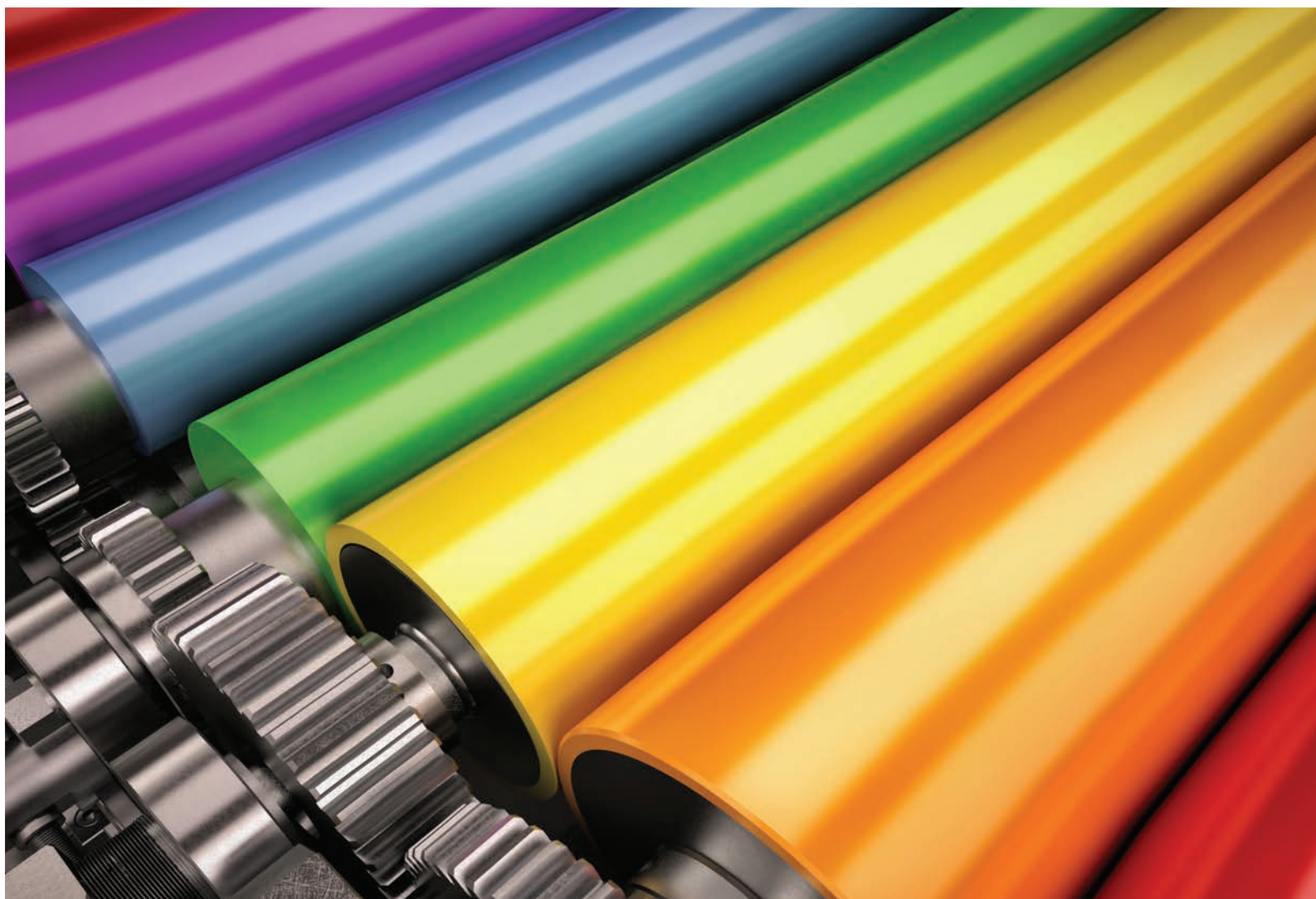


Fundamental Review of the Trading Book (FRTB)

Risk.net October 2016

Special report



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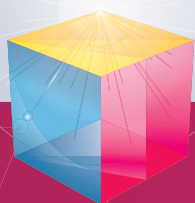
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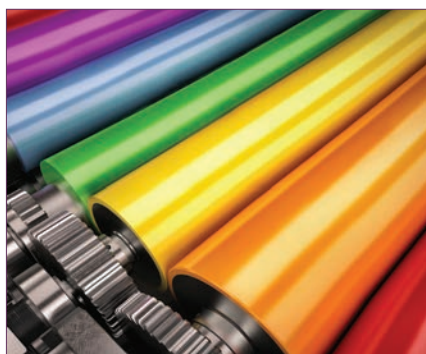
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FRTB

A work in progress

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When the Basel Committee on Banking Supervision completed its *Fundamental Review of the Trading Book* (FRTB) in January 2016, the hard work began for the banks. In practice, the final rules for each jurisdiction have yet to be drafted, and there are still many fine points that need clarifying to facilitate implementation.

At the time of writing, the industry is waiting on a frequently asked questions (FAQ) document from the Basel Committee to provide some of that clarification. Even a brief and incomplete list of questions is daunting. Most important is the profit-and-loss (P&L) attribution test, discussed in a feature on pages 4–7 in this report. This test decides whether banks can use their own internal models to calculate market risk, or whether they must revert to the regulator-prescribed sensitivity-based approach (SBA). Industry studies suggest the SBA will lead to a capital charge 2–6.2 times higher than the internal models method. Yet the final FRTB standards presented two different ways of carrying out the P&L attribution test, and banks need to know which one will apply.

Further questions surround the concept of immaterial risks mentioned in FRTB. Banks face a capital add-on for any risks they are unable to model due to lack of data. Often those risks are a very small part of the bank's trading book to which they are rarely exposed – hence the lack of data. So banks are hoping that an exemption from calculating capital requirements for risks deemed immaterial could reduce the size of the capital add-ons. But again, the Basel FAQ may shed more light on whether this is acceptable.

Even the raw materials for calculating market risk capital – market prices – are in question. FRTB requires banks to input 'committed quotes' into their risk models but, as yet, there is no firm definition of what qualifies as a committed quote.

This question shows how FRTB may extend the reach of prudential regulation beyond the banks themselves. Dealers typically source much of their market risk data from third-party vendors. The cost to the bank if data proves unreliable – potentially, the loss of approval for internal model use and the resulting increase in capital requirements – could be substantial.

Vendors are already responding to the challenge and looking to work with clients to ensure a level of data integrity that can pass muster with supervisors. There are also initiatives to pool market risk data among banks, but these must overcome dealers' natural concerns over sharing proprietary and market-sensitive data with competitors.

The systems needs, even for the standardised SBA, are particularly burdensome for smaller players. The European Commission has consulted on whether to apply FRTB at all to banks with limited trading desk operations, and industry associations report similar concerns among investment banks in emerging markets.

This may prompt smaller players to hesitate before beginning FRTB implementation projects. But with the Basel standards due to enter into force from the beginning of 2019, no-one can afford to wait too long to start their preparations. As several of the contributors to this report outline, the scale of the transformation is considerable. Alongside the trading desks themselves, risk, finance and technology divisions will all be drawn into the mix. Even if we do not yet know every minute detail of the final regulations, banks will need to identify today the tasks they must perform – and the resources required to perform them – to be ready for 2019.

Philip Alexander, Desk editor, Regulation

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No way out

The road to FRTB compliance

Banks must construct a new IT architecture to support the burden of FRTB regulation. But the pain of delivering new systems and ways of thinking can be eased if vendors and consultants collaborate



4 P&L attribution

The P&L attribution mess

8 Modelling

Banks warn of FRTB internal model approval gridlock

10 Adjoint algorithmic differentiation

Banks fear costs from loss of AAD under simpler FRTB rules

13 Sponsored feature

Regulations, sensitivities and adjoints

Using AAD for FRTB and FRTB-CVA

AAD has performed effectively and at lightning speed in regulatory calculations. With questions about its use largely resolved, support for AAD-based methodologies is growing



14 Q&A

Lining up the fundamentals

Companies must build proactive and flexible structures to handle a vast increase in market data, says our panel of market risk experts on the practical implementation of FRTB

23 Sponsored feature

Land of confusion

FRTB and the calculation burden

There are more questions than answers when it comes to FRTB. But banks cannot wait for clarification – they must stop running parallel processes and press ahead with their preparations



25 Sponsored feature

The decentralisation trap

The FRTB standardised approach

The standardised approach may seem simple enough, but front-office tools will require continuous attention to ensure complete capture of sensitivities



26 Sponsored feature

Attribution of risk measures for improved risk and capital control

Higher capital requirements from FRTB and stronger risk aversion are making capital a scarcer resource and managing firm-wide risk is becoming more critical

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Blueprint for FRTB

Building a future-state business strategy

There are no silver-bullet solutions to the myriad challenges of FRTB. Institutions should restructure and re-strategise with an eye on the business impact in years to come



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Freeing up the front office

Desk heads take on new risk responsibilities

FRTB risk programmes should be split into analytics, data and computation components, and front-office desk heads must act like business leaders and assume the daily tasks of reducing complexity and cost



No way out

The road to FRTB compliance

Banks must construct a new IT architecture to support the burden of FRTB regulation, says Bruno Castor, head of market risk at Murex. But the pain of delivering new systems and ways of thinking can be eased if vendors and consultants collaborate

Following publication of the final version of FRTB by the Basel Committee on Banking Supervision, many banks have reviewed their systems and infrastructure, and launched large IT programmes to comply with the regulation before the first reporting deadline of December 2019.

It has quickly become apparent that the implementation of such regulation cannot be achieved with a mere systems upgrade. In most cases, FRTB requires a major overhaul of the systems architecture, as well as a complete revamp of data integration, processing and management. In addition, FRTB hangs a large question mark over the integration of internal quantitative models for pricing derivatives in trading and risk management applications. This article aims to describe the largest challenges that banks are facing on their path to FRTB implementation, and the areas in which banks may need help from consulting firms, integrators and systems providers.

The combination of functional and non-functional challenges of FRTB makes it extremely difficult for banks to readily adapt their systems and infrastructure. Historically, for example, many banks have been using their front-office quantitative models and systems for producing scenario-based profit and loss (P&L) vectors. These vectors are then processed in enterprise aggregation engines. Under FRTB, the inclusion of the liquidity horizon into the internal model approach, combined with the risk factor level computation requirement and the incorporation of the stress period on a reduced set of risk factors, has fundamentally changed the equation for non-'FRTB specialist' systems. Indeed, the large number of calculations needed cannot be efficiently solved just by adding hardware. It requires built-in 'fit-for-purpose' intelligence that functionally optimises the calculation problem before leveraging off any scalability layer. In addition, the non-modellable risk factors (NMRFs) concept, which addresses the issue of data quality or availability, requires major changes in data management as well as in the calculation processes that are implemented. Systems need to feature capability that relates positions to NMRFs at the appropriate granular level in order to produce the stress-testing requirements.

Another key element of FRTB is the P&L attribution test. To achieve internal model approval, individual desks must perform monthly P&L attribution tests. These compare the risk-theoretical P&L – the daily P&L that is predicted by the risk management model – with the hypothetical P&L – the P&L based on the mark-to-market models of the desk, which are calculated by revaluing



Bruno Castor

the positions held at the end of the previous day using the market data at the end of the current day. Failing the test would trigger fallback to the standardised model that could yield to dramatically higher capital requirements. Because it may lead to reducing business for the corresponding desks, banks are taking this risk very seriously, for example, when defining desk structure under the new regulation. While there are ongoing debates about the precise implementation of the P&L attribution test, the feedback given so far by the regulator points to the 'stricter' direction, which means that P&L models and risk models must produce very close results.

The most natural approach to ensuring compliance with the P&L attribution test is to produce risk calculations and mark-to-market valuations within the same system. Such an implementation first requires the risk system to represent all types of transactions with the finest risk factor dependency as required for mark-to-market valuations. Second, it may also require the integration of the bank's proprietary models into the risk system. In this case, the risk system must ensure that the same FRTB-specific capabilities are enabled for native as well as for client-integrated pricing models.

A typical FRTB internal model implementation project encompasses the following components:

- A large integration project including, for example, trades or positions integration in a central risk system
- A model integration and model validation project
- A review of the bank's current infrastructure

With many banks facing the same challenges, resources may become scarce and make it even harder for them to comply. It is therefore essential for vendors, integrators and specialised consulting firms to work closely together to industrialise implementations and validation projects while providing the appropriate expertise to their clients. Mutualising the FRTB experience in an agile manner may prove extremely helpful for meeting the FRTB deadline.

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The P&L attribution mess

Seven months after new market risk capital rules were finalised, regulators and lobbyists are still locked in discussion over one of its key elements – the result of a mysterious eleventh-hour change to the text. By [Duncan Wood](#)

At first, it looked like a simple mistake. When the Basel Committee on Banking Supervision published new trading book capital rules in January, after five years of work, a crucial test was described in two different, contradictory ways. The strong version of the test – which the industry had been lobbying against – was replaced with a weaker version, but the change had not been copied across to the three-page glossary at the end of the document.

Bankers assumed there was a mundane explanation.

“My impression was they must have forgotten. They did some work on the main text, but didn’t get round to changing the glossary,” says the head of quantitative analytics at one dealer.

Compliance efforts can’t be founded on impressions and guesses, of course, and the profit-and-loss (P&L) attribution test is a big deal. It has to be conducted for each of a bank’s trading desks, with failure barring the desk from modelling its own capital requirements. Instead, the desk would have to apply a standardised approach, which generates a capital bill anywhere from two to 6.2 times higher than current levels; the revised internal models approach (IMA) would see a smaller 1.5-times jump, according to industry estimates.

