

Installing and Using the Monte Carlo Simulation Excel Add-in

Software for

Introductory Econometrics

By

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WARNING:

This software was written and designed for teaching purposes. It has been tested on several examples but not on a wide variety of data sets. For mission-critical projects, always check the results with full-fledged statistical programs.

The Monte Carlo Simulation add-in is MCSim.xla (on the CD-ROM or zipped archive, it is in BasicTools\ExcelAdd-In\MCSim).

PURPOSE OF THIS DOCUMENT

This document describes how to install and use the Excel add-in MCSim.xla in order to run a Monte Carlo simulation from an Excel workbook.

INSTALLING AND LOADING

Microsoft offers the following description of an Excel add-in:

Add-ins are programs that add optional commands and features to Microsoft Excel. Before you can use an add-in, you must install it on your computer and then load it in Microsoft Excel. Add-ins (*.xla files) are installed by default in the Library folder in the Microsoft Excel folder. Loading an add-in makes the feature available in Microsoft Excel and adds any associated commands to the appropriate menus. [Microsoft Excel Help, add-ins, overview]

Thus, to *install* an add-in is to have an add-in file (*.xla) in the Library folder of your hard drive. To *load* it, you must complete an additional step using the Add-In Manager. Fortunately, you need to do this only once.

Step 1: Installing the MCSim.xla file

If you are accessing the MCSim.xla add-in from a CD-ROM, place the CD in your computer. If accessing from a network server, make sure you can read from the appropriate network drive.

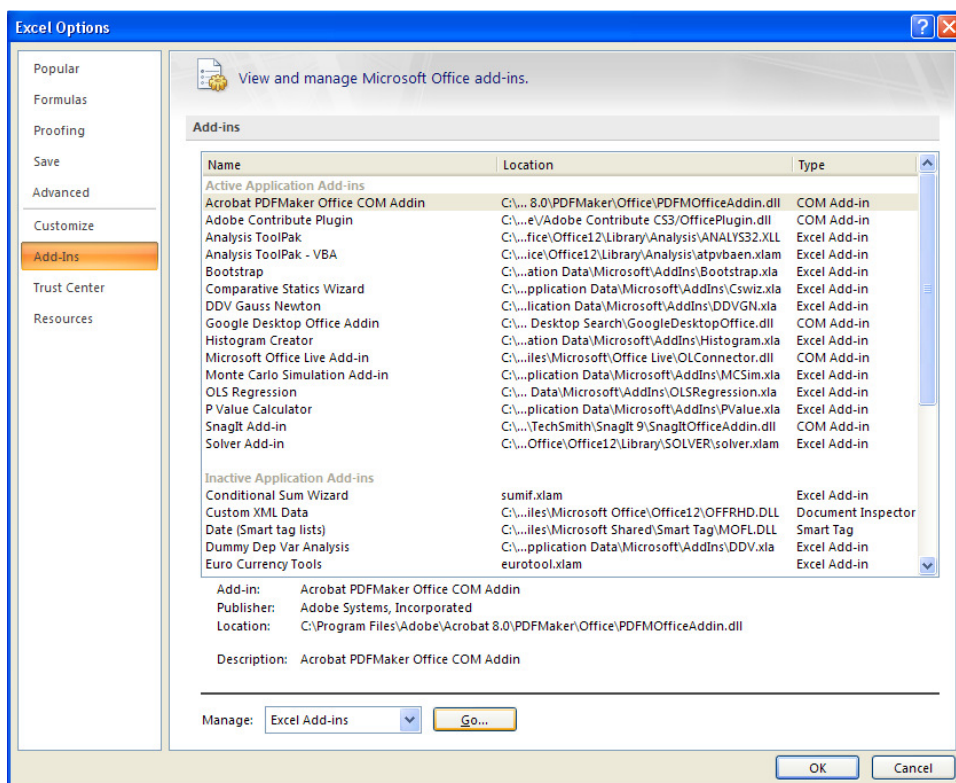
If you do not have CD-ROM or network access to the MCSim.xla add-in, download it by visiting <www.wabash.edu/econometrics>. Download the MCSim.xla file directly to the appropriate add-ins folder on your hard drive (usually, C:/Program Files/MicrosoftOffice/Office/Library) or move it there after downloading to your hard drive.

