# Tutorial #2: Assessing the Effects of a Reminder Call

## DemoData = 'ex2.sav'

In this tutorial, we estimate the effects of 1) the dollar amount mailed out with the survey ($X_1$: PAYMENT - $1, $2, or $10) and 2) a reminder call ($X_2$: CALL - - Yes or No) on the return rate of a mail survey.
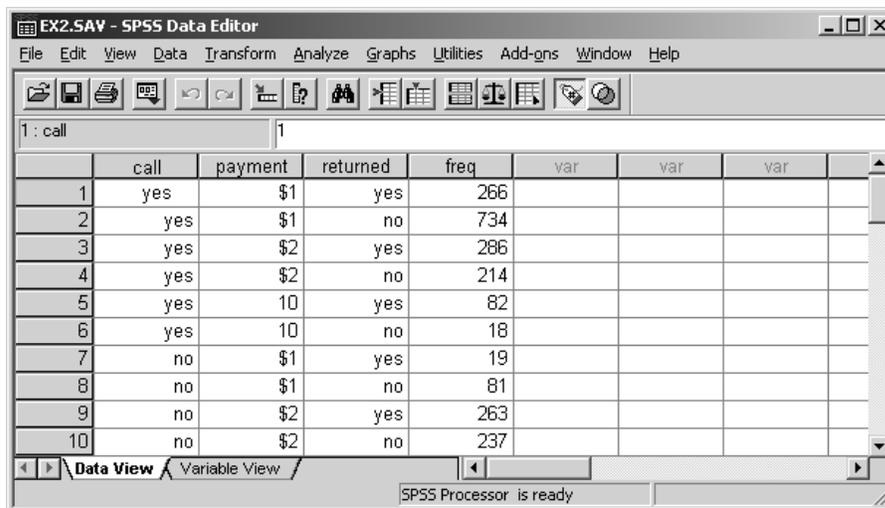
This tutorial illustrates

- the use of the goodness of fit statistic to examine the validity of the scaling and other assumptions made by a model
- obtaining various tables and regression plots, and
- the poor prediction and biased parameter estimates that can result from model misspecification (i.e., use of improper scores),

For further discussion of biases associated with improper scores see Magidson, Jay. "On Models Used to Adjust for Pre-existing Differences", chapter 8 in Bickman, L Ed., <u>Research Design: Donald Campbell's Legacy</u>, London: Sage Publications, 2000, p 181-194.

## The Data

The data is in the SPSS file "ex2.sav". Figure 1 shows the first 10 cases:



**Figure 1. Data file**

Table 1 contains frequency counts for the hypothetical mail survey where the dichotomous dependent variable RETURNED indicates whether an individual completes and returns the survey or not: Yes(1) or No(0), for the joint X variable formed by the different possible combinations of the two categorical predictor variables CALL and PAYMENT.

|  | | Y:RETURNED | | | |
| Joint X | | yes(1) | no(0) | Total | Percent Response |
|---|---|---|---|---|---|
| PAYMENT, CALL | $1, yes(1) | 266 | 734 | 1,000 | 26.6% |
| | $1, no(0) | 19 | 81 | 100 | 19.0% |
| | $2, yes(1) | 286 | 214 | 500 | 57.2% |
| | $2, no(0) | 263 | 237 | 500 | 52.6% |
| | $10, yes(1) | 82 | 18 | 100 | 82.0% |
| | $10, no(0) | 801 | 199 | 1,000 | 80.1% |

**Table 1. Mail Survey Experiment: Hypothetical Data and Simple Descriptive Statistics**

We will assess the effects of CALL and PAYMENT under each of two models that differ with respect to the category scores assigned to the three PAYMENT levels:

**Model A**: Fixed Dollar PAYMENT scale: scores = 1, 2, 10
**Model B**: Fixed Equidistant PAYMENT scale: scores = 1, 2, 3

Model A uses the original dollar payment amount to scale PAYMENT while Model B scales PAYMENT using the equidistant scores 1, 2, 3 in which the $2 option is centered midway between the lower and higher payment amounts.
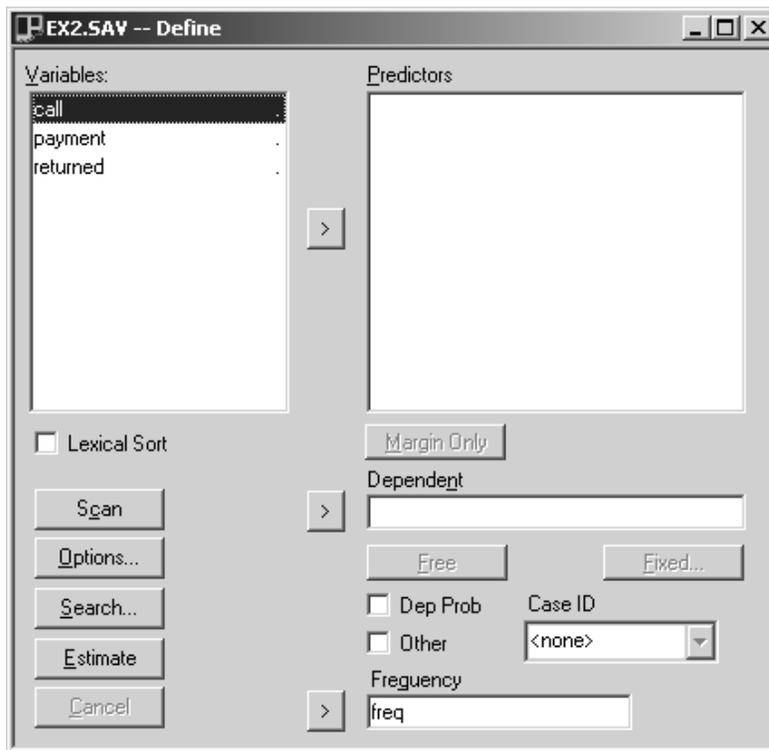