So, at least one bank asked its regulator for clarification. At that point, the apparent mistake became a very real mystery – one that still hangs over FRTB today, six months after the rules were supposedly finalised.

A conference call was organised in March between the industry and the regulators who drew up the rules, the Basel Committee’s trading book group (TBG). Banks were told – “to our horror”, according to one participant – that the hardline definition in the glossary was correct.

“We all felt a bit ambushed by that. And misguided,” says the head of risk analytics at a second dealer.

It felt like an ambush to some banks because, in the weeks leading up to the publication of the rules, they had been given a steer by contacts within their domestic regulators that the watered-down test had prevailed. After publication, messages from regulators were mixed.

“Different people heard different things from their regulators: ‘Yes, they had meant to change the text; no, they had not meant to change the text’. So a call was arranged, but it wasn’t the world’s most productive meeting because on

Need to know

- Model approval will be granted at the level of individual trading desks when FRTB comes into force in 2019.
- That requires each desk to show its risk models closely track the desk’s actual performance – via backtesting, and the so-called profit-and-loss (P&L) attribution test.
- When the FRTB was finalised in January, it gave conflicting instructions for the P&L attribution test. One would be harder to pass and require more systems changes, banks claim.
- In a March conference call, banks were told to use the hardline version; their protests resulted in an April meeting with regulators in London, and at least one more call took place in June.
- An FAQ document – tentatively slated for September – will provide the definitive answer. A regulatory source expects it to insist on the tougher version of the test.
- Banks are primarily worried about whether they can align the disparate models and systems that regulators want to compare. One current focus is on valuation adjustments.



the banks' side, we entered the meeting hoping regulators had meant to make this change, and we found out they had not," says a market risk manager at a third bank.

That surprise set tongues wagging. Many in the industry see the mix-up as evidence the TBG itself is split, while others paint it as the result of industry lobbying gone awry (see box: *Who made the change?*).

The Basel Committee secretariat did not respond to a request for comment.

The March conference call was followed by a face-to-face meeting in London on April 12, where the industry made its case in detail – and at least one more call between banks and regulators happened in late June. The list of grievances is long: banks have already complained the test would be impossible to pass for hedged portfolios, for example.

But all of this has taken place out of the public eye, between a relatively small group of insiders – one attendee estimates 60 to 80 people attended the April meeting, split evenly between regulators and bankers.

The TBG is now working on an FAQ document that will provide a definitive answer, but one industry source and one regulatory source with knowledge of the process expect the strong version of the test to prevail – possibly with some kind of concessions on timing, and more forgiving thresholds about what would count as a failing grade.

"The version in the glossary is currently the way this is going. It hasn't been fully and formally confirmed yet, but I believe we're in the process of going that way," says the regulatory source.

Publication of the FAQs is expected in September, but as conversations between industry and regulators have continued over the past six months, the simple question about which version of the test to apply has been joined by more complicated ones about its scope. The regulatory source describes this work as "messy" and says there is currently no obvious solution.

"Am I surprised we're still talking about this? Yes. We knew there were some open areas, but this language had been in the text for a long time, and some of the discrepancies we're now looking at were first mentioned to us in April. You can't necessarily forecast that kind of thing," the source says.

The answers will determine how easy it is to pass the test, with billions of dollars of capital – and

1. FRTB: the difference in capital charges



Source: International Swaps and Derivatives Association

potentially years of IT and model development work – riding on the outcome.

Right way, wrong way

In outline, the test requires two different measures of P&L to be compared: hypothetical, and risk-theoretical. Both reflect the profit or loss generated by revaluing yesterday's portfolio using today's end-of-day prices. The measures are then compared in two different ways, looking at the gap between the two, and the variance of that gap: too big a gap,

that exist in the risk models.

To put it another way, the strong version involves comparing the outputs of two different models, each using their own sets of inputs, while the weak version requires those inputs to be run through a single model. Either way, the test is supposed to reveal whether modelled capital accurately reflects the factors that drive P&L for a desk.

Whether the strong version really is the tougher of the two depends on who you ask. Smaller banks have largely been absent from the FRTB debate, and

"There are a lot of reasons why front-office and risk numbers might diverge. That is the real concern – that you might fail the test because of reasons that have nothing to do with the quality of your modelling"

Bank head of risk analytics

or too unpredictable a gap, and a breach is counted. Four breaches within any 12-month period will force a desk on to the standardised capital approach.

In both the strong and weak versions of the test, hypothetical P&L is calculated by the bank's front-office pricing models, which contain more risk factors and are generally more precise. The difference between the two versions lies in how the risk-theoretical P&L is calculated: the strong version tells a bank to use its risk models, while the weak version requires a bank to use the front-office model, but applying the more limited set of factors

may be using off-the-shelf pricing models in which the set of risk factor inputs is hard to modify, says Jonathan Berryman, senior vice president for risk strategy at software vendor FIS in London: "In a front-office system today, nobody envisaged a need for flags you could switch off to remove a certain set of risk factors. You wouldn't think of that in advance. You want pricing models that produce the most accurate number possible."

Some large banks also see the weak version of the test as the most challenging: "If you are a bank with one system for your front-office valuations and

another for the risk, the glossary tells you to use them as they are – it's then a matter of aligning the underlying data as much as possible. But the body of the text says you somehow have to do the risk-theoretical calculation using the front-office system. I think that requires quite a bit of change. I might be in the minority, though," says the quantitative analytics head at the first bank.

He is correct: the five other large banks that spoke to *Risk.net* for this article prefer the weak version of the test.

"There are a lot of reasons why front-office and risk numbers might diverge. That is the real concern – that you might fail the test because of

reasons that have nothing to do with the quality of your modelling. And to pass by design, you would really need to bring everything together. You might be modelling in a certain way because you think it's the most prudent thing to do – well, that doesn't matter, because you have to converge with what the front office is doing. It may not be correct, but at least you can pass the test," says the second bank's risk analytics head.

One potential source of divergence is timing: a big bank will typically calculate a global risk number once a day, while trading desks will calculate P&L at the end of the day in each region. The P&L calculated at the end of the Asian trading day

will therefore be different from the risk number calculated at the end of the US day, critics of the test claim.

Another problem is the data that sits behind the numbers, dealers add. Because the risk and front-office systems are separate, they may use data from different sources – another potential cause of divergence.

These problems could be addressed by applying the weak version of the test, bankers argue. If the two P&L measures are calculated in the same system, using two sets of risk factors, there would be no need to try and align models that currently run separately and have separate priorities and uses.

WHO MADE THE CHANGE?

Once regulators have taken an official position on the profit-and-loss (P&L) attribution test, life will continue: banks will have a rule to follow, technology changes to make, capital implications to calculate.

But the final text of FRTB will still contain the contradiction that triggered months of controversy and confusion.

In trying to understand what happened, both banks and regulators make the point that the glossary definition – the hardline version of the test – is in line with instructions given to the industry in July 2015, when carrying out the last impact study before the text was finalised (see below: *What regulators have said so far*). The appendix was a departure from what had been the official line, but given it sat within the nine-page section describing the testing regime, the change in language appeared to indicate a change of mind.

When regulators on the trading book group (TBG) denied that during a conference call in March – insisting the glossary was the correct version – it answered one question, but raised another. Where had the amended text come from?

One possible answer is the industry itself. With regulators in a rush to get the rules out, a draft copy of the FRTB text was sent to a working group of big banks convened and organised by the International Swaps and Derivatives Association, with instructions to review the language and suggest changes where necessary. One regulator with knowledge of the process says this step was taken in lieu of a fresh round of consultation: "We were highly reluctant to go back and ask the Basel Committee for another consultation. Any time you open something up for consultation, it's tricky in itself, so the choice was taken not to open it up."

The industry group ran through the text, marked changes and sent it back to regulators, who then reviewed the industry's wish list. During this process, then, suggested changes to the workings of the P&L attribution test may have been inadvertently accepted into the final text.

Two other bits of information seem to argue against that. First, a source on the industry working group says the wording submitted to the regulators was far more complex than the final text: "When I read the final description of the P&L attribution test, I thought it was brilliant – they managed to achieve so much more than we did by only changing two or three words. I

was impressed with the way they edited it."

Second, some banks claim to have been given advance notice from their domestic regulator that the softer version of the text would appear in the final version of the FRTB.

If true, it suggests the change to the definition of risk-theoretical P&L was not inadvertent; it also suggests the change was not approved by the TBG as a whole.

This is where the trail runs cold. Two bankers claim the editing and approval of the text was done in cloak-and-dagger fashion by a regulator who was sympathetic to the industry's complaints about the test. "You can't do that. This text has been the product of very heavy negotiation to get to this point. You can't just come in and make changes without consultation," says the global head of market risk at one European bank.

The regulator with knowledge of the process speculates the change might have been made by someone not on the TBG itself: changes to the text were handled by a variety of different TBG members and then aggregated and finalised by the secretariat of the Basel Committee on Banking Supervision. "It could have happened above our heads," he says.

Either way, it indicates a difference of opinion within the group. Five industry sources agree regulators were split earlier this year on how the P&L attribution test should work; the question is whether those splits still exist, and which camp will prevail. "At the moment, they are at pains to resolve those issues themselves and it's why, I think, they are not commenting on it in meetings. They are in lockdown until they have a common view," says the industry working group source.

WHAT REGULATORS HAVE SAID SO FAR

July 2015 impact study instruction, page 109:

The calculation of the risk-theoretical P&L should be based on the pricing models embedded in the firm's ES [expected shortfall] model and not front-office pricing systems.

Final FRTB text, appendix B, page 71:

This 'risk-theoretical' P&L is the P&L that would be produced by the bank's pricing models for the desk if they only included the risk factors used in the risk management model.

Final FRTB text, glossary, page 87:

Risk-theoretical P&L: The daily desk-level P&L that is predicted by the risk management model conditional on a realisation of all relevant risk factors that enter the model.

In fact, depending on the scope of hypothetical P&L, the work required of the industry could be even greater, says the third bank's market risk manager. One of the concerns aired at the April meeting – and later fleshed out in a call between regulators and industry in late June – is whether hypothetical P&L should also include valuation adjustments that are in some cases calculated by product controllers, potentially dragging in a third system.

"Why would anyone explain front-office P&L with their capital model? No-one does that, so it means you've got to start building some really complicated system that aligns the front-office numbers – and even the adjustments placed on top by product control – with the capital model. And these things typically belong to three different departments, live in three different systems, with different people looking after them – and while they need to align for backtesting today, they don't need to align perfectly," says the market risk manager.

He adds: "There are huge questions here about which of these systems you even build the infrastructure in. Is it the case that we need better capabilities to explain P&L, coupled with a small amount of capital model improvement? Or do we need a completely new infrastructure, front-to-back, that aligns all these different quantities that have never had to align before? That's why the industry is flapping about this. Those two or three words that vary between the strong and weak versions of the test make a huge difference."

The TBG has got the message, but will not be bounced into acting, says the regulatory source: "It's a chicken-and-egg situation at this point. The industry wants the test to be watered down before they make the necessary investment in overhauling their systems. So we need to understand that – and the question is do we really have good data on the impact, and can we expect to get good data? There is a possibility we may look at a staggered approach, so maybe there is initially a more forgiving threshold than the one in the rules text."

Time to adjust

Valuation adjustments are add-ons that might not be included in either the risk or front-office systems. They are managed by different groups and appear at different stages in the life of a trade. Examples include independent price verification (IPV) – tweaks made to trade valuations by product controllers after checking third-party pricing sources – as well as concepts such as funding and capital valuation adjustment, which are handled differently across the industry, and the

prudent valuation adjustment required of European banks as a reflection of pricing uncertainty.

"These adjustments have their own sets of controls and criteria," says the second bank's risk analytics head. "The adjustment might be made on a monthly basis, to ensure valuations are correct in month-end books and records. But if you are calculating risk on a daily basis, then the two sets of values may start to diverge, and it's not clear how the risk calculation could capture a valuation adjustment that is not part of the risk management process."

To illustrate the challenges, the industry spent

"The industry wants the test to be watered down before they make the necessary investment in overhauling their systems. So we need to understand that – and the question is do we really have good data on the impact, and can we expect to get good data?" Regulatory source

time after the April meeting surveying banks on which adjustments they apply, and whether they are currently included in P&L forecasts. The survey found around half of the participating banks incorporated IPV, for example, and that European banks tend to make IPV updates more frequently than US banks. Results were discussed in late June with the TBG and are now being considered as part of the FAQ work.

Excluding valuation adjustments from hypothetical P&L would essentially leave it as a pure measure of market risk, which is how the industry would like to treat it. The regulatory source says that "may be going a bit far. The problem is that actual P&L includes all of these things, so if that is the only place you see these adjustments, then you're less likely to get a backtesting breach. Ever."

There is a sort of precedent, the industry source

points out, in the form of backtesting rules in the US, which require the comparison of 250 days of actual trading data with the corresponding market risk measures on each day "excluding fees, commissions, reserves, net interest income and intraday trading". Valuation adjustments would be included under 'reserves', he claims. The TBG is co-chaired by one regulator from the Board of Governors of the Federal Reserve System – Norah Barger – and a second from the Banque de France, Philippe Durand.

Ultimately, regulators have a few options. They could rule that all adjustments should be included;

or that all should be excluded. A third response would be to select adjustments that should be in scope: "There is a spectrum of possibilities and one of those is to roll up our sleeves and pull out the particular adjustments we want included," says the regulatory source.

