Last updated November 28, 2011
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GeSCA User's Manual

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HOW TO USE *GeSCA*

1. Sample data and model

Bergami and Bagozzi's (2000) organizational identification data are used for illustrative purposes. The number of observations is equal to 305. The model specified for the data is displayed in Figure 1. (No residual terms are displayed in the figure). As shown in the figure, this model consists of four latent variables and 21 reflective indicators. Specifically, Organizational Prestige (Org_Pres) is measured by eight indicators (cei1 – cei8), Organizational Identification (Org_Iden) by six indicators (ma1 – ma6), Affective Commitment-Joy (AC_Joy) by four indicators (orgcmt1, 2, 3 and 7), and Affective Commitment – Love (AC_Love) by three indicators (orgcmt5, 6, and 8).

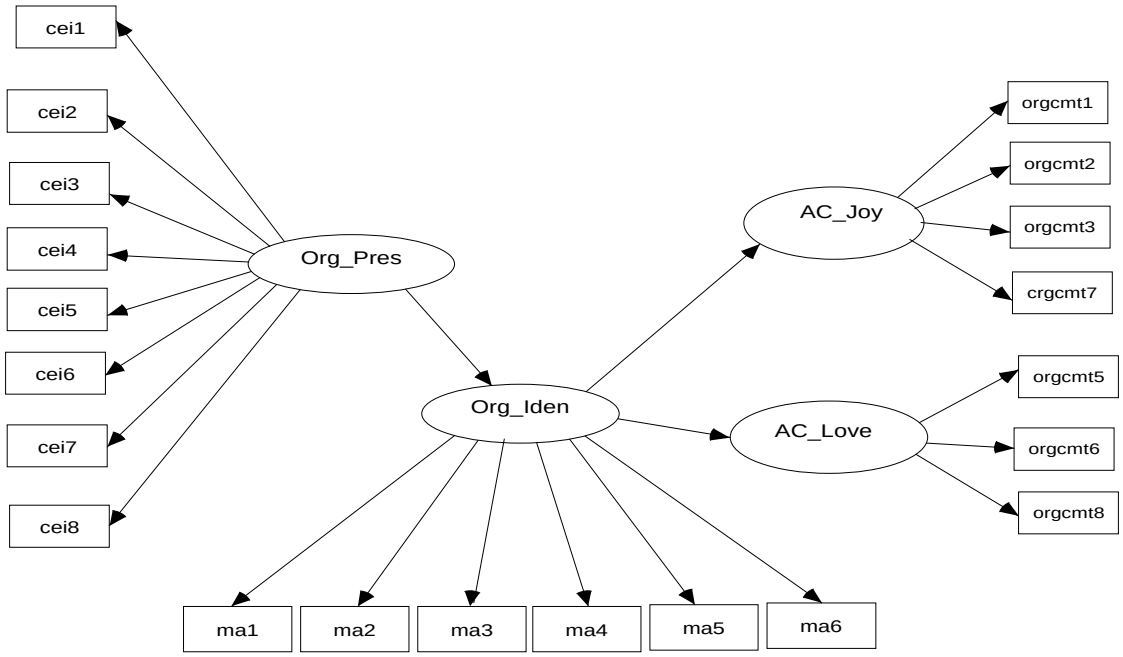


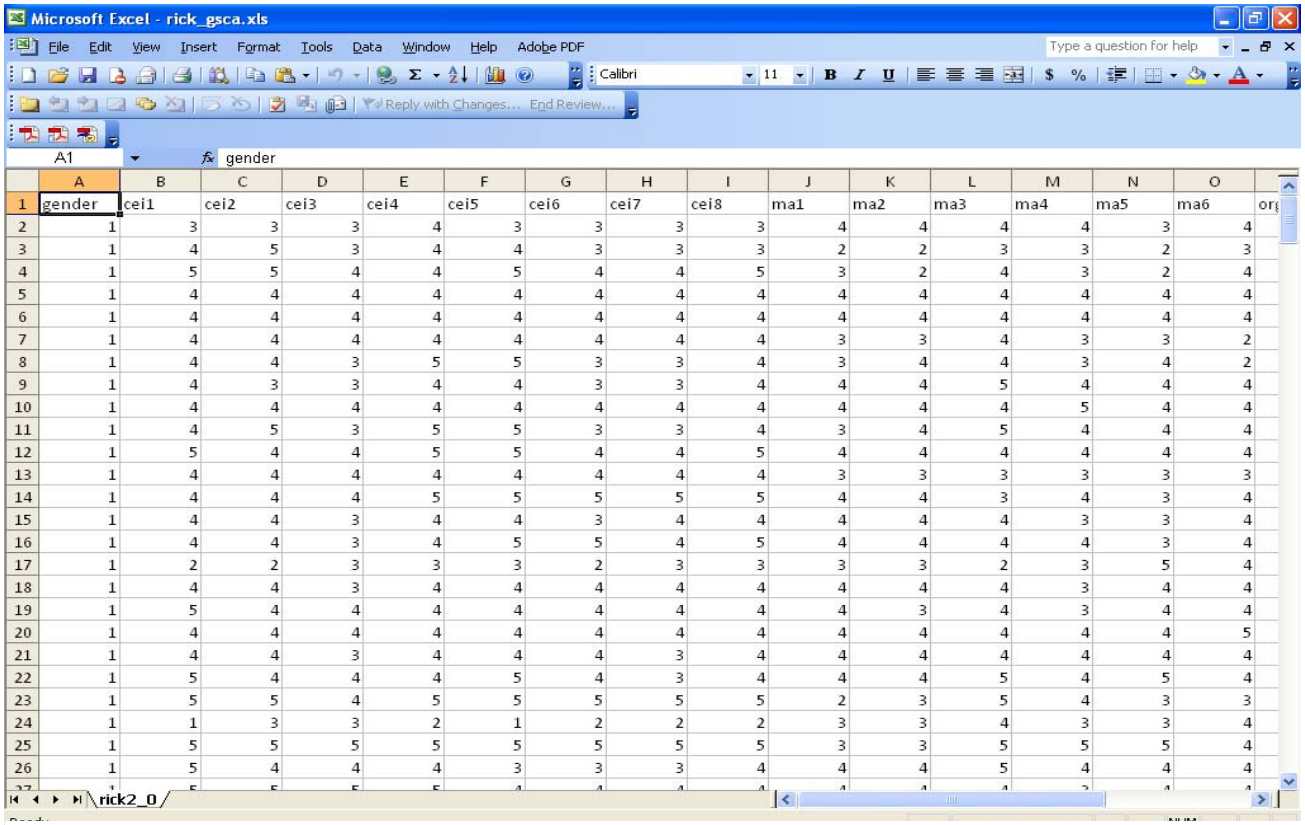
Figure 1. The specified structural equation model for the example data.

2. Prepare a raw date file

GeSCA is run on individual-level raw data. The raw data file is to be prepared in **Excel (.xls or .xlsx)**. The specific data format required is as follows:

- The first row contains the names of indicators.
- The data input begins on the second row.

The following shows the data set created in Excel for the present example:



Microsoft Excel - rick_gsca.xls

File Edit View Insert Format Tools Data Window Help Adobe PDF

A1 gender

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	gender	cei1	cei2	cei3	cei4	cei5	cei6	cei7	cei8	ma1	ma2	ma3	ma4	ma5	ma6
2	1	3	3	3	4	3	3	3	3	4	4	4	4	3	4
3	1	4	5	3	4	4	3	3	3	2	2	3	3	2	3
4	1	5	5	4	4	5	4	4	5	3	2	4	3	2	4
5	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4
6	1	4	4	4	4	4	4	4	4	4	4	4	4	4	4
7	1	4	4	4	4	4	4	4	4	3	3	4	3	3	2
8	1	4	4	3	5	5	3	3	4	3	4	4	3	4	2
9	1	4	3	3	4	4	3	3	4	4	4	4	5	4	4
10	1	4	4	4	4	4	4	4	4	4	4	4	4	5	4
11	1	4	5	3	5	5	3	3	4	3	4	5	4	4	4
12	1	5	4	4	5	5	4	4	5	4	4	4	4	4	4
13	1	4	4	4	4	4	4	4	4	3	3	3	3	3	3
14	1	4	4	4	5	5	5	5	5	4	4	3	4	3	4
15	1	4	4	3	4	4	3	4	4	4	4	4	3	3	4
16	1	4	4	3	4	5	5	4	5	4	4	4	4	3	4
17	1	2	2	3	3	3	2	3	3	3	3	2	3	5	4
18	1	4	4	3	4	4	4	4	4	4	4	4	3	4	4
19	1	5	4	4	4	4	4	4	4	4	4	3	4	3	4
20	1	4	4	4	4	4	4	4	4	4	4	4	4	4	5
21	1	4	4	3	4	4	4	3	4	4	4	4	4	4	4
22	1	5	4	4	4	5	4	3	4	4	4	5	4	5	4
23	1	5	5	4	5	5	5	5	5	2	3	5	4	3	3
24	1	1	3	3	2	1	2	2	2	3	3	4	3	3	4
25	1	5	5	5	5	5	5	5	5	3	3	5	5	5	4
26	1	5	4	4	4	3	3	3	4	4	4	5	4	4	4

rick2_0

Alternately, the raw data file can be prepared in **ASCII format (.txt or .dat)**. The specific data format required for this case is as follows:

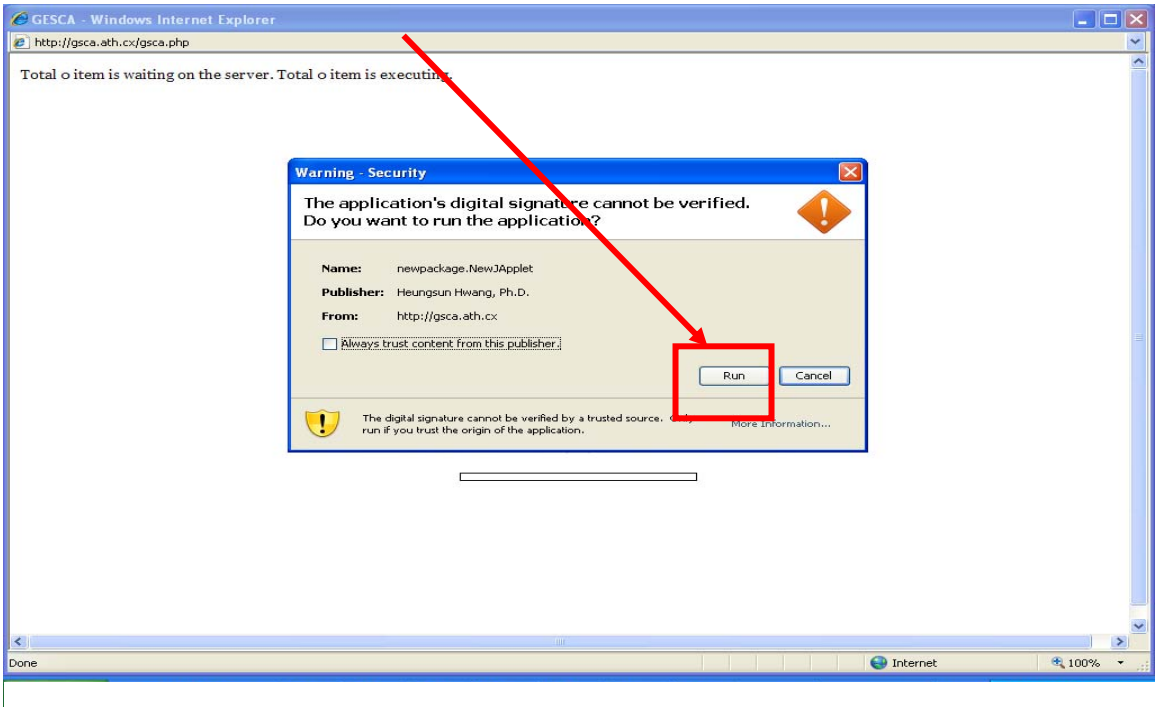
- The first row contains the names of indicators. The name of each indicator should be separated by a space.
- The data input begins on the second row. Data from an observation, or responses by an individual on each indicator, should be separated by a space.
- Data for each observation should appear on a single row.

