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How to Keep Your Spreadsheets Out of the Headlines: A Summary

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In spring 2012, a prominent trader at JPMorgan was nicknamed the “London Whale” due to the size of the trading positions he took in credit default swaps. The risk management oversight for this trading desk relied on value-at-risk (VaR) limits calculated in a spreadsheet model.

Within this spreadsheet, there was a key error. The formula in calculating the VaR limits inadvertently divided by the SUM of two numbers as opposed to their AVERAGE.¹ As a result, the volatility measure being used in calculating VaR was off by a factor of two. That error led to a significant understatement of the trading risk.

This was unlikely to be the only error in the spreadsheet, though. A report released in 2013 showed there was a series of spreadsheets being used for the risk management controls on these trades that involved several manual processes.² Information was copied and pasted manually from one spreadsheet to another.

The result of these errors: \$6 billion in trading losses over a two-month period.

To be sure, the risk management and governance problems found in this report went well beyond spreadsheets. However, lax spreadsheet practice did contribute to the loss.

THE SPONSORS AND THE SPEAKERS

A session at the 2015 Society of Actuaries annual meeting, “How to Keep Your Spreadsheets Out of the Headlines!” highlighted the above story, as well as other spreadsheet horrors that serve to focus attention on the need for controls to keep further such stories emerging from our industry.

To underscore the depth of interest in this issue, the session was co-sponsored by the Modeling, Entrepreneurial Actuaries and Joint Risk Management sections, with an eye toward addressing model risk and model governance from perspectives ranging from a large firm to a solo practitioner.

Three speakers presented, representing the range of concerns being addressed.



I am on the Modeling Section Council, and am also a member of the European Spreadsheet Risks Interest Group, which was the source of many of the spreadsheet horror stories in the presentation (see Resources at the end of this article). I was joined by Alex Cires, who consults in the health care field at Milliman, and Sandra To, deputy chief reserving actuary at SCOR Global Life Americas.

In this article, I will summarize our presentations.³ This was also a virtual session, and had special video recording showing both the slides and the presenters during the talk. You should be able to purchase a recording through the SOA as well.

HOW CAN WE PREVENT SPREADSHEET ERRORS?

Alex Cires spoke first, taking the audience through best practices for spreadsheets creation and review. Proper spreadsheet controls will help to avoid errors, make the spreadsheet easier for others to follow, reduce risk, and improve the efficiency of checking and reviewing the spreadsheets. Controls are more effective if applied throughout the spreadsheet development process rather than at the end.

Some specific advice for spreadsheet creation and control are:

- **Documentation tab(s):** high-level notes on purpose, instructions on proper use, version tracking and control, and a note as to any reviews performed.
- **Documentation within calculation spreadsheets:** document external sources, inputs and assumptions at point of use; create clear column headings and descriptive tab names to improve transparency; organize sheets so that information flows from inputs through calculations through outputs in a logical and easy-to-follow manner. Documentation should occur as the spreadsheet is being developed, not held to the end. (This is a point reinforced by all three presenters.)

- **Formatting as a form of documentation:** differentiate formatting between input, formulas and output; color code tabs; format numbers so they are easier to read and understand.
- **Specific approaches in spreadsheet creation:** break down complex formulas into simpler pieces; avoid links to files; use macros to replace manual copy/paste processes (that would have helped with the London Whale debacle); use data validation, cell protection and other built-in checks to prevent accidental errors.

The completed spreadsheet should be subject to checking and peer review. Checking is the detailed, technical review, including picking apart the formulas. Peer review is a higher level review of the spreadsheet and its results. The extent of these reviews should be commensurate with the materiality of the spreadsheet process.

Ideally, both checking and peer review should be performed by people not involved in the creation of the spreadsheet. A successful review requires adequate time, agreement on level of review, documentation and sign-offs required, and a process to ensure that these reviews actually occur. An impromptu poll of session participants showed about 50 percent being subject to such a policy.

A spreadsheet review should include a check of data integrity. Useful tools for this process include in-formula tracing within the Formula Auditing Toolbox in Excel (found under the Formulas tab for current versions of Excel) and third-party or custom-built utilities. One specific type of helpful tool compares results between two versions of the file, each using different assumption sets, to make sure the changes in assumptions produce the expected qualitative change in result.