The decision has implications for the IT work banks will need to do. The message in the June meeting was that banks did not like the idea of including adjustments in hypothetical P&L, but if they were forced to "there's no way they could get it done by 2020. So, it's possible, but it would take more time," says the regulatory source.

The FRTB text calls for national regulators to finalise their own versions of the regime by January 2019, with banks due to start reporting under the new rules in December that year.

Once the TBG has made its decisions on how the P&L attribution test should work, it will need approval from a separate oversight body – the Basel Committee's policy development group – says the regulatory source.

That could delay attempts to clearly define the test. The FAQ document was initially expected to be published in August. Sources on both sides of the debate now say the document is more likely to appear in September – and the regulatory source predicts one FAQ will not be enough.

"It will probably have to be an evergreen document, refreshed every six months or so," he says. ■

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Banks warn of FRTB internal model approval gridlock

UK regulator said to have concerns about the high volume of simultaneous approval requests, reports [Matthew Stevens](#)



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A more cumbersome process for obtaining internal model approval under FRTB could lead to a logjam, warn banks and regulatory specialists, as multiple firms seek approval for myriad trading desks at the same time.

"The increasing burden on the regulatory process is going to be significant," says one European bank source with knowledge of the matter. "Basel 2.5 and Basel III application processes are pretty weighty tomes that are compiled by banks in line with the regulatory requirements. There's a huge amount of paper, lots of policies and procedures, lots of supporting evidence, lots of capital metric reporting and lots of infrastructure reporting. They're very large applications that typically have gone in. If you multiply that by the number of desks you have, then you're talking about a huge amount of paperwork."

The final text of FRTB was released in January by the Basel Committee on Banking Supervision¹. It represents an attempt to make trading book capital rules more robust in the wake of the financial crisis, including by ditching value-at-risk in favour of expected shortfall, introducing the concept of liquidity horizons, and revising the boundary between banking and trading books.

Key driver

One of its key innovations is a new desk-level model-approval process², under which banks must obtain the regulatory go-ahead for the use of internal models, both at group level and for every individual trading desk.

The FRTB defines a trading desk as "a group of traders or trading accounts that implement a well-defined business strategy, operating within a clear risk management structure". The precise number of desks there will be is unclear; it is up to banks to propose the structure of their trading desks³, which must also be approved by regulators. However, the largest banks are expected to have anything between 50 and 150 individual desks.

FRTB is scheduled to be implemented by January 1, 2019, with regulatory reporting under the new regime set to begin from December 31 that year. In addition to back-testing, banks will have to subject their models to a controversial profit-and-loss (P&L) attribution test, the details of which remain under discussion⁴.

Carrying out the backtesting and P&L attribution tests will require 250 days' worth of data. This suggests banks will have to begin collecting data from the middle of 2018, say sources, with regulators needing to approve their desk structures prior to that date.

"When you consider this will mean finalising the desk structure, and overhauling the banks' infrastructure and technology to collect that data, it's really not a lot of time," says a source at a second European bank. "If you want to be compliant with the internal models approach by December 31, 2019, your regulator must have approved your desks, so the regulators are going to need some time – best-case scenario, half a year. They are not even staffed up for that."

Six European and North American regulators contacted by *Risk.net* declined to comment on the matter, but a spokesperson for Bafin notes the German regulator "is aware of the challenges".

Regulatory specialists at banks say supervisors have been more candid about the issue in private, with the Bank of England Prudential Regulation Authority said to be particularly concerned about the possibility of receiving hundreds of last-minute requests for model approval. During similar exercises in the past, banks have typically taken as much time as possible to complete their applications.

Given the continuing debate about how FRTB will work, including the finer points of the P&L attribution test, the possibility of gridlock in the approval process has been neglected, says the source at the second European bank. Retaining the ability to use internal models is crucial if banks are to avoid

"Two different desks doing interest rate swaps based on different rates might be using very similar models, but you may still want to look at the appropriateness of that model on each desk separately"

Mark Levonian, Promontory Financial

potentially punitive capital charges under a standardised approach.

"The issue has been completely overshadowed by all the other challenges," the source says. "The implementation challenge is not at the forefront of people's minds, but I think it will be when they realise what it means. People haven't been alerted to it."

The possibility of delays in obtaining regulatory approval is likely to favour banks that get their applications in early.

"There's invariably going to be a crunch time that's going to be coming in the middle of 2018," notes Jeb Beckwith, a New York-based managing director at technology firm GreenPoint Global and former head of global financial institutions for the Americas at Royal Bank of Canada. "Banks that get started in 2017 will have the best chance of getting their trading books and business structures optimally aligned with capital allocations and associated returns."

One potential solution to the lack of regulatory capacity would be a 'grandfathering' approach, whereby banks with previously approved models would be allowed to continue using them before trading desks' models begin to be vetted at a more granular level.

"Realistically, regulators don't want to disrupt the banks' trading activity and the capacity issue is a massive one. It could take several months before each trading desk has been thoroughly examined and approved," says Amir Kia, a London-based director in the risk and capital management team at consultancy Deloitte, who was voicing his own personal opinion and not speaking on behalf of the company.

"Either the regulators allow the banks to continue with their models, providing they meet FRTB conditions or they temporarily force them to adopt a standardised approach, and most banks' capital requirements will go through the roof," he added.

Shadow reporting

Another option is 'shadow reporting', which would involve frequent contact with regulators for them to get comfortable with internal models before they are formally approved.

"What they might require is for banks to shadow-report and share much more information earlier on – so if you've got a programme running, for example, then you might be required to share much more information during your regular regulatory meetings," says the first source at a European bank. "You might have a more gradual approach ... and your application is the final paperwork that comes in, by which time the regulator is already very familiar with your model performance."

Despite the potential for problems, the underlying logic of the desk-level approval regime remains sound, says Mark Levonian, a former deputy comptroller at the US Office of the Comptroller of the Currency and managing director at Washington, DC-based consultancy Promontory Financial.

"Models have to be evaluated for particular uses and validated for those uses," he says. "Two different desks doing interest rate swaps based on different rates might be using very similar models, but you may still want to look at the appropriateness of that model on each desk separately, in order to make sure it is appropriate for both of those uses." ■

Previously published on Risk.net

¹ www.risk.net/2442076

² www.risk.net/2452435

³ www.risk.net/2451330

⁴ www.risk.net/2465418

Banks fear costs from loss of AAD under simpler FRTB rules

Trading book regime may force use of more expensive and time-consuming ways of computing risk sensitivities, writes Nazneen Sherif



The Basel Committee on Banking Supervision's new market risk capital rules, which were unveiled in January, could prevent the use of adjoint algorithmic differentiation (AAD), a highly popular mathematical technique used by banks to speed up their risk calculations.

Similar to current rules, FRTB allows more sophisticated banks to use their own models for regulatory capital, albeit subject to tougher restrictions than existed before, including a controversial profit-and-loss attribution test (see page 4).

Banks whose internal models do not measure up must use a standardised approach, based on the sensitivities of the value of a derivative to its underlying risk factors. Banks using internal models will also have to calculate capital using the so-called sensitivity-based approach (SBA) to act as a fall-back in case they lose model approval.

But banks are concerned the way the SBA has been specified in the rules could stop them from using AAD, effectively forcing a reversion to older calculation methods that are more costly and time-consuming.

"I hope the regulators allow AAD," says one risk manager at a regional European bank. "If you don't use AAD ... calculating all these numbers in a very short time horizon is quite challenging from an IT perspective, and it brings in a lot of cost for the bank."

The SBA requires that banks calculate risk sensitivities based on a finite change or 'bump' of 1 basis point for an interest rate or spread-like risk factor and 1% for other risk factors. This reflects the traditional method of calculating risk sensitivities, which involves tweaking the underlying risk factors by small amounts and revaluing the trade every time. Since the trade needs to be revalued for each bump, banks have to run thousands of simulations to get all the sensitivities.

This is in contrast to AAD, which can speed up risk calculations by up to 1,000 times compared with more traditional methods¹. AAD computes risk sensitivities using an infinitesimally small change to the risk factor, which is much smaller than that required under FRTB.

Dealers are concerned this means they might not be allowed to use AAD in regulatory capital calculations – something one industry source describes as an "unfortunate consequence" of the rules.

"When this issue first came out there was quite a lot of discussion around that point in the quant community," says Andrew Green, London-based lead quant for derivatives valuation adjustments at Scotiabank. "If you interpret the document at face value then it would suggest you have to do an

implementation of the traditional bumping technique using finite differences."

Regulatory sources say they didn't mean to outlaw AAD. One regulator who spoke to *Risk.net* on condition of anonymity agrees FRTB appears to restrict the use of the technique, but says this was not an intentional move by supervisors.

Banks are urging the Basel Committee to address the issue. The regulator says one frequently asked question that is already being considered by the committee's trading book group regards the acceptability of alternative methods for calculating delta sensitivities. The Basel Committee did not respond to a request for comment.

One fix suggested by Scotiabank's Green would



"If you interpret the document at face value then it would suggest you have to do an implementation of the traditional bumping technique using finite differences"

Andrew Green, Scotiabank

be to define sensitivities in a more neutral fashion – perhaps mathematically as a partial derivative. This would give banks more flexibility over how to calculate the numbers.

AAD to the rescue

AAD first became widely used by large banks about five years ago. While traditional calculation methods were taking firms hours or even days to run, AAD allowed them to begin calculating all their risk sensitivities in real time. Banks that adopted the technique include Barclays, Banca IMI, Credit Suisse, Natixis and Nomura.

Several current and planned regulatory changes – such as FRTB, the standard initial margin model² for

non-cleared derivatives and revisions to regulatory capital for credit valuation adjustment (CVA) risk³ – rely on banks being able to calculate a large number of risk sensitivities. This means interest in AAD is growing rapidly. Danske Bank, for example, is in the process of developing a strategy for using AAD as part of its implementation of FRTB.

"With AAD receiving a great deal of publicity in recent years, many banks are embarking on projects to implement it for price and XVA sensitivities," says Alexander Sokol, chief executive of technology vendor CompatibL in London. "Having made an investment in AAD, these banks would like to also use it for the FRTB standardised approach and especially for the FRTB CVA framework, where it would be highly effective."

If AAD is not allowed under the rules, banks will have to fall back on traditional methods such as bumping, which aligns with a strict interpretation of FRTB, but requires a lot of investment in IT infrastructure to meet its heavy computational demands.

"The whole benefit of AAD is that it provides you with innumerable sensitivities at very low cost," says Suman Datta, head of credit quantitative research at Lloyds Banking Group in London. "There is some effort to integrate AAD into your existing technology, but the benefit is you are able to do very fast sensitivity calculations. If you are not able to use AAD, it doesn't mean you can't calculate fast sensitivities, but it would require investment in hardware, grid technology or other kind of distributed computing."

Ultimately, this may be a cost banks will have to bear to ensure they are wholly compliant with the rules. Unless there is clarification from supervisors, large banks say they will not be fully confident implementing AAD for calculating regulatory capital.

"These days, people want to make sure they are absolutely 100% accurate when it comes to interpreting regulatory text," says Datta. "So in that environment, not having clarity in the document definitely, from an upper management point of view, reduces confidence to sanction the use of AAD."

Not everybody would consider the loss of AAD to be a tragedy, however. Claudio Albanese, London-based chief executive of risk consultancy and technology firm Global Valuation, argues the very small shocks used to calculate sensitivities in AAD do not properly reflect the risk of extreme market stresses.

"Let's say you look at Brexit week: AAD would have missed the whole picture, because it loses accuracy when you move far from spot valuations," says Albanese. "You can't account for large shocks typical of stressed market conditions with the infinitesimal sensitivities that AAD produces." ■

Previously published on Risk.net

¹ www.risk.net/2389945

² www.risk.net/2466665

³ www.risk.net/2457000



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Regulations, sensitivities and adjoints

Using AAD for FRTB and FRTB-CVA

Adjoint algorithmic differentiation (AAD) has performed effectively and at lightning speed in regulatory calculations. With questions about its use largely resolved, support for AAD-based methodologies is growing, says Alexander Sokol, head of quant research at Compatibl

Adjoint algorithmic differentiation (AAD) transforms a software program that calculates a result into a program that can simultaneously calculate the sensitivities of the same result – avoiding the computationally inefficient ‘bump and reprice’ approach. With bump and reprice, the computational cost is proportional to the number of sensitivities, but with AAD the computational cost is a fixed multiple of the computational cost of the original calculation, irrespective of the number of sensitivities.

The latest regulations for the market risk capital charge – FRTB finalised in the Basel Committee on Banking Supervision Document 352 (BCBS 352)¹ – and the credit valuation adjustment (CVA) capital charge – FRTB-CVA for which the latest Consultative Document is BCBS 325² – provide the option of using a sensitivities-based standardised approach (SA) for computing regulatory capital. For FRTB, SA is both an alternative and the basis of a floor for the internal model approach (IMA). This means that sensitivities-based calculation will have to be performed by all trading desks, including those using IMA. For FRTB-CVA, IMA is not available, leaving sensitivities-based SA as the most risk-sensitive method and far superior to the Basic CVA framework.



Alexander Sokol

Sweeping consequences

The use of the best available technique – namely AAD – for the massive computational effort of calculating sensitivities in FRTB and FRTB-CVA may seem like a no-brainer, except for the peculiar way in which the current FRTB and FRTB-CVA documents define sensitivities. Paragraph 67a of FRTB, which defines delta for the general interest rate risk, states: “PV01 is determined by calculating the change in the market value of the instrument as a result of a 1 basis-point shift in the interest rate r at vertex t of the risk-free yield curve in a given currency, divided by 0.0001 (0.01%)”. Likewise, Paragraph 67g defines FX delta via a finite 1% relative shift: “The sensitivity is calculated by taking the value of a 1 percentage point change in exchange rate, divided by 0.01 (1%)”. The FRTB-CVA document uses similar definitions, with a reduced number of buckets per curve.

