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FRTB: A collection of thought leadership

From our financial risk analytics experts

Second edition

The long-awaited final version of the FRTB Market Risk Framework was published by the BCBS in January 2019. Banks should now be preparing in earnest for the incoming regulation. In our conversations with market participants we see three themes emerging:

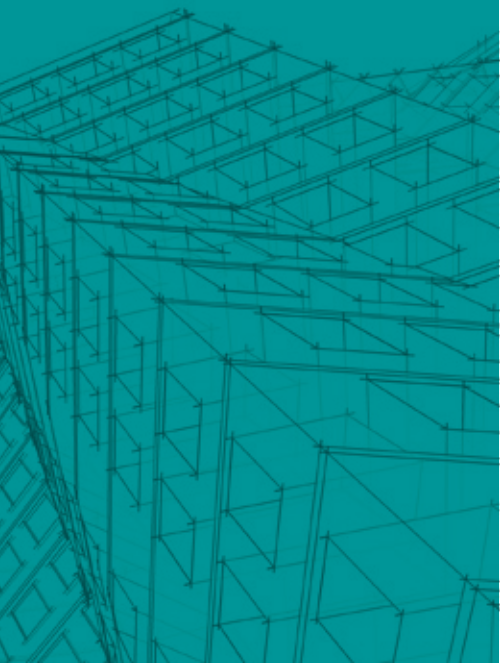
- FRTB is acting as a catalyst for the restructuring of banks' market risk architecture and a closer alignment with the front office
- The decision of whether to go with the IMA or the SA has not always been obvious. The new guidance provides significant clarity and some relief with respect to the potential impact of NMRFs, allowing banks to finally lock down their FRTB programs
- Data remains a key challenge. While the new guidance gives banks some leeway in passing eligibility tests, they will still need to maximize the availability of real price observations to manage the impact of NMRFs, either directly or via proxying.

In this second edition of our FRTB thought leadership booklet, we analyze some of the lingering questions and offer insights into possible approaches for FRTB compliance.

Dr. Andrew Aziz

Managing director and global head of Financial Risk Analytics at IHS Markit

To download the first edition of our FRTB thought leadership booklet, click here.



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Five Key Takeaways from our London FRTB Summit

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Following the publication of the final FRTB text by the BCBS in January, banks should now be preparing in earnest for the incoming regulation. And yet, questions remain. We thought the time was right to bring together regulators and market participants to debate some of the open issues and discuss the most pressing challenges. Hosting the discussion in London, we invited the Bank of England and European Banking Association along with the FRTB leads from J.P. Morgan, Santander, UniCredit, Standard Chartered and Lloyds Banking Group to discuss the path to FRTB go-live.

We were also joined by our client, ING, whose head of FRTB implementation gave a presentation on how our FRTB solution sits at the heart of the bank's risk architecture, helping them to carry out the Risk Factor Eligibility Test (RFET) and assess the impact of proxies on IMA capital alongside SA. The discussions were broad and varied, but five keys takeaways emerged:

- **The January 2019 FRTB text from the BCBS is final**
  Despite numerous revisions and postponements to the guidelines, the message was made loud and clear that the January 2019 text is indeed the final FRTB text. David Phillips, Head of Traded Risk Measurement at the Bank of England, confirmed this at the event saying, "The FRTB text is final and banks should not expect any additional changes. If there are future clarifications, it is expected to be in the form of FAQs."

- **Banks will be required to get model approval for "reporting requirements"**
  Some banks opined that they can manage with an approximation for IMA in the reporting phase. The assumption is that it is not binding and therefore they have more time to prepare their actual mappings, proxies, desk structure and PLA for when holding capital takes effect. However, Phillips refuted this assumption stating that, "We expect that banks will need regulatory approval to use internal models for the reporting phase; and they must start to work in earnest now to meet the timelines."

- **Cloud adoption will be common-place for reducing the cost of FRTB compliance**
  With all banks seeking to aggressively control costs, many are turning to off-premise solutions for risk factor management. For example, a bank with a bespoke RFET configuration can use a programmable SaaS to run the test off-premise while still maintaining full ownership of its IMA model.

- **NMRFs remain one of the biggest challenges for banks**
  With banks' trading operations already struggling to maintain risk-adjusted profitability under high capital requirements and infrastructure costs, the banks involved in our panel discussion agreed that they are looking for strategies to mitigate punitive NMRF-related capital. Our own research shows that a mix of data pooling and proxying can help banks manage NMRFs. Data pooling can increase the modellability of risk factors and lead to capital reductions of as much as 40%, while the use of proxies – where a risk factor is non-modellable – can deliver further capital savings. To read more on this topic, click here.

  A number of banks also highlighted the complexity of the EBA FRTB discussion paper published in March 2018 as an additional challenge.

- **Regulators expect a rational, rather than prescriptive, approach to FRTB compliance**
  Finally, during the event, Phillips said that, "While banks are concerned about what they can do, regulators are more concerned about what banks should do." The regulators do not intend to be overly prescriptive by explaining what banks need to do, but rather explain why they should do it.■

FRTB: The case for dynamic capital assessments

The Fundamental Review of the Trading Book (FRTB) will introduce unprecedented volatility to banks' market risk capital quotas. This diminishes the value of traditional point-in-time quantitative impact studies (QIS) as a gauge of firms' capital demands – as these can only provide snapshot calculations based on assumptions, which will vary in appropriateness as market conditions and model accuracy fluctuates.