The following shows the first five rows of the data set created in ASCII format for the present example:

```
cei1 cei2 cei3 cei4 cei5 cei6 cei7 cei8 ma1 ma2 ma3 ma4 ma5 ma6 orgcmt1 orgcmt2 orgcmt3 orgcmt7 orgcmt5 orgcmt6 orgcmt8
3    3    3    4    3    3    3    3    4   4   4   4   3   4   3       2       3       4       3       3       3
4    5    3    4    4    3    3    3    2   2   3   3   2   3   3       1       3       3       3       3       3
5    5    4    4    5    4    4    5    3   2   4   3   2   4   1       3       3       4       4       3       2
4    4    4    4    4    4    4    4    4   4   4   4   4   4   3       3       2       3       3       3       3
```

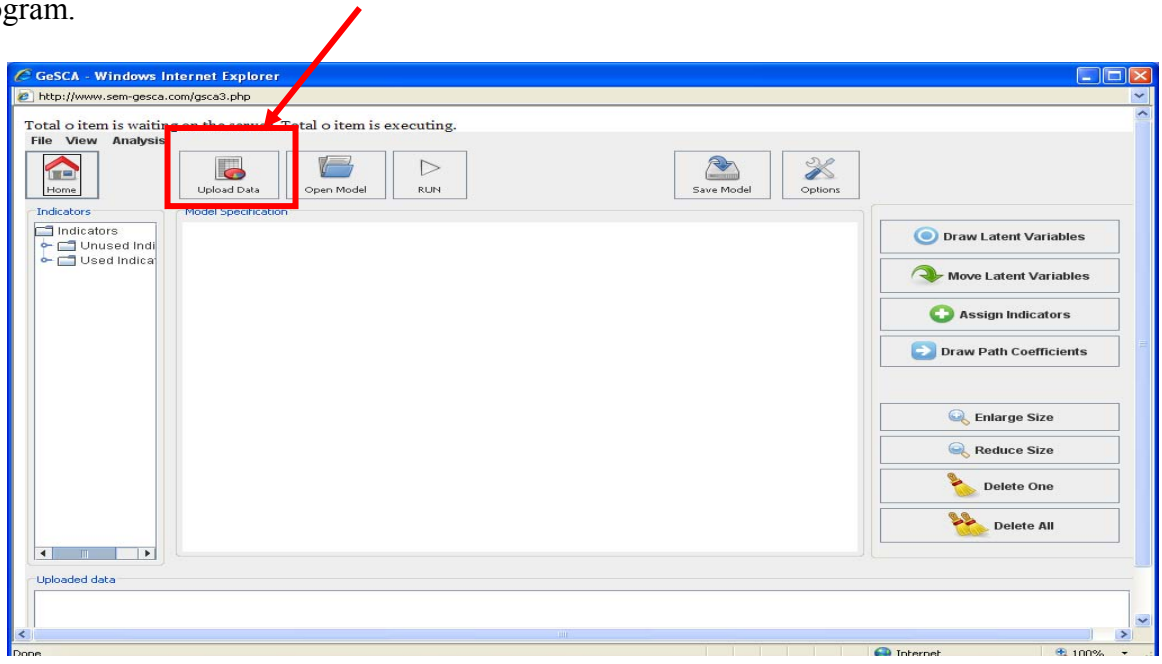
3. Open *GeSCA*

When users open *GeSCA* for the first time, they will see the following warning sign. Click on "**Run**" in order to start the program.

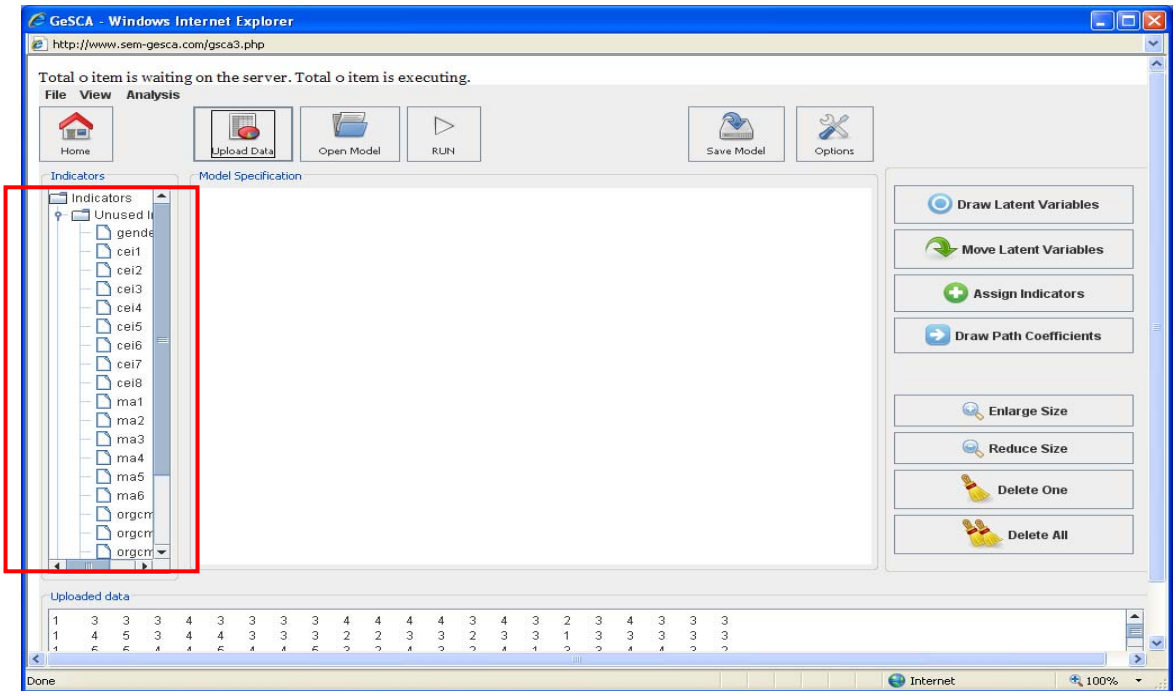


4. Upload data

Users can upload their data file by clicking on the icon **[Upload Data]** on the top menu of the program.



Subsequently, the list of indicator names in the input data file will appear in the left window of the program under the label "**Indicators**".



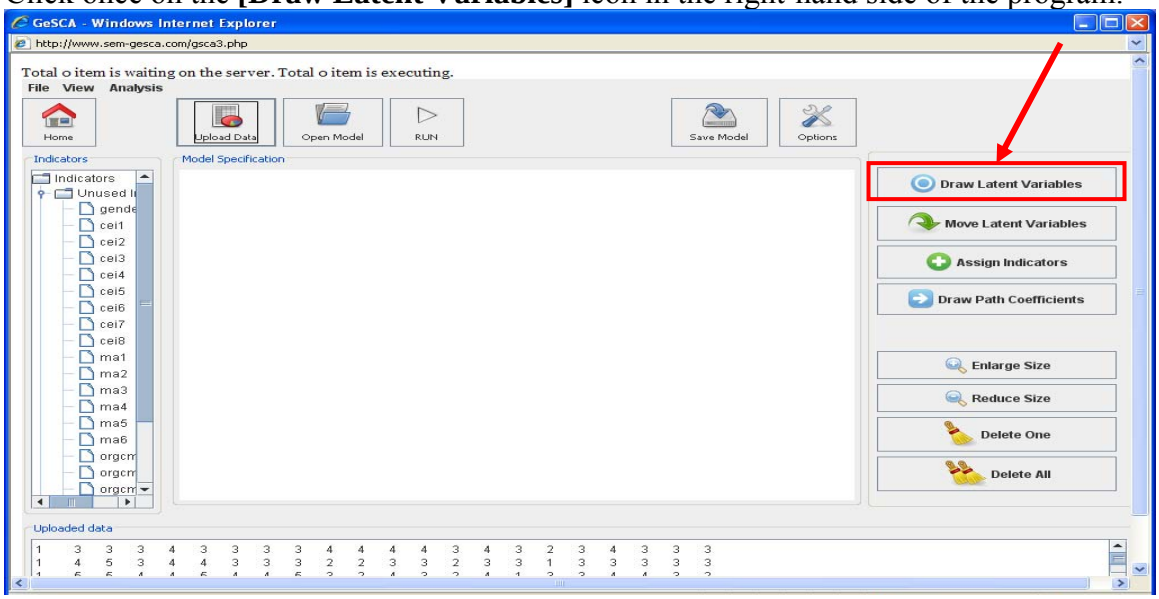
5. Specify a structural equation model

Users can specify their structural equation model with the following steps.

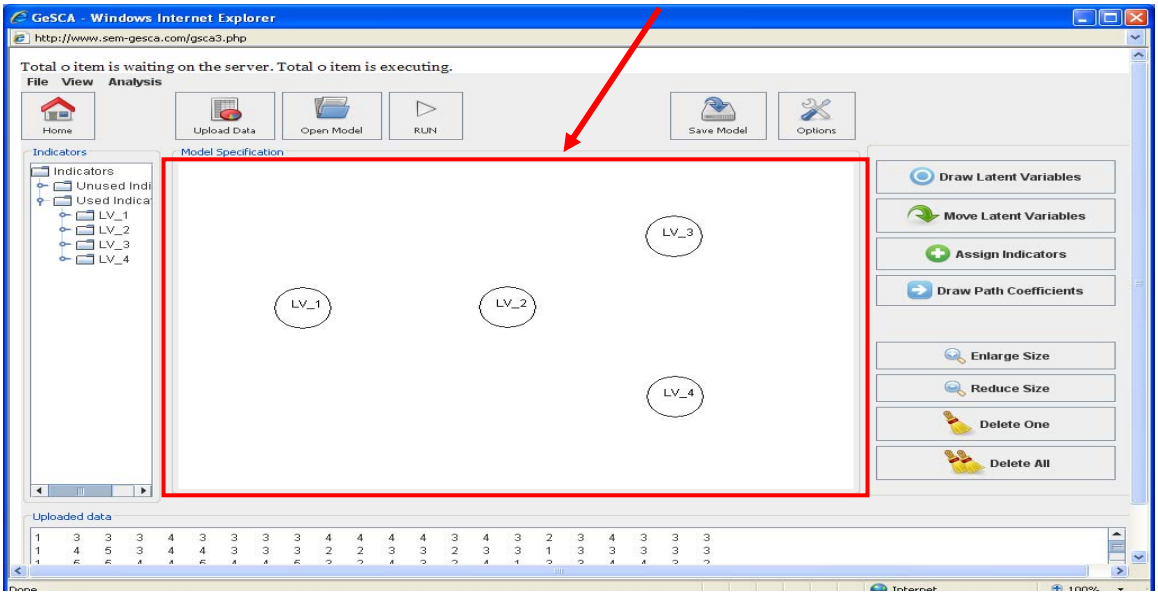
Step 1: Draw latent variables

Users are to draw latent variables before assigning indicators to them as follows:

- Click once on the **[Draw Latent Variables]** icon in the right-hand side of the program.



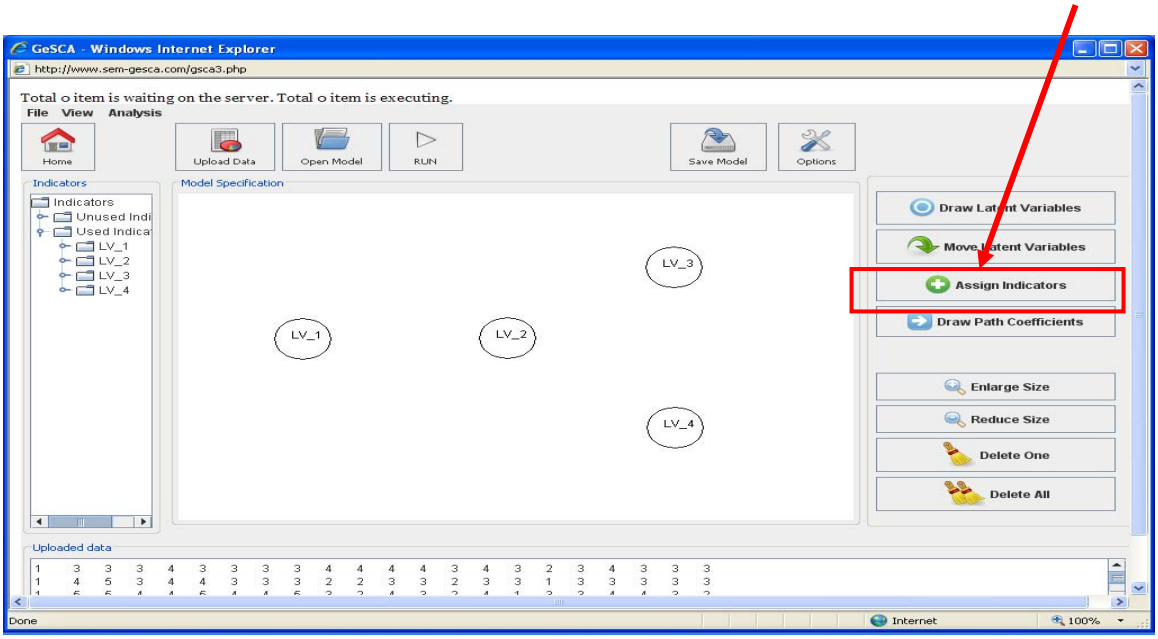
- Click the left mouse button with the cursor placed in the "**Model Specification**" window of the program as many times as the number of latent variables. In the present example, four clicks resulted in the creation of four latent variables. By default, the four latent variables were initially named *LV_1* to *LV_4*.