Step 2: Loading The MCSim.xla add-in

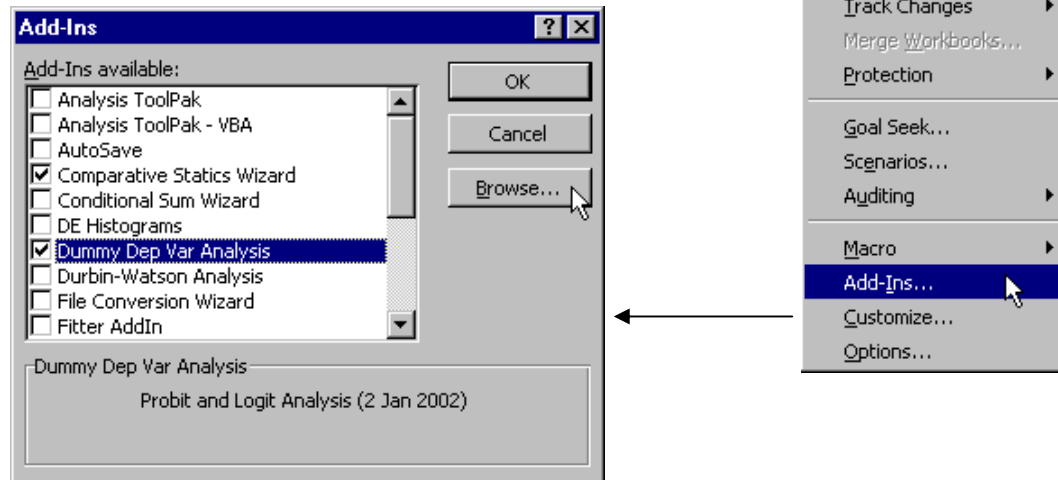
A) Getting the Add-In Manager

Excel 2007 and greater

Once the MCSim.xla file is accessible, launch Excel and use the Add-In Manager to load the Monte Carlo Simulation add-in. First, open the Add-In Manager by clicking File, then Options in Excel 2010 or the Office button (in the top left corner), then Excel Options in Excel 2007. Next, click Addins (as shown highlighted below) and, finally, clicking Go (near the bottom):



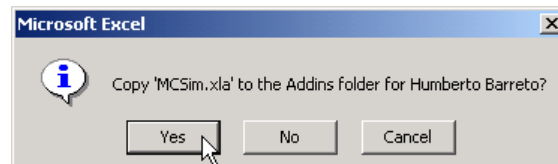
Once the MCSim.xla file is accessible, launch Excel and use the Add-In Manager to load the Monte Carlo Simulation add-in. First, open the Add-In Manager by clicking on the Tools menu item and selecting Add-Ins.



With the Add-In Manager dialog box up, the instructions for all versions of Excel are the same.

B) Installing and Loading the MCSim.xla file

If the Monte Carlo Simulation add-in is not listed in the Add-Ins scroll box (as in the example above), click the Browse (or Select) button, navigate to the MCSim.xla file on the CD-ROM or network drive, select it, and click OK.