The use of finite shifts to define something called a ‘sensitivity’ is a drafting ambiguity with far-ranging consequences. “Regulatory sources say they didn’t mean to outlaw AAD. One regulator who spoke to *Risk.net* on condition of anonymity agrees FRTB appears to restrict the use of the technique, but says this was not an intentional move by supervisors,” writes Nazneen Sherif (see pages 10–11).

While considerable performance gain can be expected from the use of AAD for both FRTB market risk and FRTB-CVA, it is in FRTB-CVA where the performance advantage of AAD is especially striking. The CVA figure depends on hundreds of curves for each netting set – and for larger netting sets, thousands of curves. Even with the reduced number of buckets per curve in FRTB-CVA compared with FRTB, the total number of sensitivities for each netting set will, on average, exceed 1,000. For this calculation, AAD is likely to provide at least a 100-fold acceleration in performance.

The International Swaps and Derivatives Association (Isda) standard initial market model (Simm), which shares many of its definitions with FRTB, provides an example of how this ambiguity can be resolved. The Isda Simm methodology³ provides several alternative definitions of sensitivities to choose from, one of which is to use a small or infinitesimal shock size. This alternative definition is fully compatible with AAD.

As the regulation for the market risk has been finalised – with BCBS 352¹ – the change in definitions can no longer be made within the document itself. Nevertheless, considering the high level of publicity surrounding the issue of using AAD for FRTB – with prominent articles and conference presentations arguing in favour of clarification permitting its use – it is highly likely that this issue will be addressed in subsequent frequently asked questions (FAQs) and/or technical guidance issued by country supervisors. According to a senior regulator quoted by Sherif, an FAQ addressing this issue is already being considered by the Basel Committee trading book group.

At the time of writing, FRTB-CVA is still a draft, and the regulators still have an opportunity to address AAD in the final version of the document. Such clarification may involve a similar definition to that adopted by the Simm model.

With the rapidly growing support for the use of AAD in regulatory capital calculations, banks that implemented the AAD technology will be well positioned to take on the challenge of FRTB and FRTB-CVA.

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¹ www.bis.org/bcbs/publ/d352.htm

² www.bis.org/bcbs/publ/d325.htm

³ Version R1.0, September 1, 2016 [www2.isda.org/attachment/ODY20A=/ISDA_SIMM_vR1.0_\(PUBLIC\).pdf](http://www2.isda.org/attachment/ODY20A=/ISDA_SIMM_vR1.0_(PUBLIC).pdf)

Lining up the fundamentals

FRTB should hold no fear for the enterprising, as it provides opportunities to revamp frameworks and implement ambitious structural changes. In this Q&A, sponsored by **Asset Control**, **Murex**, **Vector Risk**, **CompatiBL**, **Parker Fitzgerald** and **Numerix**, our panel of market risk experts discusses the impact of the systemic change, examines the technological challenges and asks how service providers can support the banking sector



Tim Rowlands
Director of Research
Vector Risk
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What impact will the new framework have on market risk management and the banking sector more generally?

Tim Rowlands, Vector Risk: In the 1990s, the concept of value-at-risk (VAR) shook up the whole market risk process, forcing banks to buy or build new independent risk measurement technologies. The new requirements under FRTB will usher in a new generation of market risk technologies. This should be seen as a once-in-a-generation opportunity to create an independent risk measurement environment focused on speed, drill-down and strategic what-if analysis to help shape the trading business – both to manage risk and to optimise profitability. Handled in the traditional way, this would be a high-cost, low-value imposition on the business and a potential disincentive to trade. However, organisations willing to grasp the opportunity to use the most modern technologies will be able to dramatically enhance the efficiency of their risk processes without sacrificing true risk management independence.

Nick Haining, CompatiBL: By specifying that the internal model approach (IMA) approval is given at the desk level, and providing clear and unambiguous approval guidelines, the Basel Committee on Banking Supervision (BCBS) democratised IMA and made it potentially accessible to individual trading desks within mid-size firms that were previously unable to obtain internal model method (IMM) approval for the entire firm. For banks that do not pursue IMA, the standardised approach (SA) presents greater risk sensitivity than previously available methods. On the flipside, FRTB is calibrated so its capital requirement is prohibitively expensive for certain types of trading. In addition, its restrictions on the offset of sensitivities in different business lines may force consolidation of the trading desks and lines of reporting in order to take advantage of the offsets that would not be available for segregated books.

David Kelly, Parker Fitzgerald: One consequence of so much regulation has been the additional cost of production that is reflected in the large headcount increase in functions like market risk. The additional demands for FRTB are likely to follow a similar path of adding more data enrichment downstream – likely delivered offshore – with only a few banks rethinking their business models. The cost pressures of regulatory programmes are crowding out investments in the revenue-generating functions of the bank. To reverse the squeeze, data origination such as liquidity horizons and risk production need to migrate to the front office with the effect that, in the medium term, market risk will step away from many of its data production processes.

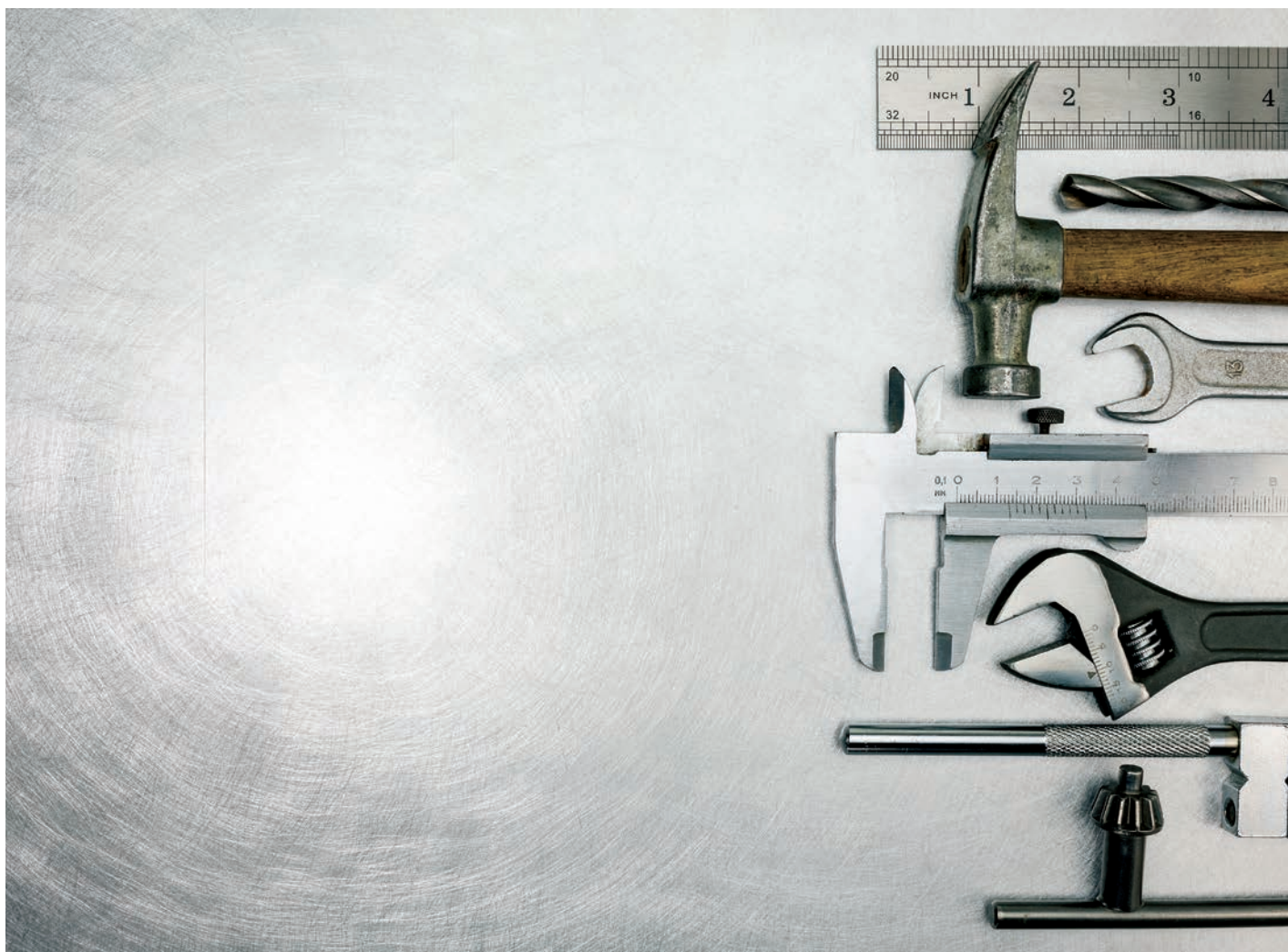
Steve O'Hanlon, Numerix: FRTB is a game-changer that demands a fundamental shift in the ways banks function and manage risk. The scale and scope of the regulation is massive, as it requires previously siloed parts of the enterprise to come together and work from a unified set of models and data – not to mention that many of those models must be revised to meet the new guidelines.

Anyone with experience in banking knows that, desk-by-desk and front office to back office, each part of a bank has its own flavour and approach to these types of calculations, has data on myriad systems and uses a disparate array of spreadsheets and software.

Additionally, derivatives valuation adjustments (XVA) calculations under the XVA desk are demanding more complexity, along with significant data aggregation and data quality and accuracy challenges.

Risk departments will now have the responsibility for and mandate of bringing together a single view of risk across the enterprise, becoming masters of risk data governance, data infrastructure and the technology to support the demands of rapid and regular reporting.

Ryan Ferguson, Scotiabank: The financial crisis sparked a reform of banking's regulatory framework, and many of the reforms should reduce the likelihood of the taxpayer being tapped for a banking sector bailout in the future. Included in this set of reforms are increased capital buffers, total loss-absorbing capacity and increased clarity around bank resolution. The banking sector is spending a tremendous amount of time, effort and money to implement changes to the market risk management framework, where it isn't clear that benefits will be commensurate. While using expected shortfall (ES) instead of VAR captures more tail risks, it does not directly address the concerns that led to the financial crisis.



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Lars Popken, Deutsche Bank: The implications for the banking sector are significant. It is a real prospect that certain businesses may become uneconomical if the rules are applied to them in their current form. To that end, the provision of such services by banks may either become more expensive for customers or not be provided at all. In certain areas it may create increased concentration risk, as the number of banks providing services reduces, providing fewer options to customers. While the drive for comparability and consistency is a key tenet, this will be heavily dependent on the consistency of jurisdictional implementation. Furthermore, the complexity of the FRTB framework is unlikely to realise the comparability of risk-weighted assets between banks, which is one of FRTB's main targets, according to the Basel Committee.

Despite these issues and the empirical evidence that has been presented to the Basel Committee, it appears that its approach is unwavering. Banks will need to come to terms with a world without internal models for some risk types – for example, credit valuation adjustment (CVA) – and made much more difficult to use for others. A widespread move towards SAs could lead to the risk of generating incentives for banks to pursue the same business models, potentially compounding overall systemic risk for the industry.

Additionally, the introduction of more conservative SAs and the discussions around the potential introduction of capital floors are likely to meaningfully increase the amount of capital required in the banking sector. This is in spite

of the Basel Committee and other regulatory bodies saying that further reforms to the capital framework should not produce a significant overall increase in capital.

Market risk management will potentially see the benefit of the framework being implemented. Greater focus on data, risk and profit and loss (P&L) consistency, and assessing quality at the more granular level all establish a good way forward in strengthening market risk management. These factors lead to greater use of full revaluation and standardised risk factors, which provide greater risk management information. That being said, the harmony between risk management and capital management may diverge. For example, where a liquidity horizon established under the framework does not align with empirical evidence, we could see firms using the best available information for risk management purposes, even if the FRTB framework for capital requires something different.

Establishing capabilities to enable such distinctions also leads to better risk management through strengthening of the toolset and the flexibility it needs. The majority of the banking sector recognises FRTB as an opportunity to revamp its front-to-back infrastructure. That said, considering the high level of uncertainty attached to certain key components of the framework, regulators should carefully balance an ambitious implementation timeline, giving banks enough time to implement a robust framework.



Pierre Guerrier, FRTB Solution Specialist
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What are the greatest challenges being faced by banks on the path to implementation?

Pierre Guerrier, Murex: We believe that FRTB is a game-changer for risk infrastructures and processes. This is due to a general lack of capacity in legacy risk systems and many trading systems to produce risk assessments consistent with trading figures and with the required accuracy across all instruments.

For banks seeking to conserve or obtain approval of an internal model, the risk theoretical profit-and-loss (RTPL) attribution is by far the greatest challenge. The P&L attribution metrics call for extremely high correlations between the P&L predictions of the risk system and the front office. If the figures are not reconciled, desks automatically lose internal model approval – without the warning shot of a capital multiplier increase, and even if they have good backtesting on all flavours of P&L. So, if not already completed, producing RTPL via legacy systems and assessing its quality is a bank's most urgent task. Depending on this assessment, the risk system may need revamping to bring it closer to the front office or it may have to be replaced altogether. Front-to-risk integration is favoured, of course; however, not all legacy front-office systems are able to produce FRTB reports. Eventually, a seemingly straightforward reconciliation exercise drives a new target front-to-risk architecture, and lays out the path to deploy it.

