Risk Adjusted Return On Risk Adjusted Capital (RARORAC)

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Risk management in banks aims at covering any kind of risk. Credit risk is the risk that the bank has to suffer losses because of a defaulting obligor or a depreciation of its financial health. Since the traditional role of banks is to lend money, credit risk has always been the major risk that they had to support, and, paradoxically, the management of this risk is evolving faster than for other types of risk.

Since the 90s, most of the large international banks have set up heavy credit risk management systems, and in particular in order to measure and monitor the risks they hold on each business line. One of the goals of theses systems is to allocate capital to each business line and to compute the overall capital of the bank. All these techniques are known under the generic acronym *RAROC methodology* (Risk Adjusted Return On Capital) ; implicitly, this methodology focuses on economic based estimations of credit risk, taking into account both all the individual risks and the portfolio view of the bank. The aim of the RAROC methodology is twofold :

1. Risk management: in the financial theory, the bank aims at reaching its optimal capital structure and finding the proportion of equity to assets that minimizes the cost of funding. The RAROC methodology is used for determining the overall capital requirement of the bank and the contribution of each business line to the total risk of the bank. This process is called capital allocation.
2. Performance measurement: the RAROC device computes the profitability of each transaction or business line for the shareholder. The performance measurement is the result of the interplay between revenues on one hand, and risk components on the other hand.

In this article, we first focus on the credit risk management aspect of the RAROC methodology, and in particular, we explain in details what economic capital is. The second part of the article will be devoted to performance measures such as RARORAC and EVA.

Let's consider the case of a AA rated bank that wants to capitalize its portfolio in a manner consistent with a AA rating target. This amount of capital is of course driven by all the stand alone risks included in the portfolio, but also benefits the internal diversification of this portfolio. In this sense, this equity capital requirement is called economic capital.

Whereas the expected loss is the average loss that the bank anticipates to loose on its portfolio, the economic capital refers to the unanticipated losses that occur in extreme situations or market conditions. The economic capital is the cushion required above the expected loss for the bank to remain solvent in the event of extreme losses on the bank's portfolio.

In order to compute the economic capital, the bank needs to determine a time horizon and a confidence interval consistent with the bank's target credit rating. The portfolio loss distribution is the quantitative tool that leads to the economic capital. There are many available criteria for defining economic capital, but generally, economic capital is defined as the amount required to cushion the portfolio up to a given confidence level. The required confidence level depends on the target rating of the bank. For instance, if the bank's portfolio has an average maturity of 2.5 years, the confidence level is around 99.9% for a AA- target rating. From a mathematical viewpoint, the economic capital is linked to Credit Value at Risk (CvaR) of the portfolio and to the expected loss of the portfolio by the relationship:

$$EC = VaR_{99.9\%} - EL$$

We show in figure 1 the typical loss distribution of a credit portfolio, and we illustrate the meaning of the economic capital in terms of portfolio protection up to a given confidence level. The portfolio loss distribution is generally obtained by Monte-Carlo simulations.
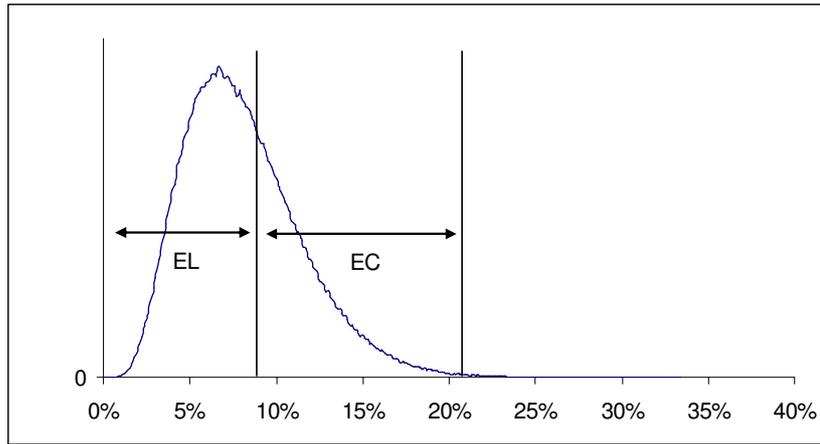
The next step in a risk management perspective is capital allocation. This step is very sensitive to portfolio effects and requires an accurate numerical device. As credit risk is more difficult to hedge away compared to market risk, the main way default risk can be reduced is through diversification. This is perfectly consistent with the modern portfolio theory of Markowitz that portfolio managers have been experiencing for about half a century.

