Tutorial: Get Running with Amos Graphics

Purpose

Remember your first statistics class when you sweated through memorizing formulas and laboriously calculating answers with pencil and paper? The professor had you do this so you would understand some basic statistical concepts. Later you discovered that a calculator or software program could do all these calculations in a split second.

This tutorial is a little like that early statistics class. There are many short cuts to drawing and labeling path diagrams in **Amos Graphics** that you will discover as you work through the Examples in the Amos 4 User's Guide, or as you review the *Amos Graphics online Help*. The intent of this tutorial is to simply get you started using **Amos Graphics** in Microsoft® Windows®. It will cover some of the basic functions and features of Amos and guide you through your first Amos analysis. Once you have worked through this tutorial, you can learn more advanced functions in the *Amos Graphics online Help*. Or you can continue to incrementally learn about Amos and its statistical applications by working through the Examples in the Amos 4 User's Guide.

Please note that there are two versions of this tutorial. The exercise **Getstart.amw** uses data from a Microsoft Excel® file, while **Startsps.amw** points to input data in SPSS® format. Both exercises are located in the **Tutorial** subdirectory, underneath **Amos 4**, typically in **C:\Program Files\Amos 4\Tutorial**.

Prerequisites

This tutorial assumes that Amos has been installed on your computer. If you have not yet installed Amos, you might want to install it now, before continuing with this tutorial. Also, this tutorial assumes that you already have some basic experience using Windows programs. We assume you already know how to select an item from a menu, how to move the mouse pointer, clicking and double-clicking the mouse, and so on.

The data

Hamilton (1990) provided several measurements on each of 21 states. Three of the measurements will be used for the present example: 1) average SAT score, 2) per capita income expressed in $1,000 units, and 3) median education for residents 25 years of age or older. The data are provided in the

Tutorial directory, inside the Excel 8.0 workbook **Hamilton.xls,** in the single worksheet named **Hamilton**. Here is a listing:

SAT	Income	Education
899	14.345	12.7
896	16.37	12.6
897	13.537	12.5
889	12.552	12.5
823	11.441	12.2
857	12.757	12.7
860	11.799	12.4
890	10.683	12.5
889	14.112	12.5
888	14.573	12.6
925	13.144	12.6
869	15.281	12.5
896	14.121	12.5
827	10.758	12.2
908	11.583	12.7
885	12.343	12.4
887	12.729	12.3
790	10.075	12.1
868	12.636	12.4
904	10.689	12.6
888	13.065	12.4

The path diagram in **Figure 1** shows a model for these data:

Figure 1
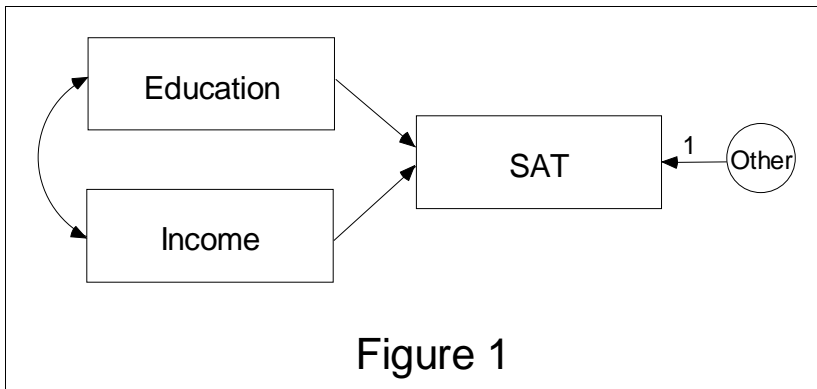
It is a simple regression model where one observed variable, SAT, is predicted as a linear combination of the other two observed variables, Education and Income. As with nearly all empirical data, the prediction will not be perfect. The latent variable Other therefore serves to absorb random variation in the SAT scores and systematic components for which no suitable predictors were provided.

Each single-headed arrow represents a regression weight. The number "1" in the figure specifies that Other must have a weight of one in the prediction of SAT. Some such constraint must be imposed in order to make the model *identified*, and it is one of the features of the model that must be communicated to Amos. You need to provide Amos with information about both the Hamilton data and the model in **Figure 1**.

Starting Amos Graphics

The are several ways to start up **Amos Graphics**:

1. You can double-click on the **Amos Graphics** icon on the Windows desktop.

2. From the Windows taskbar, you can launch **Amos Graphics** with the command path

   Start → Programs → Amos 4 → Amos Graphics

3. You can double-click on any path diagram (`*.amw`) file created with **Amos Graphics**.

4. You can double-click on a path diagram displayed by Amos's **View Path Diagrams** utility.

5. If you have the SPSS version of Amos, you can also start **Amos Graphics** from SPSS by the **Analyze → Amos** command.

