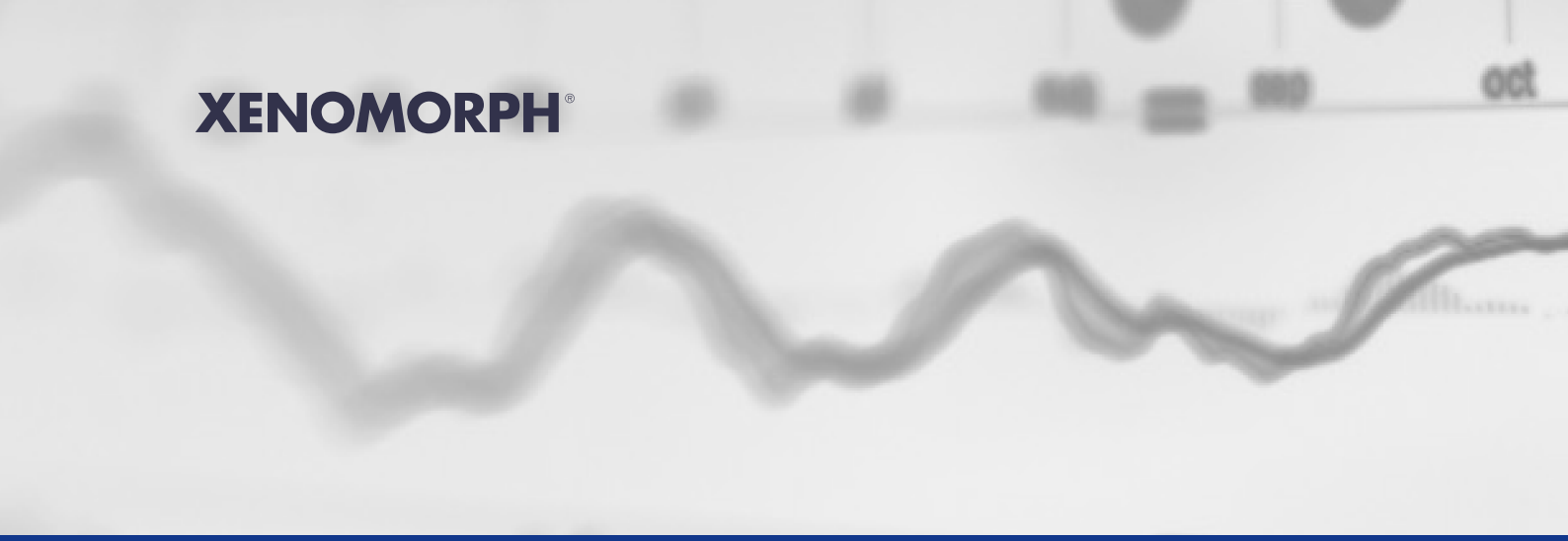

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Technical Briefing

Spreadsheets and their role within operational risk

Instrument valuation issues, data and regulation

Regulations such as BCBS 239 are forcing changes in the usage and governance of spreadsheets and other end-user computing (EUC) applications in financial markets. This paper outlines the main risks in spreadsheet usage in derivative and fixed income valuation, and explains some of the regulators motivations in addressing this source of operational risk.

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1 Introduction

Although spreadsheets are a tremendously powerful tool for the valuation of fixed income, complex derivative and over-the-counter (OTC) instruments due to their openness and flexibility, spreadsheets do not lend themselves easily to the challenge of conforming to new regulatory requirements such as IFRS, BCBS 239[1], Dodd-Frank[2] and Solvency II. These regulations require much more control, consistency and transparency regarding input and output data used in instrument valuations. Against this background, the manner in which many financial institutions currently use and manage spreadsheets within the valuation process is simply not fit for purpose.

