1. Credit Risk Management Systems

(CreditRisk+, KMV and EDF, CreditMetrics, Credit Portfolio View)

CreditRisk + (1996)

CreditRisk+ comprises three main components:

- a model that uses portfolio approach and analytical techniques widely used in insurance industry,
- a methodology for calculating economic capital for credit risk,
- applications (provisions, limits, portfolio management).

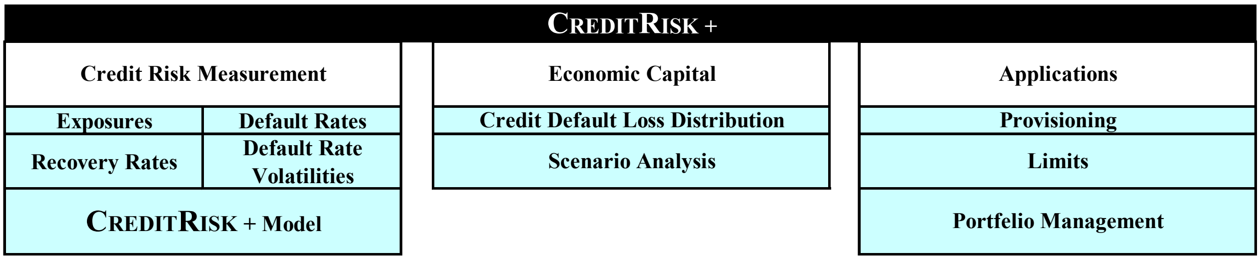

Figure 1. CreditRisk+ System
Source: Credit Swiss | First Boston, CreditRisk+, A Credit Risk Management Framework, 1997

Model

The model does not examine changes in economic value of exposure due to credit downgrades or upgrades. No assumptions are made about the causes of default. CreditRisk+ belongs to the group of statistical techniques used in the insurance industry to model the sudden event of obligor default. In the event of default, a bank incurs a loss equal to the exposure less a recovery amount. The model calculates a full loss distribution for a portfolio of credit exposures.

Inputs:

- credit exposures (book values),
- obligor default rates assigned to each obligor (based on market credit spreads or credit ratings and historic default statistics published by rating agencies),
- obligor default rate volatilities,
- recovery rates (should reflect the seniority of the obligation and collateral).

Model treats default rates as continuous random variables and incorporates default rate volatility to capture the uncertainty in the level of the default rate. Model does not use correlation explicitly but captures the concentration effects through the use of default rate volatilities that result in increased defaults. Concentration risk depends on systematic factors. Concentration effects are captured using sector analysis. Obligors are allocated to sectors. As the number of sectors is increased, the concentration risk is reduced and the fat tails of the loss distribution function become smaller.

CreditRisk+ starts with the assumption that the number of default events is approximated by the Poisson distribution. Next default rate variability is incorporated into the model. The exposures are adjusted by recovery rates to calculate loss in a given default. The net exposures are divided into bands of exposure. The level of exposure in each band is approximated by a common average. Then the full loss distribution is generated. The probability generating function has a simple closed form.

Economic capital

It is assumed that sufficient earnings should be generated through adequate pricing and provisioning to cover expected loss. Model is used to determine the level of economic capital required to cover the unexpected credit default losses. Economic capital is required, because the actual credit losses could be higher than the expected level. Credit risk economic capital is determined as a difference between the 99th percentile loss level and the expected loss.

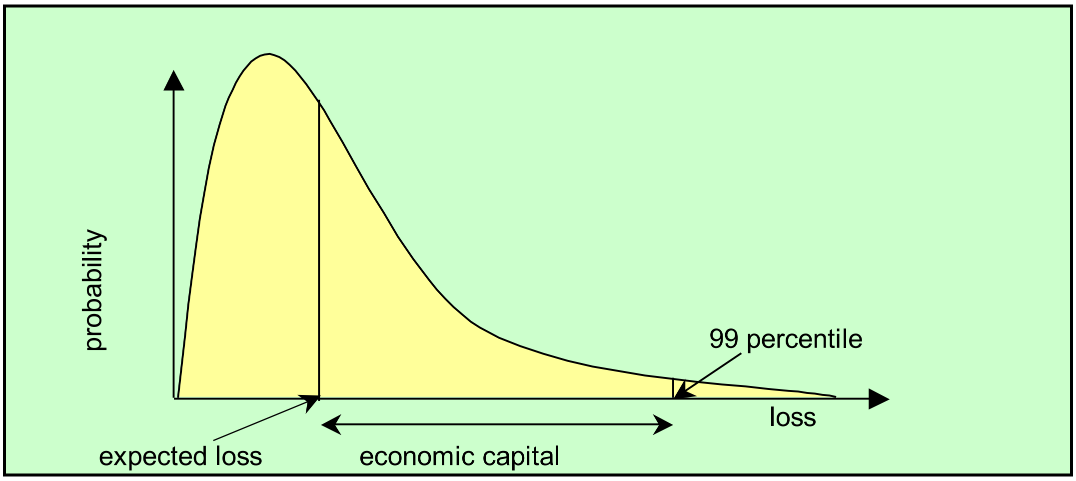

Figure 2. Economic capital for credit risk
Source: Credit Swiss | First Boston, CreditRisk+, A Credit Risk Management Framework, 1997