# The Model

To open the data file in GOLDMineR,

➢ Click File, and then Open
➢ Select ex2.sav and click OK
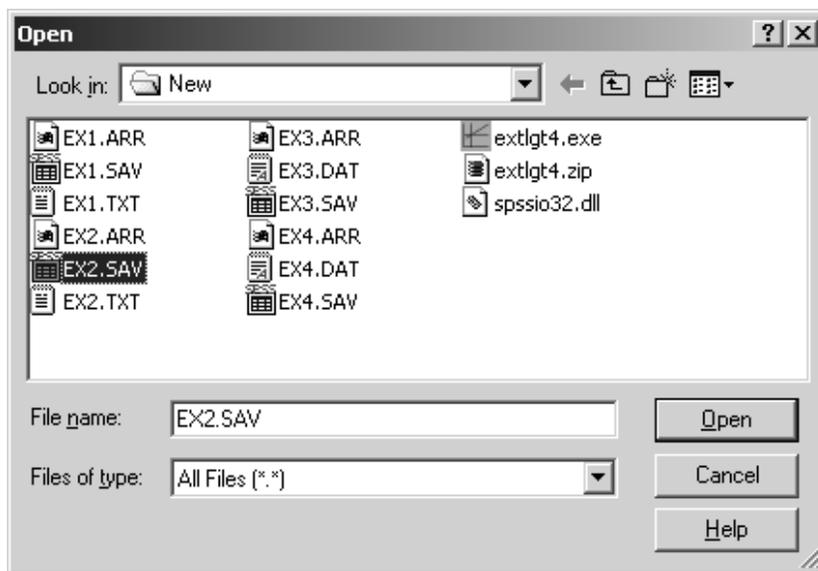


**Figure 2. File Open Dialog Box**

The Define Dialog Box opens:



**Figure 3. The Define Dialog Box**

➢ Click on RETURNED and press the arrow next to the Dependent box to move it to the Dependent Variables box.

➢ Click on CALL and PAYMENT and press the arrow next to the Predictors box to move them to the Predictors box.

➢ Click Scan to scan the data file

Your Define Dialog Box should now look like this:
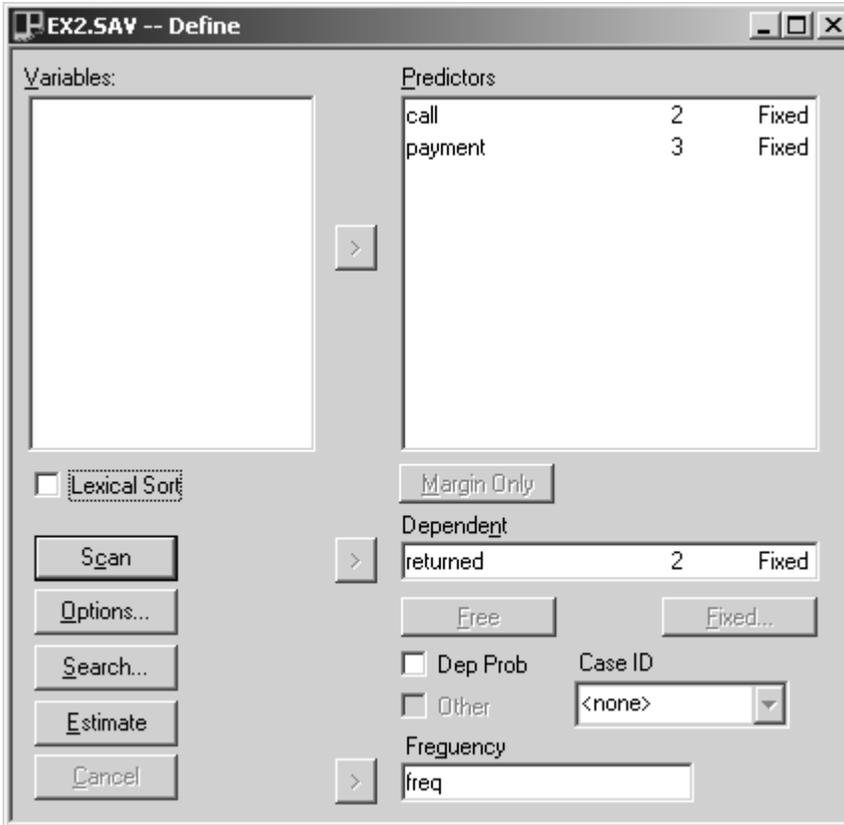
**Figure 4. Define Dialog Box after Scan**

> ➢ Double-click on each of the predictors to examine the categories and their labels.

We see that CALL has two levels – corresponding to YES (scored '1') and NO (scored '0') and PAYMENT has three levels with scores corresponding to $1, $2, and $10:



Since the PAYMENT category scores match the original dollar amounts, this is Model A.