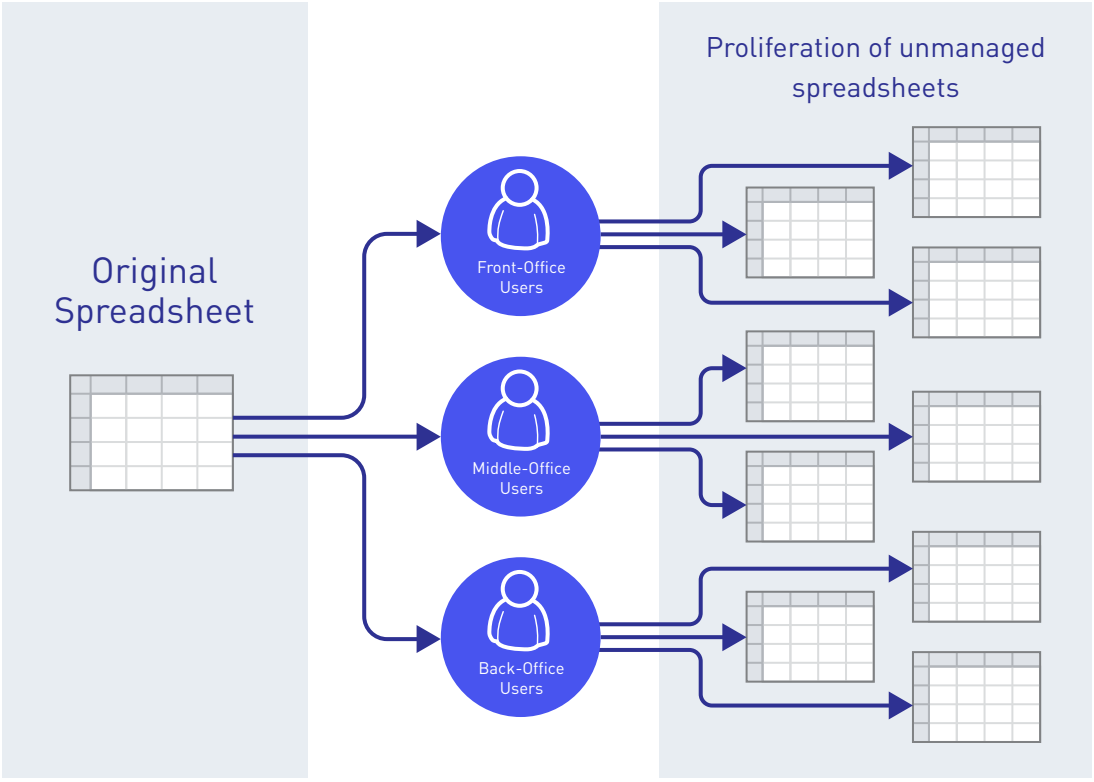

Figure 1 – Spreadsheet version proliferation between people and over time

1 For example see "*Principles for effective risk data aggregation and risk reporting*" Principle 3, 36 (b).

2 For example see "*Dodd-Frank Act Stress Testing (DFAST) Reporting Instructions*", Supporting Documentation (Appendix A), Documentation on Model Inventory.

As illustrated in Figure 1, spreadsheet-based valuations are vulnerable to inaccuracy, inconsistency and manual errors due to the way in which they manage the following issues:

- **Market Data Capture** – data is typically loaded directly into spreadsheets using *data vendor* APIs, which require vendor-specific knowledge of instrument IDs, field names, scaling factors and quote idiosyncrasies.

- **Market Data Changes** – If any market data (or any other input) is changed by a trader in the spreadsheet there is no record (audit) of this and those changes are not easily available to other users or systems.

- **Analytic/Calculation Changes** – Similarly, if any spreadsheet *functions* or *formulas* are changed, whether intentionally or by accident, again there is no record of this; if the spreadsheet is subsequently saved, the original values are overwritten and hence lost.

- **Data Persistence** – All data needed for the valuations is contained within the spreadsheet or linked spreadsheets, effectively making the spreadsheet the de facto production 'database'.

- **Data Fragmentation** – Often, consolidation of information (e.g. risk exposure) means attempting to aggregate or combine data from many large spreadsheets distributed over a large variety of locations; clearly this is impractical, cumbersome and prone to errors.

Putting aside regulatory compliance motivations for formalizing and/or reducing manual spreadsheet processes in financial markets institutions, management should also be motivated to have better controls over end-user computing in light of events such as the JPMorgan "Whale"[3]. The following sections explore this and the issues above in more depth and outline how and why they present a data management challenge to an organization. In summary, spreadsheets are undeniably a very powerful and indeed very useful tool, but to take a quote from another context: "*With great power comes great responsibility*".

