

```

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 |
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| 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.