> ➢ Click Estimate to estimate Model A

## Interpretation of Model Results

Figure 5 shows the contribution of each predictor and Figure 6 shows the assessment of model fit:
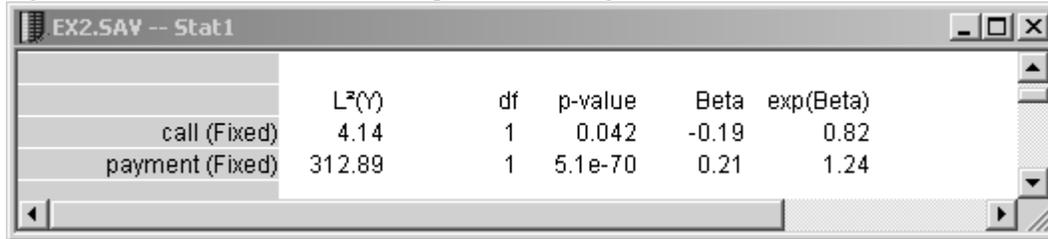
| | L²(Y) | df | p-value | Beta | exp(Beta) |
|---|---|---|---|---|---|
| call (Fixed) | 4.14 | 1 | 0.042 | -0.19 | 0.82 |
| payment (Fixed) | 312.89 | 1 | 5.1e-70 | 0.21 | 1.24 |

EX2.SAV -- Stat1

**Figure 5. Effect Estimates for Model A**

Both effects are significant at the .05 level. However, notice that the effect of the reminder call is negative (Beta = -0.19) which is counter-intuitive.

Scroll down to examine the Model fit statistics:

EX2.SAV -- Model5 -- Stat1
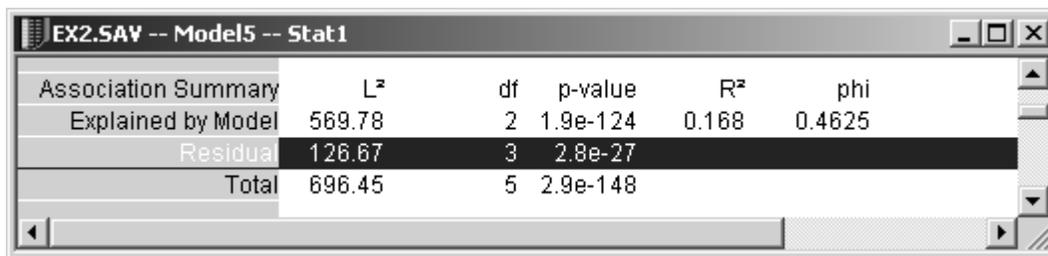
| Association Summary | L² | df | p-value | R² | phi |
|---|---|---|---|---|---|
| Explained by Model | 569.78 | 2 | 1.9e-124 | 0.168 | 0.4625 |
| Residual | 126.67 | 3 | 2.8e-27 | | |
| Total | 696.45 | 5 | 2.9e-148 | | |

**Figure 6. Model fit statistics for Model A**

While the results find the respective estimates to be statistically significant, the test of significance relies on the assumption that the model is true. How can one tell which (if any) model is true? Fortunately, the chi-squared goodness of fit statistic is available which assesses the truth (validity) of assumptions made by a model, whenever the sample is sufficiently large and can be expressed as a table of nonsparse multiway frequency counts as in Table 1. Note that the fit of this model is very poor as indicated by the large residual $L^2$ statistic, which is significantly greater than 0 at well below the .05 level (p = 2.8 x $10^{-27}$). Hence, Model A is rejected. (The addition of a CALL x PAYMENT interaction effect in Model A does not improve the fit and the estimated effect of CALL becomes even more negative when the interaction is included.)

Now, let us estimate a model specifying equidistant payment scores (Model B) and compare the results to Model A.
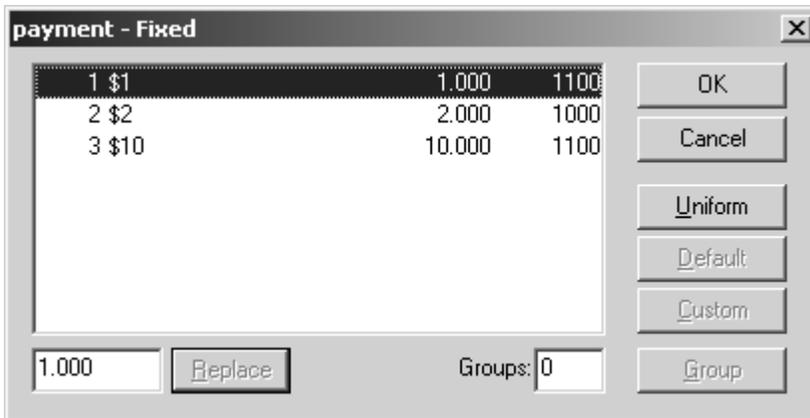
> ➤ To estimate Model B, go to the menu and click Model
> ➤ Click Define to open the Define Dialog

For Model B, change the PAYMENT category scores from 1, 2 and 10 to 1, 2, and 3.

