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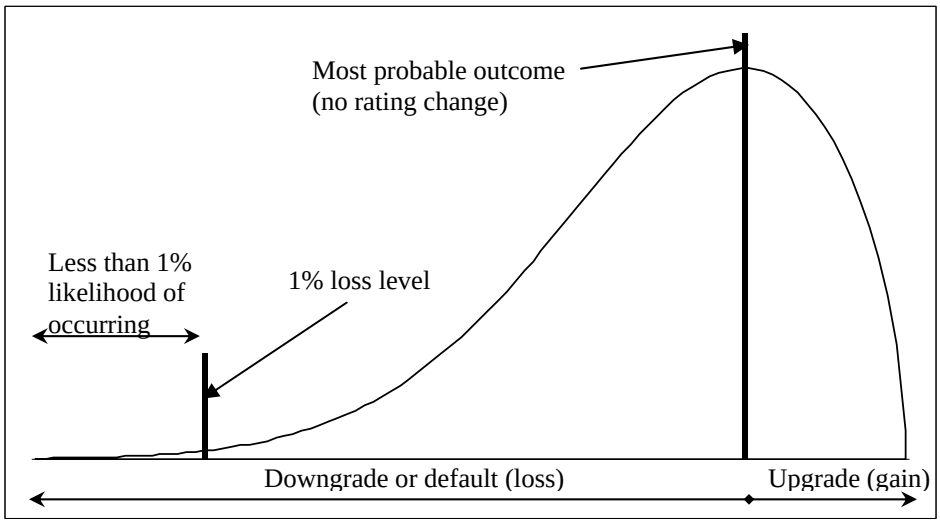
Risk Management Using Economic Capital

For a corporate bond, losses due to credit risk can vary over a wide range. With a strong economy and good luck, a bond may be upgraded, resulting in a gain. With a weak economy, poor corporate management or bad luck, losses can be high. The typical distribution of loss vs. probability looks like this:



When there are gains, the size of the gain is limited. For a 5-year bond, the price differential between BBB and A ratings is only in the range of 5%. And a bond can't be upgraded higher than AAA. But potential losses are many times as large as potential gains. Bonds can fall all the way to D (default), losing over 50% of their value.

For a large portfolio, there will usually be some credit losses (the area under the curve to the left of the "most likely" bar is greater than the area to the right). But the higher yield on the portfolio (compared to risk-free bonds) should normally compensate for that.

For publicly traded bonds, there are three main sources of loss:

1. Rating downgrade – the bond trades at a higher yield (lower price).
2. Spread widening – the market decides that all risky bonds should trade at higher yields (e.g. economic conditions are deteriorating, investment money is becoming scarce)
3. Default – where half of the principal is usually lost.

When looking at credit risk, it is useful to split potential losses into two parts:

Expected losses: The level of loss that is anticipated, on average, for the portfolio.

For AAA and AA bonds, nearly all of the expected losses are due to rating changes. Probability of default is extremely low – less than 0.05% per year. Even with a portfolio of 100 single-A-

rated bonds, you would only expect one default every 10-20 years. For 100 BBB-rated bonds, you would expect one default every 2-3 years.

Expected losses are provided for in pricing – they are built into the yield at which the bonds trade. Losses on individual assets are recovered through the yield premium on the rest of the assets in the portfolio.

To calculate the expected loss for a portfolio, you merely add up the expected loss for each of the individual assets in the portfolio. Diversifying a portfolio does not reduce expected loss.

Unexpected losses: These are losses in excess of the expected level. They occur infrequently, but can be many times larger than the expected loss. Except for very high-grade portfolios, the level of unexpected loss tends to be driven by spread widening and default, rather than rating downgrade. Unexpected loss can be reduced through diversification.

Unexpected losses are not provided for in pricing. When they occur, they lower net income and reduce the available capital of the company. For every company, there is a level of unexpected loss that will wipe out the available capital and bankrupt the company. It is obviously wise to ensure that this level of loss is exceedingly unlikely. A common practice is to estimate unexpected losses at the 1% level – i.e. where the company is likely to wipe out its available capital (and face probable bankruptcy or forced merger) once every 100 years.

In its 1988 capital accord, the Bank for International Settlements (BIS) addressed the risk due to unexpected losses through a new set of capital regulations. These have filtered down in the form of risk-based capital rules for banks and MCCSR for insurance companies.

But these capital formulas have significant shortcomings. MCCSR is 4% for a commercial mortgage, regardless of whether it's on a prime downtown office building with loan/value ratio of 40%, or a suburban strip mall with loan/value of 80%. MCCSR is the same for a bond rated A+ with a positive outlook as it is for one rated A- with a negative outlook. Also, MCCSR makes no allowance for diversification. A well-diversified portfolio of single-A bonds has the same MCCSR as a portfolio consisting of only one issuer.

The BIS has begun, in Basel II, to address these flaws by allowing major international banks to use internal credit models to calculate risk and risk-based capital. Each bank must continually prove the validity of its model by comparing actual losses with those predicted by the model. Where loss magnitude or frequency exceeds the predictions of the model, the bank is forced to hold additional capital. These rules will eventually filter down to other parts of the financial services sector.