Assessing desk- and firm-level requirements through these static lenses would undermine capital planning initiatives because they cannot account for the ebbing and flowing of capital consumption over time, nor permit the range of scenario testing necessary to inform the most efficient FRTB internal models approach (IMA) configuration and implementation strategy. One FRTB lead at a European bank says that "dynamic scenario analysis" would be the bank's preferred method of estimating its capital needs under the framework.

Interactive capital study frameworks

Thus, there is demand for a smarter analytical tool – namely an interactive capital study (ICS) framework capable of charting FRTB constraints on a dynamic basis. Through an ICS, banks can gain a comprehensive view of their resource requirements that considers the effects of assumption changes, varied data inputs, different desk configurations and internal model failures. It can also adapt to various iterations of the regulation, allowing firms to see how their capital demands would be affected by different calibrations of the regime. This is especially useful as no-one can guess how FRTB will be implemented across jurisdictions.

ICS frameworks equip firms with the means to restrain their costs and minimise the risks associated with their FRTB change programmes – saving time, money and effort.

"Many firms have a target risk architecture for FRTB, but to achieve this they are using a static QIS – which locks them into making decisions now that they can't validate," says Andrew Aziz, global head of financial risk analytics at IHS Markit. "We think it is suboptimal to do a static impact study based on imperfect data, then have to wait until implementation to know if it was the correct decision. It's much better to do dynamic assessments, considering several scenarios without becoming locked into a decision – particularly as certain aspects of FRTB may change," he adds.

Many firms have a target risk architecture for FRTB, but to achieve this they are using a static QIS – which locks them into making decisions now that they can't validate.

- Andrew Aziz, IHS Markit

A dynamic analysis is indispensable, considering the fragility of permissions surrounding the use of internal models. While firms have the option of applying an IMAto their trading desks – which should produce smaller market risk capital increases than those associated with the new standardised approach (SA) – the conditions under which this approach can be deployed are limited.

Model robustness is challenged on an ongoing basis through a new profit-and-loss attribution (PLA) test and value-at-risk backtesting. The failure of too many tests within a rolling 12-month period will force a desk off of the IMA and onto the more capital-intensive SA.

Even desks that clear these hurdles may attract punitive capital add-ons in connection with non-modellable risk factors (NMRFs). Indeed, a 2016 industry study demonstrated that these could account for 30% of total market risk capital for IMA banks.

The ability to assess how the balance of IMA and SA desks will shift over multiple time horizons – as certain portfolios move in and out of model eligibility – will allow firms to better judge where to focus their modelling efforts, and save resources squandered on desks unlikely to retain model eligibility over time.

Similarly, an ICS framework would offer an insight into model risk factors that are vulnerable to an NMRF downgrade – assisting decision-making related to risk factor proxying, which can markedly reduce the capital add-on burden. It could also take firms even further by providing a window into how certain modellable risk factors can degrade over time, allowing early warning of when add-ons will increase, and helping to visualise seasonality effects. This intelligence could in turn help firms fine-tune their FRTB calibration – by, for example, identifying critical risk factors for which model approval should be a priority, or earmarking desks where the NMRF burden is such that reversion to the SAwould be more capital-efficient.

“NMRFs are a big wild card, and you have to plan for different scenarios. Some businesses may survive and some may not – some may be borderline. You need flexibility to keep checking the viability of your plans,” says a head of analytics at a large North American bank.

Complementing existing infrastructure

Banks are hungry for these capabilities. But with implementation projects already in train, and calculation engines in the front and middle office already undergoing convergence in response to the demands of the PLA test, appetite for uprooting existing infrastructure is lacking.

IHS Markit is therefore promoting a solution that can leverage in-house calculation engines or vendor packages to produce an ICS.

"Banks have little appetite for expensive or risky projects. What we provide with an ICS leverages the sensitivities already used for front-office risk management, and can provide end-to-end workflow capabilities. These include everything from real-price observations – such as committed quotes, modellability assessments and NMRF proxying – to capital impact across IMA and SA. While we do have a risk engine as part of our offering, we are really focused on providing modular components that can be easily embedded within banks' existing ecosystems," says Aziz.

The industry will therefore converge around common methods of assessing desk modellability. This increases the added value of leveraging software-as-a-service type solutions to perform these assessments, as they can liberate resources in-house to work on those risk management tasks that actually sharpen a bank's competitive edge.

"What we've done with our service is build an application programming interface layer that allows firms to be completely proprietary with how they develop risk factor proxies and generate scenarios, but at the same time is largely turnkey. That combination of features doesn't exist in bank infrastructure today – which is why IMA is becoming too expensive for many banks," says Paul Jones, global head of FRTB solutions at IHS Markit.

What we've done with our service is build an application programming interface layer that allows firms to be completely proprietary with how they develop risk factor proxies and generate scenarios, but at the same time is largely turnkey.

- Paul Jones, IHS Markit

↘ This article originally appeared on Risk.net as an IHS Markit sponsored article.

Final FRTB text: Is the light finally green for modellability?

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The alarm around non-modellable risk factors seems to have faded in the long-awaited final version of the FRTB Market Risk Framework published by the BCBS on January 14. But do the numbers support it?

As a reminder, the original FRTB framework required risk factors to be observable 24 times a year and at least once a month to be eligible for expected shortfall under IMA. The industry (and our analyses) quickly demonstrated that the binding constraint was the gap requirement (once a month) rather than the count of 24 – which had some firms wondering whether they would have to reschedule their traders' holiday calendars. There was even talk of abandoning seasonal markets such as credit. In a previous post we called this unintended consequence the "FRTB Scrooge of Christmas" effect and the industry lobbied for a relaxed gap criterion of three observations every 90 days.