3 See U.S. Senate report "*JPMorgan Chase Whale Trades: A Case History of Derivatives Risks and Abuses*".

2 Market Data Capture

Typically, spreadsheet-based valuations obtain the required market data directly from a data vendor (e.g. Bloomberg; Thomson Reuters) via native tools or APIs. Figure 2 below illustrates how a Bloomberg formula could be used to obtain quotes for overnight indexed swaps.

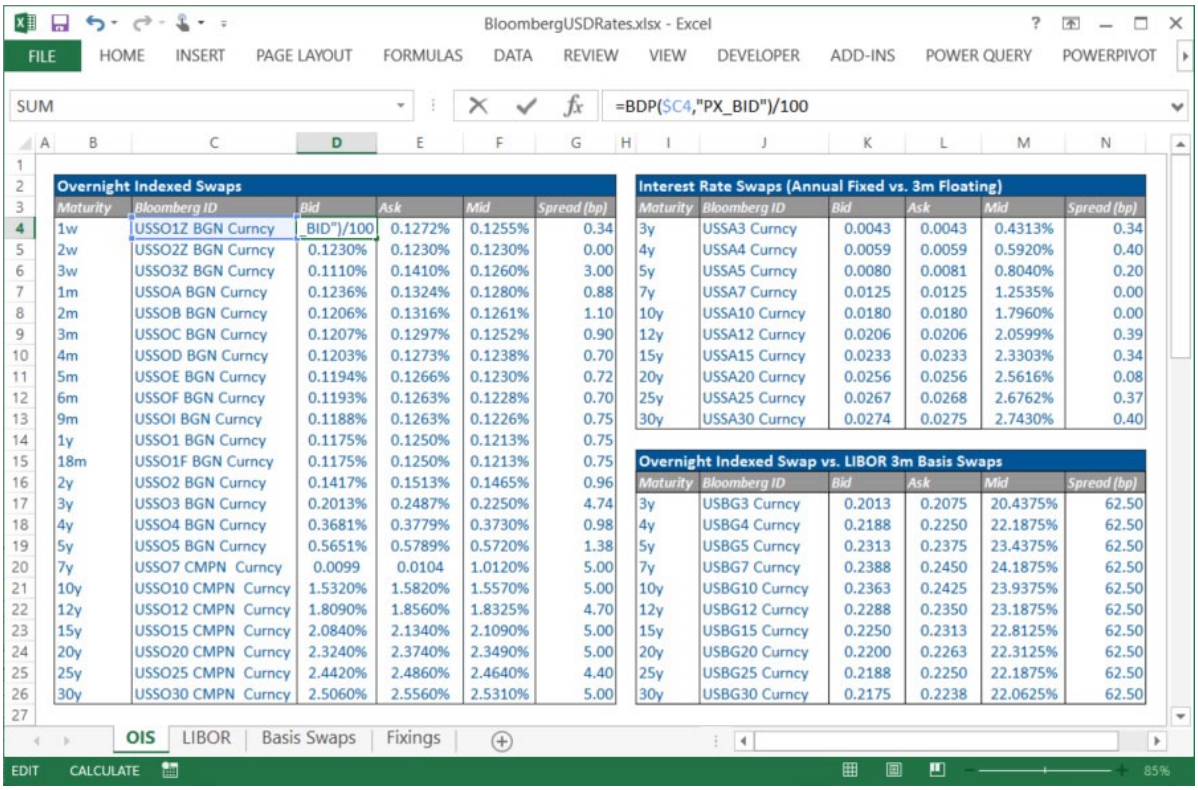

Figure 2 – Obtaining overnight indexed swap quotes from Bloomberg

Using a data vendor native API function to obtain each quote gives rise to issues related to:

- **Identifiers** - Data vendor-specific identifiers for each instrument are required; these have a tendency to change and different users may inadvertently use different variations introducing inconsistencies in the acquisition and usage of the quote.
- **Fields/Scaling Factors** - The appropriate field and any relevant scaling factor are also needed**.** Although users may start with identical spreadsheet templates, they can easily change elements to cater for their own specific requirements resulting in the loss of the original configuration and inconsistency across the institution.
- **Empty Quotes** – Cases where the function does not return a quote at all – due to a market holiday or a technical problem with the data vendor feed for example. Either way, the absence of data may cause other spreadsheet functions to fail, including actual instrument validation, unless some kind of protection is built into the spreadsheet.
- **Data Validity/Quality** - The quote from the data vendor has also not been validated. Clearly, some due diligence is likely to have been done by the data vendor to ensure the accuracy of the quote. However, what is missing is the ability to compare the quote to either the

previous business day (day-on-day change such as +/- 5%) or some statistical historical measure (e.g. outliers +/- 2 standard deviations from the mean). Such tests are essential to assess the quality of the data and flush out any obvious anomalies; unfortunately the above mechanism does not easily allow this, particularly historical tests. These could be added to the spreadsheet, but it would then become even larger, more complex and more unwieldy.

- **Spreadsheet Size/Speed** - Having large numbers of data vendor formulas to acquire all the market data needed also means the spreadsheet itself can become very large, with each workbook needing many worksheets (tabs). As a result, the workbook could take a considerable time to open or to calculate if the data vendor feed is slow. This is compounded if it happens each and every time the workbook is opened.

Using multiple data vendors introduces even more complexity. Figure 3 below shows similar data sourced from Thomson Reuters.

