Credit Metrics contd…

PRISTINE

- Like KMV Model, this model also assumes that changes in asset values of a firm follow a normal distribution. However, instead of a standardized default point, standardized rating migration points are determined for each borrower on basis of its present rating. For instance, if a borrower is ‘A’ rated, rating migration point can be determined using Normsinv function in Excel (Normsinv(0.09%) = -3.12 and so on)

Present rating	AAA	AA	A	BBB	BB	B	CCC	D	Total
A	0.09%	2.27%	91.05%	5.52%	0.74%	0.26%	0.01%	0.06%	100.00%
Cumulative	0.09%	2.36%	93.41%	98.93%	99.67%	99.93%	99.94%	100.00%	
Rating migration point	-3.12	-1.98	1.51	2.30	2.72	3.19	3.24	>3.24	

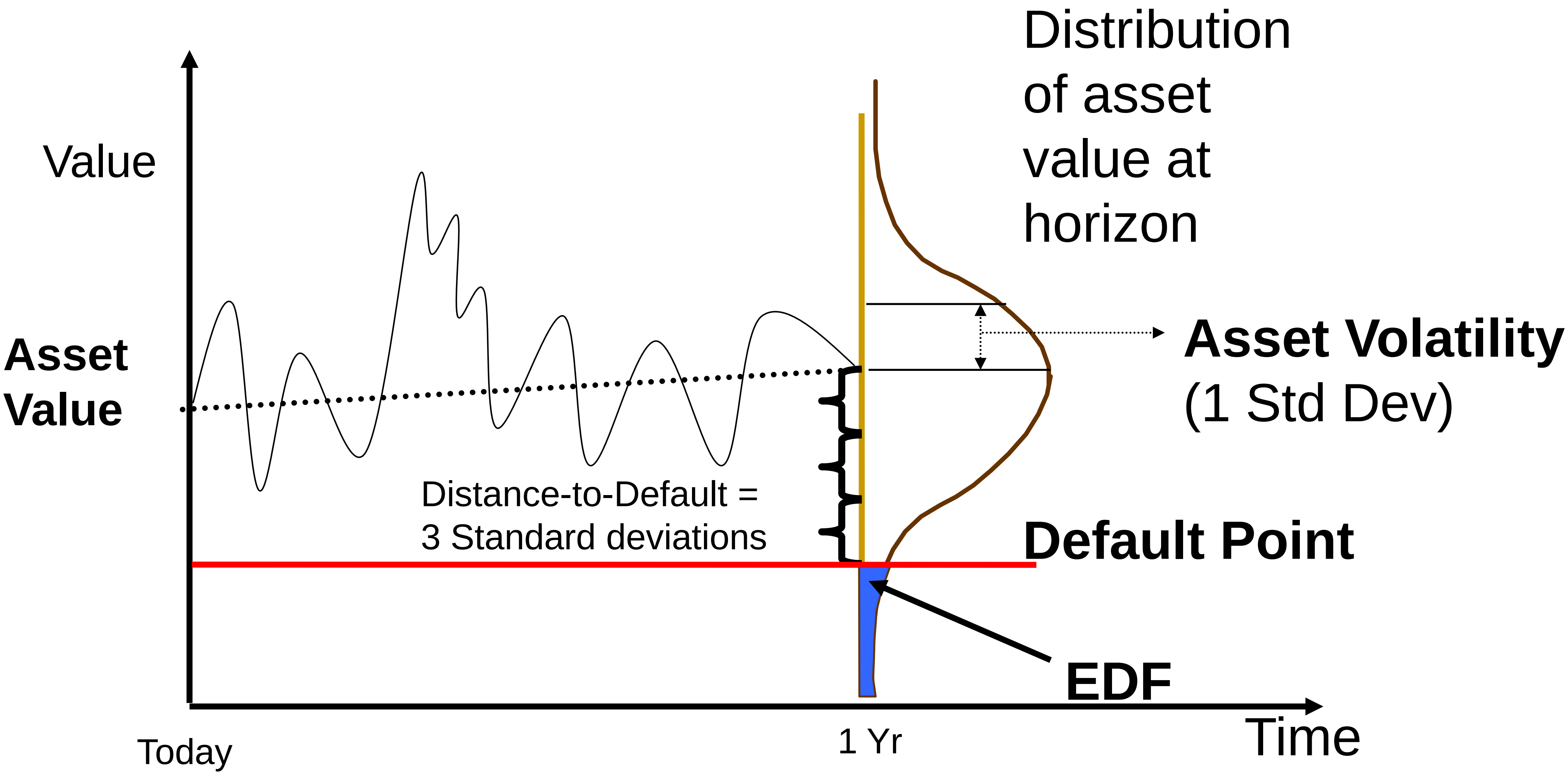
Monte Carlo Simulation

- **Monte Carlo simulation:** Correlated normally distributed random numbers are generated for all borrowers. In the above example, if random number is below -3.12, it is assumed that borrower has got upgraded to AAA (which has 0.09% probability). If random number is between -3.12 and -1.98 then borrower is assumed to get upgraded to AA rating (which has a probability of 2.27%) & so on.
- For each scenario, simulated rating of each borrower is determined. Any rating upgrade leads to MTM gains in the value of exposure, while rating downgrade reduces the value of exposure. MTM value of all exposures are added to determine portfolio value for each scenario.
- Portfolio value distribution is then generated using output of each simulated scenario. Derive Credit VaR at a certain confidence interval.
- Therefore, this model consider impact of rating migrations on MTM value of each exposure