Economic capital is a more appropriate measure of risk than regulatory capital as it takes into account credit quality, size of the exposure and diversification effects.

Provisioning for Credit Risk

The system includes two types of provisions:

1. the Annual Credit Provision (ACP) reflects the future expected loss on the performing portfolio and is calculated using formula (1),
2. the Incremental Credit Reserve (ICR) protects against unexpected future losses and is used to absorb losses that are higher than expected level.

The ACP represents the expected level of credit losses. The Annual Credit Provision (expected loss) is calculated as

(1) $E(L) = p_d (1 - r) W$

where
p_d – default rate,
r – recovery rate,
W - exposure.

The ICR provides protection against unexpected credit losses. The ICR cap represents an extreme level of credit losses e.g. the 99the percentile loss level.

Problem 1. Provisioning for Credit Risk

Assumptions

	0	1	2	3	4
Actual loan losses		600	300	300	650
ACP		525	550	610	625
ICR - initial level	1900				
ICR Cap		2100	2200	2250	2300
Operating profit		2100	2205	2315	2430

(a) Calculate ICR with cap applied
(b) Calculate pre-tax profit.

Solution

(a)

	0	1	2	3	4
ICR Cap		2100	2200	2250	2300
ACP - Actual loan losses		-75	250	310	-25
Excess unutilised provision over ICR cap		0	0	-135	0
ICR (with cap applied)	1900	1825	2075	2250	2225

(b)

	0	1	2	3	4
Operating profit		2100	2205	2315	2430
ACP		-525	-550	-610	-625
Excess unutilised provision over ICR cap		0	0	135	0
Pre-tax profit		1575	1655	1840	1805

KMV and EDF

The KMV model concentrates on the probability of default of the company as a whole, rather than valuation of the debt. The default probability is defined as the probability that the counterparty or borrower will fail to service its obligations. EDF is the probability of default within a given time period. It is a function of the distance to default.

KMV Corporation methodology

The default probability is determined in three steps:

1. Estimation of asset value and volatility. The asset value and asset volatility of the firm is estimated from the market value and volatility of equity and the book value of liabilities.
2. Calculate the distance-to-default. The distance-to-default is calculated from the asset value and asset volatility and the book value of liabilities.
3. Calculation of the default probability. The default probability is determined directly from the distance-to-default and the default rate for given levels of distance-to-default. Historical empirical databases of KMV (today Moody's databases) are used to determine the corresponding default probability.

The market value and volatility of assets is determined directly using an options pricing model in which equity is treated as a call option on the underlying assets of the firm. Equity holders have the right, but not the obligation, to pay off the debt and take over the remaining assets of the firm. Equity is the same as a call option on the firm's assets with a strike price equal to the book value of the firm's debt. Debt and equity are both derivative claims on the underlying assets of the firm. The more volatile assets have higher probabilities of high values, and consequently, higher is the equity value (option value).

A simplified balance sheet of a firm is:

Net Assets	Equity
	Debt

Figure 3. Balance Sheet
Source: ZM

The market value of equity and the book value of debt can be used to determine the implied market value of the underlying assets. That is, the reverse of the original BSM problem is solved.

The following two relationships are solved.

(2) $$C = f_1\left(\mathbf{S}, \boldsymbol{\sigma}_A, d, R_B^*\right)$$

(3) $$\sigma_E = f_2\left(\mathbf{S}, \boldsymbol{\sigma}_A, d, R_B^*\right)$$

C – market value of equity,
S – market value of assets,
σ_A – asset volatility,
σ_E – equity volatility,
d – leverage (capital structure),
R_B^* – risk-free interest rate.

Distance to default point may be calculated:

(4) $$d = \frac{S - S_d}{\sigma_{ROA} S}$$

where
S – market value of assets (Merton model),
S_d – default point (1/2 of long term debt + current liabilities),
σ_{ROA} - volatility of the firm's assets.

The distance-to-default is interpreted as the number of standard deviations the asset value is away from default.

If the value of the assets falls below the default point, then the firm defaults. Therefore, the probability of default Expected Default Frequency, or EDF) is the probability that the asset value will fall below the default point.