After **Amos Graphics** has started up, click on **File → New** to start a new model. You will see a window containing a large rectangle and several menu titles:
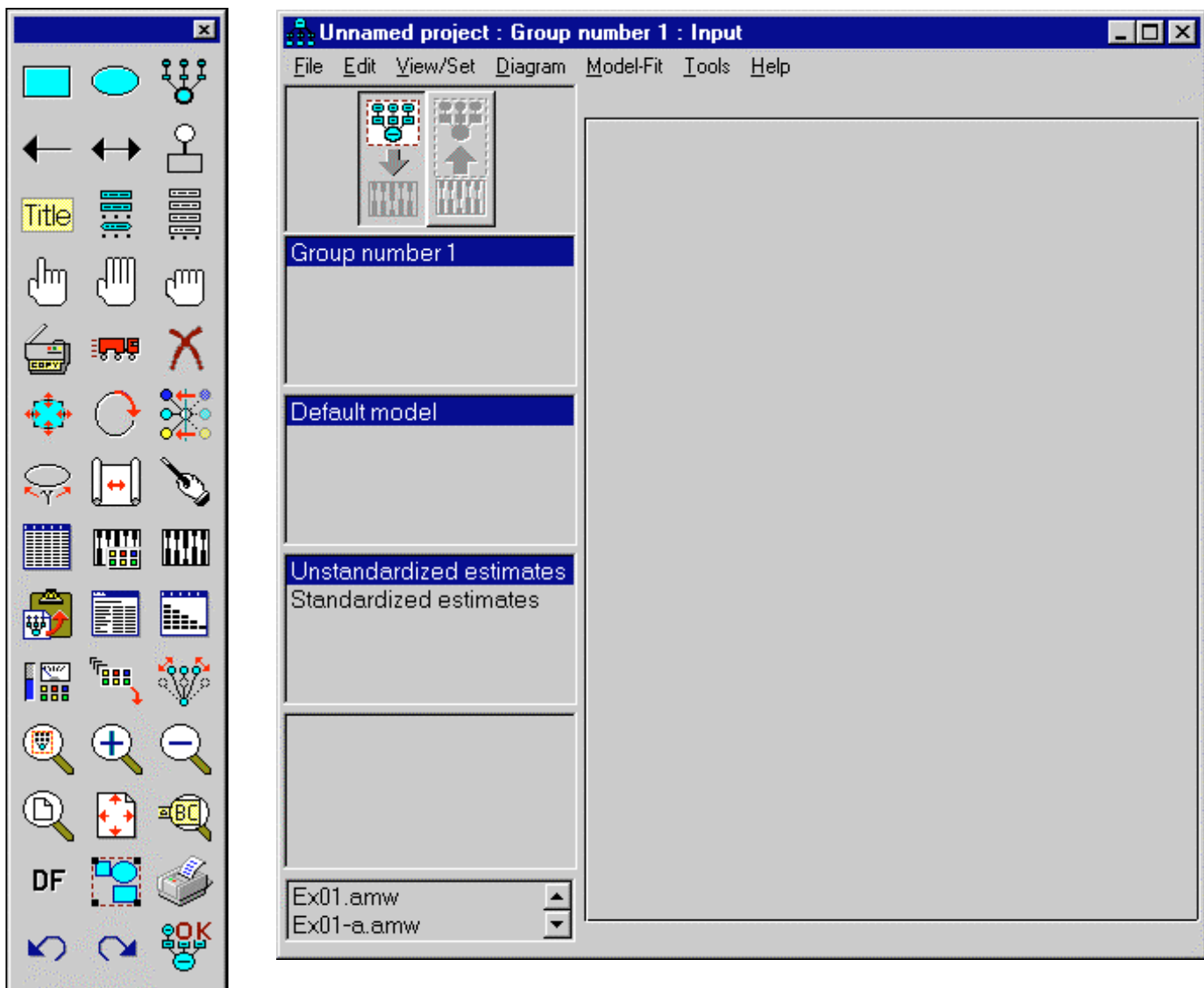
The large rectangle (in the center of the window) represents a sheet of paper. Its shape depends on how your printer is set up. In this example, the printer is set up in *portrait* mode, so the rectangle is taller than it is wide. If your printer is set for *landscape* printing, the rectangle will be wider than it is tall.

In addition to the **Amos Graphics** main window, Amos displays a toolbar window with "button" or icon commands that are shortcuts for drawing and modeling operations (as shown on the left).

You have a choice of running **Amos Graphics** commands either by clicking on their toolbar icons or by selecting their corresponding menu commands.

Actually, Amos features even more icon shortcuts than the ones shown here on the default toolbar. The *Amos Graphics online Help* has information about customizing your toolbar so you have immediate access to your most-used shortcuts.

Attaching the data

The next step is attaching the Hamilton data to the model. While inputting ASCII (or text) based data input is possible, **Amos Graphics** supports input of several common database formats, including SPSS ***.sav** files. For the tutorial, we will attach a Microsoft Excel 8.0 file of the Hamilton data. Do this by selecting:

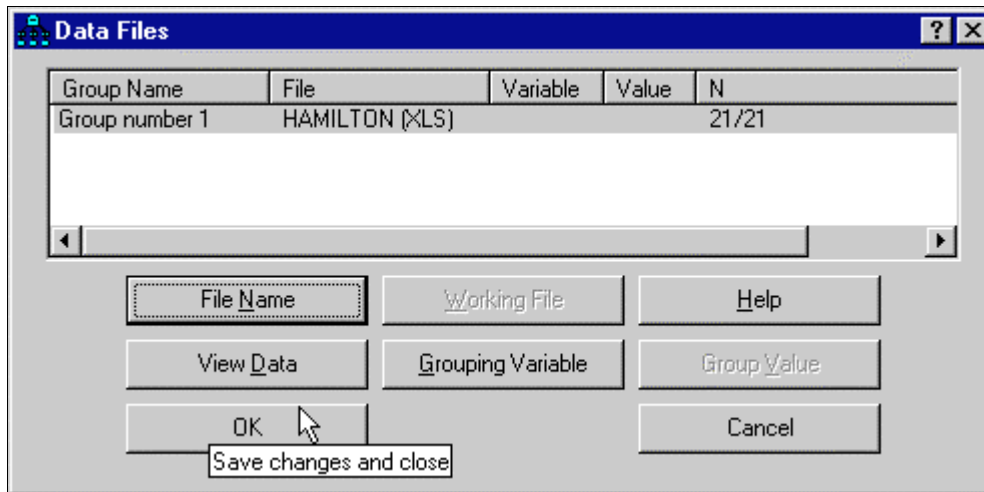<u>**File**</u> → <u>**Data Files...**</u> → **File <u>Name</u>**