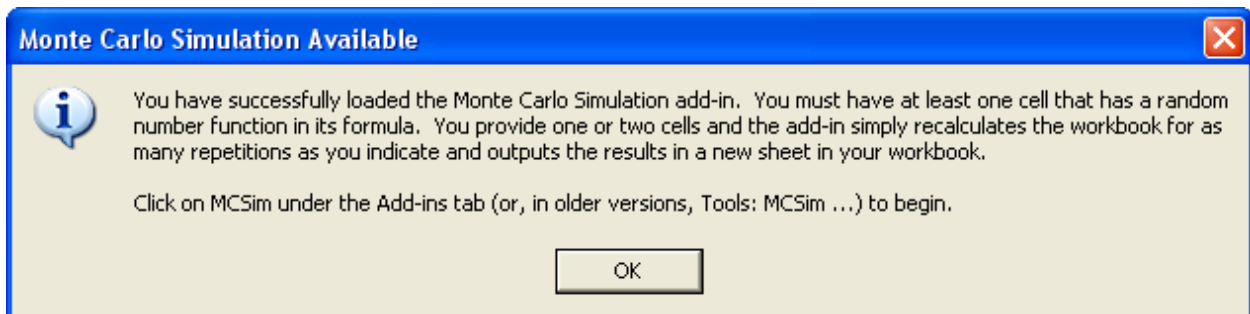


Macs that run Visual Basic Note: Some versions of OfficeX report "Unable to Copy add-in to the Add-ins folder." This is a bug. The add-in really is there. Simply *quit Excel*, then restart it, return to the Add-In Manager, and continue following the instructions.

Click OK if you are asked to write the MCSim.xla file to the Addins (or Library) folder. The Add-In Manager dialog box will now list the Monte Carlo Simulation add-in.

The Add-In Manager lists all of the installed add-ins, and those with checkmarks are also loaded. Microsoft offers the following advice, "To conserve memory, unload add-ins you do not use often. Unloading an add-in removes its features and commands from Microsoft Excel, but the add-in program remains on your computer, and so you can easily load it again." [Microsoft Excel Help, add-ins, overview]

Make sure to select the check box next to the Monte Carlo Simulation add-in and click OK.
Excel will load the MCSim.xla file and notify you of successful installation with the following message:



USING THE MCSIM.XLA ADD-IN--ORIGINAL VERSION:

Using the Monte Carlo Simulation add-in is easy. You need a spreadsheet with at least one cell that uses a random number formula. Cell A1 has formula “=RAND()”; thus, when the sheet is recalculated (by hitting the F9 key¹), the value of the cell (the number displayed) will change.

| Before hitting F9 | | | | | After hitting F9 | | | | |
|-------------------|----------|---|---|---|------------------|---|---|--|--|
| A1 | | | | | A3 | | | | |
| =RAND() | | | | | =IF(A1>0.9,1,0) | | | | |
| A | B | C | D | A | B | C | D | | |
| 1 | 0.617718 | | | 1 | 0.926907 | | | | |
| 2 | | | | 2 | | | | | |
| 3 | | | | 3 | 1 | | | | |
| 4 | | | | 4 | | | | | |
| 5 | | | | 5 | | | | | |

Notice that the spreadsheet can have cells that depend on other cells. Cell A3 uses an IF statement based on the random draw resulting from cell A1, “=IF(A1>0.9,1,0)”. Thus, A3’s value will be either 1 or 0, as determined by the value of A1. The Monte Carlo Simulation add-in can be used on cell A3 even though it does not have a random number in its formula because A3 is based on A1.

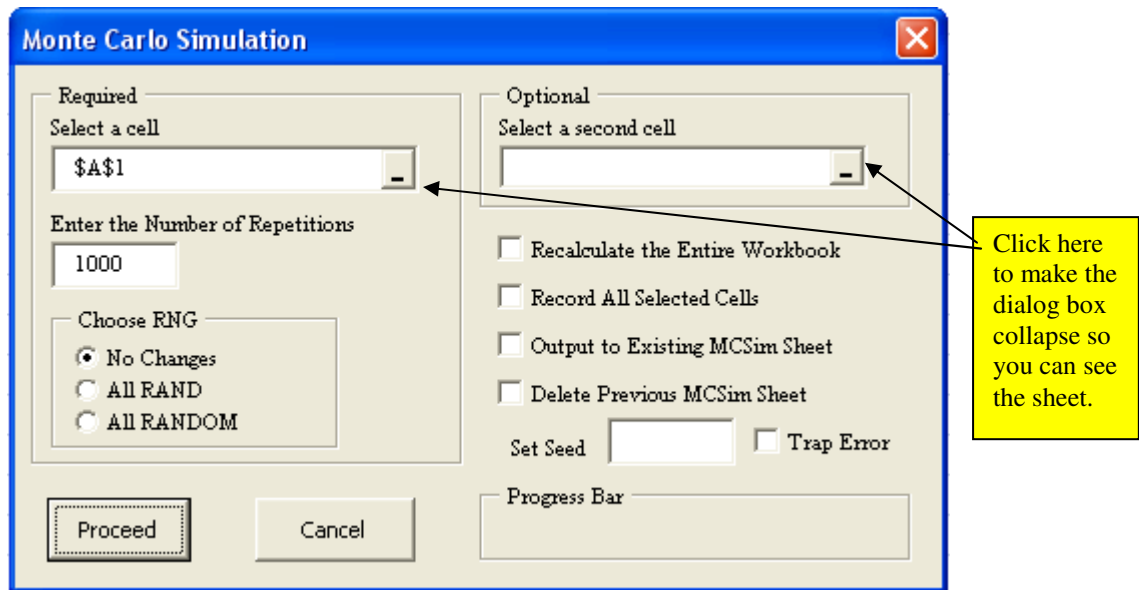
To run a Monte Carlo simulation, simply click on the Add-ins tab, in Excel 2007 or greater, or the Tools menu item in earlier versions, and select the MCSim item to access a dialog box that controls the simulation.

