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A Tale of Two Formulas: Solvency II SCR and RBC

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For the past decade, Solvency II has been developing in Europe to update approaches to insurer capital requirements, amongst other issues with respect to insurance regulation. In July 2008, in response to Solvency II (and then reacting to other regulatory developments in the wake of the financial crisis), the National Association of Insurance Commissioners (NAIC) kicked off its Solvency Modernization Initiative (SMI). As the end of 2012 approaches, most major decisions surrounding calculations for required capital have been finalized, though some details are still open for development. Below, I will examine the central formulas and look at their underlying assumptions.

THE CAPITAL FORMULAS

The core life authorized control level risk-based capital (ACL RBC) formula is as follows:

$$ACL\ RBC = C_0 + C_{4a} + \sqrt{(C_{1o} + C_{3a})^2 + (C_{1cs} + C_{3c})^2 + C_2^2 + C_{3b}^2 + C_{4b}^2}$$

The core formula for the Solvency Capital Requirement (SCR) under Solvency II is:

$$Basic\ SCR = \sqrt{\sum_{i,j} \rho_{i,j} \cdot SCR_i \cdot SCR_j}$$

The more complete SCR requirement includes a separate operational risk charge, but I will not deal with that issue here. Let us ignore what the individual components mean, other than the various C amounts are risk charges for particular risk categories, such as credit risk or mortality risk. We can see from the forms that there are similarities between the two types of formulas.

However, the surface similarities go away when one looks into the assumptions that have gone into developing the various components and the formulas themselves. To begin with, there is a top-down vision of the Solvency II SCR: It is defined as being the one-year value at risk (VaR) at the 99.5 percent confidence level. One starts at this high-level concept and then drills down to modules and submodules of risk that conform to this vision. One could have a full internal model to simulate the losses to get a multivariate VaR, but, in general, one would have separate individual models that have their results aggregated as noted in the formula above.

On the other hand, U.S. RBC is more of a bottom-up calculation in its core concept. There is no specific time horizon or risk metric that is specified, much less a specified confidence level. As the RBC formula has been updated, it has been at the component level, with various pieces having their own calibration points, not necessarily in conjunction with any other factors seen in the equation. The method for updating RBC has been one of incrementalism, with new factors being targeted to very specific risks and/or lines of business. The projects have involved targeting missing risks or outdated factors. For example, the C3 Phase II project to determine C3 (asset-liability mismatch risk) for variable annuities with guarantees, was intended to recognize risks that had been poorly captured by prior factors. To that end, as part of the SMI, the NAIC has already designated certain areas of the formula needing updating, such as the need for an explicit catastrophe risk charge in the P&C RBC formula and also to recalibrate asset risk factors and provide a different granularity than that which existed before.

RISK METRIC AND CONFIDENCE LEVEL

Let us first consider the risk metrics used in these formulas. As noted above, Solvency II SCR uses the VaR metric, which gives the potential loss in value over a defined period for a given confidence level. In this case, the confidence level is 99.5 percent, so it is expected that there would only be a 0.5 percent chance for capital set at this level to be fully depleted.

Considering that last sentence, one can see the primary strength of the VaR metric: It is easy to interpret and has a clear connection to probability of insolvency (defined as capital depletion). In addition, a lot of mathematical and computational machinery has been built to calculate VaR speedily. Much of this was originally developed for banking risk management.

However, there is a glaring problem with VaR, especially if one is a regulator concerned with what happens when insurers fail. The VaR metric only looks at how bad it can get up to a certain failure probability;

it does not reveal anything about the shape of the loss distribution beyond that point. This is akin to a black hole's event horizon—one can observe the effect of a black hole outside that range, but, once inside, there is no clue what is going on.

The issue of "risk blindness" past the confidence level specified has caused problems in the financial world before, most notably with collateralized debt obligations (CDOs). "Fat-tailed" risks means that, when things go bad, they can go catastrophically bad. If one is a regulator, one wants to make sure that, in the case of insolvency, policyholders are relatively well protected. A catastrophic insolvency whereby other insurers could not assume the liabilities in question is the almost-worst-case scenario for regulators. The worst-case scenario would be a catastrophic collapse of the entire insurance industry.

