

Introduction

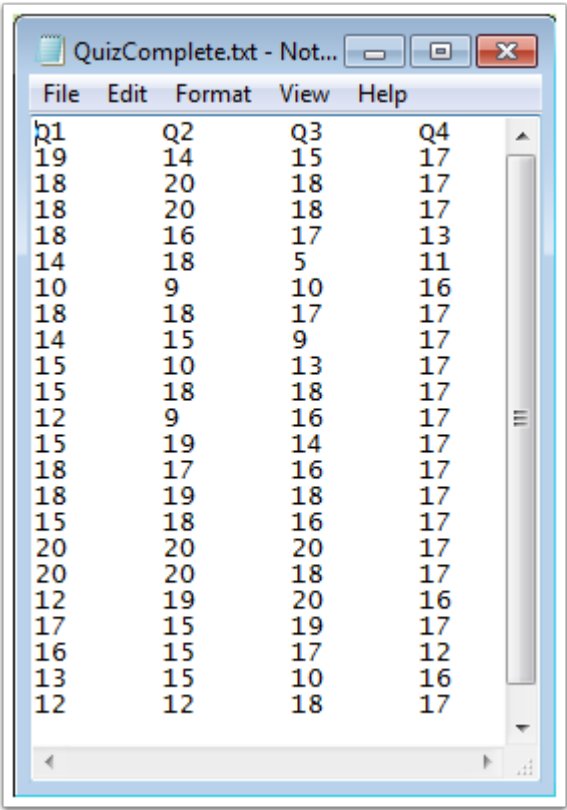
Amos comes with the built-in ability to estimate all of the quantities that you normally want to estimate in a SEM analysis. This includes model parameters (like regression weights) and various other quantities (like standardized regression weights, covariances and correlations among variables in the model, factor score weights, and so on.)

Sometimes you want to estimate some quantity that Amos doesn't normally estimate. It may be as simple as wanting to estimate the difference between two values that Amos already estimates. Then again, you may need to estimate some more complicated function of values that Amos already estimates.

This tutorial shows how to estimate quantities that you define as functions of other quantities that Amos already estimates. In particular, the tutorial shows how to estimate various indirect effects that Amos does not normally calculate.

The data

The data consist of scores obtained by 22 students on 4 quizzes administered at roughly equally spaced time points.



Q1	Q2	Q3	Q4
19	14	15	17
18	20	18	17
18	20	18	17
18	16	17	13
14	18	5	11
10	9	10	16
18	18	17	17
14	15	9	17
15	10	13	17
15	18	18	17
12	9	16	17
15	19	14	17
18	17	16	17
18	19	18	17
15	18	16	17
20	20	20	17
20	20	18	17
12	19	20	16
17	15	19	17
16	15	17	12
13	15	10	16
12	12	18	17

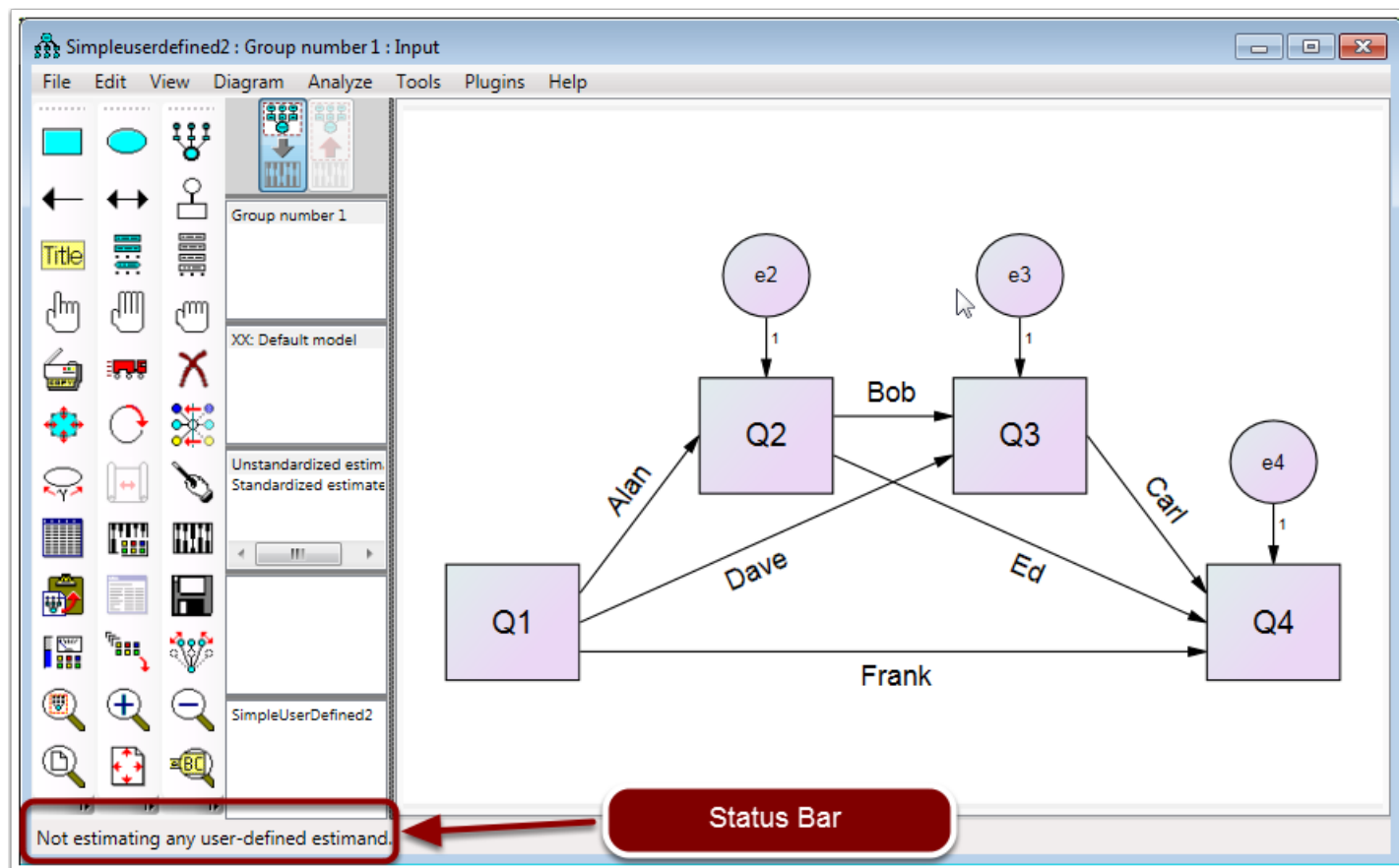
A model for the data

The path diagram below shows a model for the quiz scores. In this model, scores on each quiz can be predicted as a linear function of scores on earlier quizzes. Q4 in particular can be predicted as a linear function of Q1, Q2 and Q3. While Q4 depends directly on Q1, it also depends indirectly on Q1 in multiple ways. For example, Q4 depends on Q2, which in turn depends on Q1. This tutorial shows how to estimate all of the direct and indirect effects of Q1 on Q4. Bootstrapping will be used to estimate standard errors and confidence intervals for each effect.

Notice that all the regression weights have been named -- "Alan", "Bob", and so on. These parameter names will make it especially easy to define new estimands. The parameter names are not absolutely necessary, however. A separate tutorial shows how to define new estimands without making use of parameter names.

