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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 sensitivities $\partial X_P / \partial h_k$ 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

$$\begin{aligned} \text{Comp } L_{S, h_k \text{ in } P} &= h_k(t) * \frac{\partial L_{S, P}}{\partial h_k} = h_k(t) * l_k \\ \text{Comp } VaR_{h_k \text{ in } P} &= h_k(t) * \frac{\partial VaR_P}{\partial h_k} = E[h_k(t) * l_k \mid L_P = VaR_P] \\ \text{Comp } ES_{h_k \text{ in } P} &= h_k(t) * \frac{\partial ES_P}{\partial h_k} = E[h_k(t) * l_k \mid L_P > VaR_P] \end{aligned}$$

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

⁴ Basel Committee on Banking Supervision 2014, The standardised approach for measuring counterparty credit risk exposures, www.bis.org/publ/bcb279.pdf
⁵ BCBS 279 presents SA-CCR exposure: An overdue arrival in the 21st century, *GFT whitepaper*, October 2016

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

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