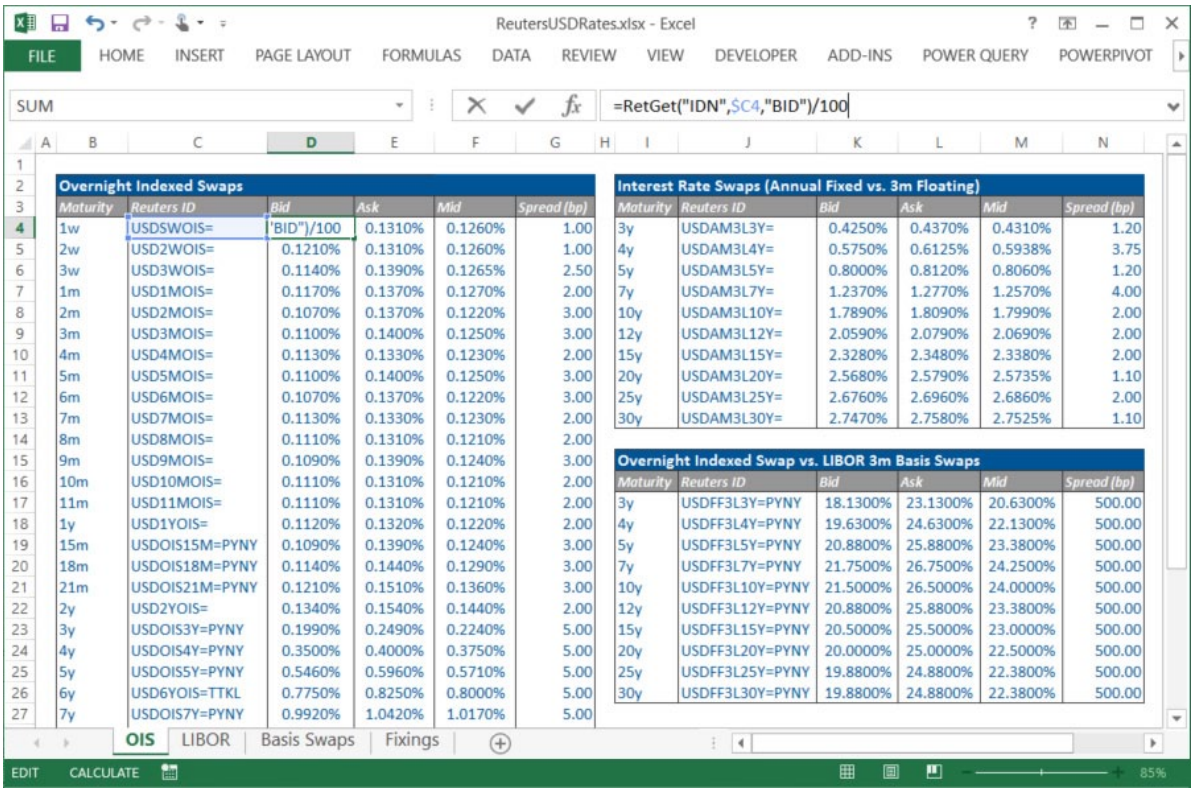

Figure 3 – Obtaining overnight indexed swap quotes from Thomson Reuters

Here a Thomson Reuters native API function has been used to obtain each quote, and more issues arise such as:

- Having a second data vendor requires a duplication of effort and introduces the same problems as the first one – including a different API and instrument/field naming convention.

- The bigger problem is trying to combine these if a user wanted to 'mix-and-match' the quotes based upon their own preferences or data vendor precedence order. Such a solution would only lead to larger, slower spreadsheets with more complex formulas – and bigger headaches for the risk managers.

3 Market Data Changes

As most of the quotes are obtained directly from the data vendor via spreadsheet formulas, to 'change' the value of any given quote there could be two approaches:

1) Change the instrument identifier or the field.

2) Keep the identifier and field the same, but create a mechanism in the spreadsheet to allow the user to override each quote with their own custom value, which would replace the data vendor quote as appropriate.

In both cases, you would still utilize the data vendor formulas to obtain the actual data. The problems with either approach are:

- **Data Changes** - If the identifier or field is changed in the data vendor formula, the original ones are lost unless a copy of the spreadsheet (or portions of it) is made prior to any changes, or the change is recorded in an adjacent cell or via a comment.

- **Visibility** - Whichever method is used, the changes cannot easily be seen without opening the spreadsheet. Furthermore, other users may not be privy to those changes and might have made similar (and different) changes.

- **Consistency** – With differing changes by users, you have a potential situation where users are in fact valuing their trades using inconsistent market data – it is extremely difficult to even detect this, let alone ascertain what those differences are without comparing spreadsheet content.

- **Consolidation** - Seeing a 'consolidated overview' of what each user has changed is therefore problematic and it would require much development effort to achieve a consistent, consolidated view for reporting purposes.

- **Complexity** - If users modify quotes that form part of a *custom index, curve*, *surface* or *cube* used for valuations it becomes even more difficult to find and explain valuation discrepancies because of the complexity of these business objects.

- **Audit** - Multiple changes compound the problem. The regulatory requirements being introduced globally dictate that any changes made to market data are centrally tracked for the easy generation of reports. These reports must identify each and every change made to any input data used for valuations.

4 Analytic/Calculation Changes

Many derivatives and OTC valuations may also require a layer of spreadsheet calculations on top of the market data quotes in preparation for trade valuations. For instance:

1) Synthesizing quotes for the long-end tenors (e.g. *40Y*, *50Y*) of some curves, because the data vendors may not supply any direct quote values for these – as they may not be available as market data.

2) Some curves also require quotes to be 'modified' from their raw values to include some kind of specific risk measure or adjustment to reflect market conditions more accurately[4].

As a result, we have to be aware of:

- **Calculation Changes** - Spreadsheet formulas offer us a flexible and powerful means of doing any calculations we wish on the market data quotes. However, like the quote data, there are regulatory issues, with the potential for inconsistent data and un-audited changes.

- **User Errors** - Formulas can be complex, being nested or involving lookups. It is easy to accidentally change something without realizing it thereby adversely affecting the results of calculations – small changes can be problematic to identify and subsequently correct.

- **Formula Audit** - Similarly, if changes are made, it is very difficult to know what was there before once the spreadsheet has been saved (unless copies are kept on the network somewhere), making comparisons difficult.

- **Inconsistent Analytics** - Any changes made are not easily available to other users, so again you run the risk of different users using inconsistent calculated market data elements (such as future convexity adjustments) in their trade valuations.

4 A good example of this is to add *convexity adjustments* to quoted future prices, which generally do not include them. Some data vendors provide these adjustments but many financial institutions like to do these calculations themselves so as to remain independent of the data vendor logic used, which may not be to their liking.