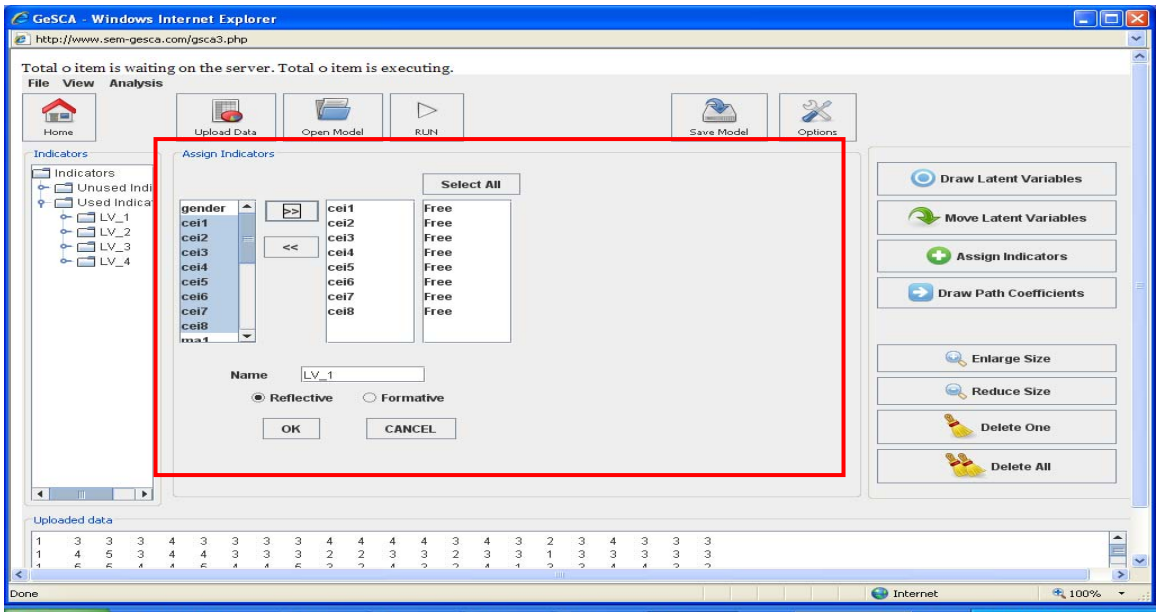
Step 2: Assign indicators to latent variables (measurement model)

After drawing latent variables, users are to specify their measurement model as follows:

- Click once on the **[Assign Indicators]** icon in the right-hand side of the program, and then click on an individual latent variable (a circle) on the "**Model Specification**" window.



- The latent variable can be renamed by typing its label in the "**Assign Indicators**" window.
- Select the appropriate indicators in the list, which appears on the left-hand dialog window, and move them to the right-hand dialog window ("**Free**" means a free loading to be estimated).
- Choose whether the selected indicators are to be specified as *Reflective* (default) or *Formative*.

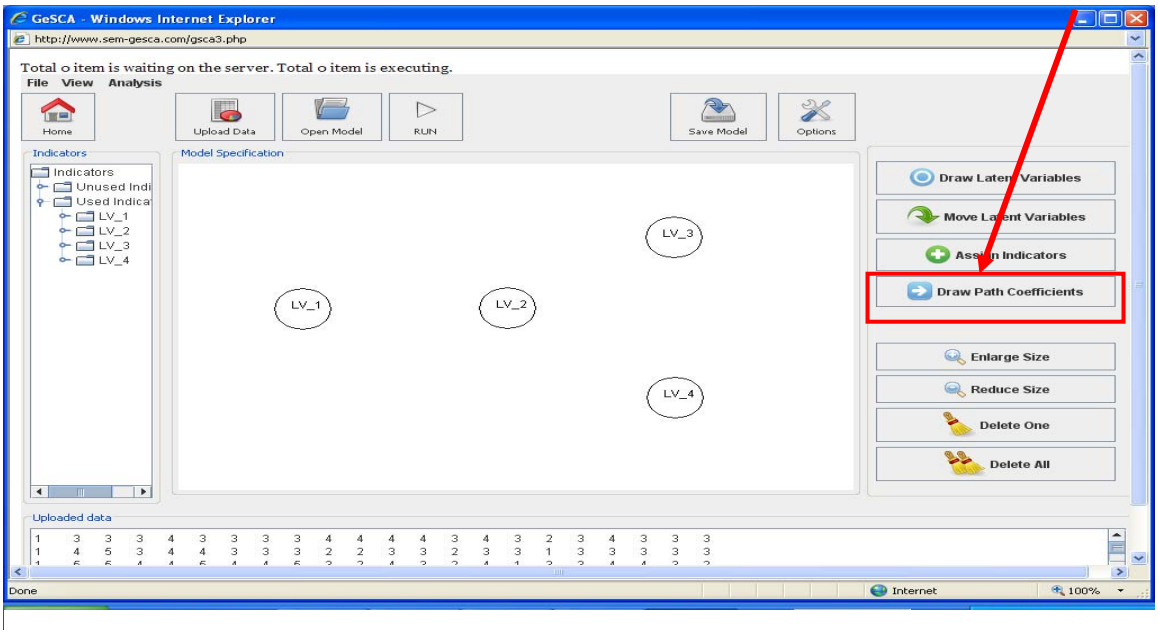


- Repeat the above steps for the remaining latent variables.

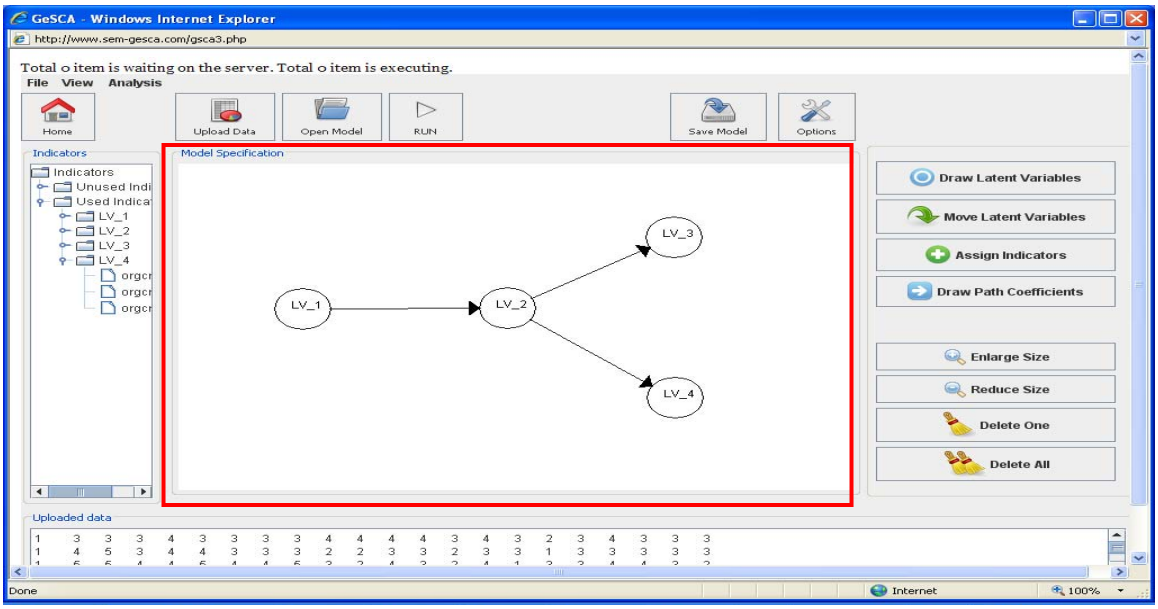
Step 3: Draw path coefficients (structural model)

Path coefficients are to be drawn as follows:

- Click once on the **[Draw Path Coefficients]** icon in the right-hand side of the program.

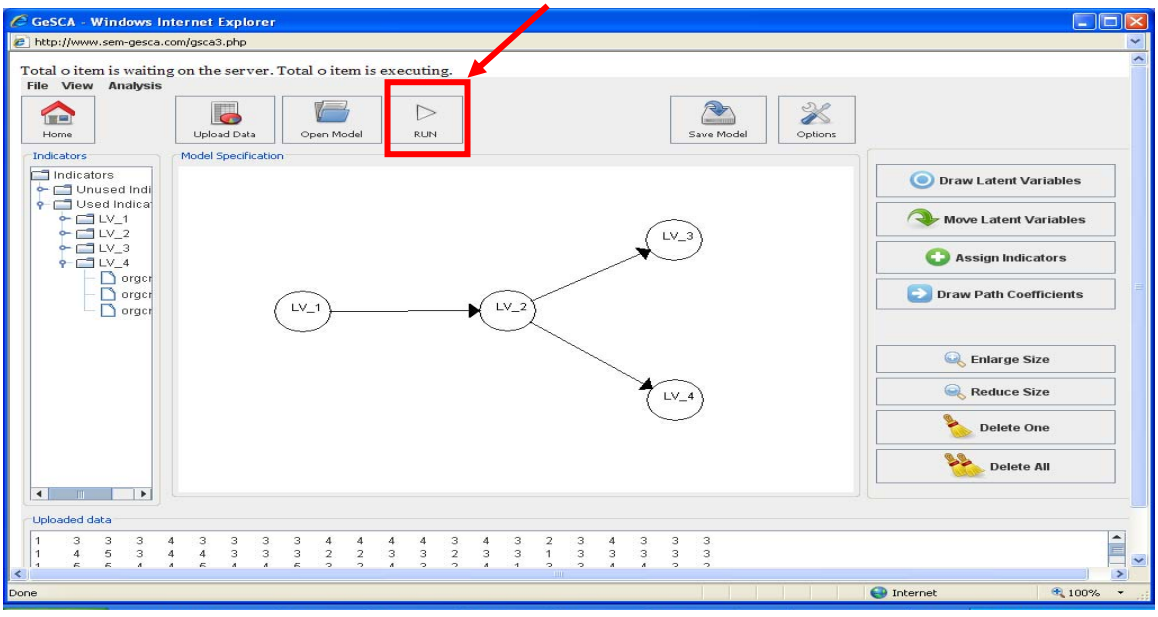


- Drag a path from an exogenous latent variable to the corresponding endogenous latent variable. Repeat the above steps until all paths are drawn.

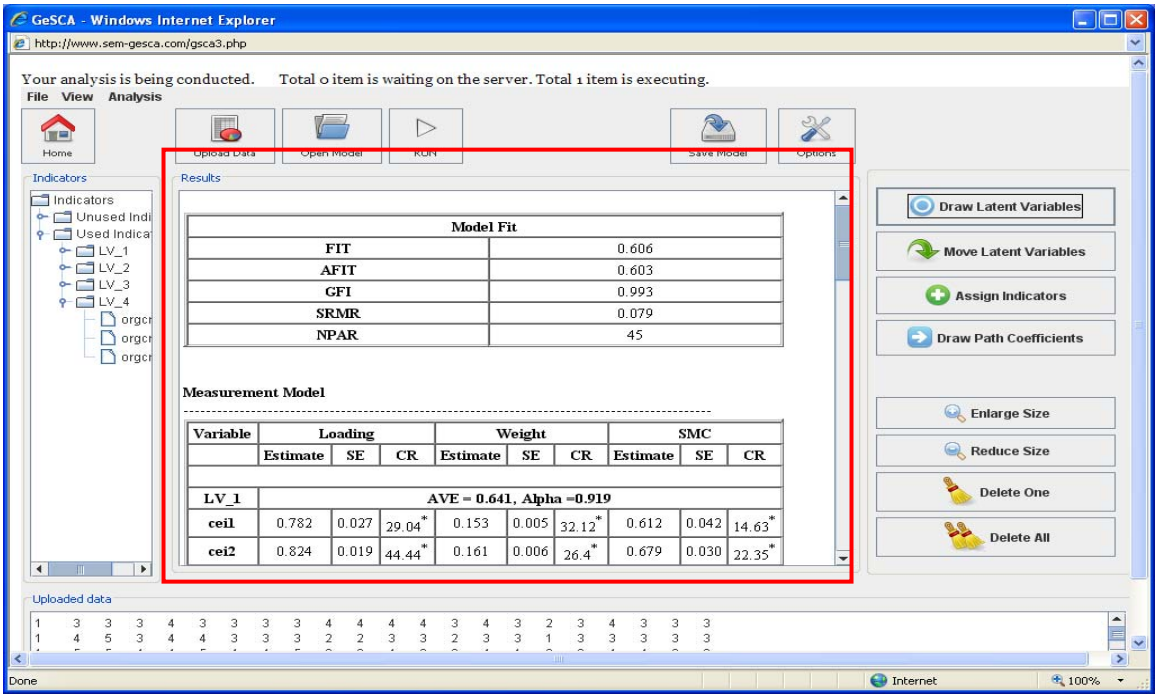


6. Run *GeSCA*

Once the above steps are complete, users can run *GeSCA* for fitting the specified model to the data. This is done by clicking on the **[RUN]** icon on the top of the program.



As shown below, all analysis results are displayed in the "**Results**" window.



Model Fit	
FIT	0.606
AFIT	0.603
GFI	0.993
SRMR	0.079
NPAR	45

Measurement Model

Variable	Loading			Weight			SMC		
	Estimate	SE	CR	Estimate	SE	CR	Estimate	SE	CR
LV_1	AVE = 0.641, Alpha =0.919								
cei1	0.782	0.027	29.04*	0.153	0.005	32.12*	0.612	0.042	14.63*
cei2	0.824	0.019	44.44*	0.161	0.006	26.4*	0.679	0.030	22.35*

Users can **copy and paste** the results into WORD by using shortcut functions: In the "**Results**" window, **Ctrl + a = Select all, Ctrl + c = Copy, Ctrl + v = Paste**.

HOW TO INTERPRET *GeSCA* RESULTS

Model Fit	
FIT	0.535
AFIT	0.532
GFI	0.993
SRMR	0.078
NPAR	45

This table provides four measures of overall model fit and the number of free parameters.