The active cell (the last cell clicked by the user) appears by default in the Select a cell box. If this is not the cell you want to use, simply click in the Select a cell box and click on the desired cell.

The Choose RNG option enables you to use either Excel’s built-in random number generating function RAND or Barreto–Howland’s RANDOM algorithm (packaged with this add-in). If you select the All RANDOM option, every occurrence of RAND will be replaced by RANDOM.

¹ On Macintosh computers that run Visual Basic, hit the Command (clover) and equals sign keys simultaneously instead of the F9 key. On PCs, CTRL+= will also recalculate cells in the workbook.

To run a Monte Carlo simulation of two cells, click in the Select a second cell box and then click on a cell in the worksheet. The screenshot below shows the options;



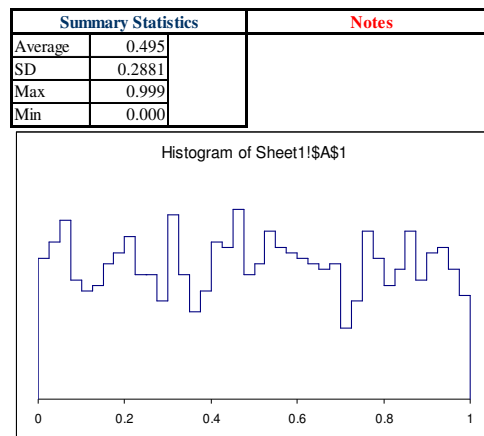
Click Proceed to run the simulation. Use the Progress Bar to gauge how long it will take to finish the simulation. You may use other programs while the simulation is running, but doing so may slow Excel down. You can always hit the Escape (ESC) key (on the top left corner of most keyboards) to kill the simulation. Click End when prompted. The add-in runs faster if no other Excel workbooks are open.

Excel recalculates your worksheet for as many repetitions as indicated and stores the value of the cell (or both cells) after each calculation. The results are then presented in a new worksheet in your workbook.

Results of Monte Carlo Simulation

| Sample Number | Sheet1!\$A\$1 |
|---------------|---------------|
| 1 | 0.423 |
| 2 | 0.421 |
| 3 | 0.146 |
| 4 | 0.202 |
| 5 | 0.871 |
| 6 | 0.322 |
| 7 | 0.723 |
| 8 | 0.247 |
| 9 | 0.270 |
| 10 | 0.769 |
| 11 | 0.557 |
| 12 | 0.429 |
| 13 | 0.131 |
| 14 | 0.038 |
| 15 | 0.426 |
| 16 | 0.174 |
| 17 | 0.554 |
| 18 | 0.300 |
| 19 | 0.268 |
| 20 | 0.654 |

| Simulation Stats | |
|------------------|-------------|
| 1000 | repetitions |
| 1 | seconds |



Histogram bins include the left endpoint but not the right.