In order to do that,
> ➤ Double-click on PAYMENT in the Define Dialog Box to open the category scores Box:

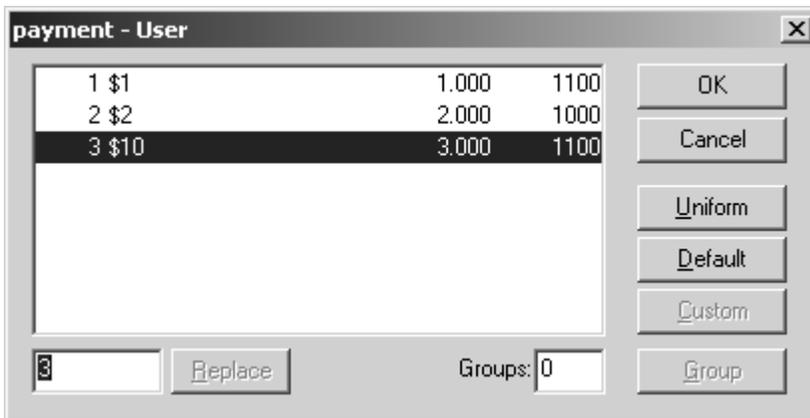| Model | Statistics | Windo |
|---|---|---|
| **Define...** | | |
| Scan | | |
| Options... | | |
| Estimate | | |
| Search... | | |
| Cancel | | |
| History... | | |
| Category Weights | | |
| Design Matrix... | | |
| SPSS code... | | |

**Figure 7. PAYMENT Category Scores**

To change the category scores:

➢ Click on 10.00 in the category scores box
➢ Enter '3' in the lower left-hand Replace box
➢ Click Replace

The category scores have now been changed:



**Figure 8. New Category Scores for PAYMENT**

➢ Click Estimate

Here are the predictor effects estimated under the assumptions of Model B:



| | $L^2(Y)$ | df | p-value | Beta | exp(Beta) |
|---|---|---|---|---|---|
| call (Fixed) | 4.37 | 1 | 0.037 | 0.22 | 1.24 |
| payment (Fixed) | 438.62 | 1 | 2.2e-97 | 1.32 | 3.74 |

**Figure 9. Effect Estimates for Model B**

Again we see that both predictors have significant effects, but now the effect of the reminder call is positive.

The model fit statistics (Figure 10) show that Model B now provides an adequate fit to the data (p=.81):
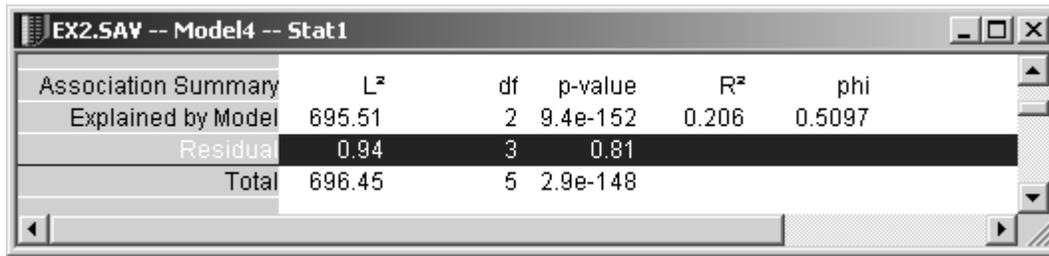


| EX2.SAY -- Model4 -- Stat1 | | | | | |
|---|---|---|---|---|---|
| Association Summary | L² | df | p-value | R² | phi |
| Explained by Model | 695.51 | 2 | 9.4e-152 | 0.206 | 0.5097 |
| Residual | 0.94 | 3 | 0.81 | | |
| Total | 696.45 | 5 | 2.9e-148 | | |

**Figure 10. Model Fit statistics for Model B**

Table 2 summarizes the surprising result that very different effect estimates are obtained depending upon whether PAYMENT is scaled according to Model A or B.  Specifically, we observed that under Model B the estimated effect of CALL is positive (0.22) and significant (p < .05), but under Model A the estimated effect of CALL is negative (-0.19) and significant (p < .05).

| | | β (p-value) | Significance (p-value) |
|---|---|---|---|
| **Model A** | **PAYMENT** | 0.21 | $5.1 \times 10^{-70}$ |
| | **CALL** | -0.19 | 0.042 |
| | | | |
| **Model B** | **PAYMENT** | 1.32 | $22 \times 10^{-97}$ |
| | **CALL** | 0.22 | 0.037 |

**Table 2. Effect Estimates**

The model fit statistic, Residual $L^2$, for each model is summarized in Table 3.  The corresponding p-values show that Model B provides an excellent fit to the data in Table 1 (p = 0.81) while we saw earlier that the fit under Model A is so poor (p = $2.8 \times 10^{-27}$) that the fixed dollar scaling assumption made under that model must be rejected at any reasonable significance level.

| | Model Fit Residual $L^2$ | d.f. | Significance (p-value) |
|---|---|---|---|
| **Model A** | 126.7 | 3 | $2.8 \times 10^{-27}$ |
| **Model B** | 0.94 | 3 | 0.81 |

**Table 3. Model Fit Statistics**

To gain an understanding as to why the effect for CALL is negative under Model A, we will compare the actual sample return rates predicted under each model with the observed rates.

