

## Bootstrap Modeling: Beyond the Basics Files Model Instructions

In the “Beyond the Basics.zip” file you will find 6 files you can use to review the details of the calculations of the modeling framework in the “Bootstrap Modeling: Beyond the Basics” paper:

1. Model Instructions.pdf (this PDF document)
2. Industry Data.xls (Schedule P data as of 12/31/08)
3. Bootstrap Models.xls
4. Best Estimate.xls
5. Aggregate Estimate.xls
6. Correlation Ranks.xls

The last four Excel files contain the bootstrap models described in the paper. Reading the paper will guide you when exploring the educational content of the model files, but not all of the issues and model variations discussed in the paper are reproduced in these Excel files.

All of the sheets in each file are protected (without a password) to maintain the integrity of the calculations, but the unprotected data entry cells are noted in [blue](#). You may unprotect the sheets to review the calculations, but you may not use a password when protecting the sheets again as this will cause an error in the routines. You must set the Macro Security level low enough to enable macros before any of these files are opened. The model files are set up to run a 10 x 10 triangle and NO other size. All data must be annual and no data cells can be missing. Finally, you must not change any of the range names stored in the files as this may create problems with the routines included with the files.

### **Bootstrap Models:**

The **Bootstrap Models** file is the first file you should open. There are six visible sheets in the file:

- A. *Inputs* – on this sheet you can enter data for a business segment and choose model options.
- B. *Bootstrap* – on this sheet you will find the calculations for the paid and incurred bootstrap models as well as the substitute steps for the Bornhuetter-Ferguson, Cape Cod and GLM framework (referred to as the “flexible” model) models. You can also select hetero groups and outliers for each model.

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- C. *Diagnostics* – on this sheet you will find the diagnostic graphs described in section 5 of the paper. When the “flexible” model is selected on the Input sheet, the parameters for that model are selected on this sheet.
- D. *Calcs* – on this sheet you will find most of the details of the calculations related to the *Bootstrap* and *Diagnostics* sheets.
- E. *Hat Matrix* – on this sheet you will find the details of the hat matrix calculations used in the *Bootstrap* sheet.
- F. *Results* – on this sheet the results of your simulations will be stored and summarized.

There is also one hidden sheet in the file where the random numbers are stored.

Start with the *Inputs* sheet and enter information about your company name and LOB/segment, then enter paid and incurred loss triangles, earned premium, exposures (if available) and your assumptions for the tail factors, Bornhuetter-Ferguson and Cape Cod models. **[Note:** If you copy and paste we recommend that you use paste special, values so that you do not accidentally erase any range names.] On the *Bootstrap* sheet, you should set all hetero group values to zero (Step 9) and make sure all of the cells in the outliers triangle are set to zero (Step 10) – for both the Paid and Incurred models. **[Note:** Clicking on the Reset Assumptions button will do this for you.]

Once the data has been entered, hitting F9 (recalculation) will set up the graphs on the *Diagnostics* sheet so that you can assess the assumptions of the model. Clicking on the buttons on this sheet will adjust the scales on the graphs to make them easier to read. You can also change the column used in the graphs at the bottom of the sheet, but you will need to hit F9 to update the graphs.

Using the graphs on the *Diagnostics* sheet, you can manually set up other hetero groups and remove outliers to adjust the model fit to the underlying assumptions (See section 5 of the paper for more guidance). For the hetero groups you should start with group zero and number the other groups sequentially using integers for group numbers (e.g., 0, 1, 2, etc.). For the outlier triangle, a one is used to indicate a cell that will be removed from the calculations (i.e., given zero weight), otherwise use a zero.

After you are satisfied with the model assumptions, you can select the data type you wish to use (e.g., paid or incurred) and the model type (e.g., chain ladder, Bornhuetter-Ferguson or Cape Cod) on the *Inputs* sheet. These six different combinations give you six different models you can run for each LOB/segment. You can also use the “flexible” model option on the Inputs sheet and then select parameters on the Diagnostics sheet. While you can run

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simulations for the “flexible” model the other Excel files are not set up to include them when combining multiple models.<sup>1</sup>

Set the number of iterations you want to use in the simulation process (from 10 to 1,000) and use the same number of iterations for every model you run for each LOB/segment. [**Note:** While the model will accommodate up to 1,000 iterations it is not designed for speed so you should consider limiting the number to say 100 or less.] You can also input the four percentiles you wish to see in the results summaries (the percentiles can be changed at any time).

To run each model, use the following steps:

1. Click on the Generate Random Values button to generate all the random numbers for the model. You should generate new random numbers for each model to avoid creating correlation between the models.
2. Click on the Run Simulations button to run all of the simulations and save the results to the *Results* sheet.
3. Review the summaries on the *Results* sheet to make sure you don't need to adjust the model assumptions. Occasionally, adjusting the “Negative Incremental” constraints on the *Inputs* sheet will help the model. [**Note:** You can drill down to any individual iteration in the model by entering the iteration number on the *Inputs* sheet (in the “hidden” cell two to the right of the Iterations cell), hitting F9 and then reviewing the calculations on the *Bootstrap* sheet.]
4. Save the **Bootstrap Models** file in a common data directory using a different file name for each model and LOB/segment. [**Note:** To save file size you can click on the Clear Random Values button, which will remove the data generated in Step 1. Similarly, clicking on the Clear Results button will delete the simulation output on the *Results* sheet, but you should not do this for any file you want to combine for the next model.]