The default probability is obtained from data on historical default and bankruptcy frequencies. From this data, a frequency table is generated which relates the likelihood of default to various levels of distance-to-default.

CreditMetrics (1996)

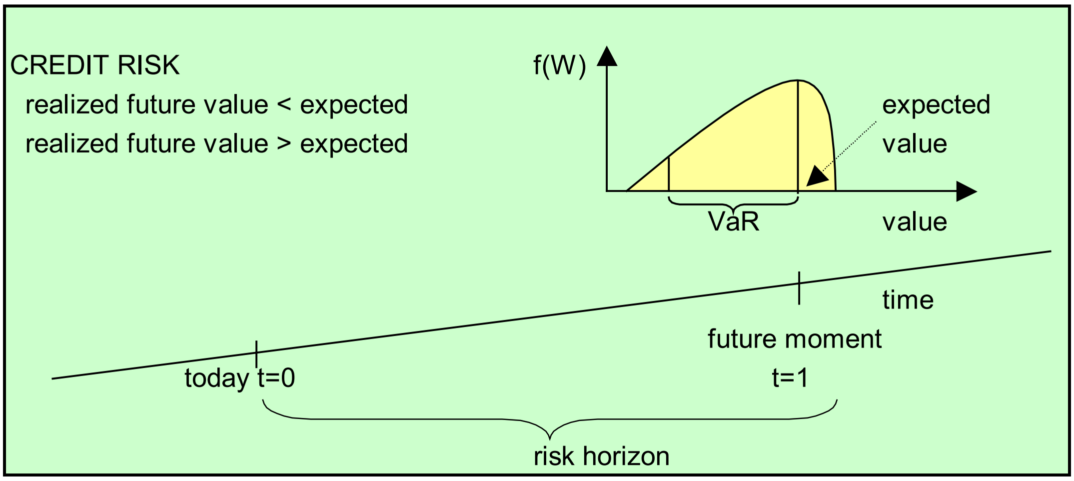

Figure 4. Credit Risk and Value Distribution
Source: ZM

The CreditMetrics™ framework can be described in the following diagram.

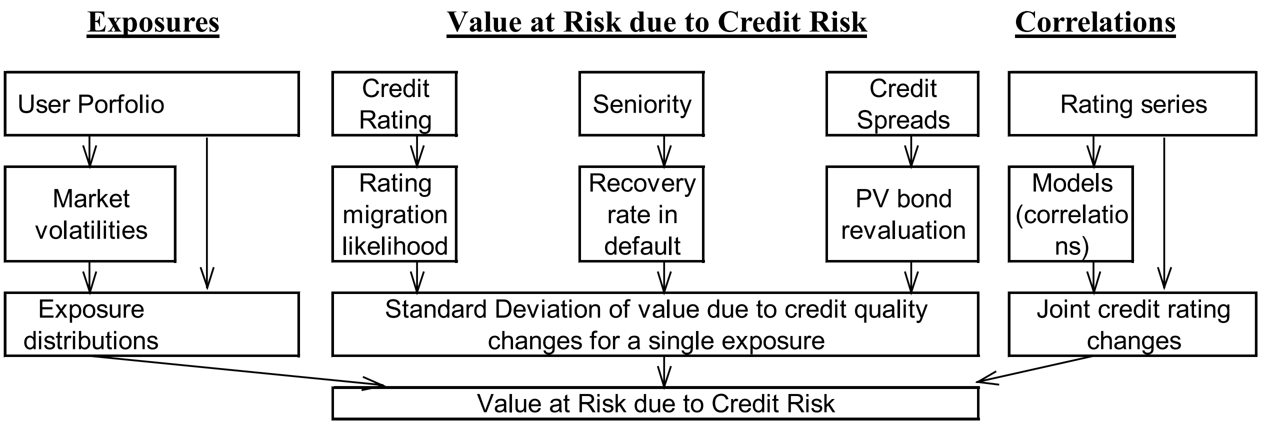

Figure 5. CreditMetrics. VaR
Source: CreditMetrics™—Technical Document

Credit Portfolio View (1998)

McKinsey proposes a discrete multi-period econometric model that measures only default risk. Default probabilities depend on macroeconomic variables. The default probabilities are assumed to be generated by a logit function. The macro variables are specified for each country. Each of these independent variables is assumed to follow an autoregressive model of order 2 (AR(2)). The joint country or industry default rates are calibrated and the Choleski decomposition is used to allow the simulation of the distribution of joint default probabilities across all segments. Then the unique unconditional Markov transition matrix for each of the country/industry segments is inferred. The last step is to produce the distribution of cumulative default and migration probabilities.