Sociology 593
Exam 3 Answer Key (DRAFT)
May 6, 2004

I. True-False. (20 points) Indicate whether the following statements are true or false. If false, briefly explain why.

1. If a model is recursive, the use of OLS regression will result in biased parameter estimates.

False. Change "recursive" to "nonrecursive."

2. One unfortunate difference between logistic regression and OLS regression is that, with logistic regression, it is not possible to identify extreme outliers that may be affecting the results.

False. There are various residual statistics, such as standardized residuals, that can be computed and examined.

3. The log odds of an event occurring are 0. This means that there is no chance the event will happen.

False. If log odds = 0, odds = 1, p(event happening) = .5.

4. In a multinomial logit model, if the number of cases in some categories is small, you may wish to combine two or more categories.

True.

5. In population 1, $R^2 = .6$. In population 2, $R^2 = .4$. This means that the structural effect of X on Y is larger in population 1 than it is in population 2.

False. The variance of X could be greater in population 1, or the residual variance of Y could be less. The structural effect of X on Y is not the sole determinant of R^2.

II. Short answer. (25 pts each, 50 pts total). Answer *both* of the following.

II-1. (25 points) The data used here are described in Hosmer, D. W. Jr. and S. Lemeshow. 2000. Applied Logistic Regression. 2nd ed. New York: John Riley and Sons. This example is adapted from the Stata 8 Reference Manual documentation on the `logistic` command. You can access these data from within Stata with the command

```
use http://www.stata-press.com/data/r8/lbw.dta
```

The following results are based on a study of risk factors associated with low birth weight. The variables are:

Variable	*Description*
low	Coded 1 if birth weight was low (less than 2500g), 0 otherwise
smoke	Coded 1 if the mother smoked during pregnancy, 0 otherwise
white	Coded 1 if white, 0 if black or other
whsmoke	= white * smoke

Based on the printout below, answer the following.

a. In Model 1, what do DEV_M, G_M, DEV_0, and McFadden's Pseudo R^2 equal?

It is easier to get this information in Stata than it is in SPSS.

$DEV_M = -2LL_M = -2*-114.9023 = 229.8046$
G_M = LR chi2(1) = 4.87
$DEV_0 = -2LL_0 = -2 * -117.336 = 234.672$
McFadden's Pseudo R^2 = .0207

b. Using Model 2, complete the following table:

Smoke	*White*	*Log odds*	*Odds*	*P(Low birth weight)*
Did not smoke	White			
Did not smoke	Black or Other			
Did smoke	White			
Did smoke	Black or Other			

Here is how Stata can do the work:

```
. quietly logit  low smoke white

. * preserve real data
. preserve

. * temporarily delete real data
. drop in 1/l
(189 observations deleted)

. * Interactively enter hypothetical data
. edit
- preserve

. list

     +-------------------------------+
     | low   smoke   white   whsmoke |
     |-------------------------------|
  1. |   .       0       1         . |
  2. |   .       0       0         . |
  3. |   .       1       1         . |
  4. |   .       1       0         . |
     +-------------------------------+

. * log odds
. predict logodds, xb

. * odds
. gen odds = exp(logodds)

. * predicted probability
. predict p, p

. list  smoke white logodds odds p
```

```
     +---------------------------------------------------+
     | smoke   white     logodds       odds          p |
     |---------------------------------------------------|
  1. |     0       1   -1.838502   .1590554   .1372285 |
  2. |     0       0   -.7381552   .4779949   .3234077 |
  3. |     1       1   -.7254624   .4841007   .3261913 |
  4. |     1       0    .3748849   1.454824   .5926388 |
     +---------------------------------------------------+

. * restore original data
. restore

.
```

c. Three models are estimated. Which model do you think is best, and why? What does this model say about the effect of smoking on low birth weight? What does this model tell you about racial differences in the determinants of low birth weight?