> ➢ In the Window menu, select New Table:
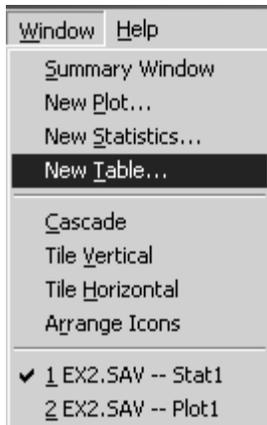
- ➢ The Estimated Models window pops up. Click OK
- ➢ In the Table menu, select Specialized Charts
- ➢ In the Table menu, select Joint Y:
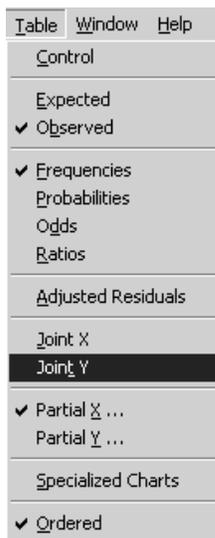


By default, each cell of the multi-way table shows the *observed* return rates under each predictor profile (under the column labeled 'average score'), in addition to the observed frequency counts (denoted by the symbol 'f' in the right-most column of the table). For example, the first row 'no,$10' refers to the predictor profile where no reminder call was made and the payment was $10 The associated return rate is 82.0% as indicated under the 'average score' column. Note: The return rates can alternatively be obtained by right clicking on the table and selecting 'Probabilities' instead of 'Frequencies'.

```
EX2.SAV -- Model2 -- Table1                              _ |□| X|
(Joint Y)                        returned
            average                no       yes
 X-profile   score   weights    1.000    0.000      Y-ref  (cell)
 yes,$10     0.820    0.000        18       82     18.000   f
  no,$10     0.801    0.000       199      801    199.000   f
 yes,$2      0.572    0.000       214      286    214.000   f
  no,$2      0.526    0.000       237      263    237.000   f
 yes,$1      0.266    0.000       734      266    734.000   f
  no,$1      0.190    1.000        81       19     81.000   f
                       X-ref    81.000   19.000    81.000   f
                    Y-scores     0.000    1.000      3200
```

**Figure 11. Observed counts and return rates**

Comparing the actual sample return rate in Table 1 for persons receiving a reminder call with the rate observed for persons receiving *no* reminder call but the same payment, suggests that the effect of the reminder call is positive -- an increase from 19.0% to 26.6% for those receiving a $1 payment, 52.6% to 57.2% for those receiving a $2 payment and 80.1% to 82.0% for those receiving a $10 payment (see Table 1).

> ➢ To see the *expected* counts estimated under the assumptions of Model B (the current model open), go back to the Table menu and check Expected:

```
EX2.SAV -- Model2 -- Table1                              _ |□| X|
(Joint Y)                        returned
            average                no       yes
 X-profile   score   weights    1.000    0.000      Y-ref  (cell)
 yes,$10     0.834    0.000    16.629   83.371     16.629   F
  no,$10     0.801    0.000   198.816  801.184    198.816   F
 yes,$2      0.573    0.000   213.532  286.468    213.532   F
  no,$2      0.519    0.000   240.577  259.423    240.577   F
 yes,$1      0.264    0.000   735.839  264.161    735.839   F
  no,$1      0.224    1.000    77.606   22.394     77.606   F
                       X-ref   77.606   22.394     77.606   F
                    Y-scores     0.000    1.000      3200
```

**Figure 12. Expected counts and return rates under Model B**

Notice that these expected counts are very close to the corresponding observed counts. This is why the $L^2$ statistic indicates that Model B provides a good fit to the data.

Now, we will compare these rates with those obtained under Model A.

To obtain the corresponding table for Model A, we need to retrieve the results from Model A. To do that

> ➢ In the Toolbar, click on the Summary icon:

> ➢ Alternatively, you can select Summary Window from the Window menu
> ➢ The Summary Window appears:
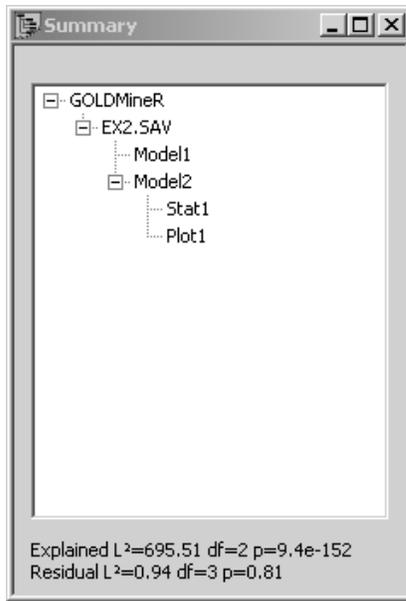
**Figure 13. Summary Window**

> ➢ Double-click on Model1 (which is Model A)
> ➢ A pop-up menu appears
> ➢ Select Table in the pop-up menu
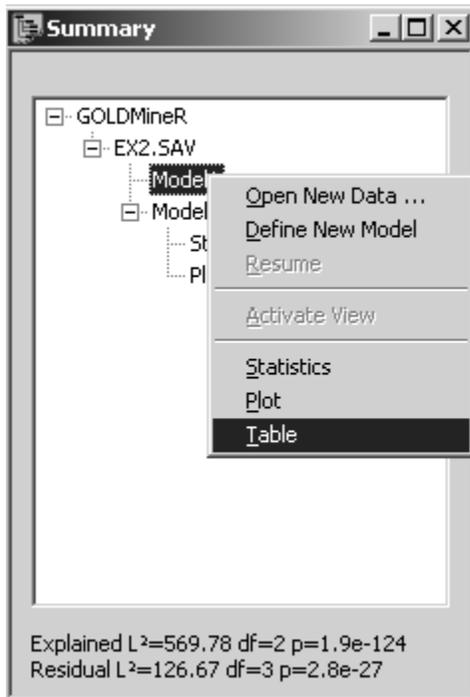