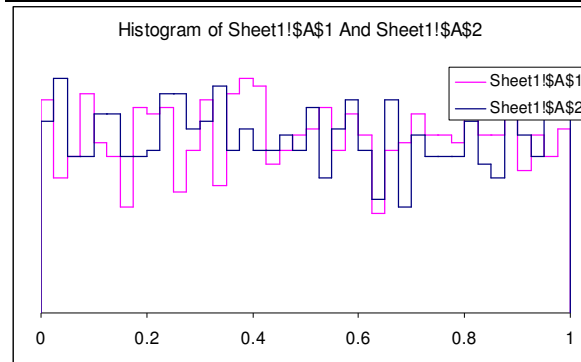
Results for a two variable simulation look like this:

Results of Monte Carlo Simulation

| Sample Number | Sheet1!\$A\$1 | Sheet1!\$A\$2 |
|---------------|---------------|---------------|
| 1 | 0.514 | 0.722 |
| 2 | 0.059 | 0.644 |
| 3 | 0.076 | 0.356 |
| 4 | 0.291 | 0.922 |
| 5 | 0.852 | 0.996 |
| 6 | 0.942 | 0.598 |
| 7 | 0.282 | 0.502 |
| 8 | 0.083 | 0.323 |
| 9 | 0.309 | 0.282 |
| 10 | 0.442 | 0.103 |
| 11 | 0.852 | 0.570 |
| 12 | 0.533 | 0.518 |
| 13 | 0.227 | 0.637 |
| 14 | 0.226 | 0.583 |
| 15 | 0.773 | 0.468 |
| 16 | 0.688 | 0.936 |
| 17 | 0.703 | 0.445 |
| 18 | 0.429 | 0.380 |
| 19 | 0.487 | 0.956 |
| 20 | 0.850 | 0.876 |

| Simulation Stats | |
|------------------|--|
| 1000 repetitions | |
| 1 secs | |

| Sheet1!\$A\$1 | | Sheet1!\$A\$2 | | Notes |
|---------------|--------|---------------|--------|-------|
| Average | 0.501 | Average | 0.492 | |
| SD | 0.2875 | SD | 0.2934 | |
| Max | 1.000 | Max | 1.000 | |
| Min | 0.002 | Min | 0.001 | |



The new spreadsheet in your workbook is alive—you can change the scale, title, and legends on the graphs, change labels and colors on the cells in the spreadsheets, and add descriptive information as needed. The data underlying the graph are available by scrolling right.

You can run as many Monte Carlo simulations as you want by simply returning to your original worksheet and executing Tools: MCSim. Delete unwanted results by simply deleting the sheet.

The Recalculate the Entire Workbook Option

If you have a complicated data generation process that spans several sheets in a workbook, be sure to choose the option to Recalculate the Entire Workbook. This forces a recalculation of all of the sheets in the workbook, instead of just the active sheet. You can track cells in other sheets by collecting all of the cells to be tracked on a single sheet.

If your model is implemented in a single sheet, you need not check this option. Excel will recalculate only the single sheet you are working on. This saves time in running the Monte Carlo simulation if you have many formulas in other sheets in the workbook since Excel does not recalculate those formulas.

Testing has shown that, for simple workbooks (with few formulas in other sheets), recalculating the entire workbook is faster than recalculating a single sheet.

The Record All Selected Cells Option

You might want to track more than two cells or see all of the simulation results (instead of just the first 100). The Monte Carlo simulation add-in allows you to track up to 256 variables (including one or two you selected for histogram display) and see results for up to 65,000 repetitions.

To take advantage of this, you must *first* select the cells you want to record (using the CTRL key, as usual, to select noncontiguous cells), then execute Tools: MCSim and, finally, check the Record All Selected Cells option. By checking the Record All Selected Cells option, the add-in will track all cells that were selected *before* you executed Tools: MCSim and brought up the Monte Carlo Simulation dialog box. The add-in inserts a new worksheet in your workbook and shows ALL of the values generated by the Monte Carlo simulation. You can use this information to sort the results in order to find percentiles (e.g., to approximate the chances of values falling in a particular interval) and to track more than just one or two cells.

The results generated by the Record All Selected Cells option are in “raw” form. You will need to compute averages, SDs, and draw histograms on your own. You can see the full set of simulation results for any cell (including one that was chosen as a tracked cell) by simply selecting that cell *before* executing Tools: MCSim.