- **FIT** indicates the total variance of all variables explained by a particular model specification. The values of FIT range from 0 to 1. The larger this value, the more variance in the variables is accounted for by the specified model.
- **AFIT** (Adjusted FIT) is similar to FIT, but takes model complexity into account. The AFIT may be used for model comparison. The model with the largest AFIT value may be chosen among competing models.
- (Unweighted least-squares) **GFI** and **SRMR** (standardized root mean square residual). Both are proportional to the difference between the sample covariances and the covariances reproduced by the parameter estimates of generalized structured component analysis. The GFI values close to 1 and the SRMR values close to 0 may be taken as indicative of good fit. For example, SRMR $\leq$ .08 is indicative of an acceptable model fit.
- **NPAR** is the number of free parameters estimated, including weights, loadings and path coefficients.

Measurement Model

Variable	Loading			Weight			SMC		
	Estimate	**SE**	**CR**	**Estimate**	**SE**	**CR**	**Estimate**	**SE**	**CR**
LV_1	**AVE = 0.641, Alpha =0.919**								
cei1	0.781	0.025	31.03*	0.150	0.010	14.5*	0.609	0.039	15.55*
cei2	0.825	0.021	40.0*	0.160	0.010	15.72*	0.680	0.034	20.2*
cei3	0.770	0.029	26.92*	0.157	0.010	16.0*	0.593	0.044	13.53*
cei4	0.804	0.030	26.55*	0.147	0.009	15.58*	0.646	0.048	13.43*
cei5	0.801	0.028	28.13*	0.162	0.011	14.93*	0.642	0.045	14.31*
cei6	0.843	0.028	30.65*	0.168	0.009	19.68*	0.711	0.046	15.61*
cei7	0.776	0.024	31.79*	0.150	0.009	16.96*	0.603	0.038	15.99*
cei8	0.801	0.033	24.33*	0.154	0.009	18.0*	0.642	0.053	12.2*
LV_2	**AVE = 0.581, Alpha =0.855**								
ma1	0.787	0.026	29.74*	0.219	0.021	10.57*	0.619	0.041	14.95*

ma2	0.758	0.025	29.73*	0.211	0.020	10.77*	0.575	0.038	15.01*
ma3	0.637	0.039	16.23*	0.194	0.017	11.54*	0.405	0.050	8.12*
ma4	0.823	0.028	29.86*	0.261	0.019	13.76*	0.678	0.045	15.09*
ma5	0.811	0.024	34.04*	0.237	0.019	12.55*	0.657	0.039	16.98*
ma6	0.743	0.040	18.44*	0.184	0.021	8.64*	0.552	0.060	9.27*
LV_3	**AVE = 0.589, Alpha =0.766**								
orgcmt1	0.748	0.036	20.76*	0.302	0.018	16.41*	0.559	0.053	10.5*
orgcmt2	0.790	0.024	33.14*	0.330	0.016	21.08*	0.624	0.038	16.64*
orgcmt3	0.820	0.020	40.78*	0.364	0.019	19.14*	0.672	0.033	20.34*
orgcmt7	0.707	0.033	21.43*	0.303	0.018	16.52*	0.500	0.047	10.72*
LV_4	**AVE = 0.583, Alpha =0.641**								
orgcmt5	0.796	0.029	27.6*	0.453	0.025	18.4*	0.634	0.046	13.83*
orgcmt6	0.709	0.050	14.07*	0.387	0.026	15.08*	0.503	0.070	7.2*
orgcmt8	0.782	0.030	25.87*	0.467	0.031	15.21*	0.612	0.047	12.91*

CR* = significant at .05 level

This table displays the estimates of loadings and weights of individual indicators. The SMC (Squared Multiple Correlation) of each indicator is equivalent to its squared loading, indicating how much variance of an indicator is explained by the corresponding latent variable. The "absolute" bootstrap critical ratio (CR) is obtained by dividing a parameter estimate by its bootstrap standard error (SE). The CR is used for testing the significance of an estimate. For example, an estimate may be considered significant at .05 level, if its bootstrap critical ratio is equal to or larger than two in absolute value under the assumption that the bootstrap distribution of the estimate is roughly normal.

The AVE (Average Variance Extracted) is the average amount of variance of indicators that is explained by their corresponding latent variable. The Alpha indicates Cronbach's alpha.

When indicators are formative, their loadings and SMCs will not be reported.

Structural Model

Path Coefficients			
	Estimate	**SE**	**CR**
LV_1->LV_2	0.362	0.067	5.41*
LV_2->LV_3	0.614	0.042	14.52*
LV_2->LV_4	-0.404	0.049	8.25*

CR* = significant at .05 level

This table shows the estimates of path coefficients and their bootstrap standard errors (SE) and critical ratios (CR).

R square of Latent Variable	
LV_1	0
LV_2	0.131
LV_3	0.377
LV_4	0.163

This table provides the R square value of each "endogenous" latent variable, indicating how much variance of an endogenous latent variable is explained by its exogenous latent variables. In the present example, the first latent variable (LV_1) is exogenous only. Thus, its R square is equal to zero.

Means Scores of Latent Variables	
LV_1	4.078
LV_2	3.663
LV_3	3.164
LV_4	2.790

This table provides the mean score estimate of each latent variable.

Correlations of Latent Variables (SE)				
	LV_1	**LV_2**	**LV_3**	**LV_4**
LV_1	1	0.362 (0.067)*	0.388 (0.055)*	-0.209 (0.060)*
LV_2	0.362 (0.067)*	1	0.614 (0.042)*	-0.404 (0.049)*
LV_3	0.388 (0.055)*	0.614 (0.042)*	1	-0.461 (0.046)*
LV_4	-0.209 (0.060)*	-0.404 (0.049)*	-0.461 (0.046)*	1

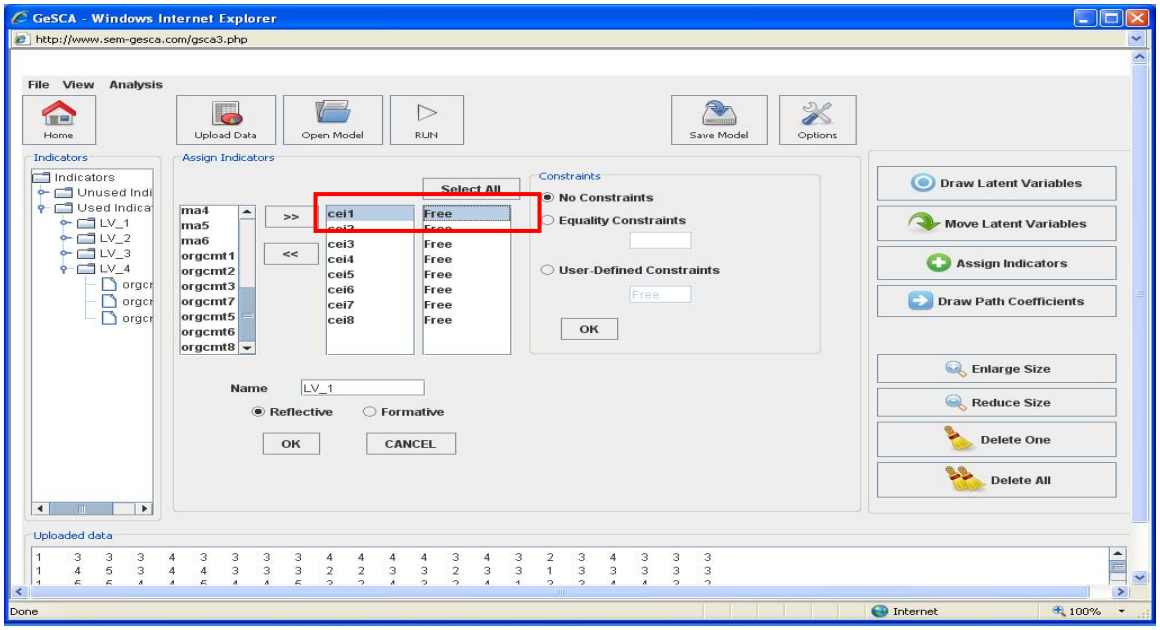
* significant at .05 level

This table shows the correlations among latent variables along with their bootstrap standard errors in parenthesis.

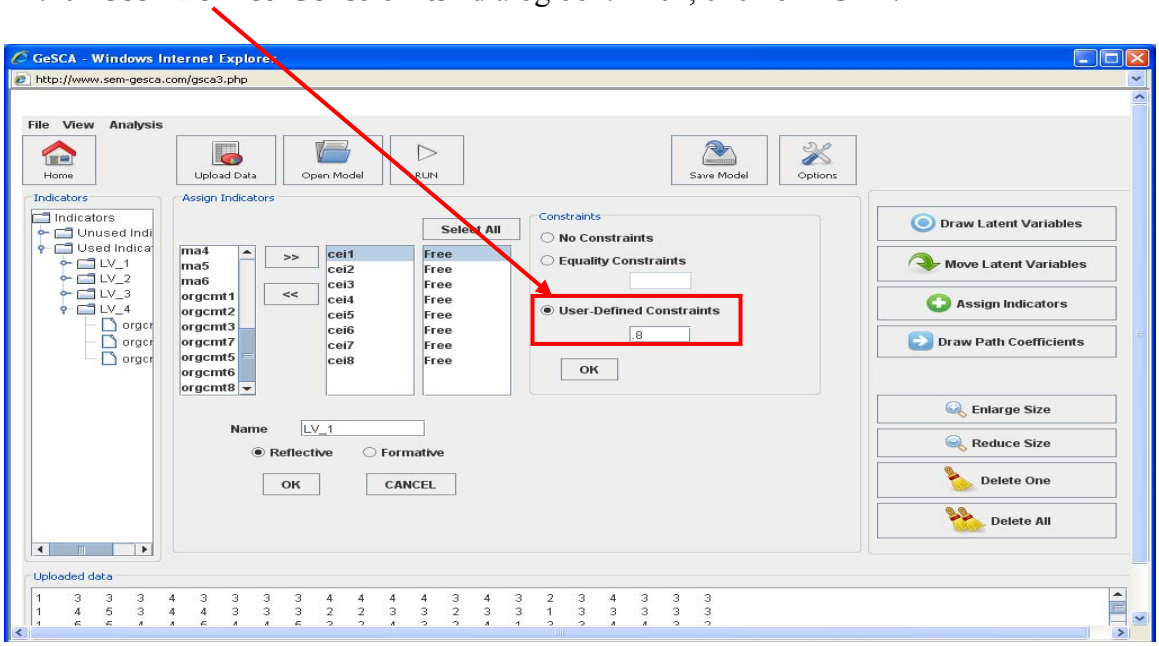
OTHER OPTIONS IN SINGLE-GROUP ANALYSIS

1. How to constrain loadings to user-defined values

- In the "**Assign Indicators**" window, select an indicator whose loading is to be fixed to a user-defined value.

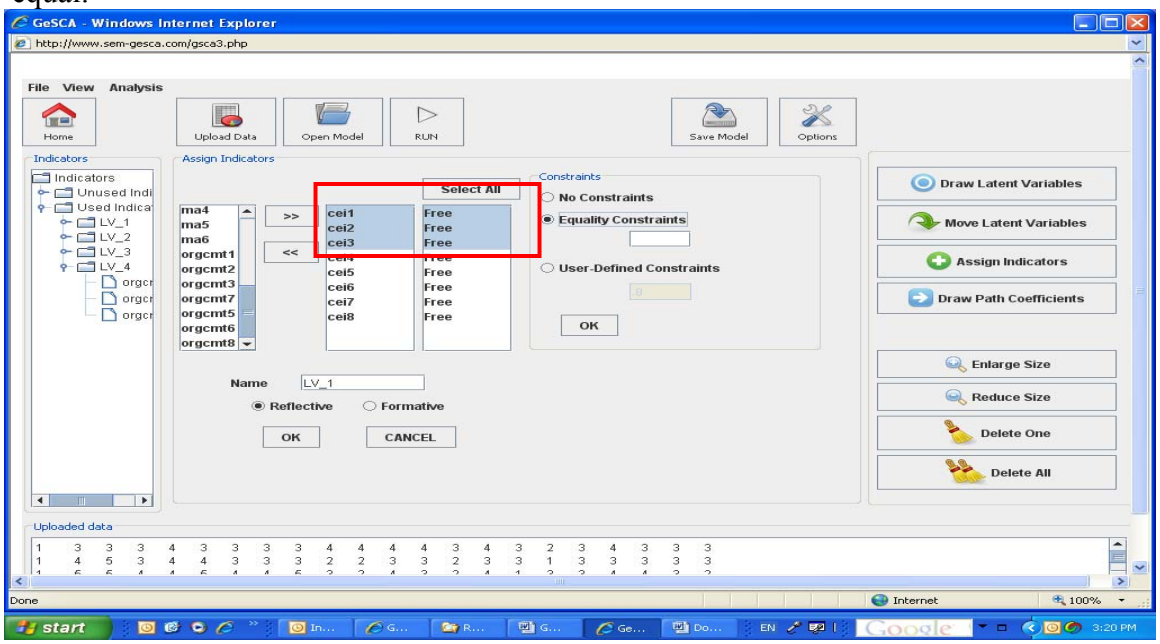


- Constrain the loading of the selected indicator to a user-defined value by inserting that value in the "**User-Defined Constraints**" dialog box. Then, click on "**OK**".