**Figure 14. Selecting Table for Model A**

Now, repeat the same steps to get the expected return rates for Model A:

> ➢ In the Table menu, select Specialized Charts
> ➢ In the Table menu, select Joint Y
> ➢ In the Table menu, select Expected
> ➢ The resulting table shows the expected return rates for Model A:

```
EX2.SAV -- Model1 -- Table3                          _ □ ×

(Joint Y)                      returned
              average                no      yes
  X-profile   score   weights    1.000    0.000      Y-ref  (cell)
   no,$10      0.818    0.000   182.180  817.820    182.180   F
  yes,$10      0.787    0.000    21.269   78.731     21.269   F
    no,$2      0.451    0.000   274.695  225.305    274.695   F
   yes,$2      0.403    0.000   298.268  201.732    298.268   F
    no,$1      0.399    1.000    60.125   39.875     60.125   F
   yes,$1      0.354    0.000   646.464  353.536    646.464   F
                        X-ref    60.125   39.875     60.125   F
                     Y-scores     0.000    1.000       3200
```

**Figure 15. Expected Return Rates for Model A**

Table 4 (below) compares the return rates for the two Models with the observed rate. It shows that under Model A, the predicted return rate is not only poor (in comparison with the observed rate), but persons who received a reminder call are predicted to have a lower return rate than the corresponding group receiving no reminder call (a consequence of the negative effect estimate for CALL).

| | | **Response Rate** | | |
|---|---|---|---|---|
| | **CALL** | **$1** | **$2** | **$10** |
| **Observed** | Yes | 26.6% | 57.2% | 82.0% |
| | No | 19.0% | 52.6% | 80.1% |
| | | | | |
| **Model A** | Yes | 35.4% | 40.3% | 78.7% |
| | No | 39.9% | 45.1% | 81.8% |
| | | | | |
| **Model B** | Yes | 26.4% | 57.3% | 83.4% |
| | No | 22.4% | 51.9% | 80.1% |

**Table 4. Response Rates**

Various plots available in GOLDMineR can provide insight into understanding why the biasing effect for CALL occurs under Model A. We will look at the partial Regression plots for PAYMENT under the CALL = yes and CALL = no situation respectively.

A plot is already open by default.

> ➢ Click on the plot to make it the active window.

To obtain the partial Regression Plot as a function of PAYMENT,
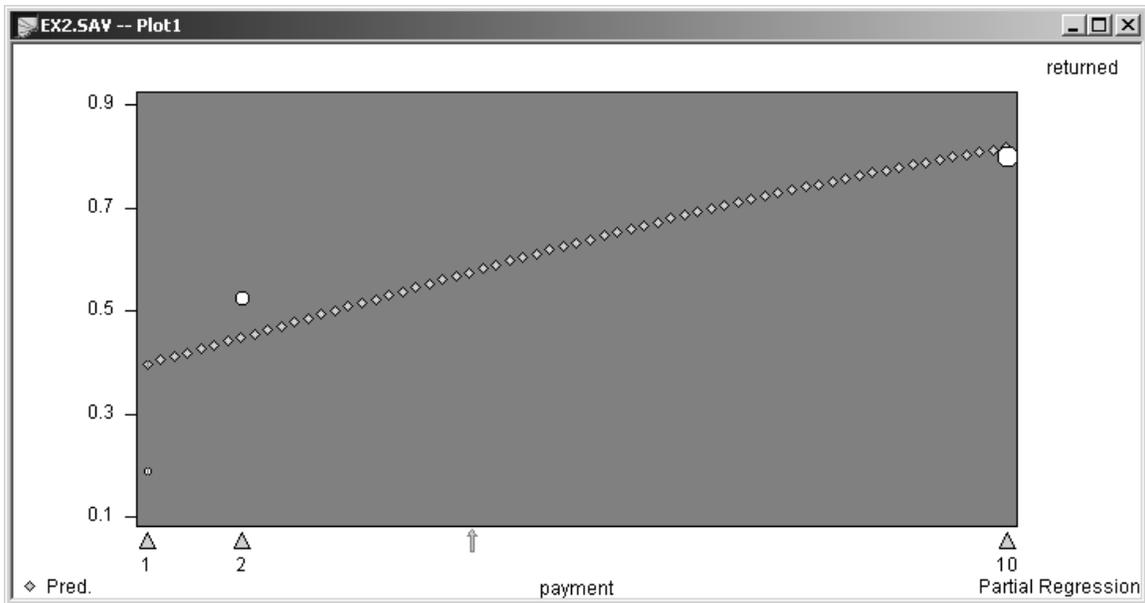
> ➢ In the Plot menu, select Partial Regression:

