187	12	19.04	<.0001	0.05	3.6871	4.6399	0.000016

```
proc nlmixed;
parms bet=2.5 gamd=5 rho=2;
gamg=rho*gamd; gam=gamd*dd+gamg*dg;
t=(deposit/gam)**bet;
p=t/(1+t);
model y~binomial(n,p);
run;
```

Fourth NLMixed

The NLMIXED Procedure					
Specifications					
Data Set			WORK.INSECT		
Dependent Variable			y		
Distribution for Dependent Variable			Binomial		
Optimization Technique			Dual Quasi-Newton		
Integration Method			None		
Dimensions					
Observations Used			12		
Observations Not Used			0		
Total Observations			12		
Parameters			3		
Parameters					
bet		gamd		rho	
2.5		5		2	
				NegLogLike	
				155.448559	
Iteration History					
Iter	Calls	NegLogLike	Diff	MaxGrad	Slope
1	3	51.1032767	104.3453	77.76662	-938.654
2	5	47.1353752	3.967902	22.18537	-53.4762
3	7	33.5502428	13.58513	22.58646	-13.2707
4	8	33.2342302	0.316013	28.80981	-2.67963
5	10	32.509376	0.724854	1.631572	-1.60408

6	12	32.4137701	0.095606	0.546839	-0.10035
7	14	32.4121872	0.001583	0.012647	-0.00301
8	16	32.4121859	1.328E-6	0.001436	-2.52E-6
9	18	32.4121859	2.963E-9	0.000052	-5.42E-9

NOTE: GCONV convergence criterion satisfied.

Fit Statistics

-2 Log Likelihood	64.8
AIC (smaller is better)	70.8
AICC (smaller is better)	73.8
BIC (smaller is better)	72.3

Parameter Estimates

Parameter	Estimate	Standard Error	DF	t Value	Pr > t	Alpha	Lower	Upper	Gradient
bet	2.5576	0.2322	12	11.02	<.0001	0.05	2.0518	3.0635	-9.34E-6
gamd	5.2621	0.3009	12	17.49	<.0001	0.05	4.6065	5.9176	-0.00002
rho	0.7912	0.06119	12	12.93	<.0001	0.05	0.6579	0.9246	-0.00005

SAS/IML and Graph

```
proc iml;
  start neg2ll(th) global(depd,depg,nd,nq,vd,vq);
    bet=th[1]; gamd=th[2]; rho=th[3]; gamg=rho*gamd;
    td=(depd/gamd)##bet; tg=(depg/gamg)##bet; pd=td/(1+td); pg=tg/(1+tg);
    tomax=t(vd)*log(td)-t(nd)*log(1+td)+t(yg)*log(tg)-t(ng)*log(1+tg);
    return(-2*tomax);
  finish;

  depd={2,2.64,3.48,4.59,6.06,8}; depg={2,2.64,3.48,4.59,6.06,8};
  nd={50,49,47,38,49,50}; nq={50,49,50,50,50,50};
  yd={3,5,19,19,24,35}; yg={2,14,20,27,41,40};
  th0={2.5 5 .5}; opt={.,0};
  con={.001 .001 .001,
        . . . };
  call nlptr(rc,theta,"neg2ll".th0.opt.con);
  minn2ll=neg2ll(theta); print theta minn2ll; ans=j(50,5);
  do jj=1 to 50;
    ans[jj,3]=minn2ll+2.71;
    ans[jj,4]=minn2ll+3.84;
    ans[jj,5]=minn2ll+6.63;

    star=0.6; fini=1; rho=star+(fini-star)*(jj-1)/49; ans[jj,1]=rho;
    th0=theta; opt={.,0};
    con2={0.001 0.001 0.001,
          . . . };
    th0[3]=rho; con2[1,3]=rho; con2[2,3]=rho;
    call nlptr(rc,tthil,"neg2ll",th0,opt,con2);
    ans[jj,2]=neg2ll(tthil);
  end;
  create dset from ans[colname={rho negll cut90 cut95 cut99}];
  append from ans;
quit;
data final; set dset;
  y=negll; zz=1; output;
  y=cut90; zz=2; output;
  y=cut95; zz=3; output;
  y=cut99; zz=4; output;

axis1 w=2 minor=none label=(a=90 font=swiss 'Profile Likelihood');
axis2 w=2 minor=none label=(font=swiss 'relative potency');
symbol1 i=join w=5 l=1 c=blue;
symbol2 i=join w=3 l=2 c=blue;
symbol3 i=join w=3 l=3 c=blue;
```

```

symbol4 i=join w=3 l=4 c=blue;
title 'Profile Likelihood Graph';
proc gplot data=final;
  plot y*rho=zz / fr vaxis=axis1 nolegend haxis=axis2;
run;

```

THETA	MINN2LL
2.55762 5.2620783 0.7912255	627.35732

Profile Likelihood Graph