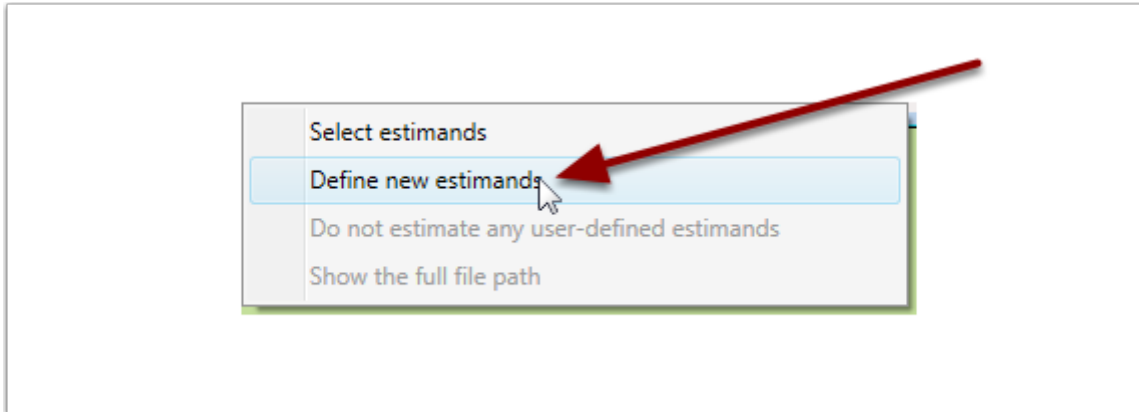
The status bar at the bottom of the Amos window displays the message "Not estimating any user-defined estimand." This means that no user-defined estimand has yet been specified. Amos will estimate only the quantities that it normally estimates.

(If the status bar isn't visible, click **View > Interface Properties** on the menu. Then on the **Misc** tab of the **Interface Properties** dialog, put a check mark next to **Show the status bar**. The status bar will appear when you click the **Apply** button.)



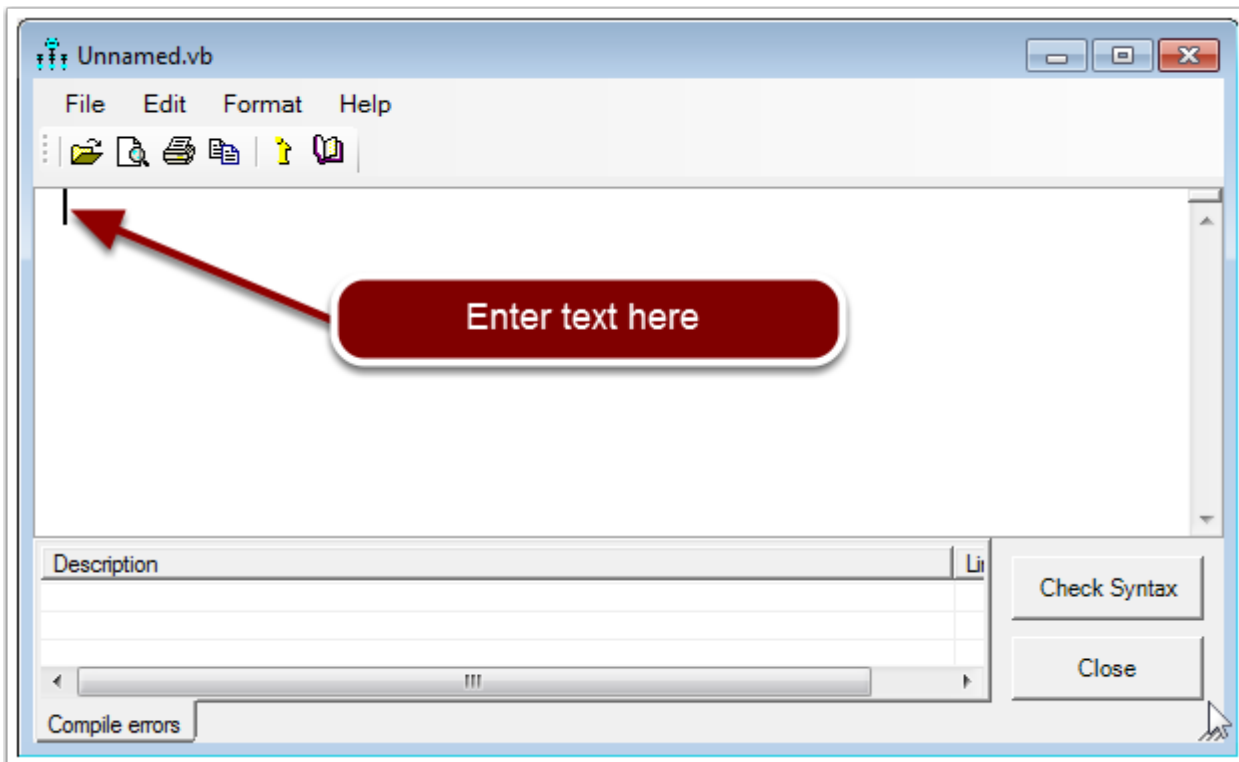
Defining new estimands

Click the status bar in the main Amos window. Then select **Define new estimands** in the menu that pops up.



Specifying new estimands

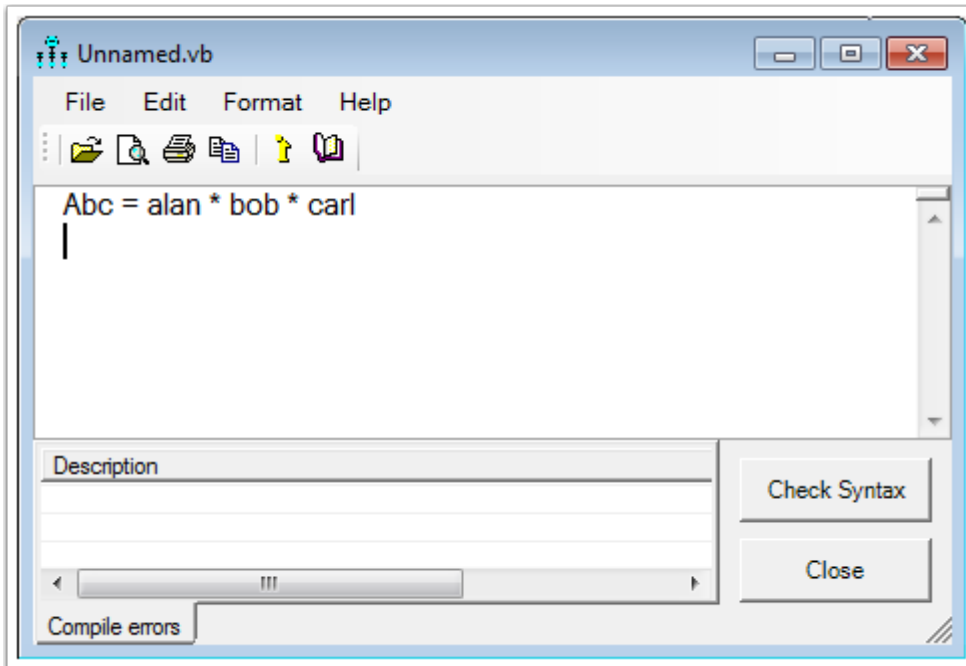
A new window opens, where we can specify the indirect effects that we want to estimate.