On the face of it, Basel's response is pretty accommodating by offering the following optionality: either the risk factor is observable 24 times a year and at least four times in 90 days or it can pass by achieving 100 observations in a year. At IHS Markit, not only are we fortunate enough to have tens of millions of cross-asset Real Price Observation (RPOs) across Interest-Rates derivatives, Credit Derivatives, Bonds, Equities and FX (and that's before any additional pooling from the banks), but we also have the analytics infrastructure to run such studies on the fly. This article will thus attempt to quantify the regulatory option and explore the fruits of industry advocacy.

Our data shows that the second leg of the criteria (100 observations in a year) has virtually no impact in terms of reducing the number of NMRFs for alternative 2 (using the regulatory buckets). So instead we will focus on the change in the original gap criterion: one per month became four in 90 days. As previously, this affects risk factors passing the count but failing the gap (the ambers of our RAG coloured heatmaps!).

As rates dominates capital for most firms, we thought we'd start there: unfortunately, only 13 out of 379 (i.e. 3.5%) Interest Rate fixing tenor risk factors now pass the RFET where they previously didn't (Amber). Examples include the long end of CZK.3m and PLN.3m curves and a few middle buckets of HKD.1m, SGD.6m.

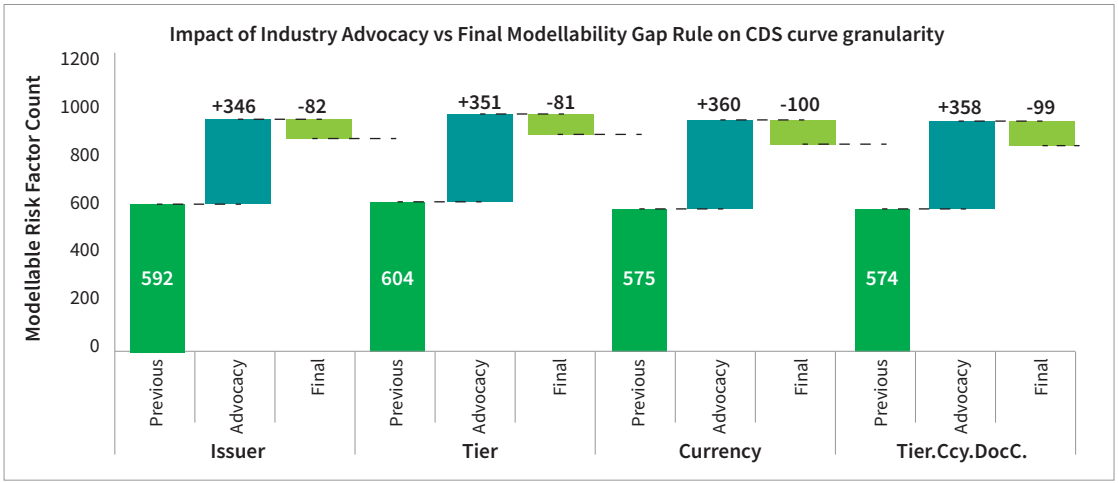
However, the improvement is quite significant on markets suffering from structural or behavioural seasonality such as cash bonds or CDS. Below is the result of a study on the aggregate CDS single names and cash bond universes respectively.

Out of 3.2k traded CDS issuer buckets, the 592 previously modellable ones are joined by another 264 amber risk factor buckets to achieve 26% overall modellability.

The next question is what level of granularity is required to pass PLA: is issuer-level sufficient? Predictably, the lower the granularity, the lower the modellability pass rates: when combining issuer, currency and doc clause, overall modellability falls to 19% under the final rules (vs 13% on the previous rules so still an improvement!). Alternatively, banks have the option to capitalise just the basis between non-modellable issuer curves and modellable country/sector/rating curves – which we will explore in a later article.

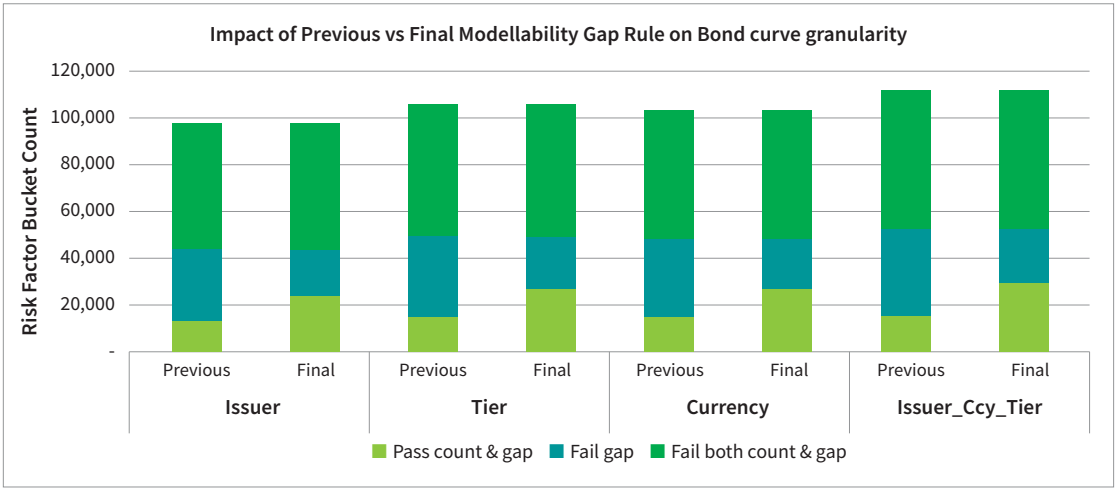
This is all well and good in terms of improving the previous version of the FRTB framework but does it live up to industry lobby expectations? Originally the industry proposed a gap criterion of three observations in 90 days. Could one more observation per quarter have made a material difference?