The peer reviewer should be involved throughout the project. Timely discussion between the spreadsheet creator and peer reviewer can improve the development of the spreadsheet. With this approach, problems get resolved along the way, and the final review should not reveal problems that could set the project back significantly.

One final issue is version control and archiving. We may have multiple versions of a spreadsheet we work with, developed over time. We should avoid having multiple **working** versions; prior versions can be archived in read-only mode. You need to archive these prior versions to follow professional standards or to meet employer or regulatory document retention policies.

BEST PRACTICES IN EXCEL

Sandra To was the second speaker, covering multiple best practices for Excel spreadsheets. Her presentation was emphasized the “W” question words.

WHO has access to the spreadsheets and what access should they have? Read only? Read/write? Password protecting spreadsheets can prevent accidental changes, which is especially of concern, and of regulatory interest, if the spreadsheets support financial reporting.

WHERE are the spreadsheets going after you create them? Are your “customers” taking your spreadsheets and doing subsequent analysis with them? A discussion of the users’ needs during development can help in creating a spreadsheet that meets these needs with no post-processing, and help provide greater control over the use of spreadsheet results.

WHAT is in the spreadsheet? Does everybody know the scope of the spreadsheet? Do users understand your data definitions and labels, or know which blocks of business are included and which aren’t? The example Sandra gave from her own work is that SCOR has global business, and if she is given spreadsheets with number values, but no indication whether the values are in U.S. dollars or in euros, this can create a great deal of trouble in financial reporting.

Sandra detailed some of the types of controls she uses in spreadsheet work, primarily following the flow of information through the spreadsheets. First, look at information coming into the spreadsheet: Do inputs tie directly to data from a source file? Are these kept updated? She often puts in an explicit check to make sure the proper inputs tie, such as making sure the spreadsheet inputs match the ledger. When there are multiple input sources, consider adding a column to indicate the source of each piece of input data.

One major issue is that we as actuaries often deal with great masses of data within our spreadsheets and need to find approaches to make reasonable checks on these data. One approach is to aggregate results to higher levels, and to compare period-to-period results in aggregate. Another approach is to graph the data, which can show patterns more effectively than just a table of values.

The goal in spreadsheet development is to have a well-documented and repeatable process. External links can be an issue in reproducing the process; links may not be up-to-date, variable names may have changed in linked files, data definitions may have changed, or the linked file may not be updated with the frequency required.

Pivot tables also present a challenge. Pivot tables are very convenient for aggregating and slicing large amounts of data in different ways, but there can be issues if you don’t keep the tables refreshed. Underlying data may have changed without the pivot table being updated. A change in the underlying data may change the dimensions of a pivot table, which may cause problems for any formulas referencing the table.

As Sandra is involved in financial reporting, her spreadsheets are often audited, and the same spreadsheets get reused from period to period. In this situation, it is helpful to capture key information in a printout, as audits often review printed results. The printouts should include the filename and path (using the =CELL("filename") function) and a timestamp (using the =NOW() function).

PREVENT TROUBLE BY LOOKING FOR IT

I was the last speaker, and while I agreed with much of what Alex and Sandra had to say, my focus was on what individuals can do to best check their own work. This would most obviously be applicable to a solo practitioner, but even in a corporate setting, a qualified third-party reviewer may not always be available on demand for spreadsheet review.

The main thrust of my message was that you should expect errors in your work. Earlier in telling some of the spreadsheet horror stories, I looked at the damage made by bona fide experts (such as the Long-Term Capital Management blowup in 1998) and academic research in spreadsheet error (essentially, 100 percent of nontrivial spreadsheets have errors). If one expects no errors, and doesn't look for errors, one will not find any ... until the results are catastrophic and undeniable, at any rate. The worst error is the error that is not found, and often it's not found because nobody was looking.

My high-level principles for spreadsheet checking are to anticipate the answer and compare to what the spreadsheet actually gives you, test the boundaries of possible inputs, deliberately break the spreadsheet to find out how it fails, and make sure failure isn't silent. Look at the results you're getting out of your spreadsheets and compare these to your expectations. Make estimates by calculating the results in a different way. If you have no expectation of what your results should be, or how they should change with changing inputs, you will not know if there are errors in your spreadsheet.

One control I build into my spreadsheets is to make them fail in an ugly manner. I make sure that an error visually stands out in the sheet so I can see it. Conditional formatting is a good tool to make this work well within spreadsheets themselves. In Excel's Visual Basic for Applications (VBA), I use message boxes detailing the error to pop up.