Even banks aiming only for the revised standardised approach (RSA) face challenges. The RSA specification clearly directs users in defining input sensitivities and stress tests – for example, curvature and loss-given default – to achieve consistency across asset classes and source systems. For instance, pervasive basket and index drill-through capabilities – both for Greeks and for stress testing – call for best-of-breed front-office analytics.

Martijn Groot, Asset Control: FRTB poses significant market data challenges. The risk factor mapping requirements necessitate that firms are able to cross-reference between internal instrument taxonomies and the Basel risk factor classification with assignment of the regulatory liquidity horizon. For banks using an IMA, risk factor assessment requires an insight into overall market activity and confirmation on a minimum number of 'real prices'. Proving this modellability entails integration of internal data and data available from trade repositories and new pooling services. On top of this, risk managers will want to track (and be proactively notified on) any changes in mapping or modellability status due to real-price availability or a change in the drivers of the liquidity horizon, such as the market capitalisation and credit rating. Generally, banks require a more structural approach to market data sourcing, quality management and operations.

Tim Rowlands: In any new project there is the overarching question of whether to buy or build. Historically, larger banks have chosen to build or to buy and customise. Smaller banks have generally looked for simple vendor solutions to meet minimum requirements and often believe they are locked

out of the more sophisticated internal models due to cost and complexity. For large banks trying to build a new risk engine in-house or extend an existing system, it is hard to know if the solution will be fast enough to meet the IMA requirements. Some banks are hoping that extensions to their front-office systems will meet the requirements, but care is needed to ensure that the independent risk oversight function is not lost. Also, risk management groups need extra drill-down and what-if analysis tools over and above just generating the regulatory reports. It is possible to expend a large amount of effort only to realise that it is difficult to extend front-office systems to cover highly computationally intensive IMA runs, and that high-performance risk engines are hard to build in-house. Banks looking to buy off the shelf are faced with lots of 'intention-ware'.

It is hard to know which vendor will actually deliver, and when. Do you stick with your vendor of choice even if they have nothing to show? Or do you embrace a new solution that is unfamiliar and requires a change of mind-set in the IT department? Many banks, especially mid-tier and smaller, have the option of employing just the SA. However, if potential capital savings dictate use of an internal model, banks with single end-of-day and reduced product and market coverage can meet the IMA requirements effectively. The P&L attribution challenge and non-modellable risks are likely to be less onerous, as they are usually dealing vanilla instruments in liquid markets. This is a great opportunity for these smaller banks to leapfrog their slower and larger rivals by using cloud technology, a software-as-a-service risk engine and a market data supplier's FRTB data set. The challenge is choosing the right outsourced solution.

Nick Haining: Previously, the regulatory capital methodologies that imposed heavy demands on analytics and software performance (for example, IMM) were pursued only by the largest and most sophisticated firms. In contrast, the methodologies not based on internal models were typically much simpler and did not involve significant implementation challenges. The methodology expected to be used most widely by mid-size and smaller firms for FRTB and FRTB-CVA – the SA – requires calculating a large number of sensitivities and imposes a greater challenge than the methodologies these firms previously used.



Steve O'Hanlon
Chief Executive Officer, Numerix
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Steve O'Hanlon: Banks are embarking on structuring their FRTB programmes and mobilising the necessary resources to assess what it means for them. From a solutions standpoint, there are complex interdependences to consider.

A key first step, and a daunting challenge in this process, is achieving a firm understanding of the business impact of the regulation. There is an immediate need for the results of impact studies reflecting real numbers FRTB teams can use to scale their institution's response.

Next, they must consider how they will deal with managing cost, legacy systems and the unification of risk data. Overlapping and duplicate legacy systems present complexities and costly change management issues that create barriers to scalable growth. Siloed, black-box approaches typically used to

underpin the architectural foundations of front-office, risk management and finance operations will be increasingly costly to maintain. Different products and business lines often have different analytic libraries, trade capture and data management with different technologies. To address these challenges, firms must make key functionality decisions to holistically support the front office, risk, market data and product control. As part of this, they must weigh up the costs and benefits of build-or-buy and, while full-scale systems may exist, most will have to take an approach that evolves over time.

David Kelly: The focus on approval at the desk level complicates what could have been a smooth transition from Basel 2.5 to FRTB, as it directly involves the participation of the front office in the risk management process. Desk heads are expected to prove they are in control, front-to-back, of the risk they originate. FRTB is not forgiving of risk that does not trade much or is entirely unobservable, and it will punish those products where the hedge creates noise. The desk head will need to actively manage this situation and demand much more analysis to help steer through this new regime. The main challenge for current risk infrastructure will therefore be how desk heads either switch to a much more decentralised and agile computational environment or move the heavy lifting back into the front office.

Ryan Ferguson: I think getting and maintaining IMA status is going to be a sizeable challenge. There will be a significant burden placed on regulators to evaluate dozens of new models from each bank they oversee within a very tight time frame. Aligning front-office data and models with risk management data and models will also be very time-consuming. I can see banks triaging their IMA deployment so that desks where the sensitivity-based approach (SBA) is untenable gain approval in time for the switchover to FRTB. Desks that can manage on the SBA will do so until development resources become available.

Adolfo Montoro, Deutsche Bank: FRTB is 'fundamental' for a reason. It introduces a multitude of new approaches and processes spanning from new methodologies to changed quality controls on market data and desk-level approvals. FRTB also induces computational demands that are a formidable challenge for any bank, regardless of whether it aims for the IMA or SA.

Although the FRTB standard text was finalised in January 2016, there is still a great deal of regulatory uncertainty embedded in the framework. Most of the questions submitted by various institutions via industry associations requiring clarification from regulators are still awaiting response. Such uncertainty is another dimension of the challenges that banks need to deal with when designing solutions that are flexible enough to cope with different interpretations of the rules provided only at a late stage by rulemakers. It is key at this stage for national regulators to actively engage with banks – via industry groups or on a bilateral basis – to refine the existing framework and to achieve a common interpretation of key components of the framework.

As the 2019 go-live deadline approaches, it is important that the infrastructure departments in risk, finance and technology do not rush into building out their current infrastructures. Instead, the framework requires front-office desks to play an active role. A new intra-bank interaction model needs to be established to provide oversight on data integrity, resource usage including central processing unit (CPU) grid time, portfolio risk management, end-of-day valuation, business strategy and transfer pricing.

Heightened levels of front-office desk engagement are key because FRTB increases the operational complexity and the capital cost of running market risk; therefore, desk heads will need to redefine the suite of products that provides

value-add for clients at an appropriate cost of origination. This new interaction model needs to be defined before the framework can be properly implemented.

In a nutshell, FRTB requires a complete change to the operating model of the industry between front office, risk, finance and technology.



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Martijn Groot, VP Product Management
Asset Control
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What new demands will FRTB place on firms' IT resources and data?

Martijn Groot: FRTB raises the bar for market data quality, insight into lineage and control around business rules operating on the data. Quite simply, because of the additional requirements and data needs, the window for reruns is greatly reduced – banks need to get it right first time.

FRTB P&L attribution testing poses much more stringent demands on the consistency between front-office and risk data. Differences in snap times, market data sources and risk factor construction methods can easily lead to failed backtesting.

There is also the requirement for 10 years of historical data, while many banks currently use only one or two years for historical simulation. Banks need to baseline the 10 years initially, but also require backfilling functionality when onboarding new risk factors. On top of that, the most stressed period over that 10 years needs to be easily identified for ES calibration.

In addition, more control on any form of time-series operation is required. This includes risk factor and sensitivity calculation, the management of proxy rules and the management of shocks for regulatory and internal stress scenarios. Best practice would be to manage the calculation of these derived data sets in the market data system in order for the different risk and valuation systems to be supplied with consistent data.

Pierre Guerrier: We heard a lot about the CPU requirements related to the liquidity-adjusted ES. However, we believe that the key factor to the solution is proper software optimisation designed with FRTB in mind and, in particular, eliminating redundancy in calculations. Only a small part of the increased workload will be absorbed by natural performance gains associated with hardware turnover in the next three years.

Market data management is another concern – there is a real need for both data quality audit for non-modellable risk factor (NMRF) classification and increased data volumes – for the stress period and the default risk charge.

But the real resource pressure comes from the daunting task of upgrading diverse systems to their chosen target architecture within a very short time frame. It applies to both IMA and SA institutions, and pressurises both consultancies and system integrators globally. Securing adequate resources to execute this strategy is the most urgent challenge.

Tim Rowlands: The cloud is the future. Banks that decide to host solutions internally will face substantial costs. Many of these solutions require investment in large CPU or graphic processing unit (GPU) clusters that cannot be reused outside FRTB. Instead, IT personnel and resources must be diverted to managing

cloud providers, data security and internet reliability. Banks need to be working with vendors to deliver pre-built, cost-effective services; and with regulators to bring them on board with the cloud and their ability to manage it securely. This will also require managing user expectations around the trade-off between cost and customisation, and a focus on service delivery.

Nick Haining: The greatest challenge will be to achieve the significant increase in software performance and computing power required to provide the sensitivities for the SA for market risk and SA-CVA, and for P&L attribution in IMA. With the recent changes in regulatory framework represented by FRTB and FRTB-CVA, the number of sensitivities that need to be computed has increased dramatically. Computing them for the entire portfolio is challenging for the market risk, and even more so for FRTB-CVA, which relies on sensitivities of CVA, a metric that requires Monte-Carlo simulation for a large number of trades. This challenge can be solved by analytics advances such as adjoint algorithmic differentiation (AAD), or by increasing the capacity for cluster or cloud computing.



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David Kelly
Partner
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Are there likely to be areas in which banks will require guidance or assistance from consultants, vendors and other service providers?

David Kelly: The delivery of FRTB will require collaboration and co-ordination across a number of expert groups in the front office, risk, finance, technology and regulatory engagements. Consultants that have considerable industry experience in trading or risk management and know what works with these programmes can help clients make the right strategic decisions around business selection, capital planning, vendor selection and target operating models, while helping quant teams deliver prototyping tools to gain insights on how to adapt to the new capital regime.

Martijn Groot: Banks will look for the most efficient path towards compliance with new regulation. Commonalities in regulatory requirements on data need to be taken into account in programme planning to ensure optimal cost effectiveness. Data providers can help with real-price assessment and additional tagging and flagging of quotes.

Market data integration providers can assist by supplying a fully auditable sourcing and quality management process. This should cover integrating internal and external sources, pre-mapping data to Basel and other regulatory risk factor classifications, and full transparency into risk factor status, sourcing and delivery via dashboards. On top of the packaged integration and population of risk factor data, banks also need the flexibility to track deviations – for instance, in cases where they want to stray from the regulatory floor liquidity horizon.

Steve O'Hanlon: The solutions market continues to evolve, as vendors enhance and launch new functionalities to help financial firms operate effectively under the FRTB regime. There is also an opportunity to empower banks to study their

business on their own and not spend millions in consultancy fees.

To determine its path forward, today's institution must build a blueprint of its desired future-state IT and architectural strategy. As banks are not yet in a position to say what their future state will look like, there are initial steps firms can take towards implementing an FRTB strategy that could serve as a basis for a broader enterprise-wide transformation.

FRTB business impact study solutions that are cloud-enabled will allow banks to upload their portfolios, use provided market data or their own data and, within a very short time, obtain a full picture of what FRTB means for them. This will allow institutions to grasp the business implications of FRTB immediately – understanding capital charges, how FRTB is impacting each of their desks from a profitability standpoint and how operational risk and market risk are coming into play.

As banks all have different approaches to handling FRTB, it is also important that solutions of this nature be highly scalable, flexible and incredibly fast.

Pierre Guerrier: We believe vendors and integrators have a key role to play because of the fundamental changes FRTB brings to risk infrastructures, data and processes.

Banks will turn to their vendors for compliance upgrades. The complexity and granularity of the new reporting are such that systems must not just provide mandatory raw data and number crunching, but also help roll out new business processes and streamline the operations of internal model-approved institutions. For instance, the RTPL will require daily production, but also validation and sign-off just like the hypothetical P&L. And the calculation of multiple ES needs to not only be CPU-efficient, but also resilient, auditable and operable.

Data providers must also help. NMRFs must be kept to as few as possible, and this will increase the need for multiple data sourcing from existing providers, security custodians and consensus of market participants. On remaining NMRFs, the challenge will be the calibration of ES-equivalent stress using scarce data. This requires bespoke methods for each risk type, and quantitative analytics departments may have to tap the resources of consultancies to kick-start the effort.

Tim Rowlands: Most banks have invested little in market risk infrastructure or human capital in recent years. This lack of internal resources will result in significant reliance on software vendors, market data suppliers and consultants to help them solve the challenges of FRTB. Multi-tenancy cloud solutions that allow banks to share hardware and receive automatic software updates and round-the-clock centralised support will revolutionise software projects such as FRTB. The move to a more prescriptive market risk environment means everyone has to calculate the same things, whether using the SA or IMA, so it makes little sense to develop these in isolation. Rate vendors are creating high-quality historic rate sets that will enable banks running the internal model to avoid extra capital hits on NMRFs. Consultants are able to use new cloud-based software tools to determine the impact of FRTB and to help banks plan their future trading strategies.

Nick Haining: Compared with the previous regulations, FRTB and FRTB-CVA documents require unprecedented levels of complexity for calibrating and testing the models for both SA and IMA. The FRTB document is also very specific as to the criteria that may cause a bank to lose its IMA approval. Having been exposed to a cross-section of portfolios and implementations, consultants and software vendors who work with multiple banks will have more diverse practical experience in implementing and running the new regulatory capital methodologies, compared with the in-house team working on a single implementation. This may help those vendors to provide greater insight into

implementing FRTB and avoid typical pitfalls in running it. In addition, the computational complexity of FRTB may require advanced software solutions such as AAD, which vendors may be well positioned to deliver.