Repeat these steps for each model and LOB/segment.

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<sup>1</sup> There is no technological reason why the “flexible” model is not being combined, it is simply a matter of convenience.

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### **Best Estimate:**

After each model has been run and saved for a LOB/Segment, you can open the **Best Estimate** file and combine the results. There are two visible sheets in the file:

- A. *Inputs* – on this sheet you can import or enter data for a LOB/Segment and select model weights.
- B. *Results* – on this sheet the results of your simulations will be stored and summarized.

There is also one hidden sheet in the file where the random numbers are stored.

Start with the *Inputs* sheet and enter the directory path where you saved the **Bootstrap Models** files for the LOB/Segment [**Note:** All files for a LOB/Segment must be in the same directory and the path should end with a backslash.] Next, enter the file name for each of the **Bootstrap Models** files next to the appropriate data/model type. After this information has been entered, you can click on the Import Raw Data from Paid CL File button which will import all of the rest of the data on the *Inputs* sheet, except the model weights.

Once the raw data has been imported, you must enter weights in the Model Weights by Accident Year table such that for each year the total of the weights by model sum to 100%. You can also input the four percentiles you wish to see in the results summaries (the percentiles can be changed at any time).

To combine the model results into your best estimate, use the following steps:

1. Click on the Generate Random Values button to generate all the random numbers for the combination process.
2. Clicking on the Combine Results button will open each model sequentially; combine the results based on the weights you specified by year and save the combined results to the *Results* sheet.
3. Review the summaries on the *Results* sheet to make sure you don't need to adjust the model weights.
4. Save the **Best Estimate** file in a common data directory using a different file name for each LOB/segment. [**Note:** To save file size you can click on the Clear Random Values button, which will remove the data generated in Step 1. Similarly, clicking on the Clear Raw Data and/or Clear Results buttons will delete the raw data on the *Inputs* sheet and simulation output on the *Results* sheet, respectively, but you should not do

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this for any file you want to combine with a **Best Estimate** file for another LOB/Segment.]

Repeat these steps for each LOB/segment.

### **Aggregate Estimate:**

After each LOB/Segment has been combined and saved, you can open the **Aggregate Estimate** file and aggregate the results. There are two visible sheets in the file:

- A. *Inputs* – on this sheet you can import or enter data for up to three LOB/Segments and select the correlation assumptions.
- B. *Results* – on this sheet the results of your simulations will be stored and summarized.

There are also four hidden sheets in the file where the correlation ranks are stored and results for three different LOB/Segments can be found.

Start with the *Inputs* sheet and enter the directory path where you saved the **Best Estimate** files for each of the three LOB/Segments [**Note:** All LOB/Segment files must be in the same directory and the path should end with a backslash.] Next, enter the file name for each of the **Best Estimate** files next to the appropriate LOB file number. After this information has been entered, you can click on the Import Raw Data from LOB Files button which will import all of the rest of the data on the *Inputs* sheet and calculate the correlations between the residuals in the LOBs.

Once the raw data has been imported, you must select a correlation matrix assumption. You can use the Select Correlation button to select one of the calculated correlation matrices or to enter a constant value, or you can enter a unique value for each LOB pair. You can also input the four percentiles you wish to see in the results summaries (the percentiles can be changed at any time).

Calculating the correlation ranks to match the selected correlation assumption is outside the scope of this model. Therefore, you will need to generate the ranks (based on your correlation assumption and number of iterations) using a separate process (e.g., using a multivariate normal simulation), paste them in the “Correlation Ranks.xls” file and then save the file using another name. [**Note:** The **Correlation Ranks** file has some ranks generated for the figures used in the paper but these should be deleted and replaced.]

To combine the best estimate results into your aggregate estimate, use the following steps:

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1. Click on the Import Results Data from LOB Files button to import the results from each of the best estimate files into their respective hidden LOB sheet.
2. Click on the Import Rank Values button to import the rank values you created outside of this file for the aggregation process.
3. Click on the Aggregate Results button to combine the results from each of the LOB files using the correlation ranks and save them to the *Results* sheet.
4. Review the summaries on the *Results* sheet to make sure you don't need to adjust the correlation assumption.
5. Save the **Aggregate Estimate** file using a different file name. [**Note:** To save file size you can click on the Minimize Result Data and Clear Rank Values buttons, which will remove the all data from Step 1 not used in the Results sheet and the rank values from Step 2, respectively. Similarly, clicking on the Clear Raw Data, Clear Result Data and/or Clear Results buttons will delete the raw data on the *Inputs* sheet, all data in the hidden LOB sheets and simulation output on the *Results* sheet, respectively, but you should not do this if you want so save everything on the *Results* sheet.]