5 Data Persistence

A key issue with spreadsheet-based trade valuation is that once the market data has been obtained from a data vendor, that data 'lives' in the spreadsheet and not a centralized, managed database (i.e. it is self-contained within the spreadsheet). This has a number of problems:

- **Data Consistency** - The data cannot easily be shared with other users since it is only within the spreadsheet. Consequently, the only way they can see the data is to open the spreadsheet[5].

- **History** - An added complication occurs when trade valuations and models require historical data, such as *fixings.* Greater volumes of time-series data can make the spreadsheet become very large. As more history is added (if needed) the spreadsheet becomes even larger. Storing data in spreadsheets in this way is clearly not very efficient as they were not designed for use as databases.

- **Manual Maintenance** - As the sizes of time-series change - because business days have been added - rows are added to the spreadsheet and hence any formulas which access this data (e.g. for trade valuations) have to be continually adjusted to include these extra data points.

- **Errors** - Changing formulas is both manual and error-prone and failure to do so may result in, in this instance, the incorrect fixings being used in the trade valuations.

5 Spreadsheets were not really designed for multiple-user access of data and the user also has to know where the spreadsheet is on the network.

6 Data Fragmentation

Although spreadsheets, in combination with third-party analytics and valuation solutions, can provide a powerful and flexible means of trade valuation, there are other drawbacks in how they are used:

- A fairly large workbook is needed for the market data for each currency (e.g. *EUR*), where each set of quotes requires its own individual calls to the data vendor API. Subsequent calls to the analytics provider – to construct each of the required market data elements – reference a range of cells that contain the relevant quotes.

- These market data elements can be spread across multiple worksheets (not actually necessary but clearer).

- This method of construction, although extremely flexible, requires many nested spreadsheet ranges of different sizes, which is difficult to maintain.