Ryan Ferguson: I think there are going to be resource constraints around model development and data management prior to go-live that will need to be met through third parties.

Lars Popken: The short timelines since the finalisation of the FRTB framework and the planned implementation in 2019 – as well as the extensive array of other regulatory-driven initiatives competing for similar resources – require banks to quickly ramp up and prioritise teams across the organisation. For example, methodology teams are significantly impacted by the new framework, as a number of new requirements need to be translated into concrete mathematics, rules and algorithms, which must be carefully and thoroughly designed, tested and documented.

These new methodologies need to be implemented into IT systems and will often require a fundamental change to IT infrastructures. Boutique consultancies can help to mitigate the potentially severe workload implications by introducing new technologies and state-of-the-art techniques.

In particular, synergies across banks can be achieved for data-intensive parts of the framework such as the observability assessment of risk factors for the internal model under the new NMRF component of FRTB.

Several data vendors have begun entering this space to propose data-pooling approaches on real transactions and committed quotes. Industry participants are now working towards agreeing common standards and vendor requirements. This co-operation will allow banks to leverage each other's trading experience without exposing potentially sensitive information to competitors.

In conclusion, consultants, third-party providers and vendors are welcome partners in relieving the pressure on limited resources in key areas and supporting the condensed timelines.



Nick Haining, Chief Operating Officer
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What are the implications of moving away from VAR in favour of ES?

Nick Haining: The ES will present a considerably greater challenge to the historical or Monte-Carlo simulation models used for IMA than the older VAR-based methods did. In VAR calculation, the model has to be accurate only up to the VAR quantile, while for the ES it has to accurately represent the expected value of the distribution tail beyond the ES quantile. This means the models will have to capture the extremely low-probability events beyond the previously used VAR threshold. This presents a challenge not only to calibrating the IMA model, but also to the methodology used to backtest and validate it on a limited set of historical data in which such events may occur only a few times.

Martijn Groot: A very specific implication is that every outlier counts in the ES regime. Crudely put, a VAR process cuts off the distribution at the tail and provides an upper bound on the loss in a 'business as usual' situation. The ES

metric is an expected tail loss and zooms in on the tail losses to estimate the expected loss in the worst 2.5% of cases. This means data errors directly hit the capital requirements if they end in the tail.

FRTB also poses a number of data model requirements, such as the need for daily look-through on funds if banks want them in the banking book. Value drivers of custom baskets or options on multi-underlyings also need to be clearly modelled.

David Kelly: The move to ES might improve the optics from a mathematical perspective, but it presents a step backwards in terms of daily risk management. VAR has many features that a purist can point out as inadequate; however, its redeeming feature is its simplicity – if the trader has this portfolio over that day, then the P&L experienced is the VAR. The direct link between VAR and realised P&L is reinforced through VAR backtesting, but is now broken thanks to the shift to ES.



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Adolfo Montoro: The transition from a VAR to an ES measure has attracted a lot of attention. The Basel Committee's primary reason for the move is to "ensure a more prudent capture of tail risks and capital adequacy during periods of significant financial stress."

Indeed, severe tail events beyond the current VAR confidence level are, by definition, not directly captured in the current VAR metric, while they will have a significant impact on the ES figure. In practice, this will lead to various challenges – estimating the impact and likelihood of extremely rare events in the tail of the P&L distribution is a difficult task, subject to significant estimation uncertainty. This uncertainty is amplified by the relatively short but mandatory calibration horizon of one year. Due to the uncertainty and the corresponding statistical error bounds, the overall capital charge may fluctuate significantly over time, leading to challenges in the capital management process.

Backtesting the ES metric is significantly more challenging compared with VAR metrics, and various ways of assessing the quality of the ES are currently under discussion. The Basel Committee decided to indirectly validate the ES based on two VAR figures at different confidence levels. While the approach is a pragmatic one, the effectiveness and accuracy of capturing the extreme tail of the loss distribution is not assessed practically as part of the regular validation and eligibility assessment.

While the move from VAR to ES has several theoretical advantages and places more emphasis on proper tail-risk modelling, its practical merits must prove themselves over time, considering practical limitations such as stability concerns and statistical uncertainty of the estimated numbers, as well as the lack of a robust backtesting framework for the extreme tail of the loss distribution.

Ryan Ferguson: It's going to be similar to how moving to the metric system was. ES has nice technical properties, but against that we have years of familiarity working with VAR. In the long run, the transition probably helps, but we will initially be in for a period of confusion while we get used to the new measure

and its implications for capital allocation. ES also raises the bar significantly on data quality, as the whole tail of the distribution now shows up.

Do you expect certain business lines to expand or contract once FRTB is implemented?

Steve O'Hanlon: With or without FRTB, this is already happening – banks are exiting asset classes and entire business lines. But, in terms of FRTB, this depends greatly on capital impacts. With a solution such as Numerix FRTB, executives, heads of trading and heads of risk can respond to the top-level questions they are trying to get a handle on before transitioning to the development of an IT architectural strategy.

For example, there should be a close examination of FRTB capital costs and important questions should be answered upfront – determining which desks will remain operational, which business lines will be profitable under the new regulatory regime, which will have to be discontinued or restructured, and which asset classes will remain active.

On-demand reports for the standardised model that are fully automated, with the option to progress to the internal model if warranted by capital savings or other benefits, are also central to the solution. The cloud-based environment is also ideal for scalability testing, simulating realistic scenarios, conducting what-if analytics and using and testing different data sets.

Pierre Guerrier: Many institutions are looking at redefining their desk organisation to optimise the impact of FRTB capital changes. However, for some factors there is no room for risk diversification.

Regulators have tried to get a glimpse of this impact since the very first Quantitative Impact Study (QIS). One of the aims of FRTB is also to act as a disincentive to trading in products and markets perceived as comparatively risky since the financial crisis. However, QIS may not be accurate, and the official feedback given is not granular enough to reveal the fate of various business lines and whether they achieve regulatory goals. Competing banks and industry bodies also have an interest in not disclosing such granular data.

However, it is clear that the residual risk add-on in the RSA, combined with calibration on overly conservative liquidity horizons, will severely hit foreign exchange options trading, where digital and barrier payouts are extremely common, liquid and have never resulted in losses warranting a systemic adjustment. These activities have a strong incentive to move to, or remain under, an internal model – where they will not elicit material NMRF risk charges.

Correlation trading, whether in credit or equities, will suffer as it has nowhere to hide – under any approach, this business attracts either residual risk add-on or NMRF penalties, and a difficult RTPL reconciliation.

Nick Haining: Because of the unfavourable regulatory capital treatment of NMRFs in FRTB, and the strict criteria that must be met for a risk factor to be considered modellable, the implementation of FRTB will have the greatest impact on trading in anything other than the most liquid types of underlying. A bank that trades in an underlying with low trade volumes, perhaps even as a market-maker, may feel that there is reasonable liquidity in the underlying, but still suffer from the high capital impact of FRTB if this underlying does not fall under the modellable criteria in FRTB. In addition, the expensive convexity charge will penalise any trading in structured or other highly non-linear products, further accelerating the decline in their trading volumes.

David Kelly: Business areas that cannot evidence that they are in full control of all the risk they originate and warehouse will rightly struggle under

FRTB. Products that fail to accurately attribute P&L – due to the existence of untraded input parameters or because they have model-generated noise around their production of sensitivities – will attract linear add-ons that accumulate capital with each new client transaction. Such product offerings that lock in capital for much of the duration of the deal will quickly become uneconomic and are likely to be very difficult to unwind to release capital for other ventures.



Ryan Ferguson
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Ryan Ferguson: Liquidity may become even more concentrated, and risk that does not turn over frequently enough to cover its increased capital costs will see its liquidity further diminished.

This may become a concern for regulators in countries such as Canada and Australia, where the corporate bond market could be impacted as a result. When you add in other regulatory impacts, such as the net stable funding ratio, some of these businesses may have challenges generating sufficient returns.

I think it also exacerbates the problem of banks being 'too big to fail'. Large, highly interconnected banks might have trading velocities high enough to make some of these marginal businesses work, whereas smaller banks with lower velocities may not be able to make sufficient returns and may need to withdraw from the market.

How will the relative attractiveness of the SA and IMA be affected by FRTB?

Pierre Guerrier: The Basel II SA was decried as being coarse and conservative. But it benefited from the simplicity of its implementation, especially compared with Basel 2.5 internal models. With FRTB, both approaches require rolling out complex projects, but at least the RSA becomes risk-sensitive, this deriving from parametric VAR. The internal models, on the other hand, are raising many concerns:

- Implementation is far more complex than RSA and Basel II internal model
- Capital saving over RSA is much lowered
- This saving is highly uncertain, since any desk can be tossed out of the approved scope at any time at short notice, thanks to the stringent eligibility criteria of RTPL attribution and backtesting
- The threat of a capital floor based on RSA, which is already implicit, since granular comparison of IMA and RSA results in the regulatory filings will expose banks with optimistic models to the mistrust of funding markets.

Nonetheless, banks already approved for IMA have no formal option to revert to SA, and for desks under pressure from faltering returns-on-capital, providing more capital is not viable. In addition, some particular activities, such as forex options, should greatly benefit from an internal model.

Tim Rowlands: The bottom line is that capital will increase under FRTB. For

trading operations to be profitable, many banks will want to use the IMA despite the operational and technical hurdles of doing so. Not only large banks, but also several small and mid-tier banks have indicated to us that they intend to run the IMA, which is an unintended consequence of the capital shock. The still unreleased floor value for the ratio of standard to internal capital will have a major impact on the thinking of smaller banks. Impact analyses that we have undertaken show an IMA to SBA ratio at typically between 0.4 and 0.55. If the floor is too high, banks will not bother with the IMA.

Nick Haining: The attractiveness of SA or IMA to a firm depends on its portfolio composition; however, generally the advantage of IMA may not be as high under FRTB as the advantage of IMM was historically, because SA is a highly risk-sensitive method and, as such, does not involve crude overestimation of capital. Also, with the SA-based floor to IMA, the final calibration of the floor level will also influence the attractiveness of IMA to the banks.

David Kelly: The SA is a perfectly reasonable attempt by the Basel Committee to provide a robust and conservative view of aggregate risk across all asset classes. Unlike Basel 2.5, the SA for FRTB is viewed by supervisors as an adequate model – this is important as there is now no stigma in staying with an SBA. For banks that run a focused set of largely flow products, moving from an IMA under Basel 2.5 to an SBA for FRTB should be considered as a pragmatic alternative to a large change programme, though banks should have long-term IMA ambition for their key desks.

What might a future-state FRTB IT ecosystem look like?

Steve O'Hanlon: Firms are focused on getting to a lower cost point, as banks with next-generation technology platforms will be a differentiator and open new market opportunities.

We envision a technology platform – such as Numerix Oneview – that can transcend the front office and middle office with a single database, that can handle XVA risk in real time and also be next-generation in terms of what is needed for market risk in the middle office.

As traders and heads of desk still require a choice of validated models and analytics to cover trader conviction, house exposure standards and legacy corporate P&L measurement, we view front office first and as a gateway to firm-wide transformational activities. There is also a shift in the front office towards operating from an enterprise exposure perspective versus at the desk or book level.

The first set of changes in this area was XVA, which Numerix pioneered and brought to the market. These XVAs have evolved to capture market risk, as well as capital and margin. Going forward, we see the role of integrated analytics for trading, risk, finance, research and operations providing firms with a steady evolution towards cross-silo and cross-functional risk infrastructures.

And any solution must be flexible and robust enough to adapt – not to the regulatory requirements of today, but the next round of changes.

When will FRTB be transposed into national law, and how long do you expect its implementation to take?

Nick Haining: The technical guidance from country supervisors, irrespective of whether it is issued as a regulation or a national law, typically follows within a year of the final version of the BCBS document. If the pattern continues with FRTB, the technical guidance will be issued well in advance of the current implementation deadline. This being said, country supervisors have frequently delayed implementation deadlines for new regulatory capital frameworks. Given the complexity of FRTB and FRTB-CVA, it may well happen with the new regulations.

Martijn Groot: The full Basel timetable stretches to the end of 2019, and not all major jurisdictions have confirmed these timelines. Implementation schedules will depend on whether a bank goes for the IMA, and how heterogeneous the current risk infrastructure is.

FRTB shares certain data management requirements with other regulations, including: the need for additional tags on data; regulatory risk factor classification; the need for real prices in valuation and generally casting a wide net when sourcing market data; and documenting and tracking the use of proxy rules more clearly. The bottom line is that regulators have no tolerance for 'sticky tape' solutions and one of the most evident requirements is joined-up data. Sourcing clean market data continues to be a key challenge for risk calculations – and it is a waste of valuable quant time to spend it on data formatting and cleaning.

A market data hub that centrally sources, maps and assesses market data – and services needs in finance, risk and collateral – speeds up the process. More importantly, it will secure consistency between front-office and risk data.



Lars Popken
Global Head of Risk Methodology
Deutsche Bank
www.db.com

Lars Popken: The Basel Committee suggests that national supervisors finalise transposition into national law by January 2019, with banks formally going live by the end of the year.

Realistically, implementation within the banks will take time. FRTB doesn't just require a change to methodologies but comprises a front-to-back transformation of banks' systems. For example, the FRTB test for internal model eligibility implies that market data is fully aligned between the front office and risk systems, but the exact nature of the eligibility test is still the subject of debate between regulators and the industry.