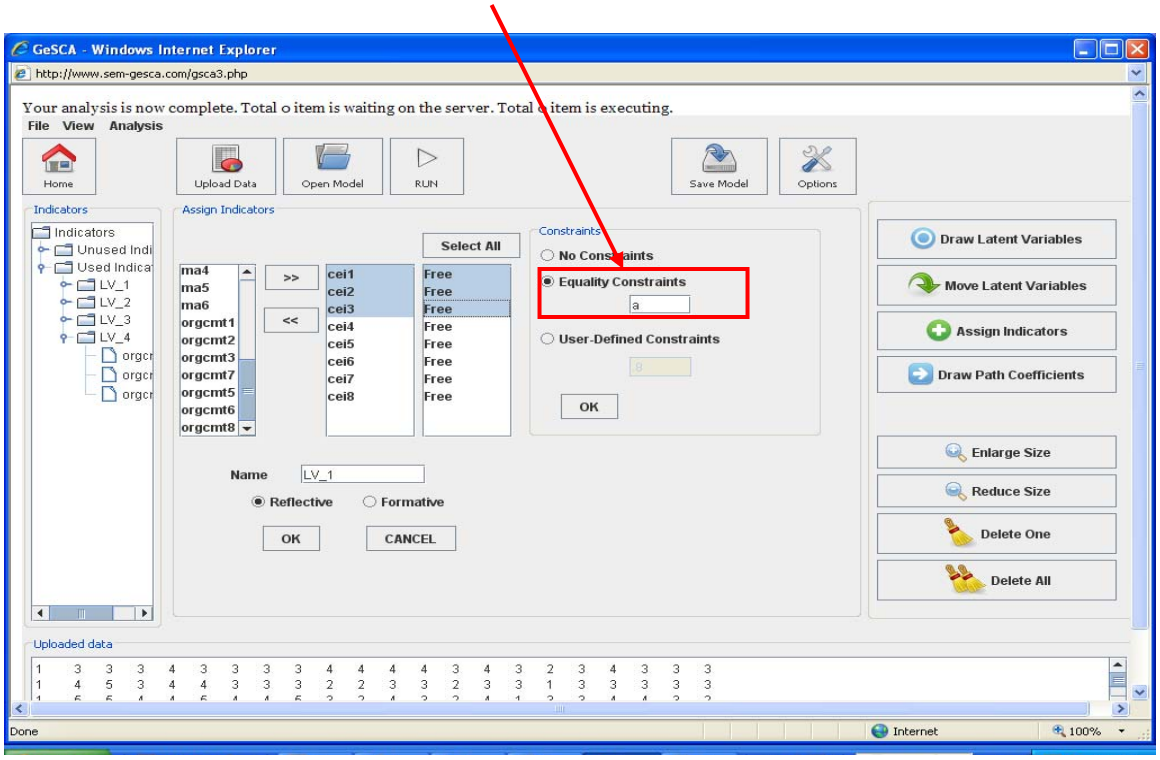


2. How to impose equality constraints on loadings

- In the "**Assign Indicators**" window, select indicators whose loadings are constrained to be equal.



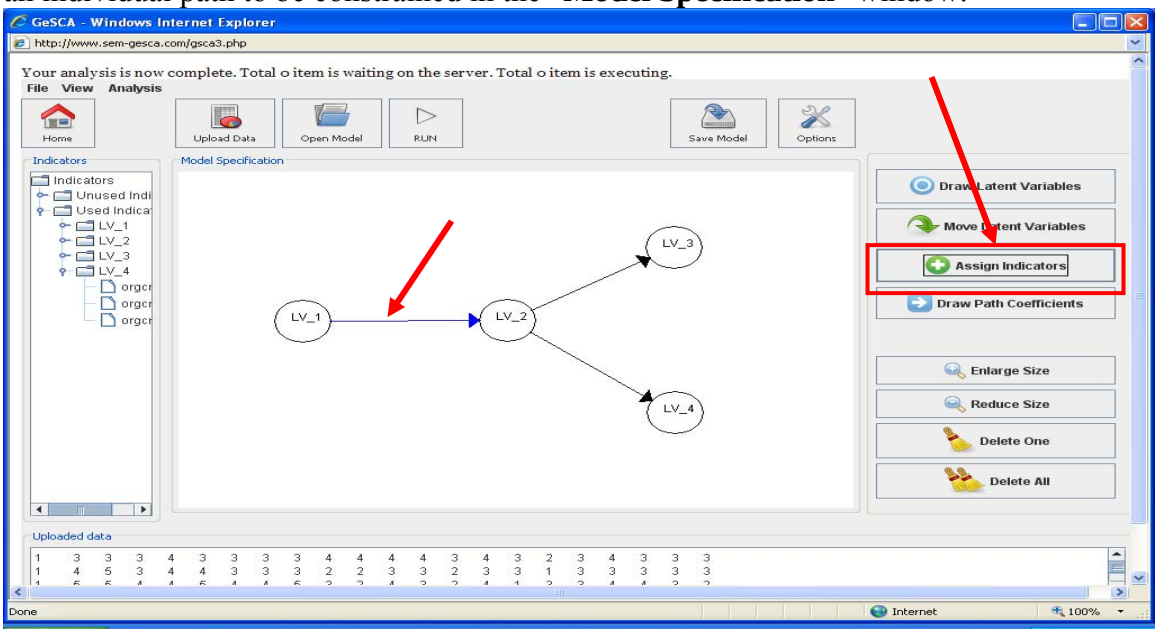
- Constrain the loadings of the selected indicators to be identical by inserting a label (e.g., an alphabet letter or number) in the "**Equality Constraints**" dialog box. Then, click on "**OK**".



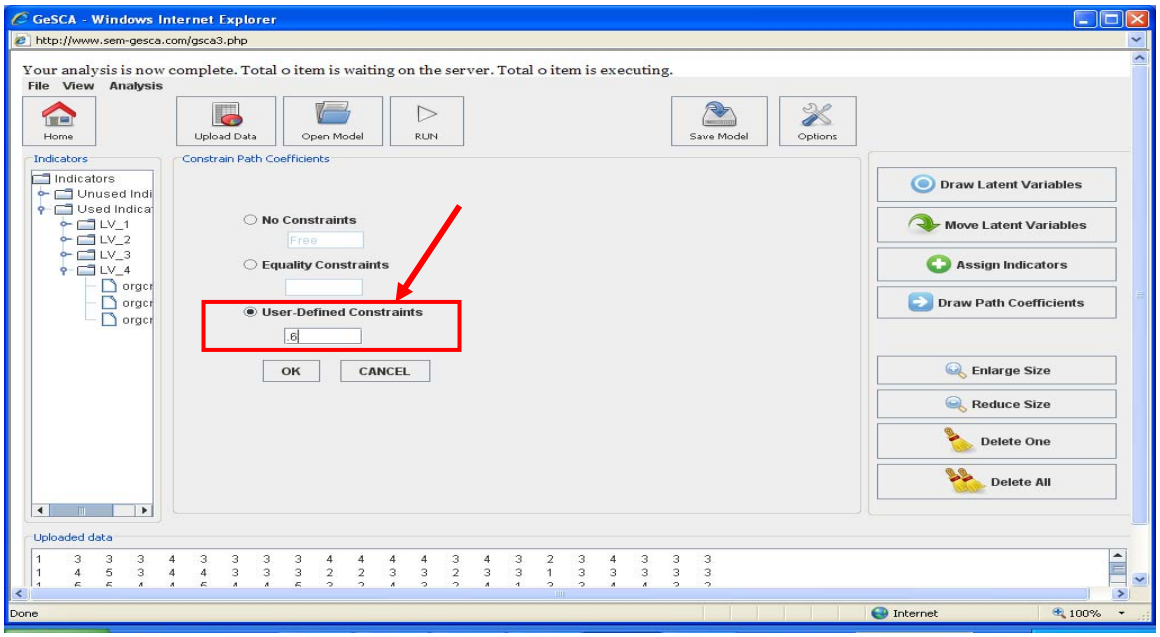
Note that any loadings with the same label will be constrained to be equal to each other. In the above example, three indicators were chosen, and labeled by an alphabet letter ("a"). This indicates that the loadings of the three indicators are to be held equal to one another.

3. How to impose a user-defined constraint on path coefficients.

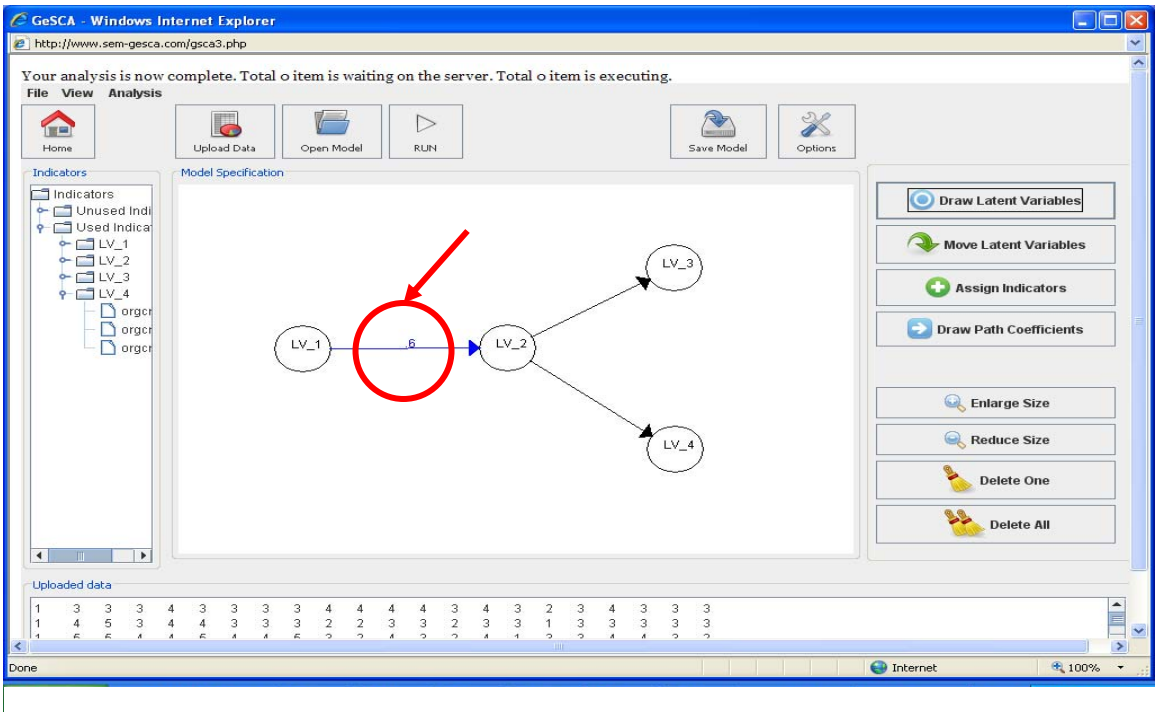
- Click once on the **[Assign Indicators]** icon in the right-hand of the program, and then click on an individual path to be constrained in the "**Model Specification**" window.



- In the "**Constrain Path Coefficients**" window, constrain the selected path coefficient to a user-defined value by inserting that value in the "**User-Defined Constraints**" dialog. Then, click on "**OK**".

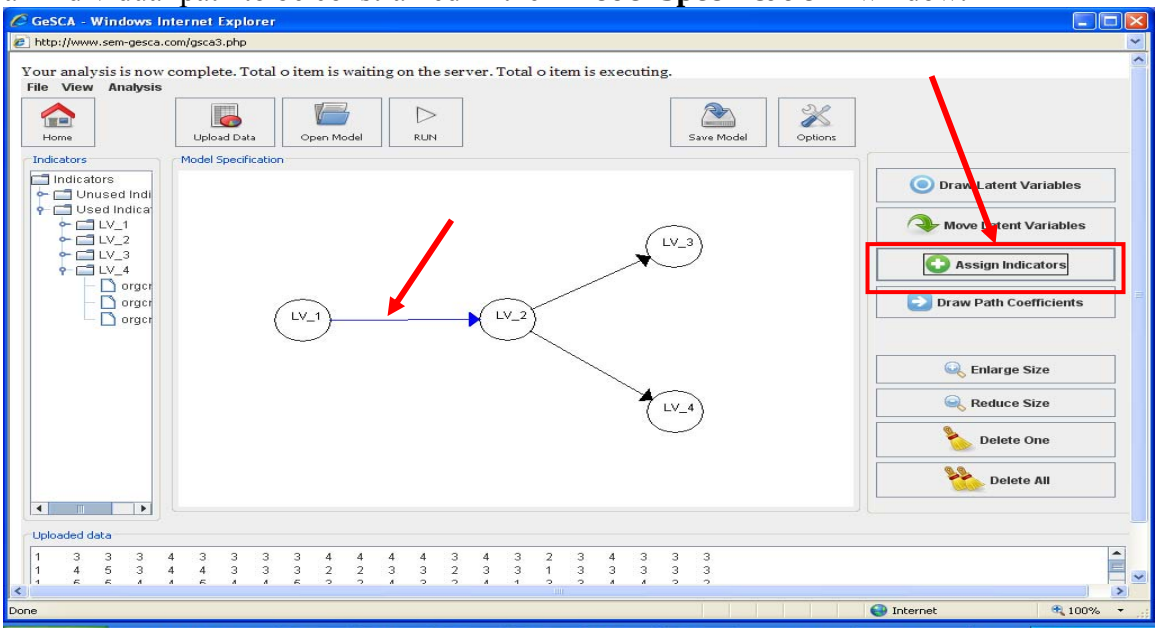


In the "**Model Specification**" window, subsequently, users can see the path fixed to the defined value.

