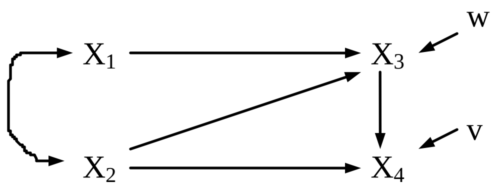
Soc 63993, Advanced Social Statistics II
Homework No. 7
Nonlinear effects/ Intro to path analysis

Problem 1. The files *nonlinhw.sps* and *nonlinhw.sav* will generate the computer runs you need for this problem. Copy them from the course web page.

There are 4 variables in nonlinhw.sav: X1 (the IV), Y1, Y2, and Y3 (the DVs). The SPSS program does scatterplots of X1 versus each IV. It also uses the SPSS Curvefit and Regression routines to fit models to these data. For each IV in turn, you are to do the following:

- Examine each scatterplot. Explain why the relationship is nonlinear and what type of nonlinearity appears to be present.
- Discuss what problems result from a linear (mis)specification. The SPSS Curvefit results will probably help you here. Curvefit shows you what the linear prediction is and compares that with the actual observed data and (in some cases) also shows you the predictions under a nonlinear model.
- Various variables are computed and then incorporated into a multiple regression. Explain why, i.e. how does the approach taken make it possible to deal with nonlinear effects?
- Present a substantive example, real or hypothetical, that the model you have estimated might be appropriate for. Explain why it is appropriate. Do not use any of the examples already given in class.
- For Y3 only, two different Curvefits are presented. Explain why, based on the graphics only, it would be difficult to decide which nonlinear specification was most appropriate, and how theory might help you to choose.

Problem 2. Consider the following model. Assume that all the X's are standardized, i.e. have mean 0 and variance 1. Also assume that changes in X1 cannot produce changes in X2, and changes in X2 cannot produce changes in X1.



a. Write out the structural equation for each endogenous variable.

b. The normal equations for X3 are

$$E(X_1X_3) = \rho_{13} = \beta_{31}E(X_1^2) + \beta_{32}E(X_1X_2) + E(X_1w)$$
$$= \beta_{31} + \beta_{32}\rho_{12}$$
$$E(X_2X_3) = \rho_{23} = \beta_{31}E(X_2X_1) + \beta_{32}E(X_2^2) + E(X_2w)$$
$$= \beta_{31}\rho_{12} + \beta_{32}$$

Write out the normal equations for X_4, i.e. the equations for $E(X_1X_4)$, $E(X_2X_4)$, and $E(X_3X_4)$.

c. In a sample of 1,000 cases, the following parameter estimates were obtained:

$r_{12} = .6$, $b_{31} = .3$, $b_{32} = .4$, $b_{42} = .5$, $b_{43} = .5$.

Determine the complete correlation matrix. (Remember, variables are standardized. You might double-check your answer by using both the normal equations and Sewell Wright's method.) Confirm your answer using either SPSS or Stata, i.e. enter the correlations into one of the programs and confirm that you get the right estimates for the betas.

d. Using the sample estimates from part c, decompose the correlation between X_4 and X3 into

- Correlation due to direct effects
- Correlation due to indirect effects
- Correlation due to common causes
- Correlation due to correlated causes

e. Again using the numbers from above, If X2 goes up by .5, how much should E(X4) increase?