Although the final FRTB standard text was published in January 2016, there are a number of components beyond the eligibility test that still require clarification or interpretation prior to implementation. This may have implications on timelines – areas of uncertainty are often tackled last, especially when they are as intrusive and costly as the internal model eligibility test P&L attribution.

Given this, it would be regrettable if the transposition process was a mere copy of the BCBS rules-set. It would be much more productive if national regulators work with the industry to refine the rules-set, and achieve consensus on as-yet undefined areas. Such a co-operative process would remediate many remaining concerns around FRTB.

Similarly, when a desirable framework requires thorough implementation of components well beyond 2019, such components could be phased in after formal go-live. Again, the internal model eligibility test P&L attribution may be a case at hand, where initial monitoring on a 'light' version of the test could be a more appropriate approach for 2019 until it becomes a hard criterion. This would allow banks sufficient time to implement robust processes for meeting the criteria – or regulators to better understand where the test is not appropriate despite its compelling theoretical justification. After all, its appropriateness has never been demonstrated in earnest.

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Land of confusion

FRTB and the calculation burden

There are more questions than answers when it comes to FRTB. But banks cannot wait for clarification – they must stop running parallel processes and press ahead with their preparations, says Scott Sobolewski, principal consultant at **Quaternion Risk Management**

Since the finalised rules were published in January 2016, FRTB has created numerous questions requiring further clarification from regulators. These include: strong versus weak forms of risk-theoretical profit and loss (P&L); whether valuation adjustments such as independent price verification or prudent valuation adjustment should be within the scope of the P&L attribution test; timing differences from a single global close versus local P&Ls; the location of the regulatory capital floor; and the potential loss of adjoint algorithmic differentiation (AAD) in calculating risk sensitivities – the list goes on.

The Basel Committee on Banking Supervision's trading book group will continue to clarify many of these outstanding questions through industry surveys, meetings, conference calls and FAQ publications until the January 2019 implementation date. But, amid the industry's confusion with FRTB's finer points, banks must continue to forge ahead with preparation on both qualitative and quantitative fronts: structural reviews of individual trading desks; cost/benefit analyses for pursuing the internal model approach (IMA); and decisions made on upgrading existing IT infrastructure or starting afresh with completely new systems.

To receive approval for an IMA model in advance of the implementation deadline, regulators require at least one year of documented model performance data. Therefore, banks must start collecting model data by the beginning of 2018, necessitating development, validation and management sign-off by the end of 2017. Even the standardised approach (SA) – considered the fallback option for banks or individual desks unable to pursue an IMA – substantially increases the calculation burden from previous Basel III iterations in the form of a sensitivities-based approach, default risk charge and residual risk add-on. The SA will likely require IT investment for banks currently unable to calculate delta, vega and curvature risk factor sensitivities.

An integrated approach

At its core, FRTB regulation is an attempt to unify the front office and risk management by ensuring that all risks driving reported P&L – including those considered non-modellable – are accounted for in the processes that measure capital adequacy and risk reporting. Regulators have stressed the importance of an independent risk management function since the implementation of the Dodd-Frank Act in the wake of the 2008 crisis and, in response, banks hired staff by the thousands to comply with such stress-testing exercises as the US Comprehensive Capital Analysis and Review and the European Banking Authority's EU-wide stress testing. Through most of the past decade, these initiatives were run almost exclusively within risk and finance functions. Given that they were often the gating factor for capital distributions, banks invested heavily in parallel risk architecture that eased the regulatory reporting burden. Along the way, a clear divide emerged between front-office pricing and risk management models developed for year-round regulatory and internal risk reporting.

While models in both camps have passed stringent internal validation

standards, and perhaps even received explicit regulatory approval, each side's model inputs and outputs must now reconcile to an unprecedented degree in the form of hypothetical and risk-theoretical P&L. It is possible that some banks may be able to align improvements to front-office and risk systems enough to pass the test, but the regulatory implication is that banks should stop running two parallel processes. Choosing between two existing systems requires an independent and unbiased assessment of existing architecture on both sides to determine where improvements could be made and efficiencies gained. For example, some banks are exploring cloud-based architecture to more efficiently scale computing power: speed will be at a premium if regulators remove AAD and risk sensitivities may require thousands of calculations per trade under the sequential 'bump-and-revalue' approach, rather than the simultaneous calculations afforded by AAD. Alternatively, some banks lacking internal quant resources have subscribed to third-party platforms that significantly reduce internal or supplemental development costs.

FRTB winners will not be judged by how effectively they meet FRTB regulation in a silo, but rather how well they integrate new and improved systems capabilities with related regulatory deliverables. For instance, the Basel Committee's new initial margin regulation for uncleared derivatives requires a calculation "consistent with a one-tailed 99% confidence interval over a 10-day horizon based on historical data that incorporates a period of significant financial stress". This value-at-risk-style calculation, including the International Swaps and Derivatives Association's standard initial margin model, similarly requires front-office calculation of delta, vega and curvature sensitivities for each trade. Furthermore, the calculation of margin value adjustment and the inclusion of initial margin in regulatory capital requires an entirely new dimension, as forward sensitivities will also require simulation. Although this regulation has only come in to effect for the largest dealer banks (since September 1, 2016), the tiered applicability through 2020 necessitates that many of the same banks subject to FRTB start planning immediately for an integrated approach that minimises the duplication of work efforts.

About Quaternion

Quaternion Risk Management has specialised in delivering transparent pricing and risk solutions for trading book clients since 2010. From evaluated pricing for structured products and illiquid instruments to XVA implementation and capital optimisation under both IMA and SA, Quaternion's track record of success with large investment banks facing time-sensitive regulatory compliance deliverables is unmatched. To find out how Quaternion can help your firm comply with FRTB, including assessment of systems architecture and trading desk structure, model development and independent validation, please contact info@quaternion.com

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2
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The decentralisation trap

The FRTB standardised approach

The penny is starting to drop, says Steve Davis, head of design at Vector Risk. The standardised approach may seem simple enough, but front-office tools lack key refinements and will require continuous attention to ensure complete capture of sensitivities

Lacking the high-performance computing requirements and profit-and-loss (P&L) controversy of the FRTB internal model approach (IMA), it has been assumed that the standardised approach (SA) will be simple to implement. After all, even small banks have to run it. Common wisdom has been that delta, vega and curvature sensitivities will flow from front-office systems into an off-the-shelf calculator that will apply the regulatory risk weights and correlations. However, the penny is finally starting to drop.

FRTB sensitivity generation requires a great deal of supporting logic to ensure trades are allocated correctly. Credit spread, equity and commodity risk factor sensitivities must be labelled with Basel-defined credit quality, industry sector, market capitalisation, economy or commodity group. A large number of definitions have to be maintained in each system that generates sensitivities. Some systems will not support the large parallel shifts for the curvature sensitivities, and some front-office pricing is still carried out in spreadsheets. Drill-down tools are needed to investigate results. A snapshot of rates must be kept in case reruns are required. Most importantly, there should be a mechanism to guarantee that all of the risk has been captured.

A decentralised solution is likely to be mixed in its support for these crucial functions, so does a viable alternative exist?

Many risk engines already have sophisticated stress-testing capabilities that bring a regular taxonomy to describing sensitivities as bumps on curves across all markets. This includes basis point shifts on rates, percentage shifts on prices and volatilities, and up/down parallel shifts for curvature. Risk management staff have ready access to results, drill-down and reruns. The pricing is very fast, so shortcuts like adjoint algorithmic adjustment are not required. The sensitivity outputs, along with default and residual risk raw data, become the inputs to the relatively simple final step that applies the Basel risk weights and correlations to produce the capital number.

Traditional versus risk factor-driven sensitivities

Compare these two approaches to defining sensitivities: in the 'traditional front-office' model, a sensitivity is explicitly defined for each risk factor, with a description that helps align it to the appropriate FRTB bucket. If a risk factor is missing from the list of sensitivity definitions, no error is recorded and the risk is not captured. Auditing for completeness becomes a manual process and requires constant attention.



Steve Davis

In the 'risk-factor driven' model, sensitivity definitions contain wild cards so one definition can match all risk factors of a given type, with a secondary match on FRTB bucket. This secondary match is only possible if the FRTB bucket is also recorded as part of the risk factor definition in the market data store. Now users only need one sensitivity definition per FRTB bucket. New risk factors are automatically included as the bank trades them, and it can be guaranteed that every risk factor on every trade will generate a sensitivity. If your market data has a risk factor with an unassigned FRTB mapping, a sensitivity will still be calculated, and routed to the FRTB 'other' bucket for that risk type where it will attract the highest capital.

The 'risk-factor driven' model is far more elegant and auditable than the traditional front-office approach because all the FRTB logic is centralised and minimised. The bank's regulator can have confidence that the bank is capturing all of its sensitivities and not underestimating capital. The bank itself has a mechanism to maintain the quality of its FRTB mappings simply by checking which risk factors end up being allocated to each FRTB bucket.

Multi-tenancy risk engines are becoming available on the cloud with standardised application programming interfaces for loading trades and market data. With no installation on the client side, they can be plugged in to fill a specific requirement, such as standardised model sensitivity generation, or further utilised to satisfy the full FRTB requirement with little or no disruption to the monolithic front-office systems supplying the data.

A final consideration is that a decentralised approach is a dead end, leaving no natural pathway to the more capital-efficient internal model approach. It is paradoxical that small banks trading in a single location – often in liquid markets with vanilla instruments and low volumes – can avoid the worst of the performance, P&L attribution and non-modellable risk factor issues faced by large banks. Throw in the low-cost, shared infrastructure of a cloud software-as-a-service and growing support from market rate vendors for shared historical data sets, and suddenly the internal model doesn't look so daunting after all.

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Attribution of risk measures for improved risk and capital control

Higher capital requirements from FRTB and stronger risk aversion are making capital a scarcer resource and managing firm-wide risk is becoming more critical. Two levers of control are needed, argues Wolfgang Mantke, principal consultant in GFT's risk management team

The adequate attribution of exposure, risk and regulatory capital charges from firm-wide to business unit, desk, cost centre, sub-portfolio and trade level as a means of controlling costs and optimising the use of resources is as important to the financial sector as cost attribution is to the non-financial industry. Many banks have yet to create an adequate attribution framework and thus continue to misprice and lack the control of their risk and capital usage. Moving towards a degree of clarity and efficiency similar to that achieved by the industrial sector in the 1980s and 1990s is made ever-more pressing by the continuing increase of regulatory capital requirements.

Moreover, the capital charge increase by the new market risk standard that has evolved out of the Basel Committee on Banking Supervision's FRTB and other new regulations will vary strongly between asset classes and banks. This raises the stakes for a capital charge attribution to identify the business units, positions and risk factors that drive such increases, and the ones for which the capital charge contribution actually decreases.

The shift from value-at-risk (VAR) to expected shortfall (ES), with the convoluted multi-layered calculation prescribed under FRTB, will also require new processes for monitoring and explaining the day-to-day changes of the new measures. On top of this, banks require new monitoring and change explaining processes for the completely revised standardised approach (SA) charge, which will define the charge for the desks that will no longer use the internal model approach (IMA) and, irrespective of this, it needs to be calculated in parallel for the IMA desks and may serve as a floor for the IMA charge.¹

Two levers for control

We believe there are two main levers with which banks can improve their control of firm-wide risk and capital consumption. Firstly, they need to identify firm-wide risk and capital charge concentrations of the current bank portfolio and propose ways to manage these. Linked to this is the requirement to monitor firm-wide risk and capital charge and to explain the changes. Secondly, banks need to complement the firm-wide business plan with a firm-wide risk profile plan and control its execution. Such a plan will allow business units to realise risk diversification benefits between business units. At the trade level, it is a prerequisite for accurate deal pricing, since the risk and capital costs of the deal depend on the risk interaction within the firm-wide portfolio, from deal inception to maturity.

For the first control problem, we review here the application of snapshot risk analysis tools such as Euler decomposition and incremental risk. This is then adapted into a causation-based and plan-related risk accounting approach to solve the second control problem.

Snapshot risk analysis and day-to-day explanation of risk changes

The first control requirements can be answered to a good degree with the Euler decomposition of the risk or capital charge measure X , in terms of holding

amounts h_k of a component k and $\partial X_P / \partial h_k$ sensitivities of the measure with respect to holding amount changes:²

$$\begin{aligned} X_P(h_k, h_l \dots) &= \sum_{k'} \text{Comp } X_{h_{k'}} \text{ in } P \\ &= \sum_{k'} \frac{\partial X_P}{\partial h_{k'}}(h_k, h_l \dots) * h_{k'} \end{aligned}$$

The components k can be any basis by which the firm-wide portfolio will be analysed, such as sub-portfolios, financial instruments or risk factor powers and cross terms in a Taylor expansion. The sensitivities support the monitoring process in explaining day-to-day, week-to-week and month-to-month changes.