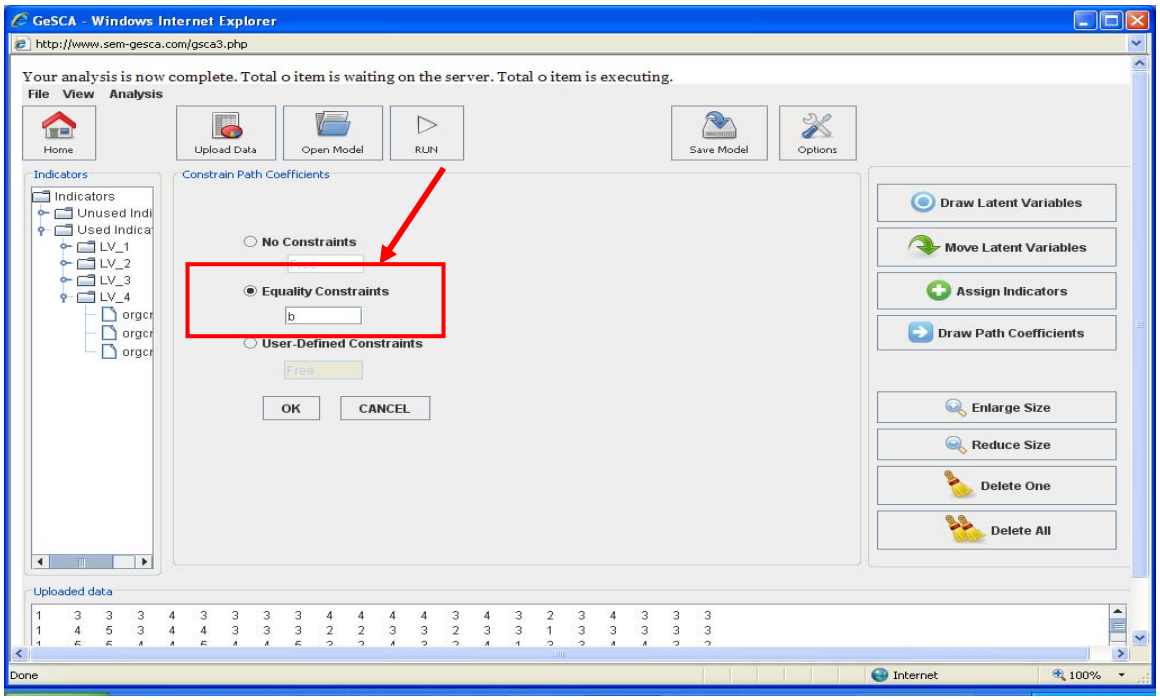


4. How to impose equality constraints on path coefficients

- Click once on the **[Assign Indicators]** icon in the right-hand of the program, and then click on an individual path to be constrained in the "**Model Specification**" window.

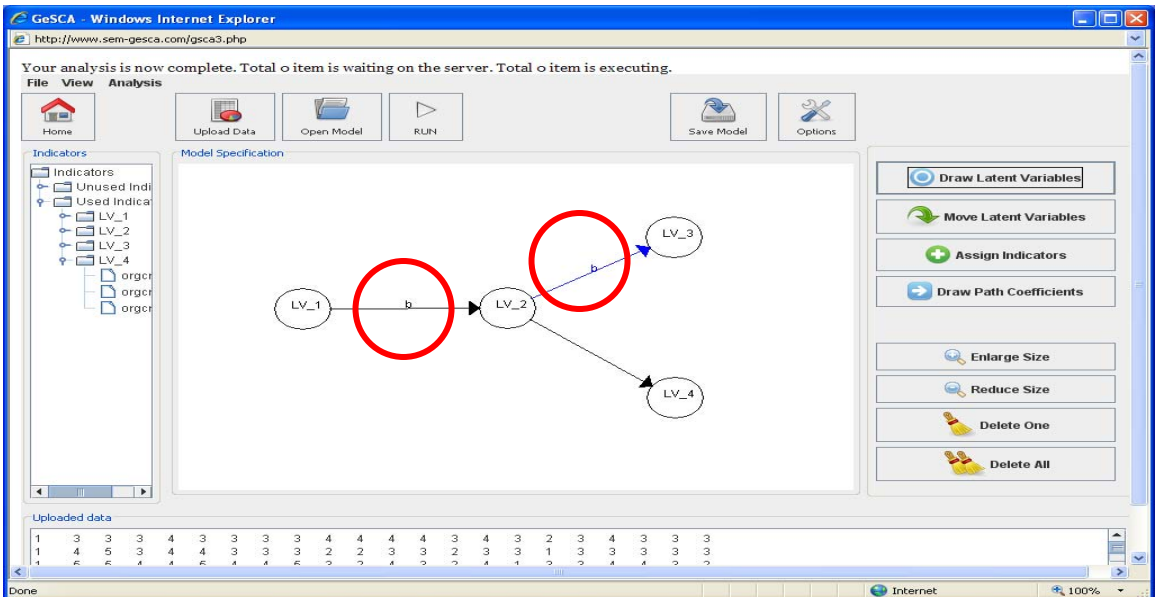


- In the "**Constrain Path Coefficients**" window, constrain the selected path coefficient by inserting a label in the "**Equality Constraints**" dialog. Then, click on "**OK**".



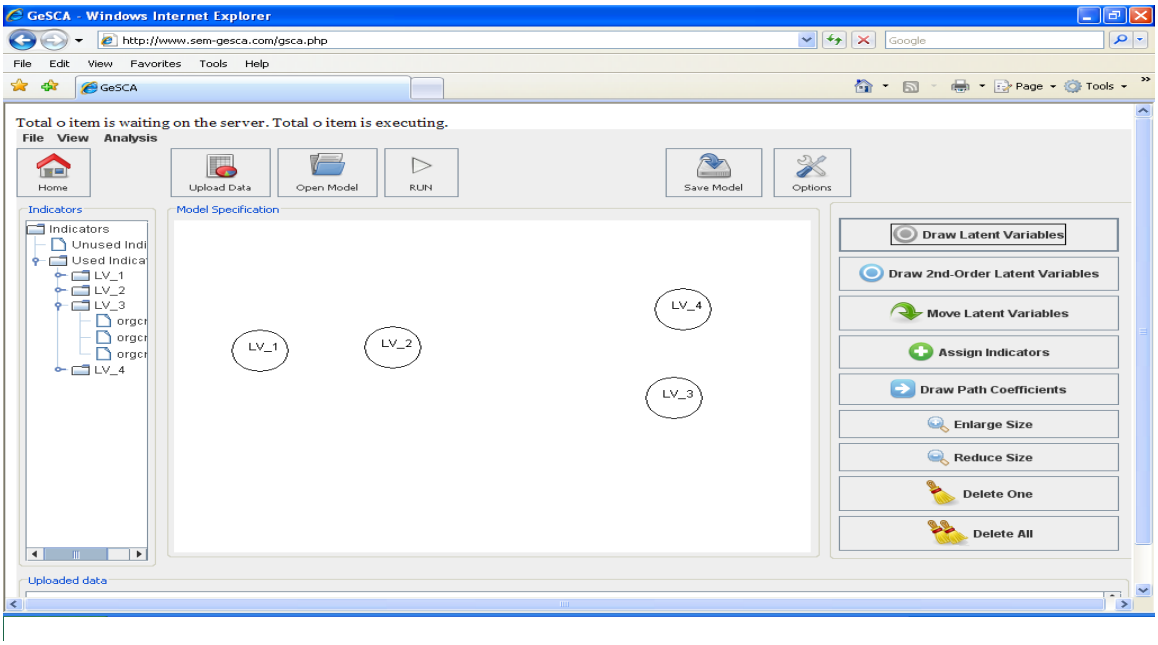
- Repeat the above step for other path coefficients that are to be held equal to the first path coefficient, using the same label.

- In the "**Model Specification**" window, subsequently, users can see all chosen paths labeled the same ("b"), indicating that they are constrained to be equal to each other.

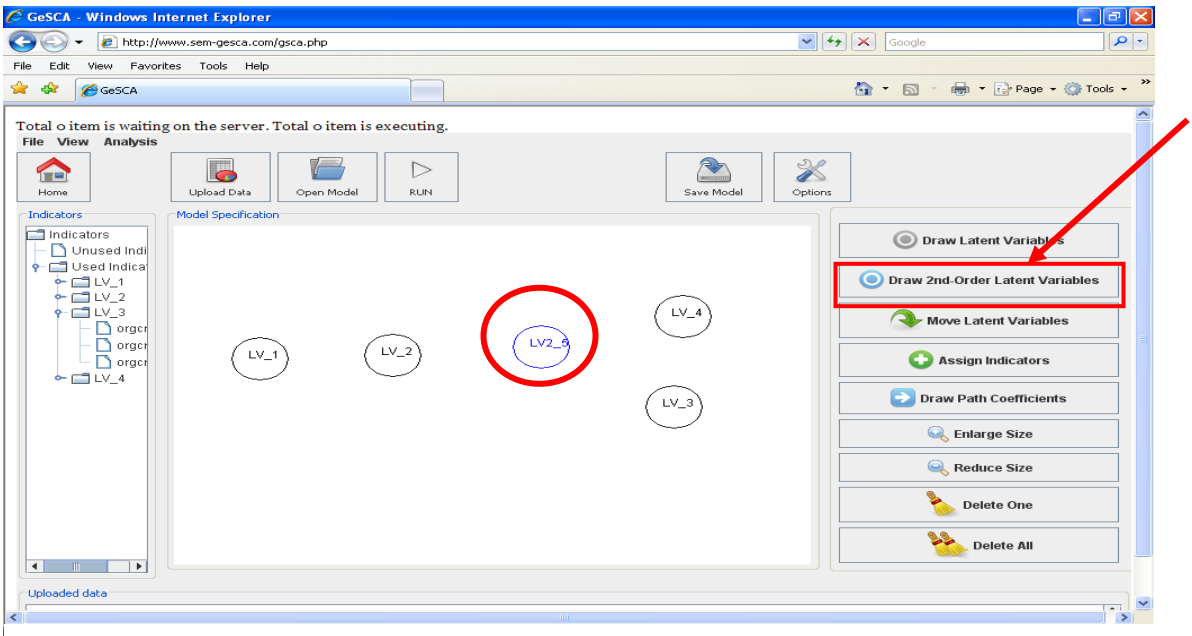


5. How to handle second-order latent variables

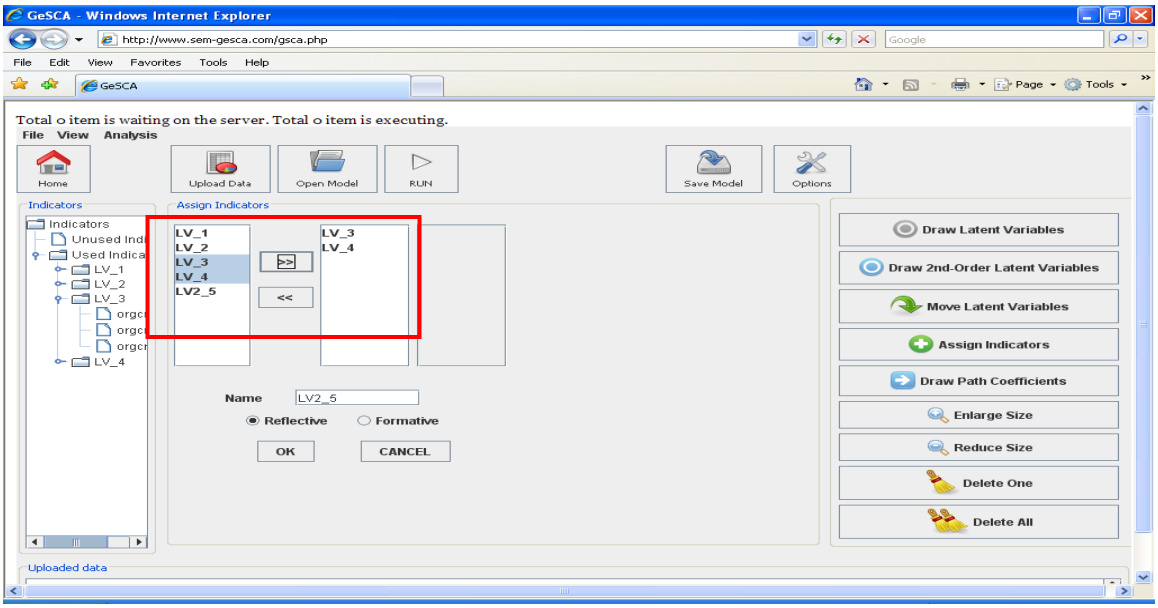
- First, users specify (first-order) latent variables as described on page 4.