The Select Effect dialog box appears:
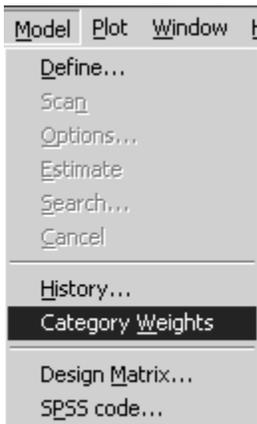


**Figure 16. Select Effect box**

- ➢ Double-click on Payment in the Select Effect box
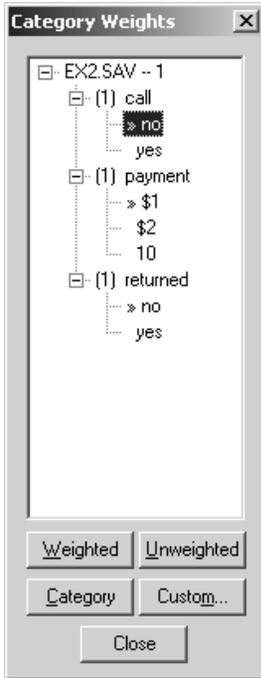- ➢ The partial regression plot as a function of PAYMENT appears:

**Figure 17. Predicted return rate under Model A as a function of PAYMENT when CALL = No**

This plot shows the predicted return rate when CALL = No. To view the plot when CALL = Yes

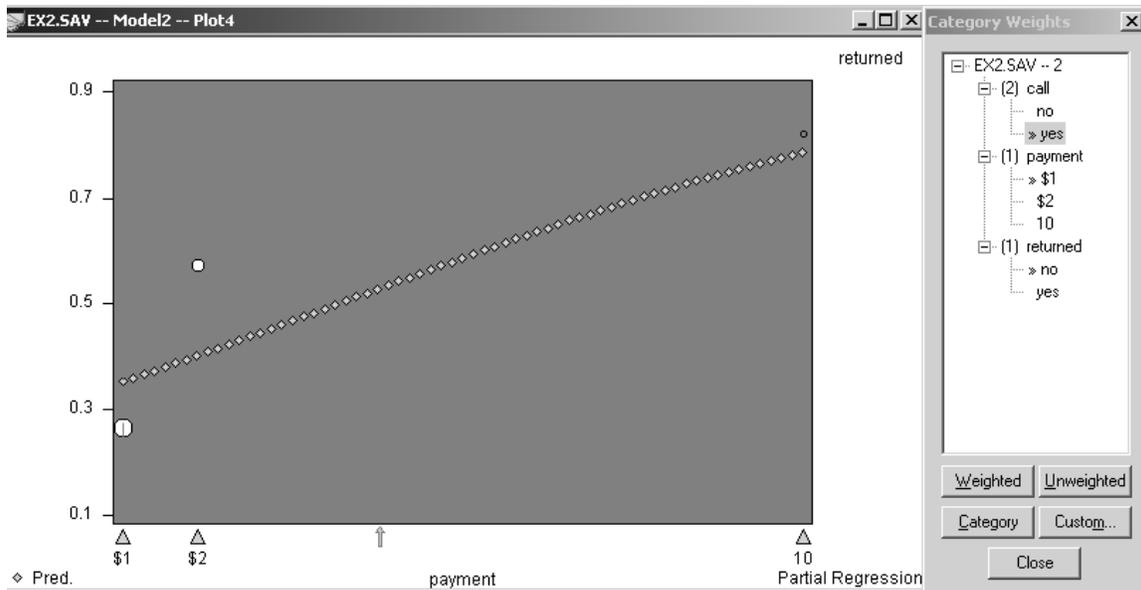> ➢ In the Model menu, select Category Weights:



The Category Weights dialog box appears:

**Figure 18. Category Weights Dialog Box**

The >> symbol next to No under CALL indicates that CALL = 'No' is active. To change to CALL = 'Yes',

- ➢ Double-click on "Yes" under CALL
- ➢ Note that the plot automatically switches to CALL = Yes:



**Figure 19. Predicted return rate under Model A as a function of PAYMENT when CALL = Yes**

Figures 17 and Figure 19 show the partial Regression plot for PAYMENT under the CALL = yes and CALL = no situation respectively. The observed return rates given in Table 4 are plotted as circles in Figure 16 and Figure 18, the diameter of which is proportional to the corresponding sample size (shading means that the estimated expected rate differs significantly from the corresponding observed rate).

While the observed rates are higher for persons receiving the reminder call, the monotonic regression curve (as well as the linear regression line) is affected by a large correlation between PAYMENT and CALL (the sample sizes are largest for *no call* persons who received *higher* payment and *called* persons who received *lower* payments). This correlation serves to inflate the predictions of the return rates for persons receiving no reminder call and deflate the predictions for those called (i.e., the regression curve is *pulled down* in Figure 16 and *pulled up* in Figure 18 by the larger circles which carry greater weight because of the larger sample sizes).