On the NAIC RBC side, there is no single risk metric that has been used. In some of the cases, a VaR metric was used to develop factors; in other cases, there was no specific metric per se. Recent projects to update life RBC calculations have used a conditional tail expectation (CTE) approach that looks at the expected value past the VaR loss. While this metric does address the risk blindness problem, the interpretation of the result is more difficult to convey. That said, the CTE metric has other nice properties, such as subadditivity (where two separate risks do not become more risky simply from combining them together; VaR fails with respect to subadditivity) as well as smaller confidence intervals for the same number of scenarios when one is estimating the metric using Monte Carlo techniques.

RISK AGGREGATION

Though theoretically the SCR is a top-down measure, generally modeling all risks at the same time and determining the loss at the proper percentile is untenable. Thus, many would use the BSCR formula as noted above, where module or submodule VaR is calculated, and then aggregate using correlation coefficients (whether developed on their own or using standard correlations).

This approach is sometimes called the variance-covariance approach to capital calculations, and it is equivalent to using a Gaussian copula for modeling the dependencies of the separate risk modules. Copulas are a method for combining single-dimensional probability distribution into a multidimensional distribution by using arbitrary marginals (the individual risks independently modeled) and using the structure from some standard distributions. Gaussian copulas are particularly popular in risk modeling, but they have a pitfall: tail independence. Tail independence shows up as a measure of probability that two extreme events occur simultaneously (in the case of a two-variable copula); as you're pushed out further and further into the tail, Gaussian copulas show these extreme events to be independent. One can see how this might underestimate the "true" VaR.

The NAIC RBC formula is a bit more extreme, in that the implied correlations in the formula are either 0 (total independence) or 1 (perfect correlation). Assuming total independence may underestimate the impact of combined risk and assuming perfect correlation may overestimate it.

TIME HORIZON

U.S. RBC does not specify a time horizon for its risk charges, while Solvency II SCR has a time horizon of one year for all risks. In commenting on this as part of RBC reviews in the SMI, NAIC working groups have noted that different time horizons may be appropriate for different risks as they develop over time. A Conning analysis of capital adequacy models commented on the importance of the time horizon with respect to risk capital measures:

> Risk can look very different over time. A risk that can dominate the risk landscape over a short time horizon can be more benign over a longer time horizon. For example, small unanticipated changes in medical inflation might require only a small portion of the total required capital over a short time horizon. Over a longer time horizon, the impact of unanticipated changes in medical inflation will compound while other risks, such as catastrophe frequency, will diversify. Therefore, a single economic capital metric is a current-point-in-time measure that does not consider how risks interact over many different time horizons. They view risk over a single time horizon. It is important to under-

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> stand how these risks interact and aggregate over different time horizons to understand the appropriate level of capital to hold. (Painter and Isaac, "A Stakeholder Approach to Capital Adequacy")

The time horizon is really only relevant for solvency measurements that use cash flow modeling. The RBC approach offers only a point-in-time assessment of capital levels and is essentially a retrospective view of capital. The Solvency II approach uses a one-year capitalization time horizon.

While an improvement over the retrospective view of capitalization, the models focused on a one-year horizon, by definition, are not designed to view the business on a multiyear/going-concern basis. The problem with the one-year view is that it misses latent, developing risks that build over time to affect capital.

As the NAIC has been adding projection elements to the RBC calculation for life products, the time horizon used for calculations have taken longer-term points of view, usually running out the liability model until the entire liability has essentially run off. There are issues with this approach as well, as one needs to project out many life liabilities for decades before run-off is complete. This means that one must also be able to model very long-term reinvestment strategies in addition to projecting mortality and policyholder behavior trends. There is a lot of model uncertainty with such long-term projections and, of course, certain company actions—such as changing investment or dividend strategy—will be influenced by actual developments that may be difficult to incorporate into a cash flow projection model.

That said, while having a theoretically infinite time horizon is troublesome, in practical terms, nearer-term cash flows generally dominate should the company be in a weakened position with regard to reserves and capital backing a particular line of business. Perhaps an intermediate time horizon, such as a five-year period, may help bridge the gap between the multiyear development of trouble as well as the practical problems with overly long horizons.