We placed the data for this tutorial in the **Tutorial** subdirectory. The directory path is:

Program Files → **Amos 4** → **Tutorial**

In the Files **of type** listbox, select **Excel 8.0 (*.xls)** as the desired file type and double click on the **Hamilton.xls** file:
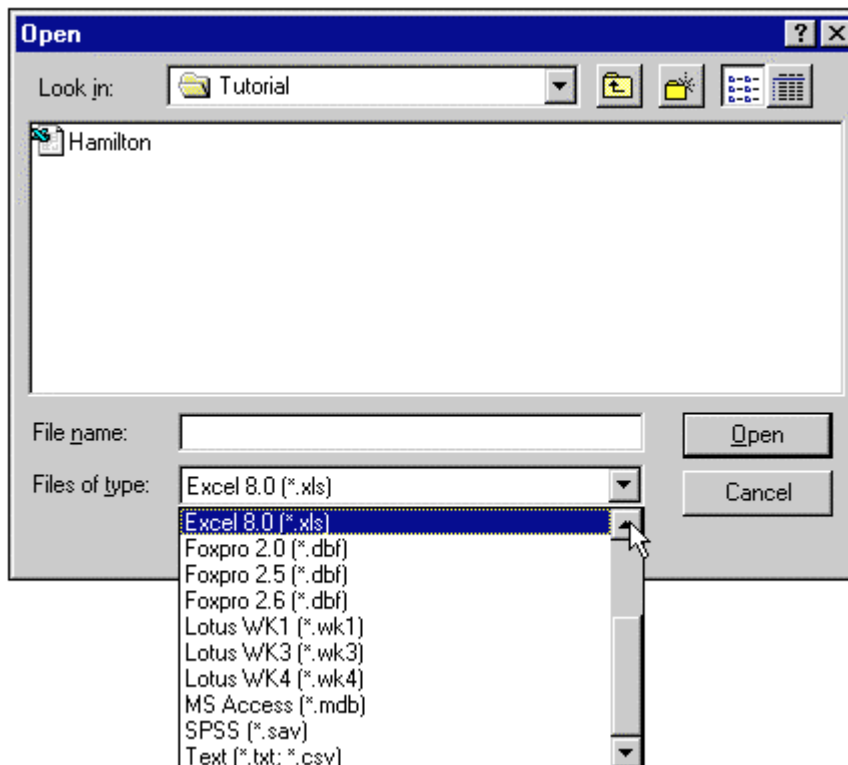
This will bring you back to the **Data Files** dialog box. Click on **OK**:

Reading data from an SPSS system file

The SPSS version of Amos 4 reads a copy of the current SPSS working file when Amos is started directly from the SPSS <u>A</u>nalyze menu. Even when run in standalone mode, all versions of Amos 4 can read SPSS (***.sav**) files that have been saved to disk. To read an SPSS file, such as the file **Hamilton.sav** in the **Tutorial** subdirectory, simply follow the same steps outlined in the previous section. However, when you get to **Files of <u>t</u>ype**, click on **SPSS (*.sav)** as the desired file type and double click on the **Hamilton.sav** file.

There is one difference to naming variables when working with SPSS data files. SPSS system files support variable names of up to eight characters. Thus, if the Hamilton data file was in the SPSS format, the variable name Education would have to be shortened to Educatn.

Specifying the model and drawing variables

First, draw three rectangles to represent the three observed variables in the model. Begin by clicking on the **Draw observed variables** icon on the toolbar, or by clicking on the **Diagram** menu and selecting **Draw Observed**:
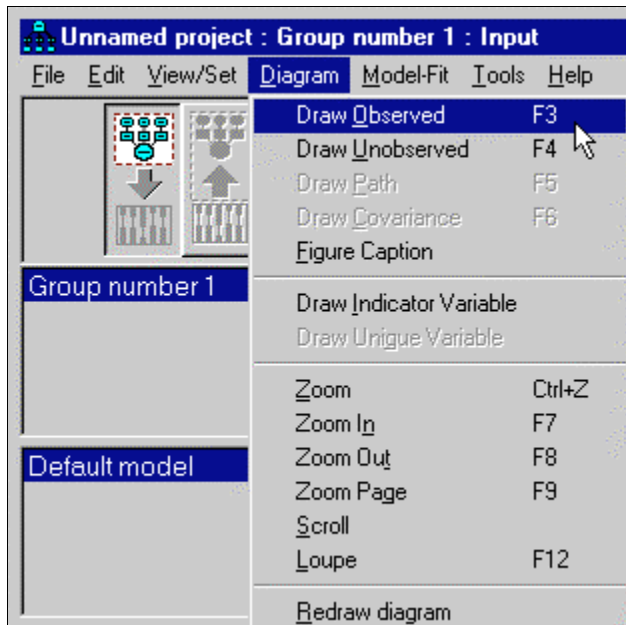
When you click on an icon, you will know it is activated because its appearance will change. The color surrounding the icon image will be brighter, as if illuminated. Move the mouse pointer to the place where you want the Education rectangle to appear in the drawing area. Do not worry too much about the exact size or placement of the rectangle — you can change it later on. Once you have picked a spot for the Education rectangle, press the left mouse button and hold it down while making some trial movements of the mouse. Movements of the mouse will affect the size and shape of the rectangle. When you are reasonably satisfied with its appearance, release the mouse button. Now, use the same method to draw two more rectangles for Income and SAT. As long as the **Draw observed variables** icon is illuminated, a new rectangle will appear every time you press the left mouse button and move the mouse.