Defining one indirect effect

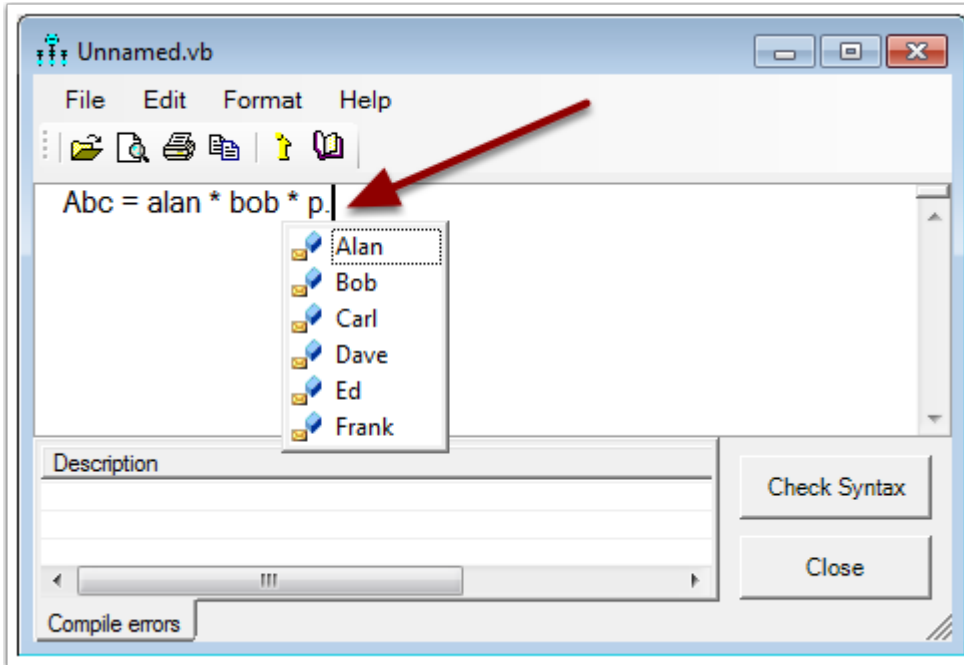
Begin by entering one line that defines an indirect effect called Abc. This indirect effect is the product of the regression weights called alan, bob and carl. Notice that parameter names aren't case-sensitive. It doesn't matter whether you type "Alan" or "alan".

"Abc" is simply a made-up name that Amos will use to label this indirect effect in the output.



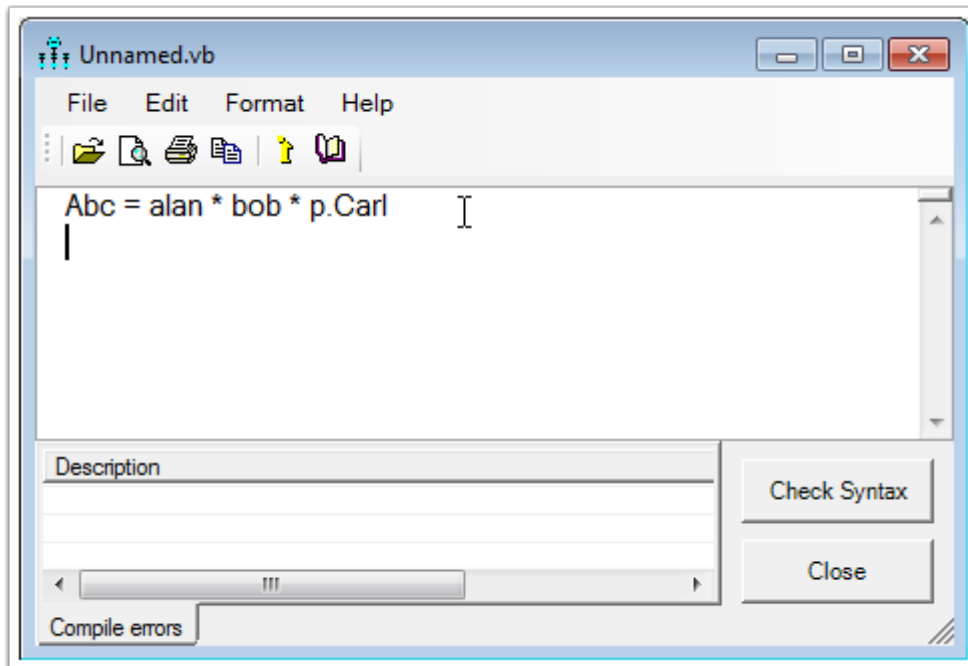
Selecting a parameter name from a list (Part 2)

Instead of typing a parameter name, you can select from a list of parameter names by typing the two characters "p." (the letter "p" followed by a period).



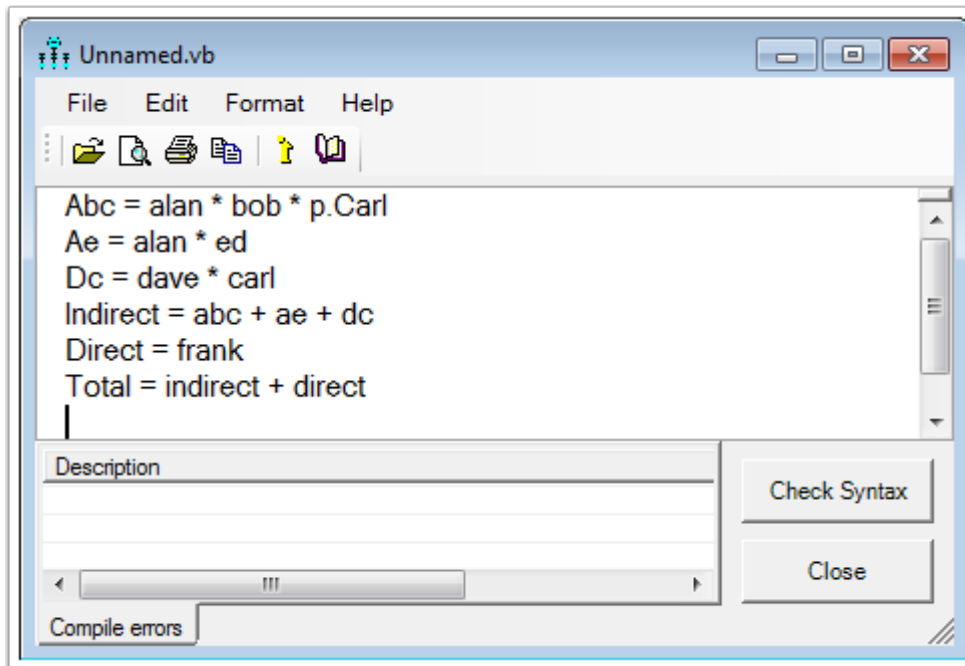
Selecting a parameter name from a list (Part 1)

If you double-click "Carl" in the list of parameter names, the definition of the new "Abc" estimand will appear as shown below. "p.Carl" has the same meaning as "Carl" or "carl" with the following exception: It is possible to have a parameter named "carl" and also a variable called "carl". In that case, "carl" is ambiguous and you have to type p.carl to make it clear that you mean the parameter named carl and not the variable named carl.