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INTERNAL MODELS

Finally, one major distinction between the approaches to capital requirements is the use of internal models. While there has been recent development of principles-based approaches for determining life RBC, on the whole, the set of factors being used are the same across the industry.

While understanding the need to modernize approaches to risk capital for complicated products, which involves the use of fairly sophisticated models, regulators in the NAIC have hesitated to grant free rein to insurers. In addition to stochastic simulation to capture tail risks, regulators have required standard scenarios to be run, in order to provide a floor for the results. In standard scenarios thus prescribed, there are no choices allowed on the part of the insurer; for many insurers, these standard scenarios have been found to dominate over the stochastic risk measure.

In a 2009 Networks Financial Institute policy brief by Therese M. Vaughan, the wariness toward the use of internal models was stated:

> A second feature of the U.S. system is the significant safeguards that have been built into the introduction of internal models. A healthy skepticism of internal models by some states resulted in the NAIC's incorporating a standard scenario into its capital requirement and reserving standards for variable annuities. The standard scenario is a single scenario with specified assumptions independent of a specific company's experience. That is, while the insurer is permitted to calculate its required capital and reserves using internal models with its own inputs, it must also calculate them using a standard deterministic scenario provided by the regulators. This scenario serves as a floor for the reserves and required capital. According to the NAIC's Life and Health Actuarial Task Force,

> the standard scenario assumptions are not intended to produce requirements that would be adequate most of the time. Rather, they are to ensure that the requirements are not unreasonably low, particularly given the lack of experience in applying internal models in this context. Regulators see the standard scenario as providing reasonable constraints to the flexibility given to actuarial judgment when doing stochastic modeling. (Vaughan, "The Implications of Solvency II for U.S. Insurance Regulation," *Networks Financial Institute*, February 2009.)

On the other hand, the ability to use internal models, or even be required to use internal models, has been a notable feature of Solvency II. The European insurance industry has conducted a series of five quantitative impact assessments (QIS1-QIS5) to gauge the adequacy of insurer capital levels under the new rules. The fifth and most recent of these showed that just under 5 percent of participating firms did not meet the minimum capital requirement (MCR) and 15 percent did not meet the SCR. (The MCR is the level at which there will be aggressive supervisory intervention and is defined to be the 85 percent one-year VaR amount. There is a further constraint that the MCR must be between 25 percent and 45 percent of the SCR.) The concern is that large, diversified groups with advanced internal modeling capabilities—using their own models—will find their capital requirement improved relative to Solvency I, but small insurers applying the standard formula will face a requirement for a capital increase.

EQUIVALENCE?

While the features noted above are rather set, there is one large, looming issue surrounding SMI and Solvency II: How will the U.S. regulatory system be considered under the new regime?

The issue ranges much farther than just capital requirements, but capital (and reserving) requirements may have the most immediate effect. If capital requirements for European Union-domiciled insurers with U.S. subsidiaries are much higher than that for their U.S. competitors, they may need to exit particular lines of business or consider redomiciling in a country with a more salutary regulatory regime. The U.S. market has already seen the exit of Canadian insurers from particular lines due to Canadian requirements being more stringent than those of the United States.

As of the writing of this article (September 2012), there have only been three regulatory regimes evaluated by the European Insurance and Occupational Pensions Authority (EIOPA), the EU parallel to the NAIC: Bermuda, Japan and Switzerland. The U.S. system has not been reviewed in the same manner, partly because there had been no formal request, but also because the reality of how the U.S. market is regulated, on the state level, does not fit within the national-level supervision envisioned under Solvency II.

As noted in the head-to-head comparison above, there are substantial differences between the approaches. The papers cited in the "Further Reading" section below illustrate that the numerical results can also be substantially different. Ultimately, the determination of "equivalence" under Solvency II is a political one, as it will be the various political bodies (as opposed to regulatory bodies) that will make the final call. Individual countries within the EU may make separate determinations. It will be interesting to see whether Solvency II, a project intended to produce regulatory convergence, provides impetus for regulatory arbitrage.

FURTHER READING

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