Next, draw an ellipse to represent Other. Ellipses are drawn the same way as rectangles, except that you begin by clicking on the **Draw unobserved variables** icon, or selecting **Draw Unobserved** from the **Diagram** menu. After drawing the ellipse, your screen should look more or less like **Figure 2** (except on a gray background).

Figure 2
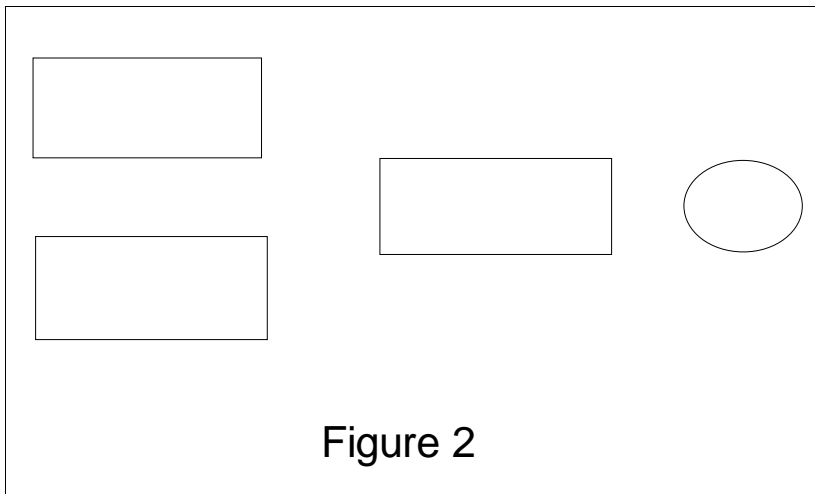
Naming the variables

To assign names to the four variables, double click on one the objects in the path diagram. It does not matter which one you start with. For this example, we will start by double clicking on the rectangle that is supposed to represent Education. The **Object Properties** dialog box appears. Click on the **Text** tab and enter the word Education in the **Variable name** field:
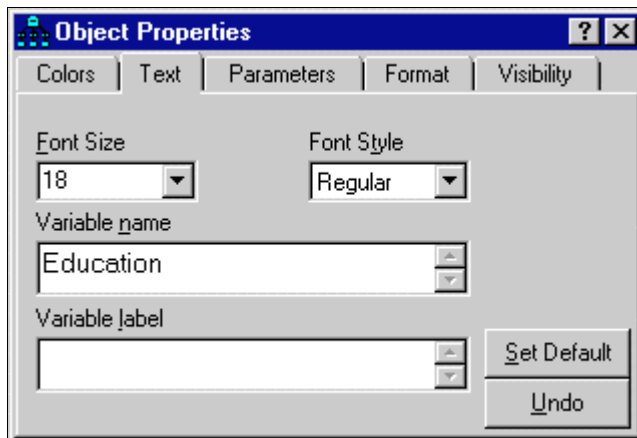
Notice that while you are typing in the field, the word Education is appearing in your first rectangle. Click once on the next rectangle and enter Income in the **Variable name** field.

> *Remember that, in SPSS files, variable names cannot be longer than eight characters. To compensate, you would need to enter* Educatn *in the* **Variable name** *field and the proper* Education *in the* **Variable label** *field. This modification is not needed for this tutorial because we are using an Excel file.*

☒ Follow this procedure until you have labeled all four objects. To close the **Object Properties** box, click on the "X" in the upper right hand corner of the dialog box. Your path diagram should look like **Figure 3**:

```
┌─────────────────────────────────────────────────────────┐
│  ┌──────────────┐                                        │
│  │  Education   │                                        │
│  └──────────────┘      ┌──────────────┐    ╭────────╮   │
│                        │    SAT       │    │ Other  │   │
│  ┌──────────────┐      └──────────────┘    ╰────────╯   │
│  │   Income     │                                        │
│  └──────────────┘                                        │
│                                                          │
│                      Figure 3                            │
└─────────────────────────────────────────────────────────┘
```
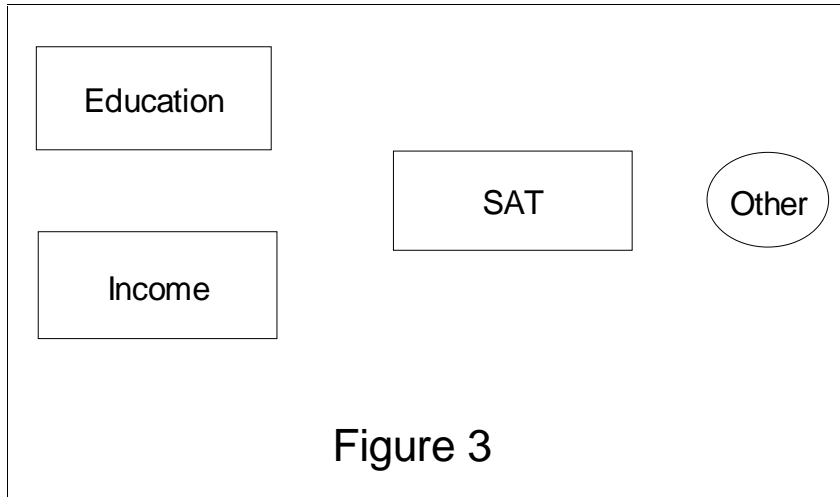
Drawing arrows

← To draw a single-headed arrow, click on the **Draw paths** icon from the toolbar. When you move your mouse into the drawing arrow, you will notice that mouse pointer has the word PATH underneath it to remind you that you are drawing a path. You will also notice that when your pointer touches an object, the object changes color. Click and hold down your left mouse button from the right edge of the Education rectangle to the left edge of the SAT rectangle. Release the mouse button and the arrow will be fixed into place. Repeat this procedure for each of the remaining single-headed arrows. Use **Figure 1** on page 2 as your model.