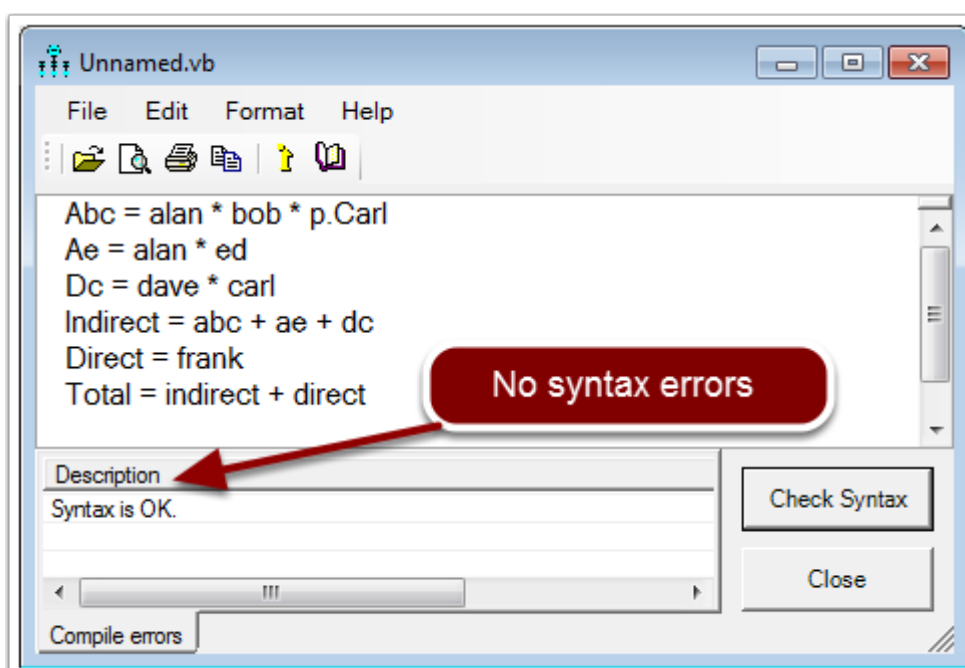
Defining additional estimands

Go ahead and define more new estimands. In the figure below, **Abc**, **Ae** and **Dc** are the three simple indirect effects of Q1 on Q4. **Indirect** is the sum of all the indirect effects. **Direct** is a new estimand which is in fact identical to the regression weight called **frank**. Finally, **Total** is the so-called total effect of Q1 on Q4.



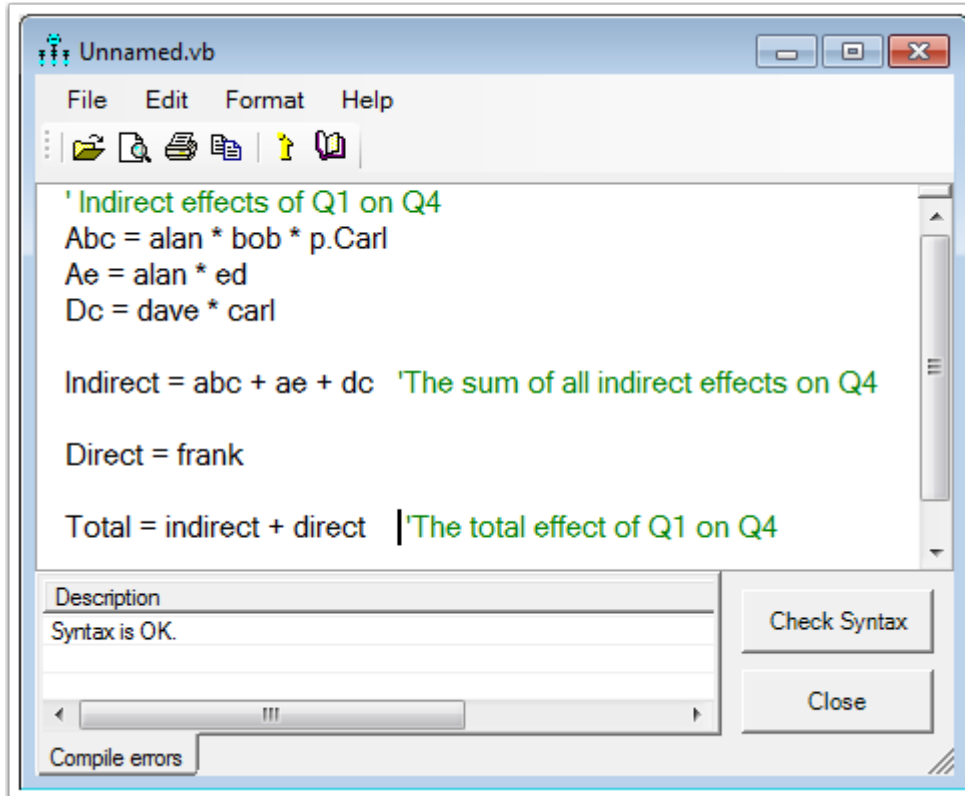
Checking for syntax errors

Click the **Check Syntax** button to check for spelling errors or any other syntax errors.



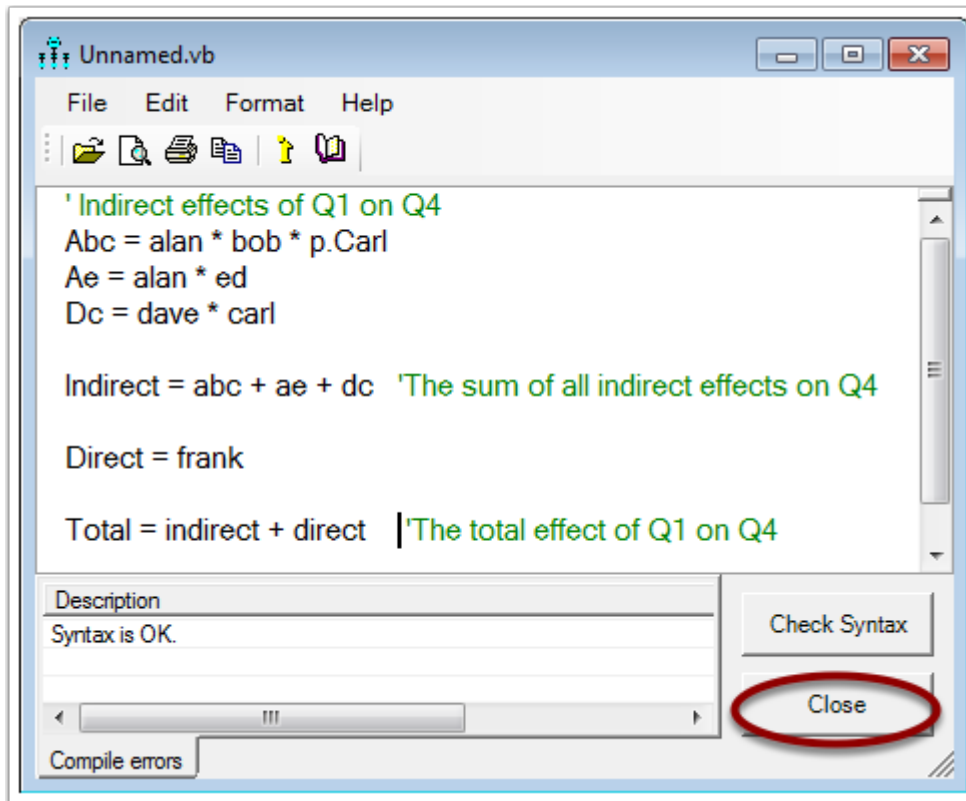
Entering spaces, blank lines and comments

You can use spaces and blank lines to make your definitions more readable. You can also enter comments preceded by an apostrophe (').