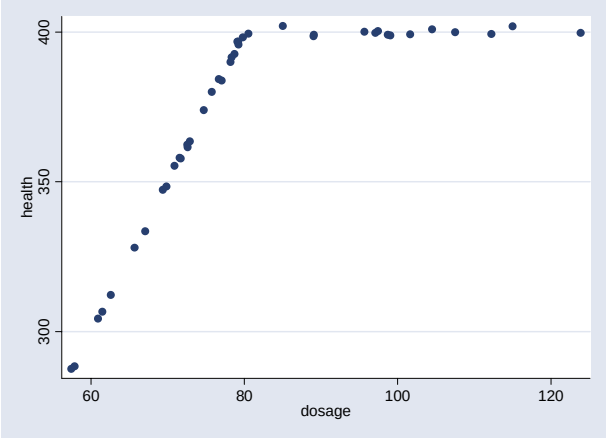
Model 2 appears best. The likelihood ratio test of Model 2 versus Model 1 shows that the effect of white is statistically significant. However, the LR contrast between Model 3 and Model 2 is not significant, meaning that the interaction between white and smoking is not significant. Thus, model 2 shows us that smokers are more likely to have low birth weight babies than are nonsmokers; and whites are less likely than nonwhites to have low birth weight babies. However, the negative effect of smoking is the same for both whites and nonwhites.

```
. * Model 1
. logit low smoke

Iteration 0:   log likelihood =   -117.336
Iteration 1:   log likelihood =  -114.9123
Iteration 2:   log likelihood =  -114.9023

Logit estimates                                   Number of obs   =        189
                                                  LR chi2(1)      =       4.87
                                                  Prob > chi2     =     0.0274
Log likelihood =  -114.9023                       Pseudo R2       =     0.0207

------------------------------------------------------------------------------
         low |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       smoke |   .7040592   .3196386     2.20   0.028     .0775791    1.330539
       _cons |  -1.087051   .2147299    -5.06   0.000    -1.507914   -.6661886
------------------------------------------------------------------------------

. est store m1
```

```
. * Model 2
. logit low smoke white

Iteration 0:   log likelihood =   -117.336
Iteration 1:   log likelihood = -110.10218
Iteration 2:   log likelihood = -109.98872
Iteration 3:   log likelihood = -109.98859

Logit estimates                                   Number of obs   =        189
                                                  LR chi2(2)      =      14.69
                                                  Prob > chi2     =     0.0006
Log likelihood = -109.98859                       Pseudo R2       =     0.0626

------------------------------------------------------------------------------
         low |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       smoke |    1.11304   .3642634     3.06   0.002     .3990969    1.826983
       white |  -1.100347   .3644827    -3.02   0.003     -1.81472   -.3859743
       _cons |  -.7381552   .2378671    -3.10   0.002    -1.204366   -.2719442
------------------------------------------------------------------------------

. est store m2

. lrtest m2 m1

likelihood-ratio test                                 LR chi2(1)  =      9.83
(Assumption: m1 nested in m2)                         Prob > chi2 =    0.0017

. * Model 3
. logit low smoke white whsmoke

Iteration 0:   log likelihood =   -117.336
Iteration 1:   log likelihood = -109.35259
Iteration 2:   log likelihood =   -108.861
Iteration 3:   log likelihood = -108.84969
Iteration 4:   log likelihood = -108.84968

Logit estimates                                   Number of obs   =        189
                                                  LR chi2(3)      =      16.97
                                                  Prob > chi2     =     0.0007
Log likelihood = -108.84968                       Pseudo R2       =     0.0723

------------------------------------------------------------------------------
         low |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
       smoke |   .6097656   .4935153     1.24   0.217    -.3575066    1.577038
       white |   -1.69282   .5802918    -2.92   0.004    -2.830171   -.5554685
     whsmoke |   1.140751   .7755588     1.47   0.141    -.3793163    2.660818
       _cons |  -.6097656   .2484736    -2.45   0.014    -1.096765   -.1227663
------------------------------------------------------------------------------

. est store m3

. lrtest m3 m2

likelihood-ratio test                                 LR chi2(1)  =      2.28
(Assumption: m2 nested in m3)                         Prob > chi2 =    0.1312
```

II-2. (25 points) For <u>each</u> of the following circumstances describe the statistical technique you would use for revealing the relationship between the dependent and independent variables. Write a few sentences explaining and justifying your answer. In some instances more than one technique may be reasonable.

a. A pharmaceutical firm has invented a new drug designed to improve general health (measured on a scale that ranges from 200 to 500). It is trying to determine what the optimal dosage is; in particular, it wants to know whether, after some point, increases in dosage produce no additional benefit or even become harmful. Since it is unsure how to model the relationship between dosage and health, it has administered varying dosages to 41 test subjects (all of whom were equally healthy before the study) and constructed the following graph:



I constructed these data so that health = 5* dosage when dosage was under 80, and that the effect of any additional dosage after 80 was 0. So, piecewise regression is the most appropriate answer, although some other alternatives (e.g. polynomial) might also be reasonable.

b. A researcher is interested in how husbands and wives influence each other's opinions. He believes that the husband's opinion on a subject is affected by his level of education, the socio-economic status of his parents when he was growing up, and by his wife's opinion on the subject. Similarly, he thinks the wife's opinion is determined by her level of education, the socio-economic status of her parents when she was growing up, and her husband's opinion. A random sample of 500 married couples will be interviewed for this study.