↔ Drawing double-headed arrows is similar to drawing single-headed arrows. Simply click on the **Draw covariances** icon on the toolbar. Then, click and hold down your left mouse button from the left edge of the Income rectangle to the left edge of the Education rectangle. The reason why we suggested starting at the bottom variable is because the initial curvature of the two-headed arrow follows an arc in a clockwise direction. That means going from bottom to top will curve the arrow to the left. If you accidentally arc your arrow in the wrong direction, you can always change it. We will discuss how to make changes to your path diagram a little later.

Your path diagram should now look like **Figure 4**:

```
┌─────────────────────────────────────────────────────────┐
│        ┌──────────────┐                                  │
│      ↗ │  Education   │ ╲                                │
│     ╱  └──────────────┘  ╲    ┌──────────┐   ╭────────╮ │
│    │                      ╲→  │   SAT    │ ← │ Other  │ │
│     ╲  ┌──────────────┐  ╱    └──────────┘   ╰────────╯ │
│      ↘ │   Income     │ ╱                                │
│        └──────────────┘                                  │
│                                                          │
│                      Figure 4                            │
└─────────────────────────────────────────────────────────┘
```

Constraining a parameter

To identify the regression model, you must define the scale of the latent variable Other. You can do this by fixing either the variance of Other or the path coefficient from Other to SAT at some positive value. Suppose you want to fix the path coefficient at unity. Double click on the arrow between Other and SAT. Once again the **Object Properties** dialog appears. Click on the **Parameters** tab and enter the value "1" in the **Regression weight** field:
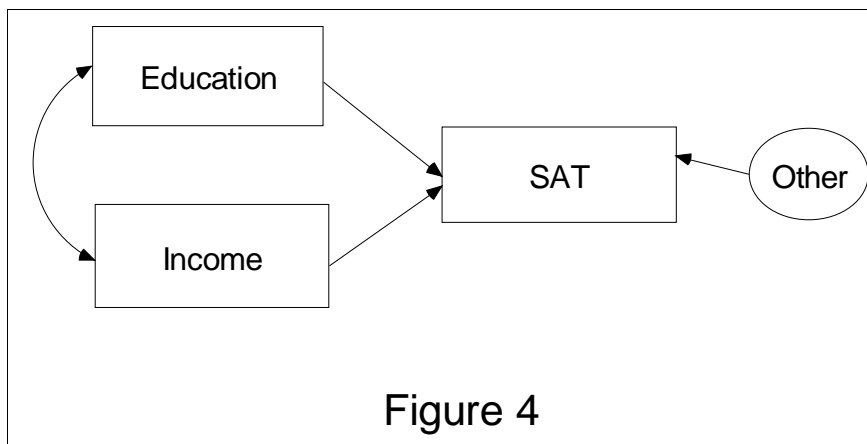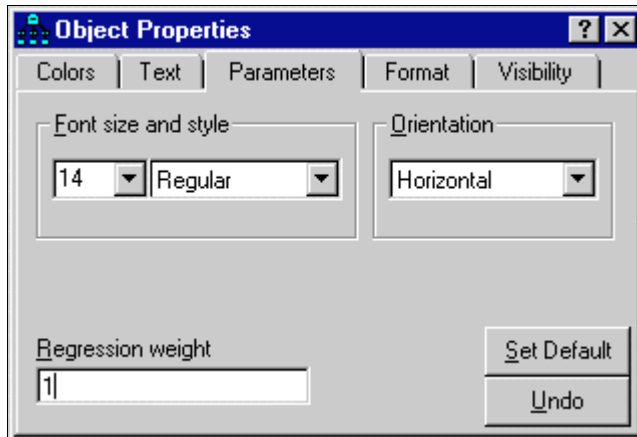

This adds a "1" above the arrow between Other and SAT. To close the **Object Properties** box, once again click on the "X" in the upper right hand corner of the dialog box. This completes the path diagram except for any changes you might want to make to improve its appearance. It should look something like **Figure 5**:
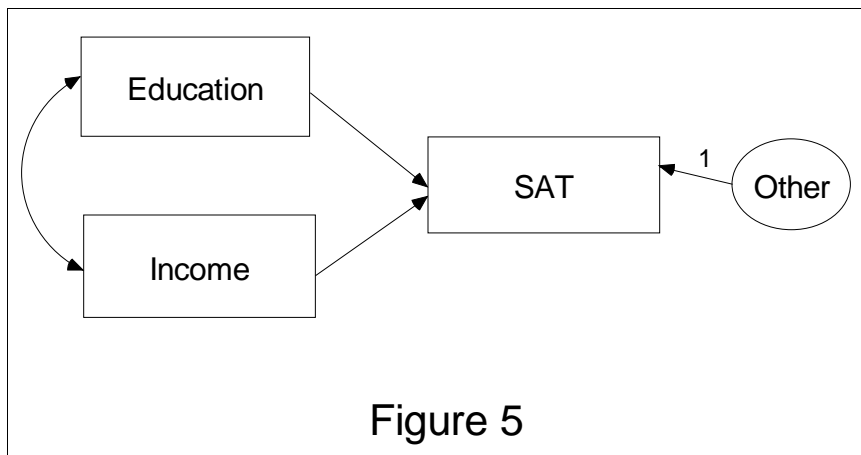

Figure 5

Improving the appearance of the path diagram

You can change the appearance of your path diagram by moving objects around, and by changing their sizes and shapes. These changes do not affect the meaning of a path diagram. That is, they do not change the model's specification. To move an object, click on the **Move** icon on the toolbar. You will notice that the picture of a little moving truck appears below your mouse pointer when you move into the drawing area. This lets you know the **Move** function is active. Then click and hold down your left mouse button on the object you wish to move. With the mouse button still depressed, move the object to where you want it, and let go of your mouse button. **Amos Graphics** will automatically redraw all connecting arrows.