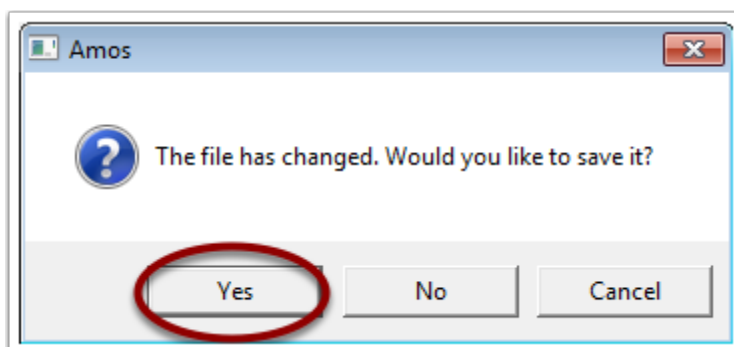
Closing the estimand editor

Click **Close**.



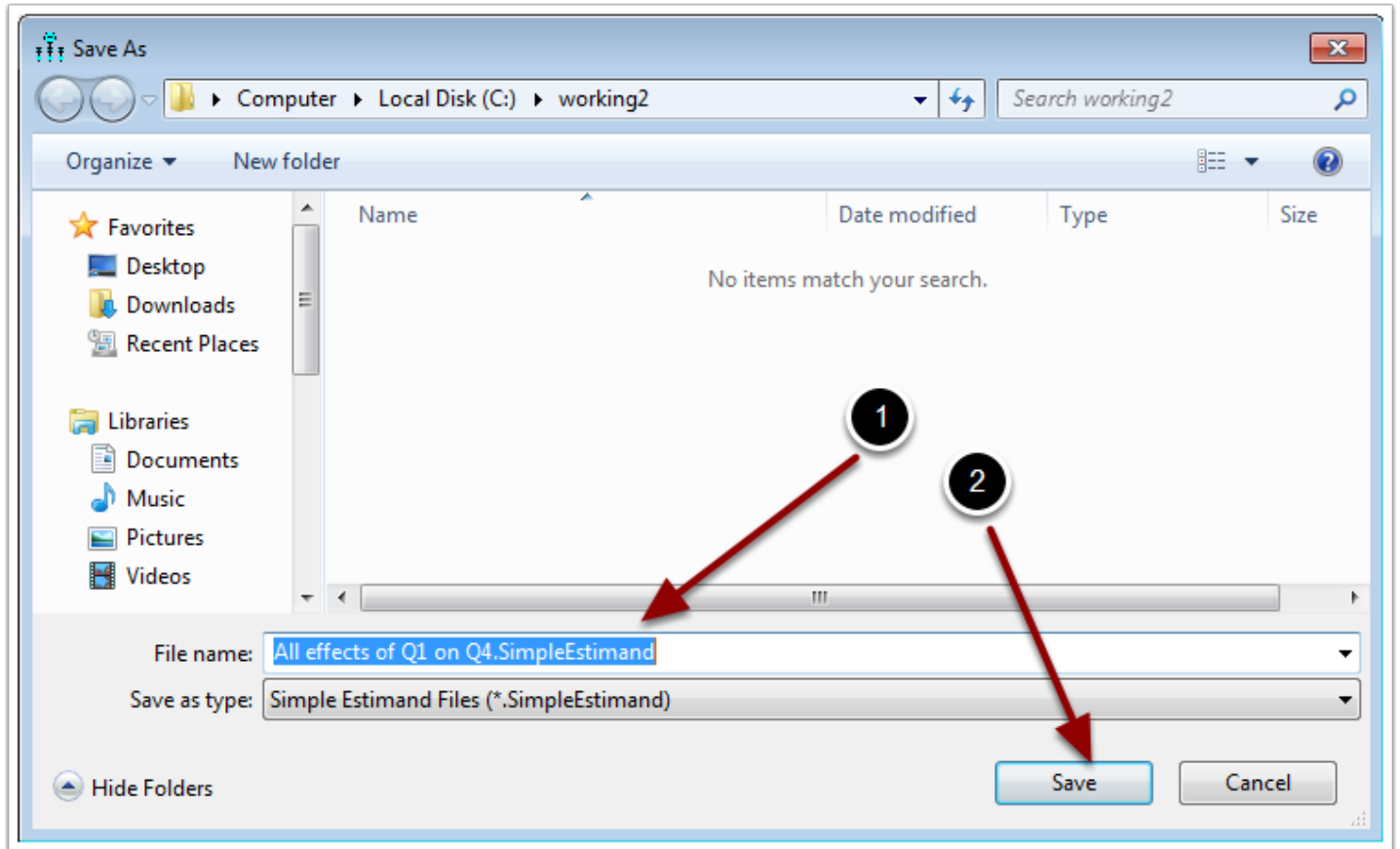
Saving the user-defined estimands

Click **Yes** to save the estimand definitions in a file.



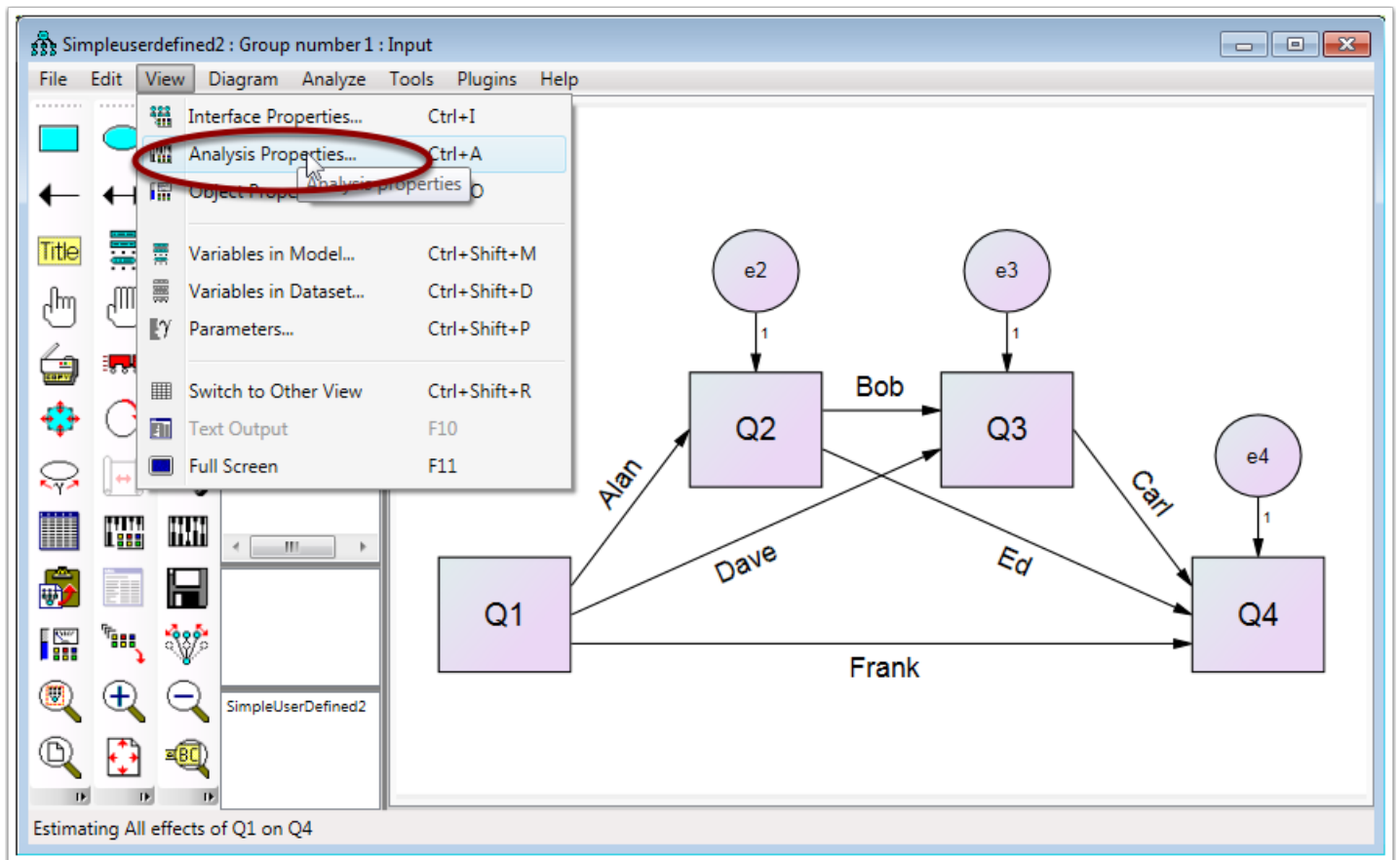
Specifying a file name for the user-defined estimands

Enter a file name, the more descriptive the better, and then click **Save**.