For our 3.2k traded CDS issuer buckets, of which the modellable sub-set is shown below, the answer is a 3% modellability decrease between three and four in 90 days. The graph below demonstrates how this varies with the granularity of the CDS curves.



In the much larger cash bonds universe of over 100,000 issue-maturity risk factors, the previous rules yielded roughly 14% modellable risk factors whereas the new gap criterion achieves a whopping 25% MRF. This jump of almost 80% can be seen by the increase in the height of the green bars in the graph below.

Clearly the materiality from a capital perspective of this will be very desk and portfolio specific. It will also depend on the risk factor configuration in the planned IMA model. For banks to make the right decisions, not least on whether to go for IMA for a given desk, it is crucial to capture the benefits of proxies which can constitute a significant portion of capital via the SES NMRF charge. Our experience suggests that a surprising number of firms still lack sufficiently realistic assessments of the full IMA round-trip and risk which can lead to sub-optimal and even irreversible decisions around development or model approval.■



FRTB: The road to IMA

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"Buy the rumours, sell the facts" is normally a good trading strategy. It plays nicely to the human bias that the Roman senator Tacitus described as "omne ignotum pro magnifico est" or "everything unknown is taken to be magnificent". But deciding a bank's overall trading book desk strategy based on the unknown does not sound magnificent at all. This is arguably the position many banks find themselves in today when making decisions related to the Fundamental Review of the Trading Book (FRTB).

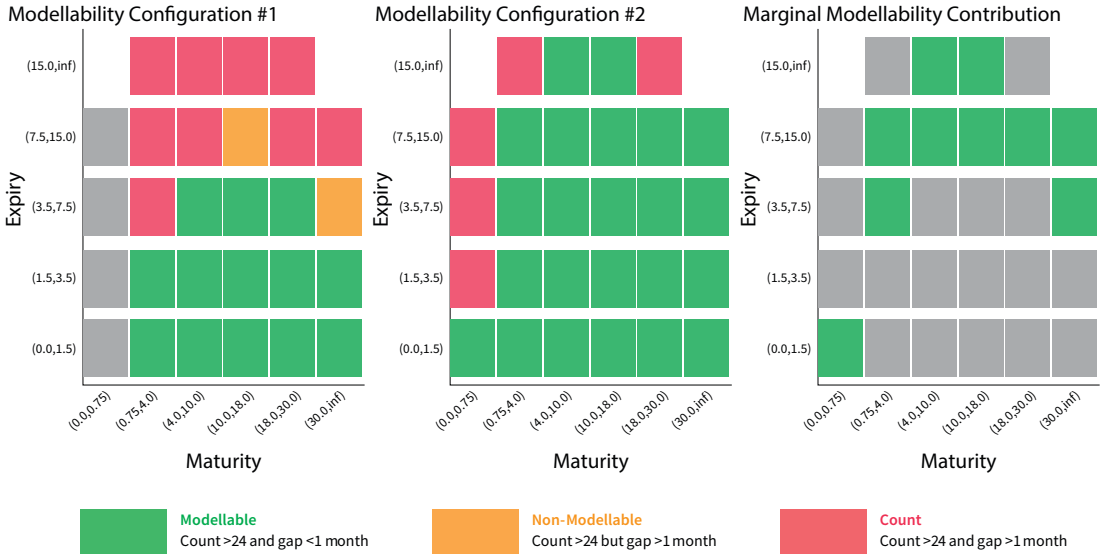
The road to FRTB's Internal Model Approach (IMA) is a complex one with many directional decisions to be made along the way. To avoid taking a misguided turn towards the Standardized Approach (SA), banks need to start using the biggest and best data available in the market ("facts") and not rely on just their own data or data they collected from publicly available sources alongside "expert judgement" to fill the gaps ("rumours").

Nevertheless, in meetings with banks, a common theme surfaces time and time again: in their modellability status reviews, banks are mostly leveraging their in-house data coupled with expert judgement. This means that fundamental decisions – including the most material decision of whether trading book risk should be computed on IMA or SA – are being made using hand-drawn maps and a good deal of guesswork.

Based on these limited data sets, a significant number of tier two and regional banks, as well as some larger ones, are seriously contemplating opting for SA, as their findings show the overall cost of IMA compared to the capital savings generated by this approach is not justified. This is typically due to high SES (Stressed Expected Shortfall) charges stemming from having too many non-modellable risk factors (NMRFs).

Studies show that data pooling can reduce the number of NMRFs when compared to a single bank view, whether that be from a global or regional institution. This is true across different asset classes, different instruments and different underlying assets, even the most liquid ones, as illustrated in Figure 1 below in the EUR swaption modellability picture.

Figure 1: Modellability analysis of a bank's own transactions versus a pooling approach



Source: IHS Markit

Some argue that banks are talking up the option of going SA as simply a tactical ploy; part of a wider strategy to force regulators into relaxing the FRTB requirements, especially around the PLA test and NMRFs.
A stronger argument for the move to SA is the operational running costs: it is easier and cheaper to run than IMA. FRTB has a long history of uncertainty around the go-live date, so convincing management to unlock substantial budget is difficult; there are usually bigger or more immediate fish to fry.