To change the size and shape of an object, first press the **Change the shape of objects** icon on the toolbar. You will notice that the word shape appears under the mouse pointer to let you know the **Shape** function is active. Click and hold down your left mouse button on the object you wish to re-shape. Change the shape of the object to your liking and release the mouse button.

Change the shape of objects also works on two-headed arrows. Follow the same procedure to change the direction or arc of any double-headed arrow.

Of course, if you make a mistake, there are always three icons on the toolbar to quickly bail you out: the **Erase** and **Undo** functions. To erase an object, simple click on the **Erase** icon and then click on the object you wish to erase.

To undo your last drawing activity, click on the **Undo** icon and your last activity disappears. Each time you click **Undo**, your previous activity will be removed.

If you change your mind, click on **Redo** to restore a change.

No matter how carefully you try to adjust the size, shape and location of individual objects in your path diagram, the path diagram as a whole will probably end up looking slightly out of kilter. You might, for example, want the Education and Income rectangles to look exactly alike, but it is very hard to do this simply by eyeballing it. Amos has many other tools for achieving the "picture perfect" path diagram, but we will not take the time to explain them all in this "Getting Started" tutorial. For more details about drawing functions, refer to the *Amos Graphics online Help.*

Performing the analysis

The next step is to decide what properties you wish to analyze. Amos gives you an array of options by following the path: **View/Set** → **Analysis Properties** and clicking on the **Output** tab. There is also an **Analysis Properties** icon you can click on the toolbar. Either way, the **Output** tab gives you these options:
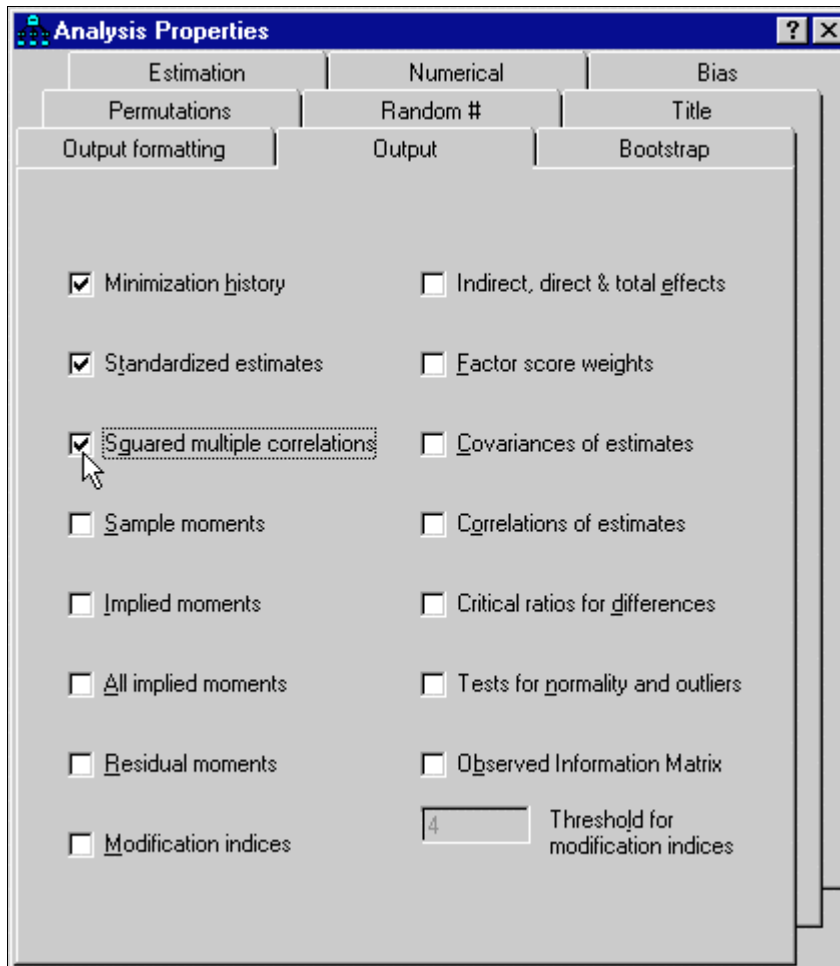

For this example, check the **Minimization history**, **Standardized estimates**, and **Squared multiple correlations** boxes. We are doing this because these are so commonly used in analysis. In the Examples section, we explore the meaning and impact of a variety of analytical property options.