A component contribution to a scenario exposure L_S , to VAR or to ES measures risk concentration relative to the current firm-wide tail scenarios, as it has the intuitive meaning of being equal to the loss contribution of the component position that needs to be expected if a firm-wide level tail scenario underlying VAR, respectively ES, occurs:³

$$\text{Comp } L_{S, h_k \text{ in } P} = h_k(t) * \frac{\partial L_{S, P}}{\partial h_k} = h_k(t) * l_k$$

$$\text{Comp } VaR_{h_k \text{ in } P} = h_k(t) * \frac{\partial VaR_P}{\partial h_k} = E[h_k(t) * l_k \mid L_P = VaR_P]$$

$$\text{Comp } ES_{h_k \text{ in } P} = h_k(t) * \frac{\partial ES_P}{\partial h_k} = E[h_k(t) * l_k \mid L_P > VaR_P]$$

These identities also provide a practical calculation method for the sensitivities. The holding amount sensitivity of ES can be obtained via the average of the component loss (l_k) over the firm-wide level tail event set. The sensitivity of VAR can be determined with the Harrell-Davis or other L -estimators. Despite the multi-layered composition of the ES-based capital charge under IMA, a practical formula can also be given for its sensitivity – and hence for the Euler decomposition – as for the sensitivities of all FRTB IMA and SA charges. As the new IMA default risk charge is a VAR-type measure, its sensitivity and its decomposition is best obtained with an L -estimator.

While the Euler decomposition is precise and does not rely on position holdings being small relative to the portfolio, the product of holding amount change Δh_k and sensitivity $\partial X_P / \partial h_k$ only well approximates the risk change for small holding changes.

¹ FRTB – The dawning of a new era for market risk management, GFT whitepaper, November 2015; update: Now that the ink has dried..., June 2016

² This is not based on a trivial linear approximation, but by Euler's homogeneous function theorem holds precisely for all extensive variables X , which for positive λ scale as follows: $X(\lambda h_k, \lambda h_l \dots) = \lambda * X(h_k, h_l \dots)$

³ The outer right sides of the second and third equations express conditional expectation values under certain conditions. For the second equation the condition is that the portfolio loss L_P equals VAR, and for the third that it exceeds it. l_k denotes the component loss.

The firm-wide risk change from eliminating a large position can only be assessed by recalculating the firm-wide risk without the position. The difference of risk before and after the position exclusion is called incremental risk,

$$\text{Incr } X_{h_k \text{ in } P} = X_P(h_k, h_l \dots) - X_P(h_k = 0, h_l \dots)$$

which represents a further important quantity for identifying risk concentrations and hedges.

While the focus here is on market risk, we would like to stress the general applicability of the Euler decomposition. First, the results shown hold for market as well as credit VAR and ES. Second, the attribution and change explanation processes of credit exposures can also be based on the Euler decomposition, the sensitivities it invokes and the incremental risk. The problem of attributing exposure and explaining its day-to-day changes will again become a priority, as banks replace current exposure method (CEM) with the standardised approach for counterparty credit risk (SA-CCR) exposure^{4,5}, and thus need to update their attribution and change explanation processes.

Causation-based risk accounting for firm-wide planning and risk pricing

For the second control lever, the risk and capital charge are attributed to a sub-portfolio based on the actions that the sub-portfolio manager is accountable for, according to firm-wide portfolio risk profile planning (with planned changes of the functional dependence on risk factors described in terms of key risk factors). The key principle is that a sub-portfolio shall be charged under the assumption that the other sub-portfolio managers have developed their sub-portfolios according to the firm-wide risk profile plan. The 'control portfolio' – from the perspective of an individual sub-portfolio manager – is his actual sub-portfolio plus the other sub-portfolios with planned risk profiles.

At the end of each business day a control risk attribution to each sub-portfolio is calculated, based on the day's risk change of the associated control portfolio. The actual day's change of the firm-wide risk is attributed to sub-portfolios in proportion to the control attributions and booked into sub-portfolio risk accounts, which accumulate the risk attributions over time.

If a method-related instantaneous jump in the risk attribution amounts is to be avoided, the firm-wide risk at the start of the plan-related risk accounting process needs to be attributed by the formerly employed attribution rule. Otherwise an appropriate attribution of the risk at the start of the new process would be obtained with the Euler decomposition.

The risk accounting approach incentivises sub-portfolio managers to develop their sub-portfolios in accordance with the firm-wide risk profile plan and constitutes a basis for the calculation of risk and capital valuation adjustments.

Know, manage and price your risks

Understanding of financial risk derives principally from three analysis dimensions:

- **Monetary assessment** – the monetary impact of the materialisation of the risk should be assessed via suitable risk measures.
- **Portfolio analysis** – business and risk managers should be informed which of their portfolio and business activities cause the main exposures to the risk scenarios. The Euler decomposition of scenario exposures L_S , VAR and ES is a powerful tool to this end, as it provides a straight drill-down to how much business units and instrument or risk factor positions are expected to contribute to the loss if the risk materialises.
- **Scenario description** – managers should be made aware of the range

of scenarios under which the risk can materialise, so they can judge their plausibility and acuteness relative to the current macroeconomic-political outlook. Used in this way, stress testing, VAR and ES processes help identify particularly threatening scenarios. For stress testing, this is already general practice. With regard to VaR (and ES so far as already employed), most firms currently report VAR and explanations of its day-to-day changes, but fall short of informing their management of the tail scenarios that the VAR/ES model identifies as especially threatening.

With the three dimensions above, a portfolio or risk manager can identify risk concentrations, determine risk hedges and judge the acuteness of identified risks with respect to the current macroeconomic-political outlook, and take de-risking decisions accordingly.

For attributing risk and capital costs, the past and planned future paths of portfolio development should be taken into account, so that a sub-portfolio is charged primarily according to the actions the sub-portfolio manager is responsible for. To this end we have outlined a risk accounting framework that both improves the individual accountability and the incentive for acting for the benefit of the whole firm.

Under stronger risk aversion, including tighter regulations such as those presented by FRTB, cause-driven risk and capital cost accounting is increasingly a key success factor as it enables a firm to price competitively while avoiding loss-making deals.



The author

Wolfgang Mantke is a principal consultant in GFT's risk management team and has extensive experience in designing, implementing and employing risk management solutions. He worked for three years at the Royal Bank of Scotland in London as a market risk manager in its investment banking division. Throughout his career in the financial sector, Wolfgang has worked in both market and credit risk. Holding a PhD in physics from

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⁴ Basel Committee on Banking Supervision 2014, The standardised approach for measuring counterparty credit risk exposures, www.bis.org/publ/bcbst279.pdf

⁵ BCBS 279 presents SA-CCR exposure: An overdue arrival in the 21st century, GFT whitepaper, October 2016

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FRTB is Important but What Does It Actually Mean for Me? My Bank?

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Blueprint for FRTB

Building a future-state business strategy

There are no silver-bullet solutions to the myriad challenges of FRTB. Numerix believes institutions should restructure and re-strategise not just for today, but with an eye on FRTB's business impact in the years to come

As the 2019 FRTB implementation deadline draws nearer, financial institutions around the globe are toiling to more effectively analyse and understand the massive implications of FRTB from a business impact, cost and profitability standpoint. With the new FRTB regime paving the way for transformational, industry-wide shifts among banks – which will, in many cases, include the restructuring of trading desks, business lines, IT architectural designs and market risk and data management systems – a key differentiator for success will be the development of a next-generation blueprint, outlining an FRTB business strategy for an organisation's future state.

Optimising business lines and trading-book composition

When it comes to FRTB's impact on individual business lines and trading desks, capital requirement implications need to be thoroughly analysed to determine whether particular desks and business lines will remain profitable. Decisioning and business impact assessment software will be an important component to enable closer examination of capital and other costs to help determine which business lines and asset classes will be most viable moving forward. Alternatively, this type of analysis will also enable institutions to discern which lines may need to be restructured or discontinued. For example, the increased capital charges on non-modellable risk factors, as finalised in the FRTB January 2016 regulation, will lead to higher charges. Will it still be profitable for the business to trade certain exotics or structured products – or to support certain asset classes? Are there any offsetting benefits to keeping these business lines that should be taken into consideration? As the new FRTB regime unfolds, siloed, fragmented and black-box approaches will become costlier and less effective in meeting FRTB requirements. Banks will need to embark on a more holistic, enterprise approach for IT transformation with a clear understanding of the complex interdependencies that exist between departments, legacy systems and data management infrastructures.

Managing escalating costs: A closer look

Implementing FRTB is proving to be a herculean task for banks. Research and advisory firm Celent reports that FRTB implementation costs for a Tier 1 bank are likely to be between \$60 million and \$150 million over the next three years, while Tier 2 and regional banks are still embarking on structuring their FRTB programmes and mobilising the necessary resources to assess what it means for them.¹

Faced with the challenge of tons of additional calculations – including computing sensitivities under the FRTB sensitivities-based approach, internal model approach (IMA), credit valuation adjustment (CVA) and profit-and-loss attribution calculations – the trend emerging among many financial institutions is to mitigate costs by leveraging cutting-edge technologies.

Cost-saving trends are emerging industry-wide through the use of cloud-based FRTB technology solutions that enable fast deployment, enhanced speed and a lower total cost of ownership. In addition, using vectorised models for extremely fast compute times, speeding up model performance with graphics processing units (GPUs) and using adjoint algorithmic differentiation (AAD) to calculate FRTB and FRTB-CVA sensitivities can all potentially enhance calculation and increase cost efficiencies.

Decision-making: Finalising strategy and blueprint implementation

While the future state for most financial institutions is still ambiguous and emerging, market participants realise there is no silver-bullet solution.

On a path towards developing an FRTB implementation strategy, the band-aid approach will not be effective for long-term success. Institutions must ensure their transformation strategy is optimal from both an investment and capital perspective. Banks must take ownership of rising costs and understand the business impact of FRTB. Financial institutions must make key decisions to support the front office, risk, market data and product control more holistically – and some of these decisions could be painful for management, especially in terms of transforming analytics and technology frameworks.

Before strategic decisions are finalised, institutions can take clear first steps to assessing the overall business impact of FRTB, including understanding capital charges, how FRTB is impacting each of their desks from a profitability standpoint and how operational risk and market risk are coming into play. Which business lines will utilise the standardised approach versus the IMA, and what would be the potential business impact of each?

By asking the right questions and having the right strategy in place, executives and heads of trading and risk can quickly and efficiently obtain a clear picture of FRTB business impact today and into the future.

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¹ Cubillas Ding, FRTB and the upcoming renaissance in market risk management, *Celent, August 2016*.



Freeing up the front office

Desk heads take on new risk responsibilities

FRTB risk programmes should be split into analytics, data and computation components, and front-office desk heads must act like business leaders and assume the daily tasks of reducing complexity and cost, writes David Kelly, partner at **Parker Fitzgerald**

FRTB presents methodology, data granularity and computation challenges for all banks, regardless of whether they seek internal model approval (IMA) or focus on the sensitivity-based approach. As the 2019 deadline approaches, there is a tendency for groups within risk, finance and technology teams to design a solution based on current infrastructure. We believe this approach needs refining, with the focus moving to a more distributed approach together with a higher level of engagement with the front office.

Multi-year risk change programmes follow a well-trodden path of acquiring transactional and end-of-day market data from front-office systems, and reference data from multiple sources. The movement of data across the globe is followed by data normalisation to enable aggregate risk calculations – value-at-risk, stress, incremental risk charge and credit valuation adjustment. The front office often struggles to use the output from this approach for daily risk management, which is a key supervisory expectation.

Each desk head will need to decide which products provide a realistic return on capital, are robust during periods of stress and present some opportunity for an orderly exit. This requires forensic analysis of their current portfolio to outline which trades are a priority to unwind, and how the capital will accumulate as it absorbs new trades, including hedges. Such prototyping requires multiple recalculation of the portfolio's capital charge under different scenarios that accurately predict the impact on new trades as calculated by the official overnight run. If the overnight run involves data mappings and enrichments that are opaque to the front office, this exercise is fraught with inaccuracies, and not only is the opportunity to manage capital lost, but the IMA is at risk.

For FRTB, the front office will always prefer the agility that comes with building its own prototype – a desktop approach with minimal technology controls and code originated by its own quants.



David Kelly

By flushing out data quality issues, it remains the cheapest way to reduce overall capital charge. But it is not a scalable model for the bank's entire portfolio. These tools are end-user applications, they are not strategic and therefore cannot compete with a large installation. Enabling the current infrastructure to be both forensic for desktop analysis and available for an entire population is likely to dim the lights when it is switched on. In short, the two requirements are incompatible, so multiple and co-ordinated solutions must prevail.

The solution is to decouple the analytics and data components so that the calculations can be done by multiple users on different portfolios.

- Risk to build the analytics for the capital model and store in a quant library that can be called by all users and systems – it must be agnostic to the user and portfolio-applied.
- Centralise the market data time series and make available for scrutiny and governance. The data should be called by the analytics and not from within the user's code base.
- The front office to centrally define the instruction set for each product on how each will be calculated for end-of-day profit-and-loss attribution and a standardised version of risk that can then map to the market data time series. The standardised view is distinct from the local view

traders use intraday.

- Risk and finance to migrate data tagging – liquidity horizons – into the product as defined above for the front office to manage going forward.

This distribution of calculations enables the front office to check the capital consumption pre-deal and not be surprised when the closed deal is part of an overnight run. The splitting of data, analytics and computation greatly reduces the complexity and running costs of the FRTB programme.


The F word

The front office will have to adopt risk sensitivity methodologies in cases where it is not the main 'owner'. Each desk head will need to be bilingual, as they switch from their local view to an aggregate view. This is a critical component to evidence an effective risk challenge environment where aggregate reports are treated as a legitimate view of risk and where the difference from the local views is understood.

The additional responsibilities pushed back on the front office will require an increase in non-revenue headcount, which signals a move away from the first line being purely income generation to one where the desk head is running a business. Keeping capital costs down through intelligent origination and portfolio management must become as significant a component of the business model as revenue generation and market share-orientated initiatives. It is this shift in the role of the front office that is really the 'F' in FRTB.

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