The model is nonrecursive and (on paper at least) is identified. Something like 2SLS or LISREL would be appropriate.

c. A psychologist is examining the factors that influence depression. Subjects are asked how depressed they are, with the possible responses being (1) not at all depressed (2) somewhat depressed (3) very depressed. The independent variables in the analysis include annual income in thousands of dollars, feelings of personal efficacy (measured on a scale that ranges from 1 to 50) and age in years.

The dependent variable is ordinal and the independent variables are continuous. An ordered logit model (or perhaps some other type of ordinal regression) would be appropriate.

d. A professor wonders whether students learn anything in her course. On the first day of class, students will complete a test that measures knowledge of the course's subject matter. On the last stay, students will take an equivalent test that measures their knowledge.

This is a matched pairs problem, where the subjects are paired with themselves both before and after the "treatment" (i.e. taking the course.) A t-test is appropriate.

e. John Kerry is very concerned about the effectiveness of his campaign ads. To help him decide which strategies are most effective, he has had two sets of ads prepared. In one set of ads he appears with General Wesley Clark and stresses the accomplishments of his military and political career. In the other set, he appears with Governor Howard Dean and focuses on his positions on key issues. A group of randomly selected individuals will see the first set of ads while another randomly selected group will view the second set. Afterwards, respondents will be asked to rate, on scales ranging from 1 to 100, (1) how likely they think they are to vote for John Kerry, (2) How much they approve or disapprove of the job George Bush is doing as president, and (3) how much they liked the ads.

Manova (or LISREL). The independent variable is a dichotomy (type of ad seen) and there are multiple dependent variables.

III. Essay. (30 points) Answer *one* of the following questions.

1. We've talked about several ways that OLS regression can be modified to deal with violations of its assumptions. Some problems, however, require the use of techniques besides OLS. For <u>three</u> of the following, explain why and when the method would be used instead of OLS. Be sure to make clear what assumptions would be violated if OLS was used instead.

a. 2 stage least squares
b. Logistic regression
c. Ordered Logit models
d. Robust regression techniques (e.g. rreg, qreg, robust standard errors)
e. Event History Analysis
f. Hierarchical Linear Modeling

2. Path analysis first became popular in Sociology during the 1960s, and has evolved considerably since then.

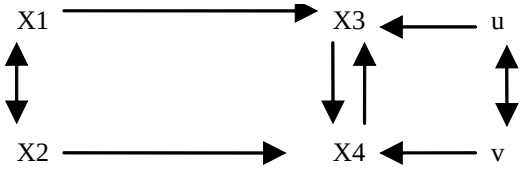
a. In the early days of path analysis, standardized coefficients were widely used. Give two or three reasons why, in Sociology at least, that practice fell out of favor.

b. In the 1970s, the development of the LISREL program gave new life to path analysis. Discuss some of the key strengths of the LISREL method. Explain how LISREL made it possible to estimate important new sorts of models and how it provided an alternative means for estimating models that could also be approached via other methods.

See the lecture notes for discussions pertaining to each question.

IV. Extra Credit. (10 points)

A researcher is interested in the following model:



Explain why the following situations would likely be problematic:

a. X2 is uncorrelated with X3.

According to the model, X2 should be correlated with X3 (unless perhaps suppressor effects are present). X2 is an indirect cause of X3, because X2 affects X4 which in turn affects X3. Also, X2 is correlated with one of the causes of X3, X1. So, unless you believe that suppressor effects are present, where positive sources of correlation are perfectly offset by negative sources of correlation, a zero correlation between X2 and X3 should not occur and may indicate problems with the model specification.

b. You do not have a 2SLS program available to you, so instead you must use an OLS program for both stages.

You can get unbiased estimates of the regression coefficients using OLS. However, the standard errors and some other statistics will be wrong. Hence, you should use a "real" 2SLS program if at all possible, or do additional adjustments by hand after using OLS.