In addition to the question of "Is IMA worth the investment?", for larger banks there is a second (and often-ignored) question of "Can we afford NOT to invest in IMA?"

Imagine a scenario involving two banks with similar activity and risk profile where one uses just its own data for analysis and decides to go SA, while the other uses a global pool of data and decides to go IMA. From that point onwards, the playing field is no longer level.

The risks to individual institutions and the system as a whole are not trivial. Banks moving away from IMA will incur reputational risk which could impact relationships with investors and supervisors. However, many banks moving together creates an undesirable clustering effect and an impairment to market liquidity.

While crowded trades are traditionally attributed to buy-side firms, a mass movement to SA could cause it to spill over to the sell-side as well. Discussions regarding systemic risk stemming from crowded trades in the CCP context have already emerged in recent years; if too many banks find themselves using the same prescribed risk methodology, concentrating their positions on a smaller set of risk factors, the road to a new systemic risk could open up.

Another unwelcome consequence of too many banks going SA is the "opting out" of different markets that they were traditionally active in. This will reduce banks' appetite to inject liquidity into the market during periods of turbulence or stress. If previous liquidity crises were characterized by a genuine lack of funds, could the next liquidity crisis be a result of banks' lack of ability or desire to deploy the funds at their disposal?

In conclusion, capital cost, running costs, reputational risk and systemic risk all need to be considered in the context of the final FRTB text due to be published later this month. Banks will have to shift gear very soon, starting with an overall assessment of their firmwide risk capital model and moving quickly to nominating which trading desks are in scope for IMA and which are not. Deciding on the direction of travel based on rumours rather than facts might be easier in the short-term, but ultimately could lead to a long and painful road-trip.■

The capital impact of proxy choice

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The Fundamental Review of the Trading Book (FRTB) rules require banks to decompose risks into (and hold capital against) risk factors, or exogenous characteristics that cause changes in position values. The standards provide a definition of what makes a risk factor "modellable" for capital purposes, with non-modellable risk factors (NMRFs) requiring extra capital to be held. Last year's ISDA quantitative impact study found that this add-on could account for some 30% of total market risk capital. With bank trading operations already struggling to maintain profitability under high capital requirements from Basel III, tough business decisions will need to be made unless they can find ways to reduce the capital impact of FRTB to maintain profitability.

Current efforts are focused on exploring reductions in NMRF-related capital. Increasing available data can also increase the modellabilty of risk factors and reduces capital. IHS Markit previously published research that demonstrated how external transaction data can be combined with a bank's existing, internal data sets to increase modellability of risk factors. This in turn led to capital reductions by as much as 40% through the reduction of non-modellable risk factors. However, even using external data, the impact of NMRF remains significant, leading banks to look for other ways of reducing the number of non-modellable risk factors.

One area worth exploring further is the use of proxies where modellability data for a risk factor is unavailable. We have assessed two such options for deriving proxies for risk factors and the capital impact of these choices. The two methods tested were:

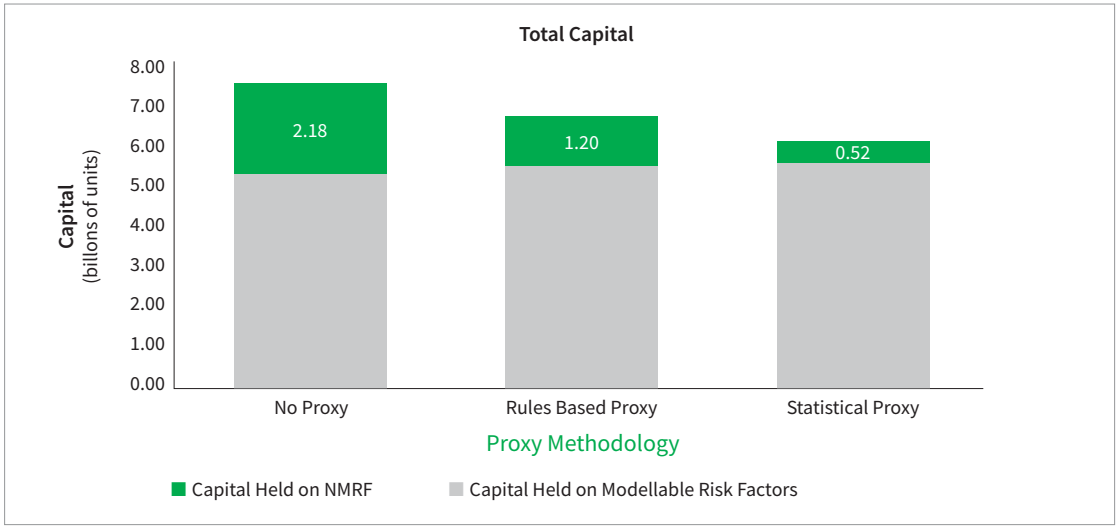
1. Simple rules-based approach

2. Statistical modelling approach

Under the first approach, the proxies are created using rules to find the closest modellable tenor from the interest rate curve. The "closest fit" modellable risk factor is then used to proxy the non-modellable risk factor.

Under the second approach, a statistical model looks to ascertain the best proxy by looking for the most correlated risk factors and using data from that modellable risk factor as a proxy for the non-modellable risk factor.

The research uses IHS Markit's internal data and a hypothetical swaps portfolio, as in the prior study.



While both approaches have merit in their transparency and auditability, our research to date shows that the second method delivers the best overall proxy, as well as the greatest capital savings. In the example above, using the rules based approach reduces capital by 11%. However, the statistical modelling approach produced a 19% saving in capital.