To practice using this option, select cells A1 and A3 (with A1’s formula “=RAND()” and A3’s formula “=IF(A1>0.5,1,0)”) by clicking on cell A1 and then holding down the CTRL key while clicking on cell A3. Next, execute Tools: MCSim. Make one of the tracking cells A1 and the other A3. Make sure to check the Record All Selected Cells option. Click Proceed.

The Monte Carlo simulation add-in inserts two sheets in your workbook. One reports summary statistics and draws a superimposed histogram, the other simply lists all of the simulation results for both variables. You can confirm that the average, SD, max, and min are the same by computing these statistics in your MCRaw sheet.

The Output to Existing Sheet Option

If you are doing repeated simulations and have set up calculations based on the simulation results, you may want to output the results to an existing MCSim sheet rather than creating a new sheet each time a Monte Carlo is run. Check the Output to Existing MCSim Sheet option to do this. Instead of creating a new MCSim sheet, output is placed in the usual way (i.e., first 100 in column B, summary statistics in range J5:J8 [and L5:L8 if two cells are tracked], and a histogram) in a previously created MCSim sheet.

Be careful in using this option because existing simulation results are overwritten and cannot be recovered. You can copy the existing MCSim sheet (Edit: Move or Copy Sheet...) if you want to preserve results from a previous simulation.

Delete Previous Sheet Option

Select this option to delete the previous MCSim sheet. This option is handy when you are running many different experiments and are not interested in saving the results. This frees you from having many MCSim sheets pile up in the workbook. Needless to say, use this option with caution—there is no warning. The previous sheet is deleted and cannot be recovered.

Set Seed Option

The Set Seed input box allows you enter a number, such as 12345, that is used as a starting value for the random number generator. You can then replicate exactly a particular simulation. Anyone who uses the same seed (e.g., your students) will also exactly replicate your results.

This option can be used only with our user-defined RANDOM() function. It cannot be used with Excel's RAND() function. The seed value is used as the first lagged value and zero is used as the second lagged value. In addition, the first value in an array of 25 possible values is used as a multiplicative coefficient. The bottom line is that the random numbers produced are much less random and this option should be used only for testing and teaching.

Because the set seed option requires RANDOM(), it automatically replaces all instances of RAND() on your sheet with RANDOM(). To change back to RAND(), simply choose the All RAND option and clear the Set Seed input box.

Clear the Set Seed input box to get the maximum performance out of the RANDOM() function.

Trap Error Option

This option stops the simulation when an error is encountered (such as dividing by zero or inability to invert a matrix). The sample that generated the error can then be inspected.

Additional Functions

The MCSim.xla add-in is packaged with two array functions for drawing correlated, normal random variables:

=BiVarNormal(mean1, SD1, mean2, SD2, rho)

=MultivarNormal(nvars, corrRange, meansRange, SDsRange)

Although we do not use these functions in the introductory text, they are essential for advanced work.

We briefly describe these functions and recommend that the interested reader go to the *CorrelatedRVs* sheet in *Random.xls* (in the Basic Tools folder) for more documentation.

For the *BiVarNormal* function, select a horizontal pair of cells (e.g., A1 and B1), then enter the function in the formula bar. For example, `=BiVarNormal(0,1,0,10,0.9)`. Press CTRL-SHIFT-ENTER to enter the array function. The values in the two cells reflect the means, SDs, and correlation coefficient you requested. The precise order of the arguments in the function is as follows: (Mean first variable, SD first variable, Mean second variable, SD second variable, Correlation coefficient). You can select the two cells and drag them down to create a data set of correlated, normal random variables.

The *MultiVarNormal* function enables creation of deviates drawn from a multivariate (3 or more random deviates) normal distribution with given means and SDs and a matrix of correlation coefficients. (The upper limit for a single sheet is 256 correlated normals, but the function operates slowly with many correlated random variables and we are not sure how well the Cholesky decomposition works with large correlation matrices.) The Range inputs in the function are cell ranges (such as, C3:E5) where appropriate information has been entered.