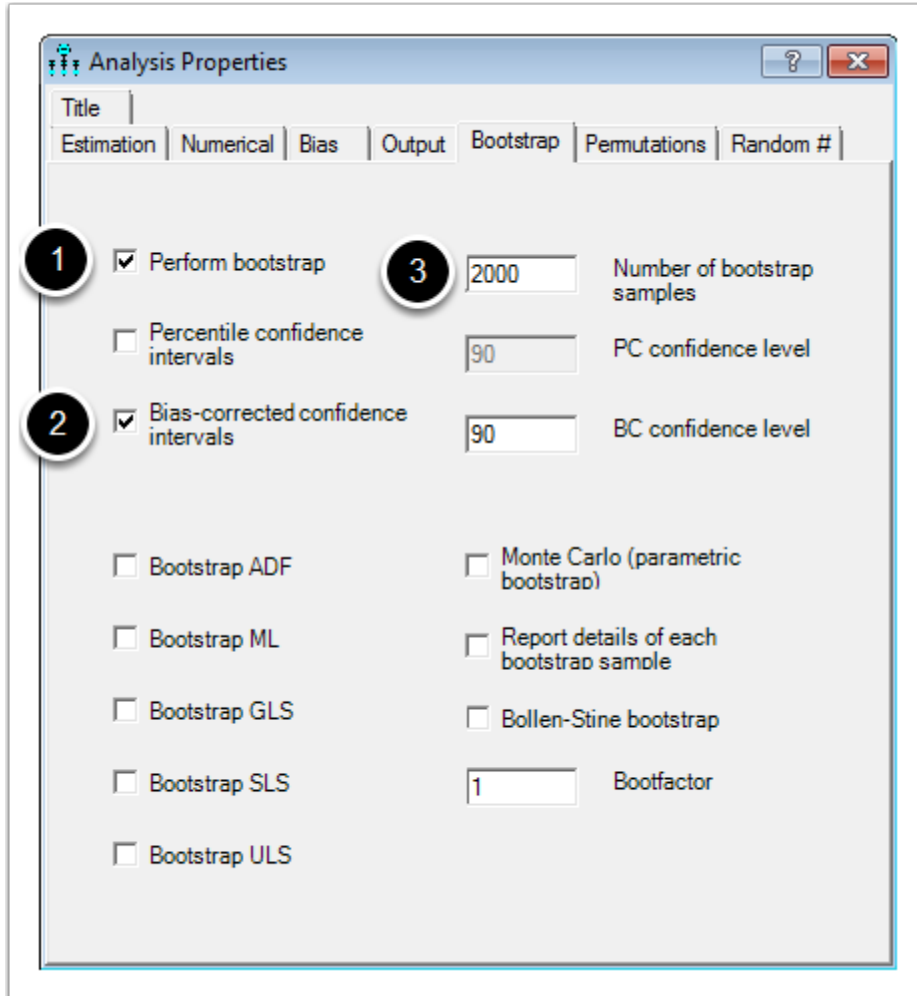
Requesting a bootstrap

To request a bootstrap analysis, click **View > Analysis Properties**.



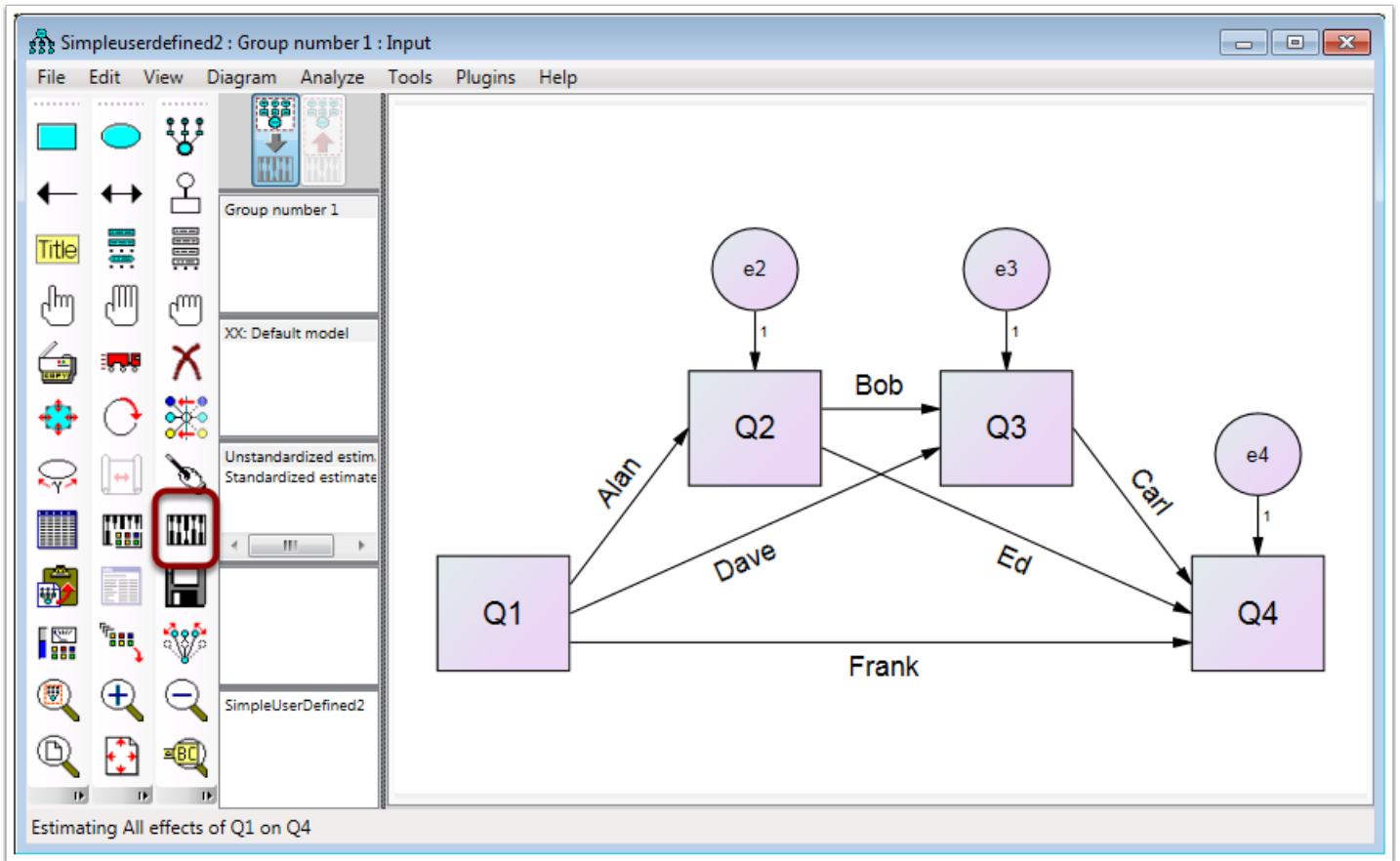
Specifying details of the bootstrap analysis

On the Bootstrap tab of the Analysis Properties dialog, put check marks next to **Perform bootstrap** and **Bias-corrected confidence intervals**. Also, enter 2000 for **Number of bootstrap samples**.



