BY VIKTOR LUKOCIUS

Implied Cost of Capital Measures for Non-Regulated Risks

A goal of this piece is to define and analyze two measures of Implied Cost of Capital, related to different types of unexpected non-regulated risks.

Measures and considerations of the regulated unexpected risks are widely addressed in the literature in the form of Solvency Capital Requirements for financial institutions. These measures are predefined by the regulator and there is limited freedom of deviation.

A point of consideration here are non-financial institutions, which could be exposed to any type of non-life risk and are not regulated by an external party. For simplicity we concentrate on the hazard risks only. Such non-life hazard risks (further simply risk) have to be addressed by the companies themselves.

The underlying expected risk is usually budgeted upfront and all the costs, which are related to its financing are a part of the usual activity of the company. However, every risk type is subject to volatility, which could result in a significant increase of the expected loss within certain year and hence cause a serious increase of the cost of its financing. It could be a need to raise the capital (through debt of equity) in order to finance this unexpected loss, which would lead to additional cost of capital over several years. This cost is a random variable and its expected value will be further defined as Implied Cost of Capital (ICC).

ICC is an important component, which is necessary to consider in addition to the traditional Cost of Risk components in order to make a fair comparison of risks and their financing structures.

Dr. ir. V. Lukocius AAG is Head of Marsh Analytics Solutions North-West Europe.

MEASURING UNEXPECTED RISK

In order to define the ICC properly, it is needed to introduce a measure for unexpected risk first.

A loss per given period of one year is defined as L, which is assumed to be a random variable following some distribution (also called loss curve). If mean of the distribution is denoted by E[L], the unexpected loss UR[L] is defined as any loss L, which exceeds E[L].

In general, there are many ways to measure severity of UR[L]. The two widely used methods are Value at Risk (VaR, also used in the Solvency II (SII) regulation) and Tail Value at Risk (TVaR, also used in the Swiss Solvency Test regulation).

A measure of the UR[L] for the certain risk L in case of VaR approach is defined as $UR_{VaR}[L]=VaR_p(L)-E[L]$, where p is chosen in line with the SII regulation to be 0,995. By using the TVaR, the required measure for UR(L) is defined as $UR_{TVaR}(L)=E[L|L>E[L]]-E[L]$, which is equivalent to $UR_{TVaR}[L]=TVaR_p[L]-E[L]$, where p corresponds to the probability P(L>E[L]).

There are a lot of discussions on which measure is more appropriate: VaR or TVaR. Formally speaking, VaR is not a coherent risk measure since does not satisfy the Subadditivity characteristic. However, in most cases it is not a problem. A real problem occurs when VaR starts to underestimate or overestimate the unexpected risks and hence, related costs of its financing, due to extreme nature of the risk itself. Non-regulated risks considered here are usually far from normality. Liability and Property risks, which companies deal with, are often extremely heavy tailed, having significant mass further than 0,995 percentile. In this case $VaR_{0,995}$ simply does not assess the risk on the level needed. As a consequence, the ICC could be significantly underestimated or unnecessary overestimated by considering only one quantile as a measure for the UR[L]. TVaR measure could solve this problem since it uses the whole loss curve above the certain quantile.

MEASURING IMPLIED COST OF CAPITAL

In this section the above defined measures for UR[L] are used in order to define the ICC. The word "Implied" emphasizes that costs related to the UR[L] are not fixed costs, which are recognized in the financial statement of a company each year. Non-financial institutions usually do not hold the $UR_{VaR}(L)$ or $UR_{TVaR}(L)$ in the form of a capital and hence, direct cost of capital is out of scope here.

However, the related cost of capital becomes real cost if unexpected event UR[L] occurs. Therefore, probability of occurrence has to be taken into account in order to make a fair assessment of this cost of capital today.

Traditional Weighted Average Cost of Capital (WACC) could be used in order to reflect costs related to financing of an unexpected event. In general, WACC takes both Cost of Equity and Cost of Debt into account and should be representative for a usual balance sheet.

In addition to the above, time component should be taken into account in order to make the cost factor complete. When an unexpected event occurs, related costs could stay on the balance sheet for several years, bringing yearly costs to the P&L. Therefore, these costs have to be projected and discounted in order to represent a fair assessment. Different risk types are expected to have different duration, which will be defined by WAL (Weighted Average Life).