Calculating expected loss:
We can calculate expected loss using a transition matrix. The following one-year matrix has been provided by Moody's, based on data from 1920 to 1996[1]:

[1] The numbers in each row do not add to 100%, since there is another category "rating withdrawn" that is not shown. To use this table, you must first adjust the values so that they sum to 100%.

	Aaa	Aa	A	Baa	Ba	BC	Caa-C	Default
Aaa	88.32	6.15	0.99	0.23	0.02	0.00	0.00	0.00
Aa	1.21	86.76	5.76	0.66	0.16	0.02	0.00	0.06
A	0.07	2.30	86.09	4.67	0.63	0.10	0.02	0.12
Baa	0.03	0.24	3.87	82.52	4.68	0.61	0.06	0.28
Ba	0.01	0.08	0.39	4.61	79.03	4.96	0.41	1.11
B	0.00	0.04	0.13	0.60	5.79	76.33	3.08	3.49
C	0.00	0.02	0.04	0.34	1.26	5.29	71.87	12.41

What this table says is that a Baa bond has an 82.52% probability of still being Baa one year from now. It has a 3.87% probability of being upgraded to A and a 0.28% probability of defaulting.

Using the prevailing credit spreads, you can calculate the price of the Baa bond if it is upgraded or downgraded to one of the other ratings. For this exercise, a 40% recovery rate was assumed in the event of default. If you multiply the bond price for each rating by the probability of that rating, and add up the results, you can calculate the expected value of the Baa bond after 1 year[2]. This expected value, less the original value (assumed to be $100 for this exercise) is the expected loss.

Based on market yields and spreads on 5-year bonds at the end of September, 2004 the expected loss (in bp), by rating is as follows. Average asset default (C1) provisions[3] used in the Canadian insurance industry are also shown, for comparison:

	Aaa	Aa	A	Baa	Ba	B	Caa-C
Expected loss	11	23	42	66	80	203	821
C1	9	15	31	59	260	260	260

This table implies is that a portfolio of single-A 5-year bonds should allow a yield spread of 42 bp to cover credit risk. Additional spread is required to cover cost of capital (see below) and liquidity risk. And there should be a yield premium to compensate for the risk that losses could exceed the expected loss. Current 5-year single-A spreads range to as high as 1%, suggesting that investors are reasonably well compensated for taking on this risk.

For single B bonds, we should be looking for a spread of more than 2% + a liquidity spread + cost of capital + an uncertainty premium. Single B spreads currently exceed 5%. For those with the stomach and skill (and enough capital), single B bonds also offer an attractive risk/reward tradeoff.

Calculating economic capital:

The process for estimating economic capital is slightly different than calculating expected loss. First, you have to simulate returns for a number of random scenarios.[4] You also have to simulate a range of recovery rates for those scenarios that end up in default[5]. Finally, returns for the

[2] In reality, you have to revalue the bond cash flows using the implied forward rates.
[3] From the 1997 CIA survey on C1 provisions.
[4] 10,000 scenarios used in this example.
[5] Recovery rates were assumed to range from 25% to 75%, with a mean of 50%.

portfolio as a whole have to be taken into account. The economic capital for a particular asset is the contribution made by that asset to the 1% scenario loss (i.e. the 1% scenario loss for the portfolio including the asset minus the 1% scenario loss with the asset removed)[6]. Economic capital (contribution to 1% loss), calculated using the Moody's transition matrix and assuming a well-diversified portfolio of 5-year bonds is shown in the following table. Capital requirements (at 200% MCCSR) are shown for comparison.

	Aaa	Aa	A	Baa	Ba	B	Caa-C
1% loss (%)	0.00	0.00	0.13	0.43	2.62	25.54	49.26
spread equivalent (%)	0.0	0.0	0.02	0.08	0.47	4.6	8.87
200% MCCSR	0.50	1.00	2.00	4.00	8.00	16.00	32.00
spread equivalent (%)	0.09	0.18	0.36	0.72	1.44	2.88	5.76

The spread equivalent shown here is the extra spread that we would have to earn on the asset to pay for the capital required to back it (assuming an after-tax ROE target of 15%).

The figures in this table suggest that the MCCSR levels are much higher than needed (on an economic capital basis) for the quality of assets that most companies hold. This probably results from the fact that MCCSR does not reflect the full risk-reducing impact of diversification.

For the lower end of the non-investment grades, MCCSR levels appear to be significantly lower than economic capital requirements.

The published literature suggests that most banks are using economic capital as a basis for measuring and budgeting risk, as well as for setting prices.[7] The difference between economic capital and regulatory capital is often cited as the reason that banks tend to move low-risk assets off their balance sheets (using securitization) while retaining higher-risk assets, where the relationship between regulatory capital and economic capital is more favorable.

By law, every regulated institution has to hold the required regulatory capital. Prudence will dictate that they also hold sufficient economic capital. This doesn't mean double capital; each $1 serves to meet both regulatory and economic capital needs. It does mean that the required capital level will be the greater of regulatory capital or economic capital. This will create incentive for the institution to select its mix of assets so that the two levels of capital are approximately the same.

[6] Note that, because the loss distribution is highly skewed, you cannot use standard deviation as a measure to predict the 1% loss amount.

[7] Recent comments at a seminar indicate that our bank-based insurance competitors are using economic capital as well.