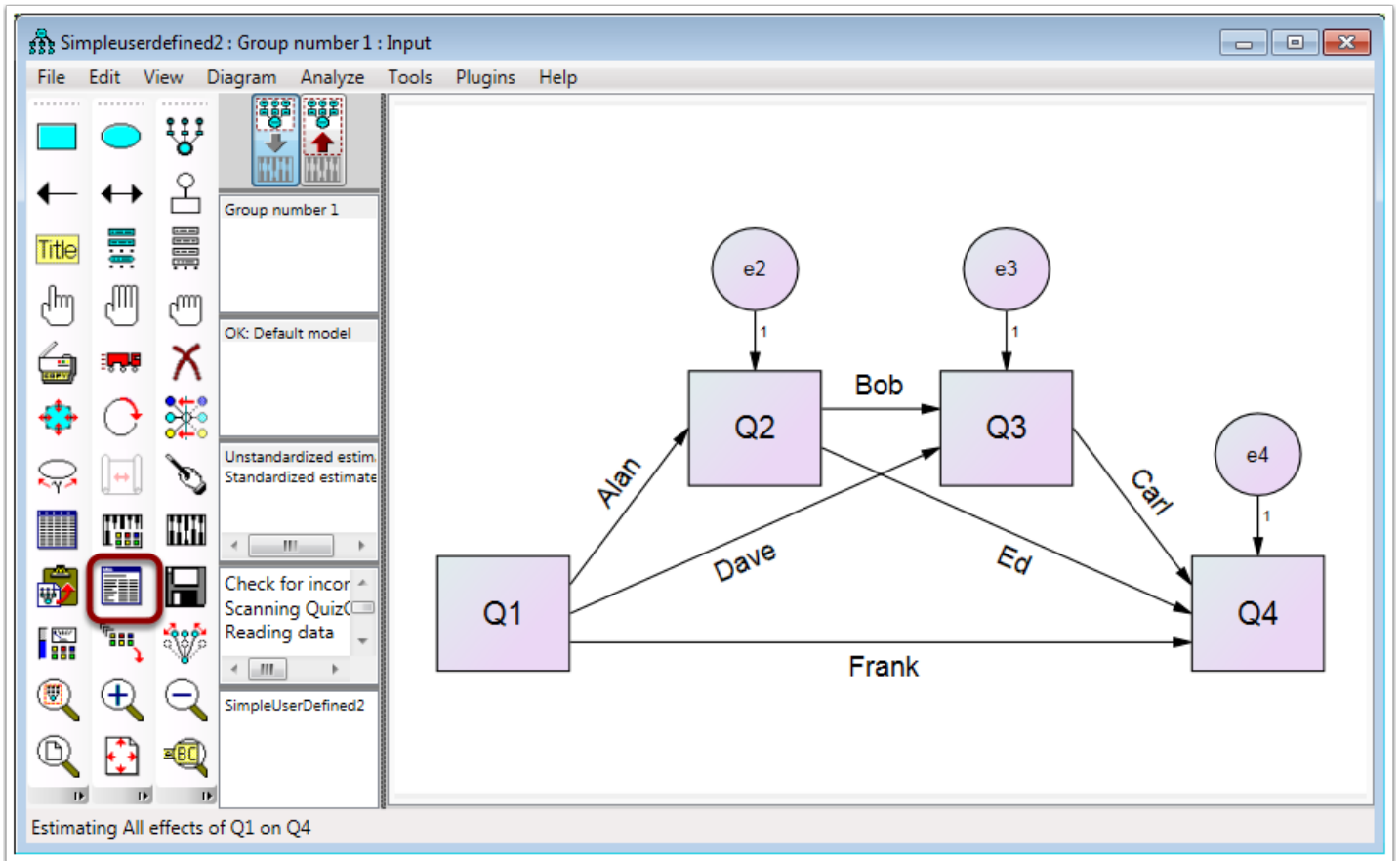
Fitting the model

Click **Calculate estimates**.



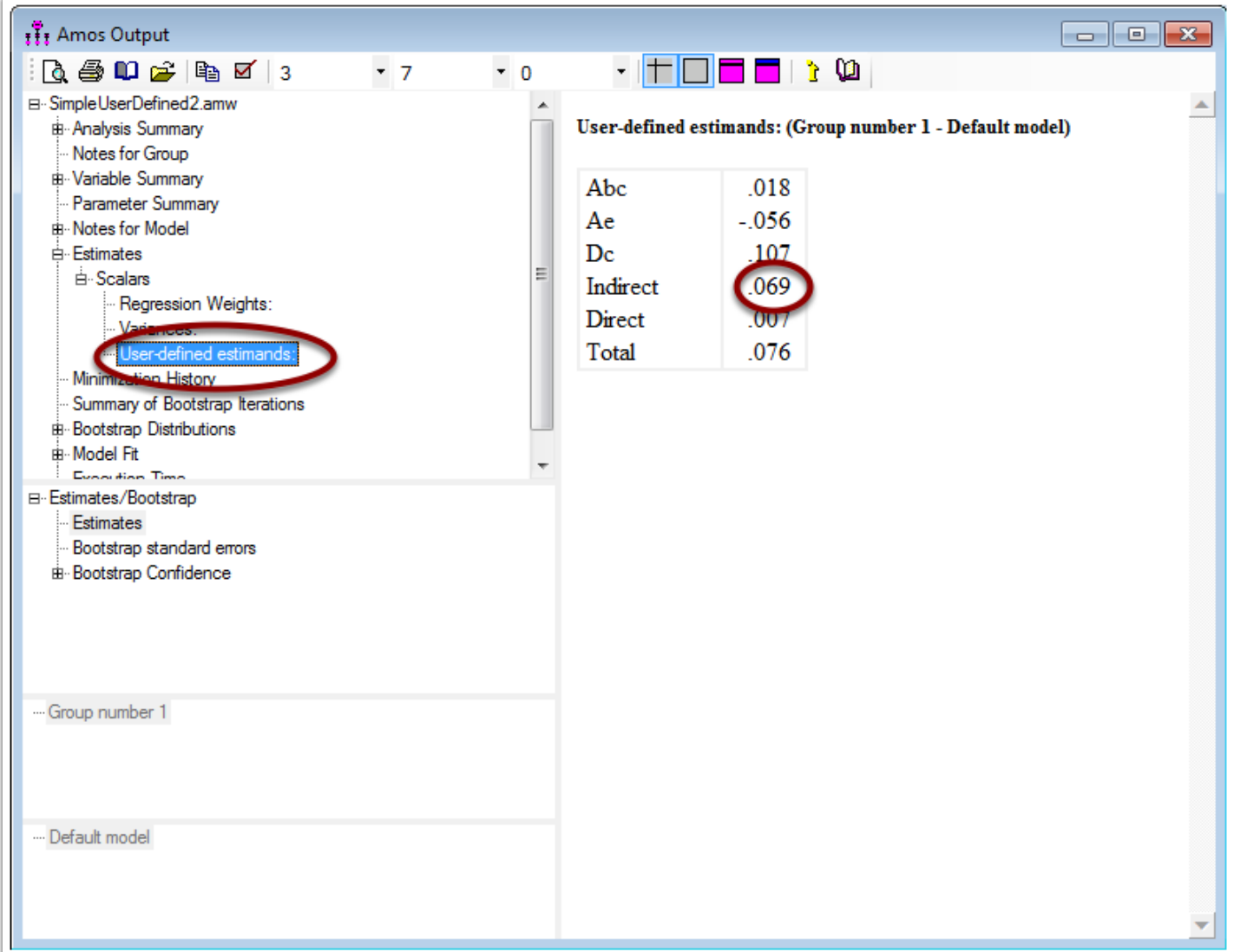
Viewing the text output

Click **View text**.