Silent errors are very deadly—the most dangerous code in VBA macros is the following statement: On Error Next. This means that if VBA runs into an error, it simply moves onto the next line, ignoring the error. Ideally, you should include real error handling into your macros as well as your formulas.

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Always check for errors but prioritize this effort. I concentrate on high-frequency cause for errors and high-severity errors in results.

Manual copying and pasting is a frequently a problem, so I check that the proper items were copied to the correct place, and check that I didn't overwrite formulas with values (or vice versa). Some high-frequency formula errors include items such as not covering a complete range (as with a SUM formula), misuse of absolute and relative cell references, using the wrong function (as with the SUM vs. AVERAGE error at JPMorgan), hard-coded numbers in the formulas, and mega-formulas that are impossible to read or audit well. As mentioned by Alex and Sandra, it is vital to make sure that all data sources are refreshed appropriately. I often have VBA code written for automatic refresh of all data sources to make sure everything is kept current.

To capture high-severity errors, I usually start at the end; that is, I look at the results and trace back the process to the beginning. For formula auditing, I work from the key results and see how they derive from the inputs. However, I need to take special care to note any VBA code being used along the way. I prioritize which results to check by materiality.

AN ACTIVE AUDIENCE

There was obviously a pent-up demand for this topic, as the audience was full of comments and questions.

One of the points of discussion was actually about **not** using Excel and spreadsheets for some work. While the session was on spreadsheet use, Excel is not a controlled environment the way a ledger or formal actuarial software is. Sandra mentioned that at SCOR they were trying to automate certain aspects outside Excel, especially for material blocks of business, and not use Excel for production (i.e., the underlying financial results and reporting) but to use it for subsequent analysis. Alex agreed, saying that Milliman had moved things out of Excel in many cases into more appropriate systems. In my own case, I noted that often actuaries put some extremely important valuations in Excel, and perhaps they shouldn't.



An audience member warned people to be wary when the spreadsheet gives you exactly the result you expected. That is when you will be most likely taken in. I made an analogy to the various models of collateralized debt obligations and similar assets in the financial crisis—that this is not merely spreadsheet risk, but model risk. Be wary when you trust the model because it gives you exactly what you want to see.

One audience member noted that actuarial students, not senior actuaries, do much of the spreadsheet work. How does one “student-proof” spreadsheets? Alex pointed to formal training on the topic; he has seen this training is provided to both new and experienced analysts to reinforce best practices. Sandra agreed, saying SCOR had documented processes on spreadsheet review. In my own case, I tend to make checklists for students when there is a repeatable process to follow. Research from preflight and surgical checklists has shown errors are reduced through standardized checklist use.

IDEAS FOR FUTURE SESSIONS?

One of the important activities of the Modeling Section Council is to plan these kinds of sessions for SOA and other actuarial meetings. In this case, Excel is one of our modeling utilities, and error-prevention and model governance is of great interest to us.

If you have recommendations for future sessions, we’d love to hear them! Feel free to email me at marypat.campbell@gmail.com or visit our section webpage at <https://www.soa.org/Professional-Interests/modeling/modeling-detail.aspx> to get more information about the section and its activities. ■

RESOURCES

European Spreadsheet Risks Interest Group:
<http://www.eusprig.org/>

Horror stories: <http://www.eusprig.org/horror-stories.htm>

Best practices: <http://www.eusprig.org/best-practice.htm>

For more resources, see “Spreadsheet Errors: Looking Over Your Own Shoulder,” *The Independent Consultant*, May 2015: <https://soa.org/News-and-Publications/Newsletters/The-Independent-Consultant/2015/may/Spreadsheet-Errors--Looking-Over-Your-Own-Shoulder.aspx>



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ENDNOTES

- ¹ James Kwak, “The Importance of Excel,” *The Baseline Scenario* blog, February 9, 2013, <http://baselinescenario.com/2013/02/09/the-importance-of-excel/>.
- ² Linette Lopez, “How the London Whale Debacle is Partly the Result of an Error Using Excel,” *Business Insider*, February 12, 2013, <http://www.businessinsider.com/excel-partly-to-blame-for-trading-loss-2013-2>.
- ³ Our slides can be found here under session 30, <https://www.soa.org/Professional-Development/Event-Calendar/2015/annual-meeting/Agenda-Day-2.aspx>.