Now, let us examine the corresponding partial regression plots obtained under Model B where equidistant scores for PAYMENT of 1, 2 and 3 were used in place of 1,2, and 10. To do that, retrieve Model B:

> ➢ To retrieve Model B, click on the Summary icon on the Toolbar
> ➢ Double-click on Model2 (which is Model B)
> ➢ In the pop-up menu, select Plot
> ➢ In the Plot menu, select Partial Regression:
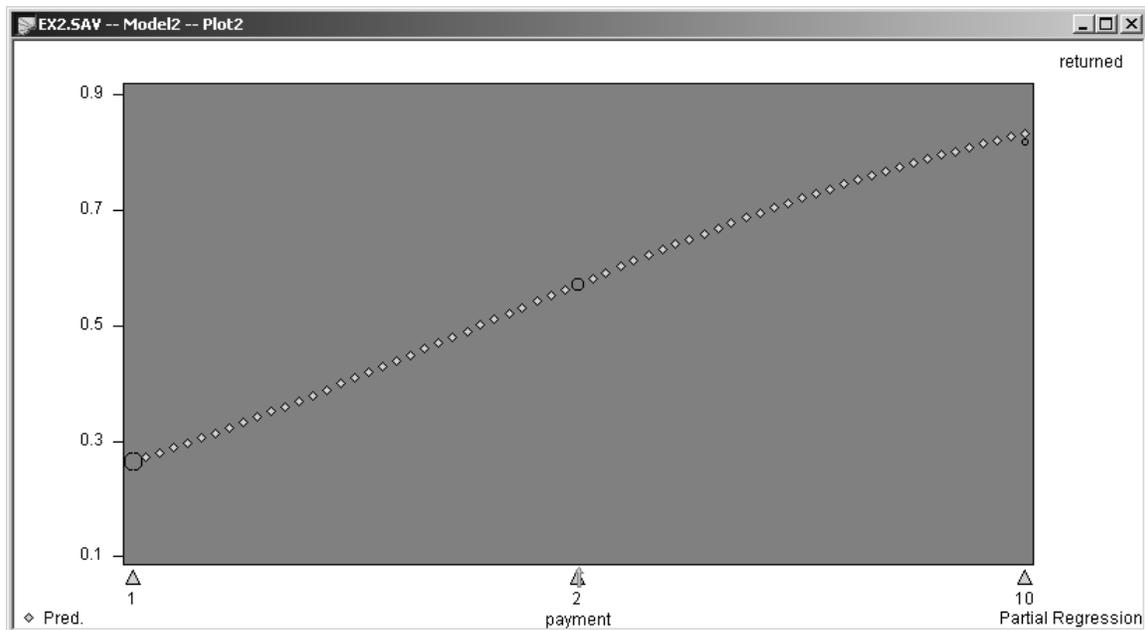


**Figure 20. Predicted return rate under Model B as a function of PAYMENT given CALL = 'Yes'**

Note that the plot shows CALL = Yes. To obtain the plot for CALL = No,

> ➢ In the Model menu, select Category Weights
> ➢ Double-click on "0" under CALL to switch CALL to "No":
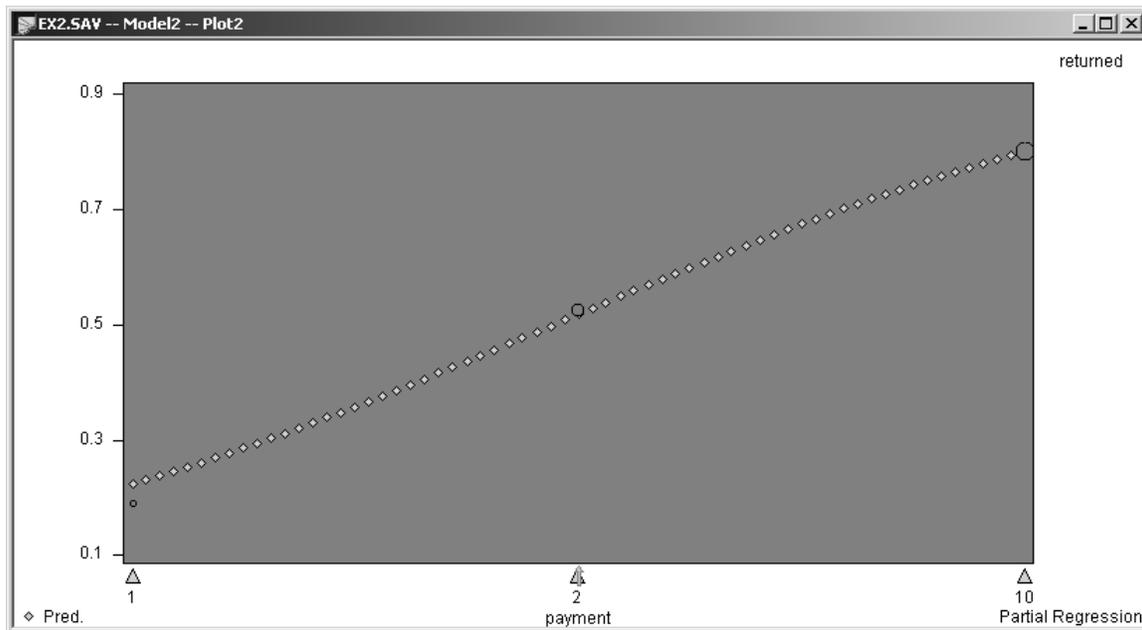
**Figure 21. Predicted return rate under Model B as a function of PAYMENT given CALL = 'No'**

The latter model provides an excellent fit to the data and shows a significant positive effect for CALL.

Hence, the large goodness of fit statistic (Residual $L^2$=126.7) alerts us to problems with Model A and causes us to accept Model B (Residual $L^2$ = 0.94) over Model A for these data and to conclude that the effect of CALL is positive, not negative.