You can use the Monte Carlo simulation add-in to confirm that the variables are operating as expected.

| | | | | | | | | | |
|----|--|-----------|---|---|----------------|----------|------------|-------------|----------|
| | A | B | C | D | E | F | G | H | I |
| 33 | Using the BiVarNormal and MultiVarNormal functions: | | | | | | | | |
| 34 | | | | | | | | | |
| 35 | Run MCSim.xla on the Output Testing cells to see that they match the user input. | | | | | | | | |
| 36 | | | | | | | | | |
| 37 | BiVarNormal | | | | MultiVarNormal | | | | |
| 38 | | | | | corrRange | | meansRange | SDsRange | |
| 39 | {=BiVarNormal(0, 1, 0, 2, 0.9)} | | | | 1 | | 0 | 1 | |
| 40 | | | | | 0.9 | 1 | 10 | 1 | |
| 41 | | | | | 0.1 | 0.5 | 20 | 1 | |
| 42 | | | | | | | | | |
| 43 | | | | | | | | | |
| 44 | x1 | x2 | | | x1 | x2 | x3 | | |
| 45 | 0.781258 | 1.311356 | | | 0.7337286 | 10.06633 | 18.95421 | | |
| 46 | -0.065111 | 0.346686 | | | 1.5275384 | 10.61138 | 18.69332 | | |
| 47 | -1.411813 | -0.957184 | | | 0.3517804 | 10.5471 | 20.75431 | | |
| 48 | 0.085173 | -1.19341 | | | 0.4843857 | 10.79606 | 20.9997 | | |
| 49 | -1.067817 | -1.551769 | | | -0.9046887 | 9.335713 | 20.52788 | | |
| 50 | 0.811482 | -0.39271 | | | -1.41555 | 8.27943 | 19.14925 | | |
| 51 | -2.281579 | -6.90773 | | | -1.4945867 | 8.654316 | 19.57414 | | |
| 52 | 0.912689 | 1.219653 | | | 0.3704282 | 10.27431 | 19.90485 | | |
| 53 | 0.883143 | 2.769886 | | | 1.3295755 | 11.41299 | 19.84843 | | |
| 54 | -1.02993 | -2.755278 | | | 0.9268079 | 10.92419 | 20.40962 | | |
| 55 | | | | | -0.5748064 | 9.119637 | 19.04451 | | |
| 56 | | | | | -0.3723905 | 9.958537 | 20.7606 | | |
| 57 | | | | | 0.1674377 | 9.864947 | 19.58345 | | |
| 58 | | | | | | | | | |
| 59 | Output Testing | | | | Output Testing | | | | |
| 60 | r | 0.865097 | | | 1 | | | 0.086896939 | 0.938454 |
| 61 | | | | | 0.9195171 | 1 | | 9.988071837 | 0.887641 |
| 62 | | | | | -0.0171518 | 0.351143 | 1 | 19.86186753 | 0.742657 |

Source: [Random.xls]CorrelatedRVs.

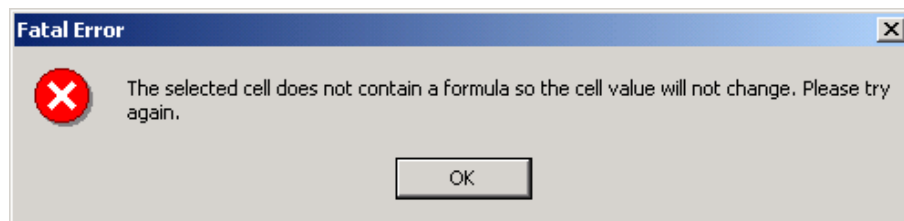
The BiVarNormal output was created by using =BiVarNormal(0, 1, 0, 2, 0.9) in columns A and B of rows 45 to 54.

The MultiVarNormal output has the formula,
=MultivarNormal(3,\$E\$39:\$G\$41,\$H\$39:\$H\$41,\$I\$39:\$I\$41), in each row.