Close the **Analysis Properties** dialog box by clicking on the "X" in its upper right corner. The only thing left to do then is to have Amos perform the actual calculations. To do this, click on the **Calculate estimates** icon on the toolbar. Amos will want to save this problem to a file, so if you have given it no filename, the **Save As** dialog box will appear. Give the problem a filename; let us say, `tutorial1`:
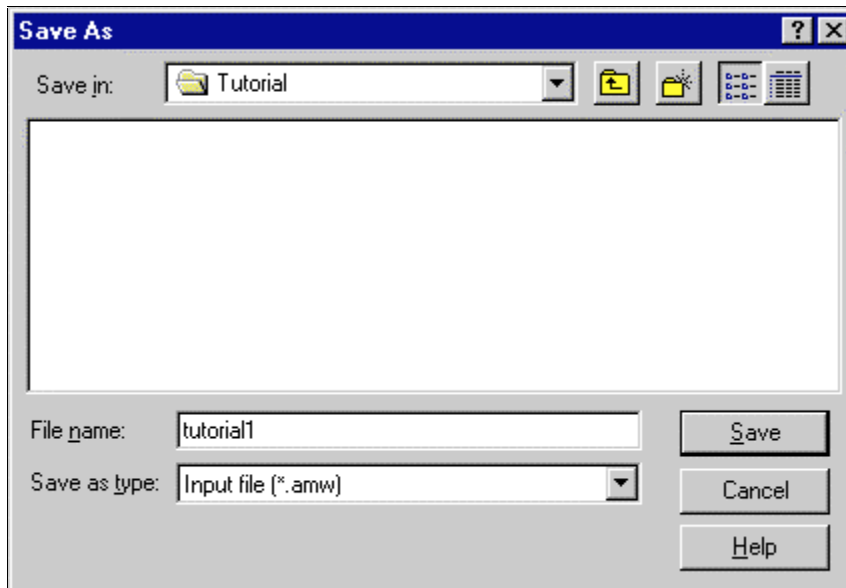
Once you click on **Save**, Amos will begin calculating the model estimates. You can view Amos' calculating progress in the dialog box that is always open in the lower left area of the window. The calculations happen so quickly, you will likely only see the end of the calculation progress:
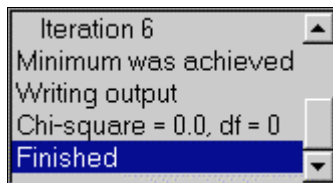
Viewing the text output

When Amos has completed the calculations, you have three options for viewing the output: text output, table (spreadsheet) output, or graphics output. For text output, click the **View Text** icon on the toolbar. Here is a portion of the text output for this problem:

```
Minimum was achieved


Chi-square =     0.000
Degrees of freedom =    0
Probability level cannot be computed

Maximum Likelihood Estimates
---------------------------


Regression Weights:                Estimate     S.E.      C.R.
-------------------                --------    -------   -------

     SAT <---------- Education     136.022     30.555     4.452
     SAT <------------ Income        2.156      3.125     0.690


Standardized Regression Weights:   Estimate
--------------------------------   --------

     SAT <---------- Education       0.717
     SAT <------------ Income        0.111

Covariances:                       Estimate     S.E.      C.R.
------------                       --------    -------   -------

     Education <------> Income        0.127      0.065     1.952


Correlations:                      Estimate
-------------                      --------

     Education <------> Income        0.485


Variances:                         Estimate     S.E.      C.R.
----------                         --------    -------   -------

                     Education       0.027      0.008     3.162
                        Income       2.562      0.810     3.162
                         Other     382.736    121.032     3.162


Squared Multiple Correlations:       Estimate
-----------------------------        --------
                          SAT        0.603
```
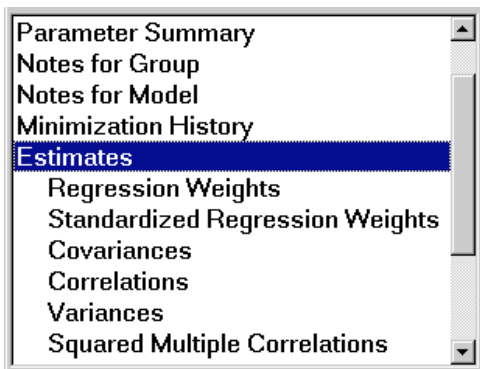
## Viewing the table (spreadsheet) output

For table (spreadsheet) output, click on the **View Spreadsheets** icon on the toolbar. The open dialog box on the left side of the spreadsheet gives you a variety of output options:

```
Parameter Summary
Notes for Group
Notes for Model
Minimization History
Estimates
     Regression Weights
     Standardized Regression Weights
     Covariances
     Correlations
     Variances
     Squared Multiple Correlations
```

Click on **Estimates** to view the following portion of the table output for this problem:

|	A	B	C	D	E	F	G
1							
2	**Regression Weights**						
3				Estimate	S.E.	c.r.	P
4	SAT	<--	Income	2.16	3.13	0.69	0.49
5	SAT	<--	Education	136.02	30.56	4.45	0.00
6							
7	**Standardized Regression Weights**						
8				Estimate			
9	SAT	<--	Income	0.11			
10	SAT	<--	Education	0.72			
11							
12	**Covariances**						
13				Estimate	S.E.	c.r.	P
14	Income	<-->	Education	0.13	0.07	1.95	0.05
15							
16	**Correlations**						
17				Estimate			
18	Income	<-->	Education	0.49			
19							
20	**Variances**						
21				Estimate	S.E.	c.r.	P
22			Income	2.56	0.81	3.16	0.00
23			Education	0.03	0.01	3.16	0.00
24			Other	382.74	121.03	3.16	0.00
25							
26	**Squared Multiple Correlations**						
27				Estimate			
28			SAT	0.60			
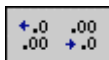
Notice that output goes to the second decimal place. If you wish to change the decimal setting, click on either the **Increase decimal** or **Decrease decimal** icon on the **Spreadsheets Output** toolbar. Amos 4 will display up to four decimal places.