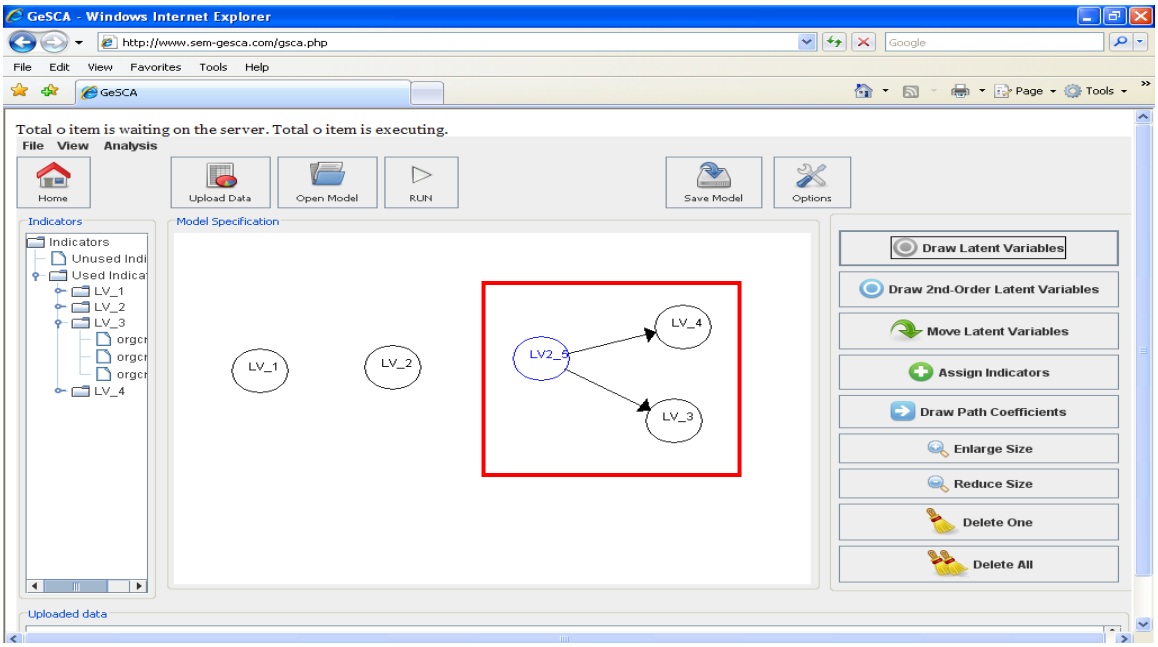
- Subsequently, users specify second-order latent variables as follows:
  1. Click once on the **[Draw 2nd-Order Latent Variables]** icon in the right-hand side of the program. Click the left mouse button with the cursor placed in the "**Model Specification**" window of the program as many times as the number of second-order latent variables, which appear as blue circles. In the example below, a second-order latent variable, labeled LV2_5, is assumed to underlie LV_3 and LV_4.



2. After drawing second-order latent variables, click once on the **[Assign Indicators]** icon in the right-hand side of the program, and then click on an individual latent variable (a circle) on the "**Model Specification**" window. Select the appropriate (first-order) latent variables in the list, which appears on the left-hand dialog window, and move them to the right-hand dialog window.



3. Once the above step is complete, paths connecting second-order latent variables to their first-order latent variables appear on "**Model Specification**" window.



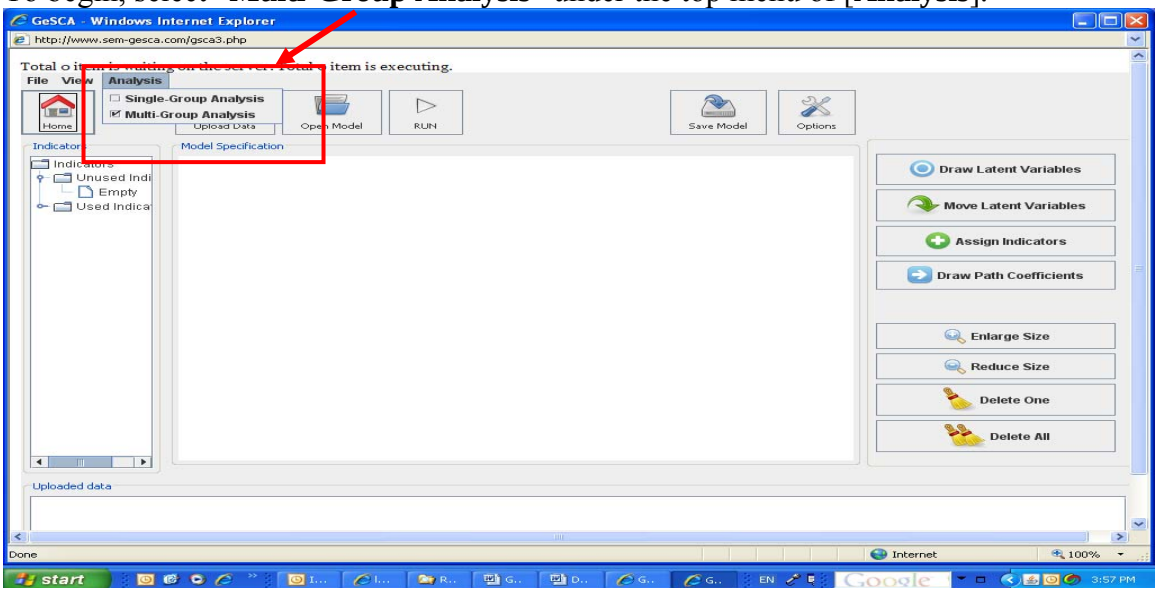
4. Users draw path coefficients to complete their structural model as described on page 6.

MULTI-GROUP ANALYSIS

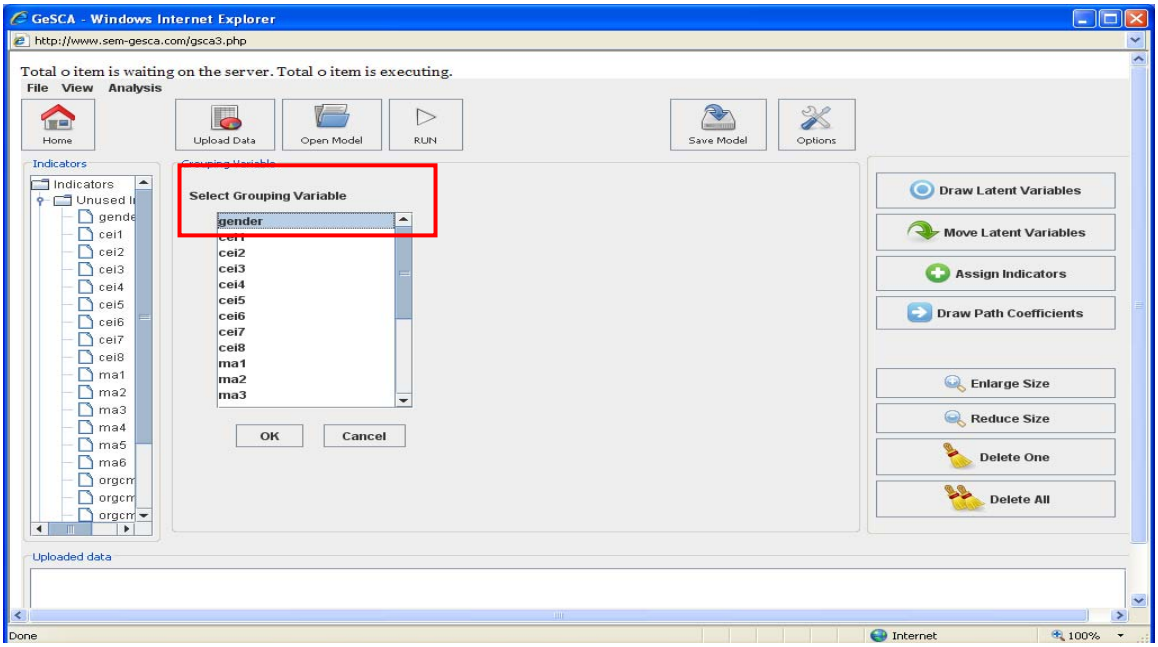
Note: To conduct a multi-group analysis, users must include a categorical, grouping variable in the data, which indicates group memberships of cases (e.g., gender (1 = male & 2 = female))

1. How to conduct a multi-group analysis without cross-group equality constraints

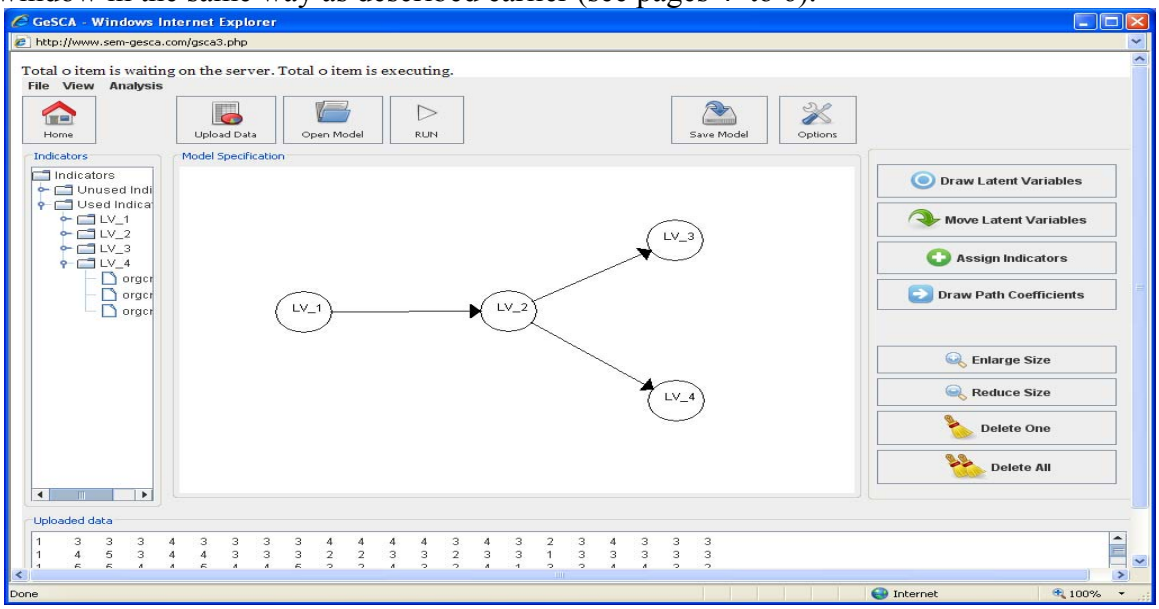
- To begin, select "**Multi-Group Analysis**" under the top menu of [**Analysis**].



- Upload a data file by clicking on the icon **[Upload Data]**. Then, users are to select their grouping variable. Then, click on "**OK**". In this example, "gender" was chosen.



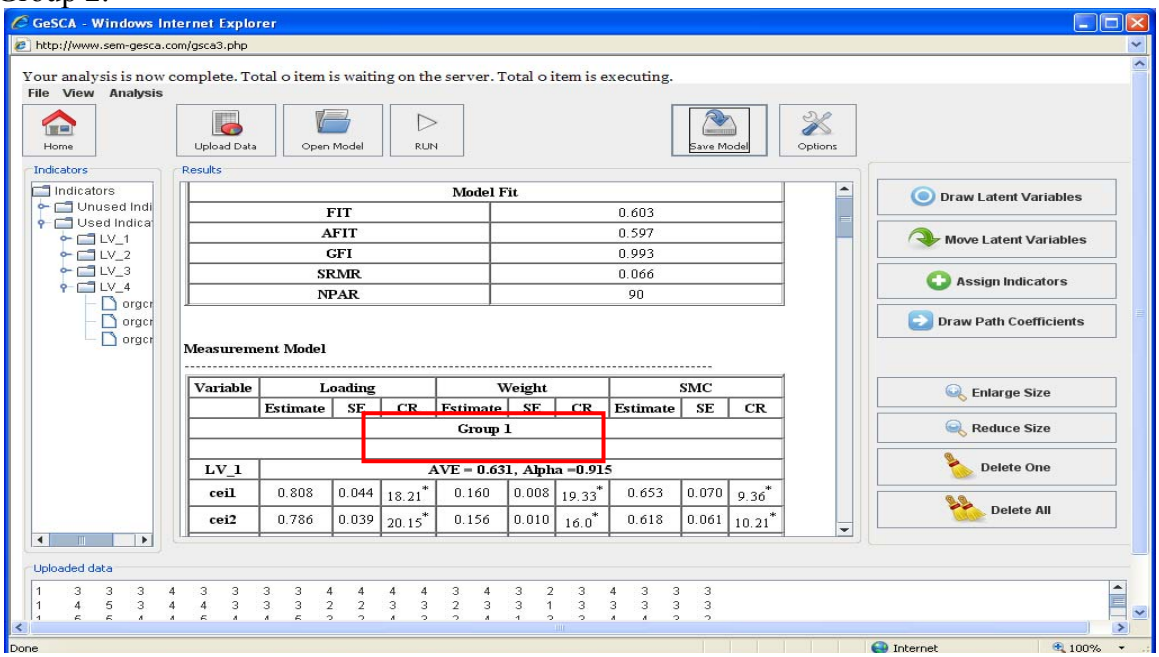
- Users then specify their measurement and structural models in the "**Model Specification**" window in the same way as described earlier (see pages 4 to 6).