In this way, taking the above definitions into account, Implied Cost of Capital (ICC) for a risk L is defined as

$$ICC(L) = \sum_{i=1}^{WAL} \frac{UR_i[L] \times WACC_i}{(1 + r_i)^i} \times p_L,$$

where r_i corresponds to the interest rate, $UR_i[L]$ represents development of UR[L] within the time interval of WAL, $WACC_i$ represents a level of WACC in a certain year and p_L denotes the probability of occurrence for UR[L], hence P(L>E[L]).

The above definition could be simplified by assuming that for all i=1...WAL, $UR_i[L]=UR[L]$, $WACC_i=WACC$ and $r_i=0$. In this way the definition of ICC[L] takes a form

$$ICC(L) = UR(L) \times WACC \times WAL \times p_L.$$

Note that the above simplification is reasonable in case of small WAL (3-5 years), but could be less realistic for longer durations.

Replacing UR[L] by $UR_{VaR}[L]$ or $UR_{TVaR}[L]$ gives us the needed measures of ICC in the form of $ICC_{VaR}[L]$ or $ICC_{TVaR}[L]$.

It could be noticed that definition of $ICC_{VaR}[L]$ is very similar to the definition of Risk Margin (RM) in the SII framework if the Cost of Capital (CoC) is aligned with WACC and the probability p_L is ignored.

Hence, the probability p_L is a key factor, which distinguishes the definition of $ICC_{VaR}[L]$ from RM. This is also make sense since SCR is not an implied measure, but is related to real capital, observed on the balance sheet.

In case the UR[L] is measured by TVaR, it could be shown that the resulting ICC takes the form, which was introduced as Implied Risk Charge by C. Yoder and D. Happen in [1].

$$ICC_{TVaR}(L) = E\left[max\left(L - E\left[L\right],0\right)\right] \times WACC \times WAL.$$

ILLUSTRATIVE EXAMPLE

In this section different risk profiles are used in order to demonstrate deviation of the Implied Cost of Capital by applying different measures. Table below summarizes different characteristics of the risks considered and presents the ICC measures.

Risk Profile	E[L]	$VaR_{0,995}(L)$	$TVaR_{P(L>E[L])}(L)$	$UR_{VaR}[L]$	$UR_{TVaR}[L]$	p_L	$ICC_{VaR}[L]$	$ICC_{TVaR}[L]$
Transportation Risk	617.578	1.846.352	899.581	1.228.774	282.003	0,43	112.132	25.734
General Liability Risk	6.259.523	150.353.865	30.927.069	144.094.342	24.667.546	0,16	4.805.258	822.613
Extreme Property Risk	4.192.035	11.753.651	84.643.508	7.559.867	80.451.473	0,04	65.503	697.080

By looking to the p_L (probability that L exceeds mean of the distribution E[L]) only, it is possible to recognize types of the underlying distributions. It is clear that Transportation Risk profile is least heavy-tailed from all the risk profiles considered. The p_L is quite close to 50% and hence the E[L] is close to the median. Therefore, the resulting ICC[L] is expected to be low.

Indeed, the $ICC_{TVaR}[L]$ illustrates € 25,7 K of Implied Cost of Capital. However, $ICC_{VaR}[L]$ illustrates more than 4 times higher figure, estimating related Implied Cost of Capital at the level of € 112 K.

In the General Liability Risk profile we observe even higher magnitude of deviation. In this case the $ICC_{VaR}[L]$ is almost 6 times higher than the $ICC_{TVaR}[L]$. Since VaR (and hence $UR_{VaR}[L]$) does not take into account the balance of the underlying distribution above E[L], the resulting $ICC_{VaR}[L]$ is significantly overestimated.

It could be argued that overestimation is a conservative and prudent view on risk, taking worst case scenario as a representative. However, in case of the Extreme Property Risk profile, the ICC[L] seems to be significantly underestimated if using $ICC_{VaR}[L]$ measure. Since significant part of the mass is above 0,995 percentile, the VaR-based measure does not take it into account. In this example $ICC_{TVaR}[L]$ illustrates more than 10 times higher result.

CONCLUSION

Two measures of the UR[L] and further of the ICC[L] were introduced and analyzed.

It was demonstrated that VaR could have significant limitations while used to estimate the ICC. Nature of the underlying risk profiles is often extreme and not homogeneous, which often does not allow to use one quantile as a representative for the significant part of the distribution. Under these circumstances TVaR suits much better since utilizes the whole tail of the distribution. ■

References

[1] Claude Yoder and Dave Happen. Using Big Data to Capture Risk Volatility. CFO Magazine, 2013.