Portfolio managers make the distinction between marginal capital and incremental capital of a transaction. The incremental capital is the additional amount of equity capital required when the transaction is added to the portfolio, whereas the marginal capital is equal to the contribution of the transaction to the total capital once this transaction is included inside the portfolio. To make this more precise, we call P the reference credit portfolio and M_x a marginal transaction with nominal amount x. Finally, we call $EC(A)$ the economic capital of portfolio A. The incremental capital of the transaction M is equal to:

$$EC_i = EC(P + M_x) - EC(P)$$

We can show that the marginal capital of transaction is equal to:

$$EC_m = x \frac{\partial EC(P + M_x)}{\partial x}$$

In the limit of a very small marginal portfolio ($x \to 0$), both indicators converge to the same value. The main property of the marginal capital compared to incremental capital is that the sum of the marginal capital over all the transactions of the portfolio is equal to the economic capital of the portfolio. This property leads to an easy capital allocation on condition that we are able to compute accurately marginal capitals.

Risk management is needed to maintain the solvency of the bank, but what is the rationale of taking risks if there are no rewards ? Performance measures are necessary in order to check that the risks taken are conveniently remunerated. What the bank needs is to include risk adjustment functions into the traditional performance measures. There are many ways of doing that. One of them is to introduce risk elements into the traditional Return On Capital (ROC) ratio defined by:

$$ROC = \frac{Revenues}{Allocated\ Capital}$$

Allocated capital is the regulatory capital that the bank has to allocate to the transaction of interest. Both revenues and allocated capital don't take into account any risk sensitivity. There are several possibilities to introduce risk sensitivity in this equation, at the numerator and the denominator. According to where we include a risk adjustment, we are led to different ratios such as RAROC, RORAC and RARORAC. The most popular performance measure is the Risk Adjusted Return On Risk Adjusted Capital (RARORAC), obtained by correcting the revenues by the anticipated losses on the transaction, and by replacing the allocated capital by the marginal economic capital of the transaction:

$$RARORAC = \frac{Revenues - EL}{EC_m}$$

We point out that the marginal economic capital at the denominator should include capital allocation for any sources of risk, not only credit risk, but also market risk, interest rate risk and operational risk. The RARORAC ratio is very helpful because it provides the bank with a unified tool to compare any transaction to each other, on the same basis. We take an example of two loans. The first one is a 1 year 100 MUSD loan to a AA client and generates 20 bp fees. The second one is a 2 years 100 MUSD and generates an upfront 1 MUSD revenue. What is the compared performance of these transactions? It is straightforward to compute the ROC ratio for both of them, and we see that loan 2 seems more interesting than loan 1, because the allocated capital is the same in both cases, but the revenues are larger for loan 2. On the other hand we can compute the risk adjustments and the RARORAC ratio for loan 1 and loan 2. Typically we are getting EL1=1 bp, EC1=30 bp, EL2=20 bp and EC2=500 bp. The performance ratios are respectively:

$$RARORAC_1 = \frac{20-1}{30} \approx 63\% \qquad RARORAC_2 = \frac{100-20}{500} = 16\%$$

Another point of view of the bank is when a credit decision has to be taken for a new transaction. The RARORAC ratio gives a feeling about the performance of the transaction, and has to be compared to the target performance of the bank. This target performance has to be larger to the cost of doing business and in particular to the return that the shareholders of the bank are expecting. For each transaction, the RARORAC ratio should be at least more than the cost of capital, equal for instance to 20%. In our previous example, loan 2 would not generate enough profit for the bank and the management would refuse the loan.

The management may also be interested in the value created by a marginal transaction or a business line. EVA (Economic Value Added) is the relevant performance measure for value creation. It is equal to the revenues less the cost of capital. It is given by the following formula:

$$EVA = Revenues - EL - 20\%.EC_m$$

where the coefficient 20% is the bank's cost of capital. In our previous examples, we would get for both loans:

$$EVA_1 = 130\,000\,USD \qquad EVA_2 = -200\,000\,USD$$

Loan 1 creates values for the bank, whereas loan 2 destroys value.

Looking for RARORAC optimization is a good way to maximize profitability while minimizing risk capital. Of course, the management should use this technique jointly with revenues and earnings targets, in order to take the most pragmatic decisions. Because of having simultaneously a risk adjusted numerator and denominator in the RARORAC function, the estimation of the risks is the cornerstone of any RAROC methodology. A global use of RAROC methodologies requires an accurate model and a sophisticated IT system. Indeed, RAROC methodologies are used to allocate economic capital on a bank-wide basis and need to catch the wide variety of the risks held, as well as the complex dependence between them.

Further reading

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