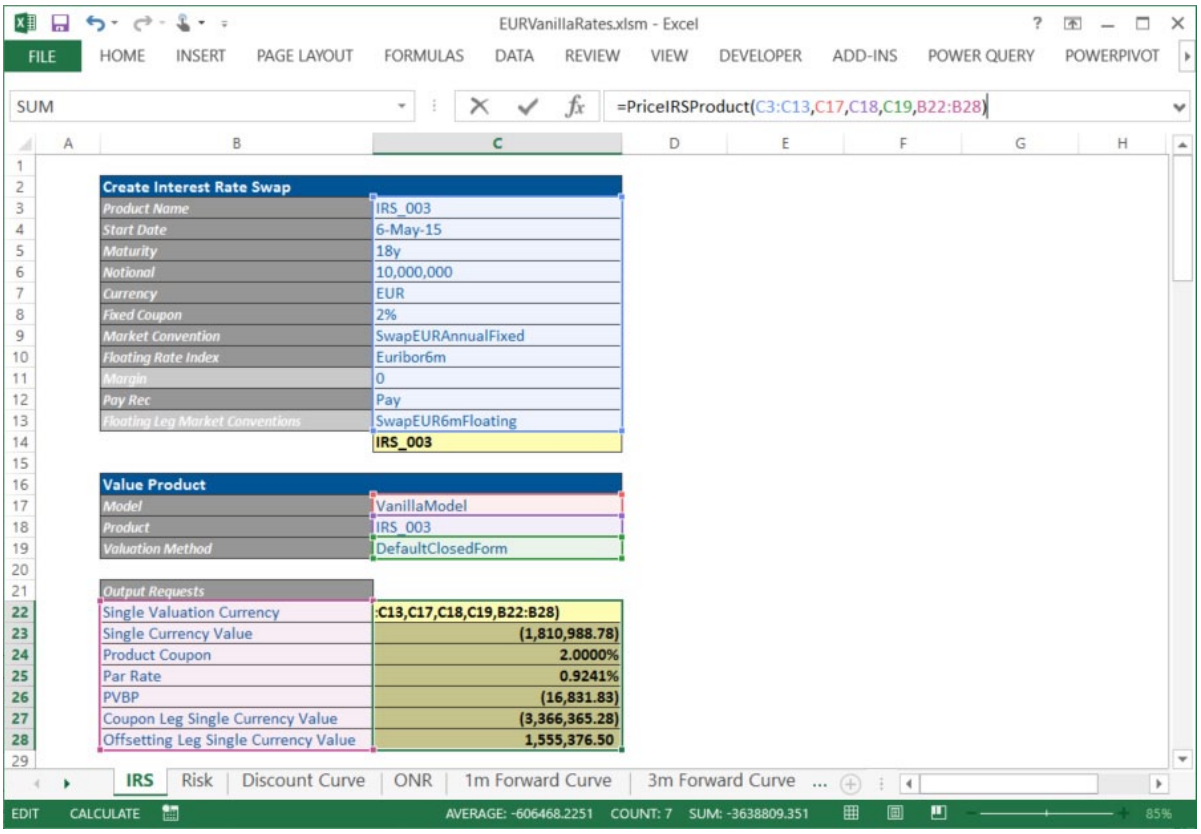

Figure 4 – An EUR IRS trade valuation

As an example, Figure 4 shows the valuation of an IRS. The terms and conditions are required, as is the relevant market data. Note that:

- Again, the spreadsheet offers a flexible and powerful means to value an individual IRS trade with all the additional features that this particular deal may require. It can however require multiple spreadsheets, the problem being compounded if we have a large number of trades.
- We also need a 'link' to the spreadsheet containing the market data, as all the calls to the analytics provider need appropriate layers to be built up in the correct way before the trade can be valued.
- If we extrapolate to having a basket (portfolio) of many IRS trades of different currencies, the collection of spreadsheets becomes even larger.
- We can see above the calculated trade value and other attributes. The fact that they are once again contained within a spreadsheet makes it difficult for us to consolidate these values with those of other trades without creating yet more formulas and workbooks to view the data in a more appropriate form.
- A separate but important issue is that the whole collection of spreadsheets is associated with only one business day. In many cases, we are interested to see how our trade values change over time, or calculate historical statistics on any attribute of any trade.[6]

6 Even if we saved yesterday's trade valuations (and the ones before) in a separate spreadsheet on the network somewhere, comparing these or doing historical calculations is extremely cumbersome and difficult and once again the data is not immediately and easily available for other users or downstream systems within the institution.

7 Conclusion

Spreadsheets are great tools, and if used well can form a very powerful and agile part of the ad-hoc analytical capabilities of any institution. However, they can be a significant source of operational risk and inefficiency, particularly if a “tactical” short-term spreadsheet solution rapidly transforms itself into a mission-critical risk and valuation engine that many departments become dependent upon.

This paper has outlined some of the specific, practical, and operational issues arising out of spreadsheet usage in instrument valuation. These include compliance and operational challenges relating to:

- Market Data Capture
- Market Data Changes
- Analytic/Calculation Changes
- Data Persistence
- Data Fragmentation

All of which form a fundamental part of how data is managed within the valuation process.

The over-use and mis-use of spreadsheets and end-user computing is something that regulators are increasingly aware of, to the extent that they are now addressing the issue explicitly in regulation to reduce operational risk, increase automation and improve underlying data quality. In order to face the challenges presented by these issues, business users and technologists need to find ways to deliver the agility and user-friendliness that spreadsheets offer, without the ever-present operational risks of their use. It is a big challenge, but one that if addressed successfully can unlock real business value.

About Xenomorph

Xenomorph provides trusted data management solutions to many of the world's leading financial institutions. The company has more than two decades' experience managing large volumes of complex data and analytics. Over that time, we have consistently reinvested in our technology, culminating in our latest generation enterprise data management platform TimeScape EDM+.

Our software is built to be future-proof. With our rules-based single-stack architecture, flexible data model, easily configurable workflow engine and integrated feature updates, TimeScape EDM+ empowers you to address any future requirements. It can be operated by business users without any prior programming expertise, which means it offers a truly agile and cost effective solution to address evolving business, regulatory and technology trends. The platform also excels at managing and validating model-derived data, thereby enabling firms to address their model risk management challenges by making sure inputs and outputs of business critical models are always validated and kept in sync.

For more information on Xenomorph, our clients, services and solutions, please see www.xenomorph.com.

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