Viewing the graphics output

To view the graphics output, click the **View output** icon next to the drawing area. Your model will display all the properties you specified. However, you must chose to view either unstandardized or (if you selected this option) standardized estimates by click one or the other in the **Parameter Formats** panel next to your drawing area:

Unstandardized estimates
Standardized estimates
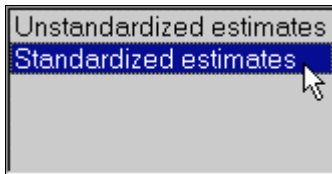
If you selected **Standardized estimates** and assuming that you selected both standardized estimates and squared multiple correlation in the **Output** tab of the **Analysis Properties** menu, your path diagram should look like **Figure 6**:
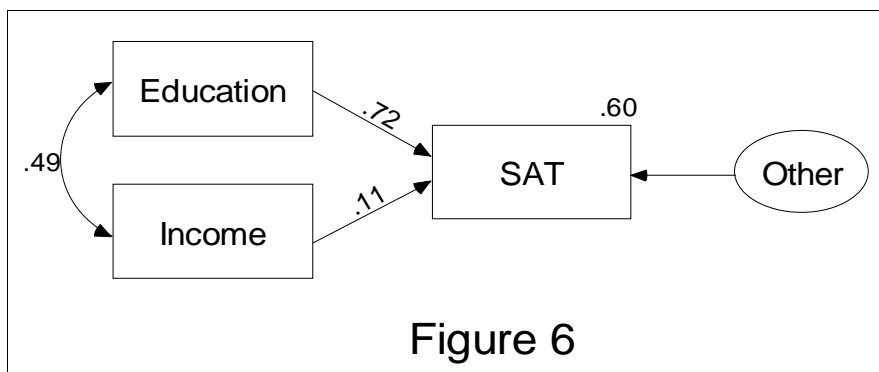

Figure 6

The value .49 is the correlation between Education and Income. The entries .72 and .11 are standaridized regression weights. The number .60 is the squared multiple correlation of SAT with Education and Income.

Now to see the unstandardized estimates, simply click on **Unstandardized estimates** in the open dialog box next to your drawing area. Your path diagram should now look like **Figure 7**:
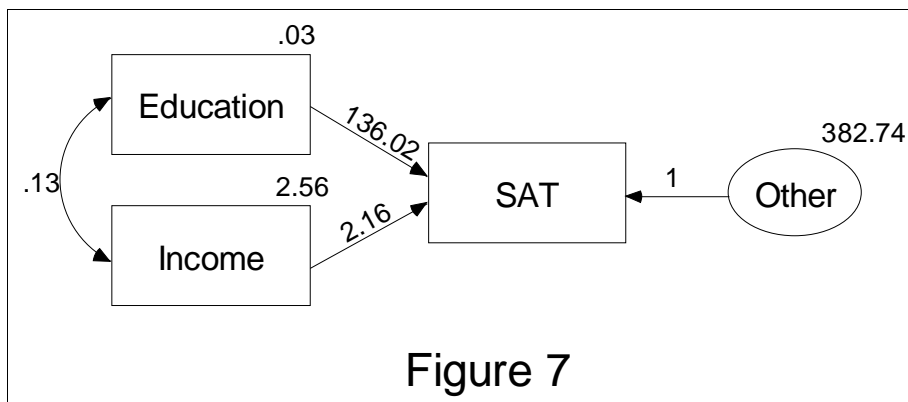

Figure 7

In the graphics output, you can click between standardized and unstandardized estimates, if you have specified the analysis of both. But note that you have to re-run the model (**Calculate estimates**) after every change to the model, data, or properties to be analyzed. This is to keep the parameter estimates up to date.
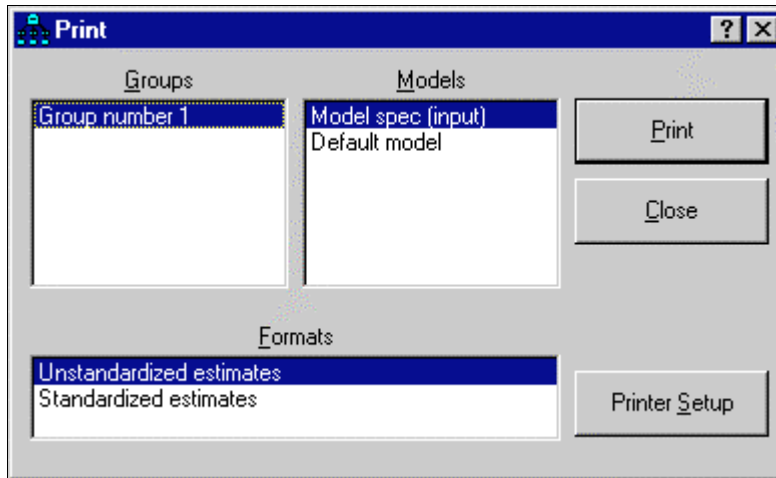
Printing the path diagram

To print the path diagram click on the **Print** icon in the toolbox. The **Print** dialog box will appear:

For the purposes of this tutorial, you can accept all the printing defaults and simply click on **Print**.

Copying the path diagram

Amos Graphics lets you easily export your path diagram to many word processing programs, such as Microsoft Word or WordPerfect®. Simply follow the path:

<u>Edit</u> → Cop<u>y</u> (to Clipboard)

Then, in your word processing program, use the **Paste** function to import in the diagram as a picture or text box. **Amos Graphics** will only export the diagram itself, and not the (typically gray) background. You will likely need to resize and crop the diagram, as **Amos Graphics** will copy the entire drawing area to the clipboard, typically leaving lots of extra space around your diagram.

You can also copy table or text output by clicking once and then dragging your mouse over the desired area (so the text is highlighted). After highlighting the data, hold down the **Control** key and the "c" key simultaneously (<Ctrl> - c). This will copy the highlighted text to the clipboard. Then use the **Paste** function (or press **Control** and the "v" key simultaneously; <Ctrl> - v) to import the text into your word processing or spreadsheet program.