As these results will likely vary when applied to different asset classes, work will need to be done to understand the differences in these two methods by instrument type. We are already expanding the research into different asset classes to ensure the results hold true and to explore further the effects of the assumptions made in the two methodologies. However, what's clear is that using proxies and the selection of the proxy methodology can have a significant impact on NMRF capital charges. Given the earlier ISDA findings, this is clearly an area of research worth pursuing.■

Forgotten but not gone: NMRF proxies and the struggle for accurate QIS and capital efficiency under FRTB

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The non-modellable risk factor (NMRF) requirements under the Fundamental Review of the Trading Book (FRTB) continue to keep risk managers awake at night. With banks' trading operations already struggling to maintain profitability under high capital requirements from Basel III, firms are looking for strategies to mitigate punitive NMRF-related capital while also meeting the FRTB guidelines.

Since the Basel Committee first announced the FRTB requirements in 2016, we've been undertaking research on the impact of NMRFs and proxying. We've observed that most banks, despite participating in recurrent regulatory QIS (Quantitative Impact Studies), have little ability to assess the real impact of proxies on capital, given that their infrastructure is still largely configured for Basel 2.5 and existing prototypes do not necessarily provide an end-to-end view.

That is why we have designed our infrastructure to run "interactive capital studies" to measure the impact in IMA capital terms of switching NMRF data sources (for instance between internal transactions and pooled real price observations), as well as changing risk factor taxonomy or granularity (including approaches to risk factor bucketing) or even changing NMRF proxy selection methods.

These interactive capital studies have also helped banks assess the relationship between their own capital and proxies choices, as well as other subjective FRTB-related decisions. We've found that their understanding of the relationship between capital and desk structure, NMRF data sourcing and definition, or advocacy focus is approximative at best. Why are banks finding it so difficult to estimate the capital impact of such central IMA configuration decisions?

The complex nature of NMRF proxies

Proxies have been used by banks to substitute returns and back-fill historical data since risk models were first invented. NMRF proxies are, however, far more complex to implement and far more important to get right as they drive capital. Banks have to contend with the complexity of the actual ES calculations (up to 63 partial runs) and SES calculations. When introducing proxies, they also need to calculate the SES charge using a stress test applied to the basis between the original NMRF and its modellable substitute.

Depending on the proxy choice itself, banks may also add new (modellable) risk factors to ES which may impact PLA and back-testing. Needless to say, this requires more data when selecting proxies in a larger universe than the risk factors driving the actual portfolio. The data required to calculate the risk on the actual portfolio under FRTB will in turn be greater than Basel 2.5 as firms work to improve "risk coverage" to pass the PLA test.

Regulatory uncertainty is another key dimension which banks must grapple with. A good example is the debate triggered by the publication of the EBA discussion paper on 18 December 2017 which could impact both implementation and capital costs materially.

The benefits of getting proxying right

Given that NMRF proxies are so complex to implement, we have a dedicated stream of research on exploring their potential. It has led us to draw three main conclusions:

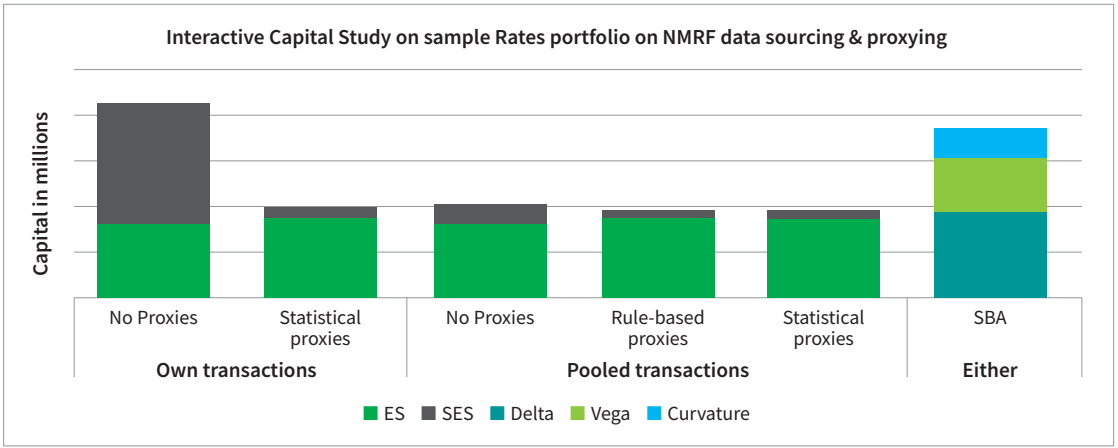
- **Data pooling* can increase the modellability of risk factors and lead to capital reductions of as much as 40%.** See our previously published research on the topic. *Combining external real price observation data with a bank's existing, internal data sets

- **The use of proxies – where a risk factor is non-modellable – can deliver further capital savings**

- **The selection of the proxy methodology can have a significant impact on NMRF capital charges.** According to our research, a statistical modelling approach to proxying produced a capital saving of 19% compared to a saving of just 11% for the simple, rules-based approach. See page 10 of the following document for more detail.

[1] Risk.net, FRTB: banks grapple with hard-to-model risks, 9 February 2018

In one of our studies, we compared the impact of data pooling and proxying on the IMA capital charge of a sample rates portfolio. The findings were somewhat surprising in that the impact of pooling transaction data across multiple participants was not as significant as applying a sophisticated NMRF proxy approach on the un-pooled dataset. The chart below shows the results:



The statistical proxy technique shown in the second and fifth bars represents an upper limit to the capital saving achievable through proxying and may not be appropriate for all banks. However, the analysis illustrates that there are several routes available for banks to improve on the "risk sensitivity" of their proxies and hence improve the capital efficiency under the FRTB.

