

```

data one;
  input city $ rate y;
  cards;
A 0.5 26.4
A 0.5 23.5
A 0.5 25.4
A 0.5 22.9
A 1.0 25.2
A 1.0 39.2
A 1.0 25.5
A 1.0 31.9
A 1.5 26.0
A 1.5 44.6
A 1.5 35.5
A 1.5 38.6
B 0.5 30.1
B 0.5 31.0
B 0.5 30.8
B 0.5 32.8
B 1.0 47.7
B 1.0 39.1
B 1.0 55.3
B 1.0 50.7
B 1.5 73.8
B 1.5 71.1
B 1.5 68.4
B 1.5 77.1
C 0.5 19.4
C 0.5 19.3
C 0.5 18.7
C 0.5 19.0
... (plus a little more data)
;

proc glm;
  class city rate;
  model y=city rate city*rate;
run;

proc glm;
  class city;
  model y=city rate rate*rate city*rate city*rate*rate;
run;

proc glm;
  class city;
  model y=city rate city*rate / solution clparm;
  estimate 'Intercept for City A' intercept 1 city 1 0 0;
  estimate 'Intercept for City B' intercept 1 city 0 1 0;
  estimate 'Intercept for City C' intercept 1 city 0 0 1;
  estimate 'Slope for City A' rate 1 city*rate 1 0 0;
  estimate 'Slope for City B' rate 1 city*rate 0 1 0;
  estimate 'Slope for City C' rate 1 city*rate 0 0 1;
  estimate 'Est. Mean for rate=1.25 City=A'
    intercept 1 city 1 0 0 rate 1.25 city*rate 1.25 0 0;
  estimate 'Est. Mean for rate=1.5 City=A'
    intercept 1 city 1 0 0 rate 1.5 city*rate 1.5 0 0;
  estimate 'Est. Mean for rate=1.5 City=B'
    intercept 1 city 0 1 0 rate 1.5 city*rate 0 1.5 0;
  estimate 'City B - City A at rate=1.5'\
    city -1 1 0 city*rate -1.5 1.5 0;
run;

```

The GLM Procedure

Class Level Information

Class	Levels	Values
city	3	A B C
rate	3	0.5 1 1.5
Number of observations		36

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	9475.515000	1184.439375	61.75	<.0001
Error	27	517.865000	19.180185		
Corrected Total	35	9993.380000			

R-Square	Coeff Var	Root MSE	y Mean
0.948179	12.95716	4.379519	33.80000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
city	2	5720.671667	2860.335833	149.13	<.0001
rate	2	1945.445000	972.722500	50.71	<.0001
city*rate	4	1809.398333	452.349583	23.58	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
city	2	5720.671667	2860.335833	149.13	<.0001
rate	2	1945.445000	972.722500	50.71	<.0001
city*rate	4	1809.398333	452.349583	23.58	<.0001

Class Level Information

Class	Levels	Values
city	3	A B C
Number of observations		36

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	9475.515000	1184.439375	61.75	<.0001
Error	27	517.865000	19.180185		
Corrected Total	35	9993.380000			

R-Square	Coeff Var	Root MSE	y Mean
0.948179	12.95716	4.379519	33.80000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
city	2	5720.671667	2860.335833	149.13	<.0001
rate	1	1944.000000	1944.000000	101.35	<.0001
rate*rate	1	1.445000	1.445000	0.08	0.7858
rate*city	2	1760.147500	880.073750	45.88	<.0001
rate*rate*city	2	49.250833	24.625417	1.28	0.2933

Source	DF	Type III SS	Mean Square	F Value	Pr > F
city	2	10.76482456	5.38241228	0.28	0.7575
rate	1	26.10122449	26.10122449	1.36	0.2536
rate*rate	1	1.44500000	1.44500000	0.08	0.7858
rate*city	2	1.50341837	0.75170918	0.04	0.9616
rate*rate*city	2	49.25083333	24.62541667	1.28	0.2933

Class Level Information

Class	Levels	Values
city	3	A B C
Number of observations		36

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	9424.819167	1884.963833	99.46	<.0001
Error	30	568.560833	18.952028		
Corrected Total	35	9993.380000			

R-Square	Coeff Var	Root MSE	y Mean
0.943106	12.87986	4.353393	33.80000

Source	DF	Type I SS	Mean Square	F Value	Pr > F
city	2	5720.671667	2860.335833	150.93	<.0001
rate	1	1944.000000	1944.000000	102.57	<.0001
rate*city	2	1760.147500	880.073750	46.44	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
city	2	111.226667	55.613333	2.93	0.0686
rate	1	1944.000000	1944.000000	102.57	<.0001
rate*city	2	1760.147500	880.073750	46.44	<.0001

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Intercept for City A	18.7666667	3.32495858	5.64	<.0001
Intercept for City B	9.2333333	3.32495858	2.78	0.0094
Intercept for City C	19.4000000	3.32495858	5.83	<.0001
Slope for City A	11.6250000	3.07831348	3.78	0.0007
Slope for City B	41.4250000	3.07831348	13.46	<.0001
Slope for City C	0.9500000	3.07831348	0.31	0.7598
Est. Mean for rate=1.25 City=A	33.2979167	1.47363039	22.60	<.0001
Est. Mean for rate=1.5 City=A	36.2041667	1.98704281	18.22	<.0001
Est. Mean for rate=1.5 City=B	71.3708333	1.98704281	35.92	<.0001
City B - City A at rate=1.5	35.1666667	2.81010289	12.51	<.0001

Parameter	95% Confidence Limits	
Intercept for City A	11.9761953	25.5571380
Intercept for City B	2.4428620	16.0238047
Intercept for City C	12.6095287	26.1904713
Slope for City A	5.3382452	17.9117548
Slope for City B	35.1382452	47.7117548
Slope for City C	-5.3367548	7.2367548
Est. Mean for rate=1.25 City=A	30.2883619	36.3074714
Est. Mean for rate=1.5 City=A	32.1460839	40.2622495
Est. Mean for rate=1.5 City=B	67.3127505	75.4289161
City B - City A at rate=1.5	29.4276709	40.9056624

Parameter	Estimate	Standard Error	t Value	Pr > |t|	95% Confidence Limits	
Intercept	19.4000000 B	3.32495858	5.83	<.0001	12.60952868	26.19047132
city A	-0.63333333 B	4.70220151	-0.13	0.8938	-10.23650997	8.96984330
city B	-10.16666667 B	4.70220151	-2.16	0.0387	-19.76984330	-0.56349003
city C	0.0000000 B	.	.	.	.	.
rate	0.9500000 B	3.07831348	0.31	0.7598	-5.33675483	7.23675483
rate*city A	10.6750000 B	4.35339267	2.45	0.0202	1.78418605	19.56581395
rate*city B	40.4750000 B	4.35339267	9.30	<.0001	31.58418605	49.36581395
rate*city C	0.0000000 B	.	.	.	.	.

NOTE: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.