- Once the above steps are complete, users can run *GeSCA* for fitting the specified model to multiple groups simultaneously. This is done by clicking on the **[RUN]** icon on the top of the program.

- As shown below, all multi-group analysis results are displayed in the "**Results**" window. In this example, the same model was applied to two groups (males and females) at the same time.

Thus, all parameter estimates are provided for each of the two groups labeled Group 1 and Group 2.



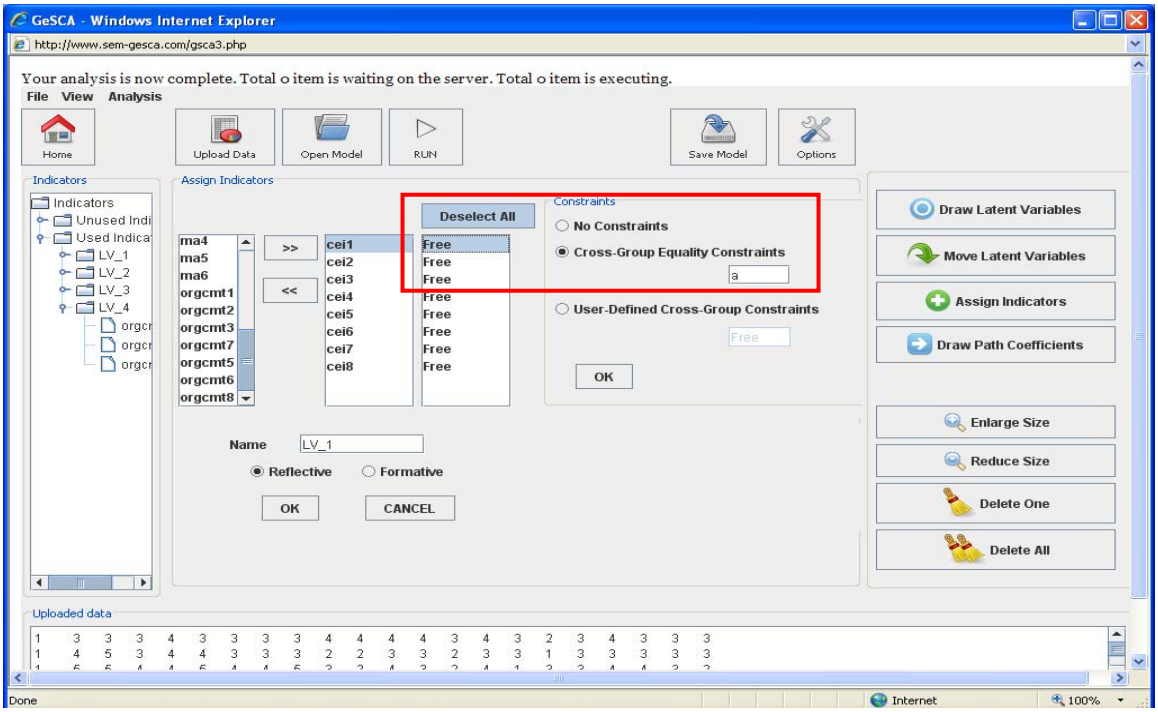
Model Fit	
FIT	0.603
AFIT	0.597
GFI	0.993
SRMR	0.066
NPAR	90

Measurement Model

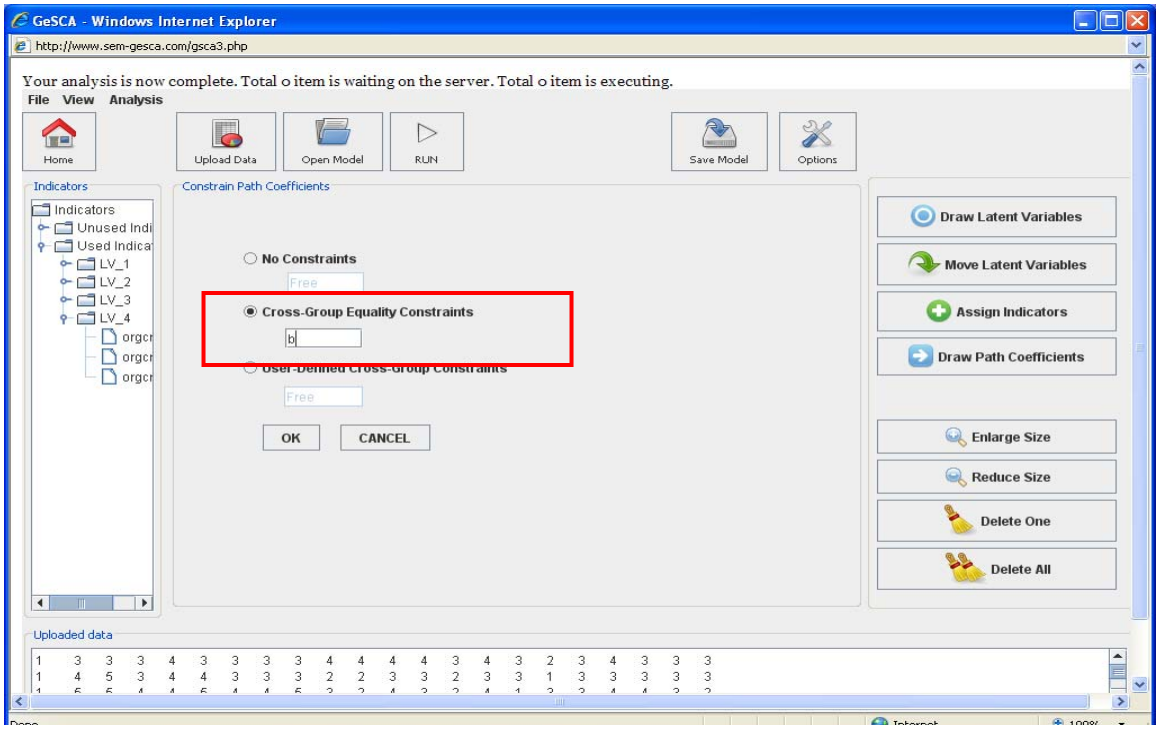
Variable	Loading			Weight			SMC		
	Estimate	SE	CR	Estimate	SE	CR	Estimate	SE	CR
Group 1									
LV_1	AVE = 0.631, Alpha =0.915								
cei1	0.808	0.044	18.21*	0.160	0.008	19.33*	0.653	0.070	9.36*
cei2	0.786	0.039	20.15*	0.156	0.010	16.0*	0.618	0.061	10.21*

2. How to conduct a multi-group analysis with cross-group equality constraints

- To impose cross-group equality constraints on loadings, select indicators whose loadings are constrained to be equal across groups in the "**Assign Indicators**" window. Then, constrain the loadings of the selected indicators to be identical across groups by inserting a label in the "**Cross-Group Equality Constraints**" dialog box. Then, click on "**OK**".



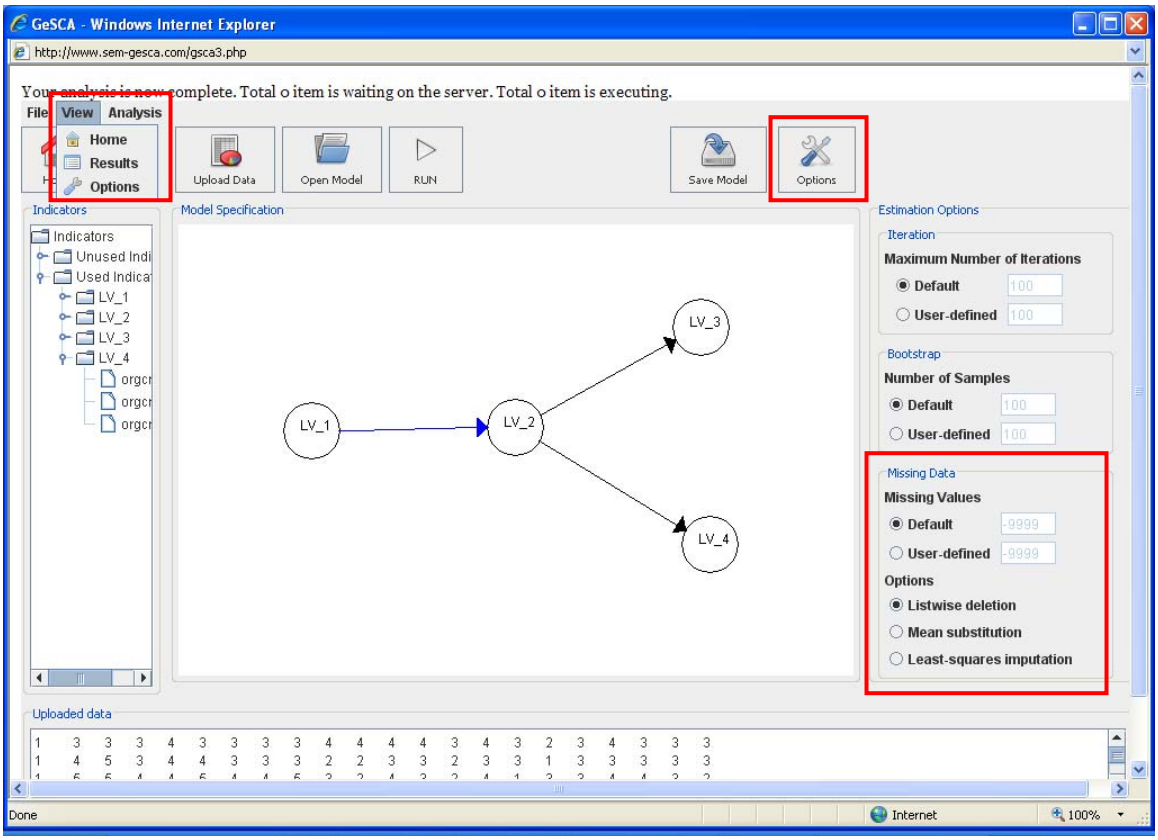
- To impose cross-group equality constraints on path coefficients, select a path coefficient to be constrained by clicking once on the **[Assign Indicators]** icon, and then clicking on its path in the "**Model Specification**" window. Then, constrain the selected path coefficient to be identical across groups by inserting a label in the "**Cross-Group Equality Constraints**" dialog box. Then, click on "**OK**".



- Note that any loadings and path coefficients with the same label will be constrained to be equal to each other across groups.

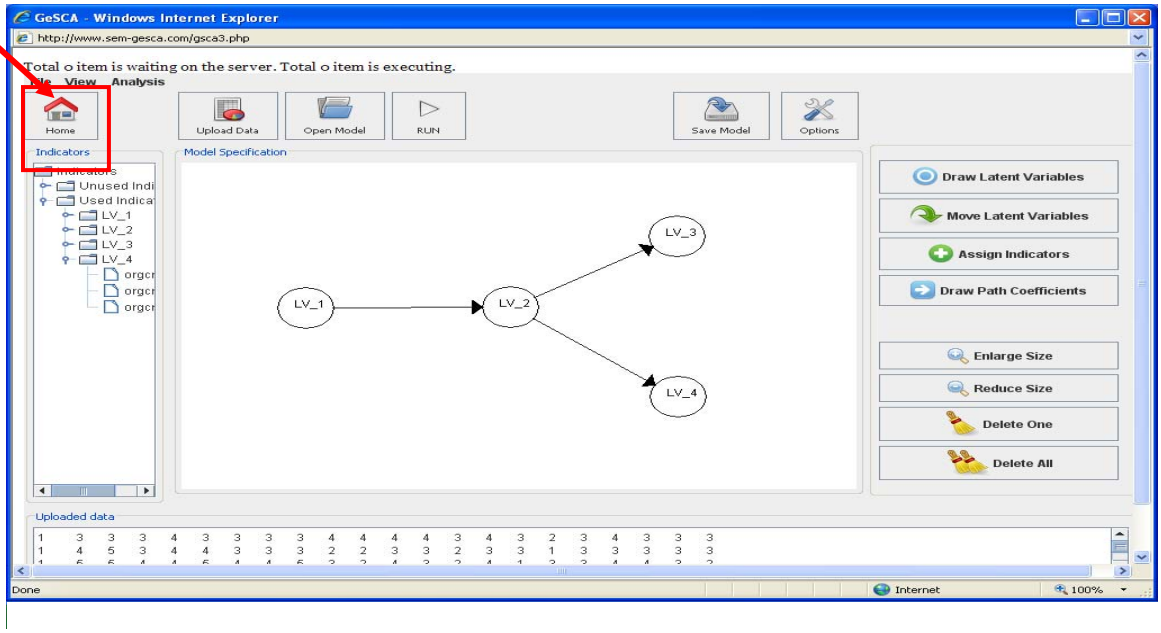
MISSING DATA

GeSCA currently provides users with three options for dealing with missing observations: (1) **Listwise deletion**, (2) **mean substitution**, and (3) **least-squares imputation**. To apply one of these options, users choose the [**Options**] icon on the top of the program or "**Options**" under the menu of [**View**]. Then, select one of the options in the box of "**Missing Data**". The default value indicating a missing observation is **-9999**. However, it can be changed to a user-defined value.



OTHER OPTIONS

1. To see the specified model again, click on the [Home] icon to return to the "Model Specification" window.



2. To view the results of the previous analysis, choose "View", and then "Results" on the very top menu.