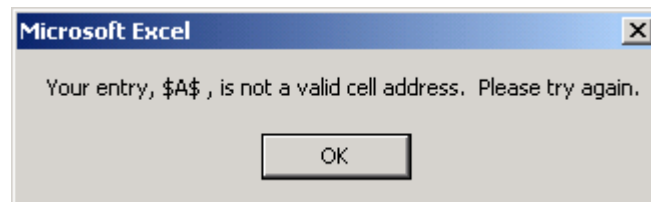
ERRORS AND TROUBLESHOOTING

The Monte Carlo Simulation add-in has a few simple error checks.

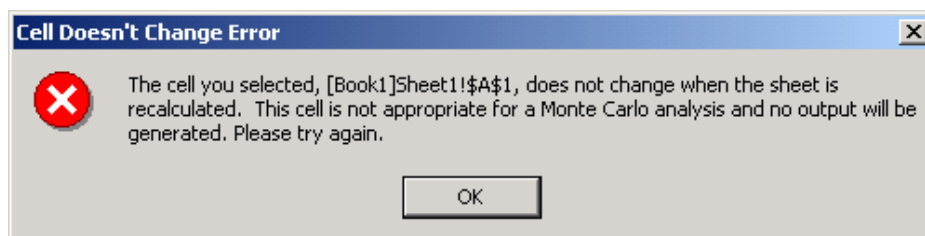
It will complain if you attempt to do a Monte Carlo analysis of a cell that is not a formula:



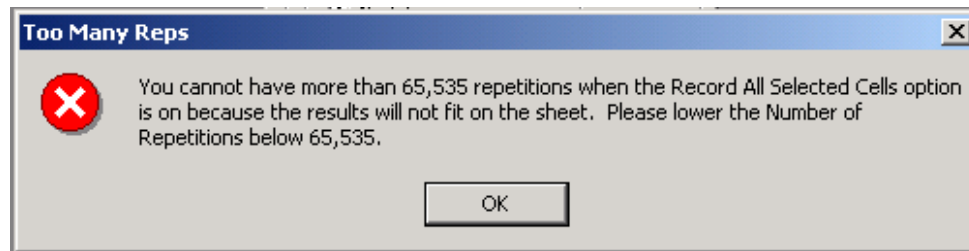
Clicking on the cell to be analyzed is better than typing it in because you might make a mistake entering the address. If you enter, for example, "=\$A\$," you will obtain



The add-in checks to make sure the cell you selected for analysis changes when the sheet is recalculated. If not (e.g., the cell address is valid and cell A1 contains the formula, "=5"), you will get



Finally, if you check the Record All Selected Cells option and have selected more than 256 cells to record or ask for more than 65,535 repetitions, there will not be enough room on the sheet. The maximum size of an Excel spreadsheet is 2^{16} , or 65,536, rows by 2^8 , or 256, columns. Thus, the add-in will display a warning like this one:



These limitations no longer apply to Excel 2007 and greater. With the latest version of the MCSim add-in and Excel 2007 or greater, you may track as many cells and run as many repetitions as your computer memory allows.

THIS VERSION

The latest MCSim.xla version is 10 June 2010.

To check the date of your installed add-in, in Excel 2010, execute File→Options→Add-ins, in Excel 2007, Office button→Excel Options→Add-Ins, or Tools: Add-ins, in older versions. Click on the add-in to see the date is displayed at the bottom.

To install this add-in for the first time, please follow the instructions starting on the first page of this document.

To install over a previous version that is already installed, please see [InstallingAddinOverPreviousVersion.doc](#) for detailed instructions. The procedure is basically this:

To install over a previous version, *quit Excel* and simply drag this new version into the Excel Add-ins folder. If you do not know where this folder is, search for “DDV.xla” and then drag the new version over the old one. Of course, you will want to accept rewriting over the previous version. Launch Excel and you are ready to use the add-in.

ADDITIONAL HELP AND FEEDBACK:

If something goes wrong in the installation or loading process, an unexpected error keeps recurring, or you have other problems, please contact us. Many problems are fixed by uninstalling (unchecking in the Add-ins Manager, clicking OK) and reinstalling. We are interested in your comments, suggestions, or criticisms of the DDV.xla software.

www.wabash.edu/econometrics

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