Viewing the estimates

In the Amos Output window, double-click **Estimates**, then double-click **Scalars**, then click **User-defined estimands** to display maximum likelihood estimates of the new estimands. The table of estimates shows, for example, that the sum of indirect effects of Q1 on Q4 is estimated to be .069.

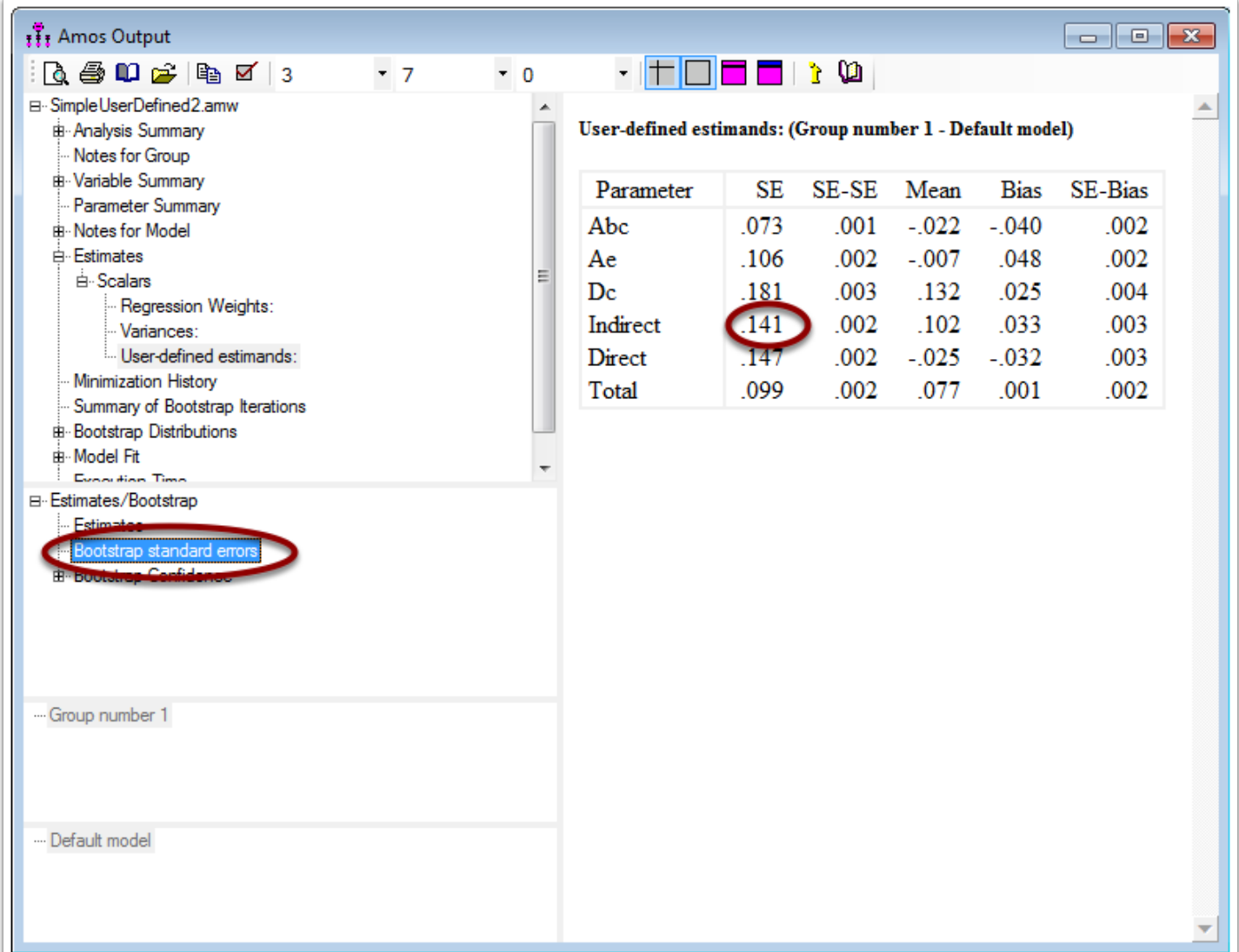


The screenshot shows the Amos Output window for a file named 'SimpleUserDefined2.amw'. The left-hand pane displays a tree view of the output, with 'User-defined estimands' highlighted under the 'Scalars' folder. The right-hand pane displays a table titled 'User-defined estimands: (Group number 1 - Default model)'. The table contains the following data:

Estimand	Value
Abc	.018
Ae	-.056
Dc	.107
Indirect	.069
Direct	.007
Total	.076

Viewing bootstrap standard errors

Click **Bootstrap standard errors**. The table of standard errors shows, for example, that the sum of indirect effects of Q1 on Q4 has a standard error of about .141.



The screenshot displays the Amos Output window for a model named 'SimpleUserDefined2.amw'. The left-hand tree view shows the 'Estimates/Bootstrap' section, with 'Bootstrap standard errors' highlighted by a red circle. The right-hand pane displays a table titled 'User-defined estimands: (Group number 1 - Default model)'. The table lists parameters and their associated standard errors (SE), standard errors of standard errors (SE-SE), means, biases, and standard errors of biases (SE-Bias). The 'Indirect' parameter's SE value of .141 is circled in red.

Parameter	SE	SE-SE	Mean	Bias	SE-Bias
Abc	.073	.001	-.022	-.040	.002
Ae	.106	.002	-.007	.048	.002
Dc	.181	.003	.132	.025	.004
Indirect	.141	.002	.102	.033	.003
Direct	.147	.002	-.025	-.032	.003
Total	.099	.002	.077	.001	.002

Viewing bootstrap confidence intervals

Click **Bias-corrected percentile method**. The table shows, for example, that the sum of indirect effects of Q1 on Q4 is between $-.033$ and $.385$ with 90% confidence. A bootstrap p value of $.336$ means that the sum of indirect effects is not significantly different from zero using any conventional significance level.

The screenshot shows the Amos Output window for a model named 'SimpleUserDefined2.amw'. The left pane shows a tree view of the output, with 'Estimates/Bootstrap' expanded and 'Bias-corrected percentile method' selected. The right pane displays a table titled 'User-defined estimands: (Group number 1 - Default model)'.

Parameter	Estimate	Lower	Upper	P
Abc	.018	-.003140
Ae	-.056	-.218	.058	.298
Dc	.107	-.018	.609	.291
Indirect	.069	-.033	.385	.336
Direct	.007	-.244	.161	.903
Total	.076	-.061	.268	.318