With Basel policymakers meeting recently to discuss possible revisions to the identification and capitalization of NMRF , there is still hope amongst risk managers that the NMRF framework will be softened. However, revisions are unlikely to be extensive, so banks should start looking for a Plan B. Carefully constructed proxies for NMRF are perhaps one underexplored area that has the potential to save the day.

This discussion has also glossed over the added complexity when tackling asset classes with inherent challenges under FRTB combined with poor liquidity, such as CDS, which we will cover in a later blog post.

FRTB Decision Making – The Data Quality Paradigm

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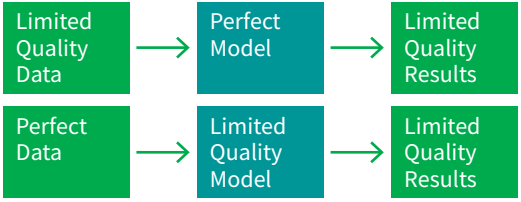
The idiomatic phrase "Garbage In, Garbage Out" still rings true 60 years after it was first coined. It has expanded from the world of computer science to encompass the wider remit of decision-making and the poor decisions made due to inaccurate, incomplete or inconsistent data. It is a concept that goes right to the heart of the main challenges associated with the upcoming Fundamental Review of the Trading Book (FRTB) requirements.

When we talk about "data quality" in the context of the decision-making process, is it just about having access to good quality data sources or is it also about how data is processed? As Ronald Coase says: "If you torture the data long enough, it will confess"; in other words, bad data processed by the "proper" model may result in an answer, but it won't necessarily be a very reliable answer or indeed the answer expected.

Another way to look at this "data quality paradigm" is as follows:



Bill Coen, Secretary General of the Basel Committee on Banking Supervision (BCBS), recognized the data quality issue in the context of FRTB during the ISDA conference in April 2018 when he said:

"…. The Committee has conducted many quantitative exercises on market risk, both before and after the publication of the market risk framework, with a QIS exercise currently under way. While the quality of data submitted by banks has improved over time, data quality concerns remain. Thus, a significant proportion of banks' data has been excluded from the Committee's analysis. … as a result, the Committee has in some areas been left with a small sample of observations to finalise certain outstanding revisions. ….".

When Coen (and others) talk about data in the FRTB context and more specifically in the context of non-modellable risk factors (NMRFs), they most likely mean Real Price Observation (RPO) data. However, RPOs alone do not portray the full picture. Through the omission of reference data and relevant market data, an incomplete data set is created. Enrichment of the transactional data is therefore vital to enable better classification and enhance accuracy, which in turn unlocks meaningful modellability test results.

And what did Coen mean when he mentioned quality concerns? Data quality has multiple dimensions: accuracy, completeness, consistency, uniqueness,

timeliness, staleness and conformance. It is most likely that the BCBS encountered a myriad of quality issues likely touching upon most of the dimensions mentioned above, reinforcing the point that quality is never a one-dimensional definition.

It is therefore not surprising that the BCBS had to exclude "a significant proportion of banks' data" when conducting quantitative exercises on market risk. Clearing data is a good example of just one element of the data reporting conundrum. It is no secret that there is no standard for the reporting of clearing data. This has a knock-on effect on downstream reporting and probably explains why the BCBS struggled to make sense of the data reported by the banks. It is just one manifestation of the data aggregation and reporting issues within the banking system, identified by regulators in the post-crisis era.

For some use cases which require higher level reporting or trend analysis, clearing and trade repository data can be of great value. However, the strict modellability criteria for FRTB (the 24 RPO count and one-month gap or whatever the rules stipulate in the final text) and the clear requirement to provide evidence to supervisors cannot be based on subjective assumptions; both the input data and the data models must be robust and traceable.

So, by putting data and quality back together in the context of FRTB/NMRF, the solution for the NMRF challenge should not just be a measurement of RPO count but a more holistic data governance approach covering the following areas:

- RPO coverage from the perspective of unique underlying assets as well as total count;
- Reference data comprehensiveness and accuracy of the pricing data used to enrich and better classify the RPO data;
- A data model to validate and normalize the data as well as deal with events such as errors in deal capture (fat finger), early terminations (partial or full) etc.;
- Data dictionary / transaction taxonomy to ensure consistency, uniqueness and completeness of the data to allow accurate mapping of the RPOs to risk factors;
- Committed Quotes: Are RPOs, both pre and post, treated homogeneously or are committed quotes being treated differently;
- Timeliness of the service: Is it an EOD service or does it take T+2/3 to reconcile and process the data?
- Is the pool of RPOs based on inventory or single evidence of trade?

The pursuit of good quality data is an ongoing struggle for most banks; this pain is amplified tenfold when trying to pool and amalgamate multiple sources (such as bank submissions, exchanges and trade repositories). Banks realize that relying on just their own trading activity can only take them so far, leaving them with a large universe of NMRFs. The BCBS acknowledged as much in its March 2018 Consultative Document by emphasizing the importance of pooling in mitigating the NMRF challenge. Participating in a pooling scheme is no longer a nice-to-have but a must-have. Therefore, banks requiring third party data to help them with their NMRF challenge must look not only for "good data" but also for good data models and processes as they have become ever more paramount.