KMV approach

- KMV derives the expected default frequency (EDF), i.e. the default probability, for each obligor based on the Merton (1974) type of model. The probability of default is thus a function of the firm's capital structure, the volatility of the asset returns and the current asset value. The EDF is firm specific, and can be mapped onto any rating system to derive the equivalent rating of the obligor. EDFs can be viewed as a 'cardinal ranking' of obligors relative to default risk, instead of the more conventional 'ordinal ranking' proposed by rating agencies (which relies on letters such as AAA, AA, …).
- Credit risk in the KMV approach is essentially driven by the dynamics of the asset value of the issuer. Given the capital structure of the firm, and once the stochastic process for the asset value has been specified, the actual probability of default for any time horizon, one year, two years, etc., can be derived.

Figure from KMV



KMV approach contd...

- The KMV approach is best applied to publicly traded companies, where the value of the equity is determined by the stock market. The information contained in the firm's stock price and balance sheet can then be translated into an implied risk of default. The derivation of the actual probabilities of default proceeds in 3 stages:
  - Estimation of the market value and volatility of the firm's assets;
  - Calculation of the distance to default, which is an index measure of default risk; and
  - Scaling of the distance to default to actual probabilities of default using a default database.

Distance to Default (1/2)

- The KMV model assumes that debt is issued twice.
- The first matures before the chosen horizon and the second matures after that horizon.
- The maturity or default threshold is a linear combination of short-term and long-term liabilities. A practical rule is given as
- if LT liabilities-to-S.T liabilities < 1.5 Then

  Short Term Liabilities + 0.5*Long-term Liabilities

  Otherwise

$$ST\ Liabilities + \left(0.7 - \frac{0.3 * ST\ Liabilities}{LT\ Liabilities}\right) * LT\ Liabilities$$

Distance to Default (2/2)

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- For calculating the distance to default (DD) we can use the following formula

$$DD = \frac{Expected\ \ Asset\ \mathrm{Re}turn - Default\ Threshold}{\sigma_{\mathrm{expected}\ asset\, return}}$$

- A more precise formula is given below

$$DD = \frac{\log(V) - \log(default\ \ threshold) + \left[E(RoA) - \frac{\sigma_v^2}{2}\right] * maturity}{\sigma_v * \sqrt{maturity}}$$

  - E(RoA): expected return on assets
  - V : Value of the firm assets
  - Σ_v : std. deviation of firms assets

Example Distance to Default

If we use the Moody's KMV Credit Monitor Model. Assuming the firm's assets is $270mn and its short term liabilities are $40mn while long-term liabilities are $120mn. The standard deviation of expected asset value is $25mn. The distance to default is closest to

A. 6.8 standard deviations
B. 5.2 standard deviations
C. 8.1 standard deviations
D. 4.1 standard deviations

Solution: A.

$$\text{Liability Value} = \text{ST Liabilities} + 0.5 \times \text{LT Liabilities} = 40 + 0.5 \times 120 = \$100\text{mn}$$

$$\text{Distance to default} = \frac{(\text{asset value} - \text{Liability value})}{\text{std.dev. Of asset value}} = \frac{(270 - 100)}{25} = 6.8\ \text{standard deviations}$$

Estimation of Default Correlations

- We try to estimate the potential changes in value of portfolio of creditors, when changes are related to credit risk
- This credit risk is based on potential rating changes over the year
- A factor to be consider here is portfolio assessment is the correlation between changes in credit ratings and default correlation for any two obligators
- The credit VAR is sensitive to these correlations, thus their estimation is a key point
- Default correlation might expected to be higher for firms within the same industry, or in regions and correlations is associated with the state of the economy which probability of default and migration doesn’t remain stationary
- In this case Credit Metrics derives the default and migration probabilities from a correlation model of the firm’s assets

Credit VaR approach of a Bond/Loan Portfolio

- The analytic approach for a portfolio with bonds issued by two obligors is not practicable for large portfolios. Instead, Credit Metrics implements a Monte Carlo simulation to generate the full distribution of the portfolio values at the credit horizon of one year.
- The following steps are necessary:

1. Derive the asset return thresholds for each rating category.
2. Estimate the correlation between each pair of obligors' asset returns.
3. Generate return scenarios according to their joint normal distribution. A standard technique that is often used to generate correlated normal variables is the Cholesky decomposition. Each scenario is characterised by 'n' standardised asset returns, one for each of the 'n' obligors in the portfolio.
4. For each scenario, and for each obligor, map the standardised asset return into the corresponding rating, according to the threshold levels derived in step 1.
5. Given the spread curves, which apply for each rating, revalue the portfolio.
6. Repeat the procedure a large number of times, say 100,000, and plot the distribution of the portfolio values to obtain a graph.
7. Finally, derive the percentiles of the distribution of the future values of the portfolio to obtain the credit VAR and/or credit economic capital.