In conclusion, with the final FRTB text due to be published shortly, banks are now re-energizing their FRTB programs and starting to work in earnest on their IMA plans. This will require them to make countless decisions and in this decision-making process, the scarcest commodity will be good quality data. The data quality paradigm of Garbage In, Garbage Out will force banks to make the acquisition and processing of reliable data a top priority. And time is short: too long a delay and the paradigm will mutate and become "Garbage data in, Garbage decisions out".■

FRTB: Sparking new approaches for big data analytics

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The introduction of the Basel Committee's Fundamental Review of the Trading Book (FRTB) standards involves a comprehensive overhaul of banks' market risk capital frameworks. The move from value-at-risk (VaR) to scaled expected shortfall (ES) in order to capture tail risk will significantly increase the number and complexity of the capital calculations that banks need to undertake, as well as the sheer volume of data to be managed.

From a computation perspective, this means that P&L vectors need to be generated per risk class, per liquidity horizon and per risk set. Removing the redundant permutations brings the total number of P&L runs to 63 (some of which can be done weekly), compared to two (VaR and Stress VaR) in the current approach.

Firms are faced with the challenge of performing a significantly increased range of FRTB capital calculations at scale while also managing their costs and risk. The question is: are banks' current IT risk infrastructures up to the task ahead?

If banks want to achieve proactive and intraday risk management while also effectively managing their capital over the long-term, they will require high-performing IT infrastructure that can handle the intensive calculations required. However, many banks today rely on technologies such as relational databases and in-memory data grids (IMDGs) to conduct risk analytics, aggregation and capital calculations.

IMDGs work by replicating data or logging updates across machines. This requires copying large amounts of data over the cluster network, which has a far lower bandwidth than that of RAM. As a result, IMDGs incur substantial storage overheads, are sub-optimal when applied to pure analytics use cases, such as FRTB analytics, and are expensive to run.

In short, banks' legacy IT architectures will need a significant overhaul when it comes to FRTB and firms are looking for alternative options. One of those options is Apache Spark, an open source processing engine built around speed, ease of use and sophisticated analytics.

Spark has a distributed programming model based on an in-memory data abstraction called Resilient Distributed Datasets (RDDs) which is purpose built for fast analytics. RDDs are immutable, support coarse-grained transformations and keep track of which transformations have been applied to them. RDD immutability rules out a big set of potential problems due to updates from multiple threads at once and lineages that can be used for RDD reconstruction. As a result, check pointing requirements are low in Spark. This makes caching, sharing and replication easy.

These are significant design wins. There are other advantages over IMDGs too:

- **Memory optimisation:** IMDGs require the entire working set in memory only and are limited to the physical memory available. Spark can spill to disk when portfolios do not fit into memory making it far more scalable and resource efficient.

- **Efficient joins:** IMDGs have fixed cubes and cannot do joins across datasets which limits flexibility. Spark supports joining of multiple datasets natively. This allows reporting using different hierarchies and analytics using other reference data without the need for a new cube and additional memory. Joins are very performant as Spark does a broadcast behind the scenes of smaller datasets. Broadcasts are based on a peer-to-peer BitTorrent-like protocol.

- **Polyglot analytics:** Spark supports custom aggregations and analytics which can be implemented in a variety of languages: Python, Scala, Java or R compared to the limited SQL or OLAP expressions possible with IMDGs.

- **Multi-tenant support:** Spark supports dynamic resource allocation, resource management, queues and quotas, allowing multiple users and processes such as operations reporting, decision support, what-if and back testing to be supported on the same cluster.

- **Frugal hardware requirements:** The immutable nature of RDDs enables Spark to scale and provide fault tolerance efficiently. A Spark cluster is highly available without the need for Active-Active hardware.

In fact, our own studies have demonstrated many of these capabilities, highlighting the power of Spark in terms of performance, scalability and flexibility. For example, we recently completed a proof-of-concept with a European bank, which showed that our capital analytics and aggregation engine can support the FRTB capital charges for IMA and SA in single digit seconds. This is based on a portfolio of one million trades with 9 million sensitivities, 18 million P&L vectors and on hardware costing just USD20k.

As one of the most active projects on the Apache platform, Spark benefits from thousands of contributors continuously enhancing the platform. In fact, we've seen a 20% improvement in Spark aggregation performance year-on-year since we started building our solutions on the platform in 2016. We're excited to see the improvements that are bound to come in the year ahead!■

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IHS Markit (Nasdaq: INFO) is a world leader in critical information, analytics and solutions for the major industries and markets that drive economies worldwide. The company delivers next-generation information, analytics and solutions to customers in business, finance and government, improving their operational efficiency and providing deep insights that lead to well-informed, confident decisions. IHS Markit has more than 50,000 key business and government customers, including 80 percent of the Fortune Global 500 and the world's leading financial institutions. Headquartered in London, IHS Markit is committed to sustainable, profitable growth.

About Financial Risk Analytics

Financial Risk Analytics delivers information-centric capital markets and risk solutions for trading desks and middle office functions supporting risk regulatory compliance, intra-day stress testing and what-if analyses.

We offer a suite of solutions for FRTB, which enables banks to comply with the new Basel market risk requirements by supplementing their existing infrastructure and processes. The solutions are designed to shorten FRTB implementation programmes, reduce execution risk and cost, and help firms manage the capital impact of the regulation. They can be implemented on a standalone basis to address specific aspects of the requirements or in combination with one another to provide end-to-end support for FRTB.

For more information, please visit our website http://www.markit.com/Product/FRTB-Solution-Suite or email one of our experts included in this booklet.

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