International Finance and Accounting

Volume 2018 | Issue 2 Article 7

4-1-2018

METHODOLOGY OF CREDITMETRICS FOR CREDIT RISK ASSESSMENT

M. Zokirjonov
Tashkent Financial institute

Zokirjonov M. – TFI, teacher

METHODOLOGY OF CREDITMETRICS FOR CREDIT RISK ASSESSMENT

Annotation: In the article CreditMetrics methodology used to assess credit risk according to the official technical document developed by J.P.Morgan is considered. According to this methodology for calculating the credit risk a road map, as well as an example of a step-by-step mechanism for calculating the credit risk of one asset is provided.

Аннотация: Мақолада J.P.Morgan томонидан ишлаб чиқилган расмий техник ҳужжат бўйича кредит рискларини баҳолаш учун қўлланиладиган CreditMetrics методологияси кўриб чиқилган. Ушбу методология бўйича кредит рискини ҳисоблаш йўл харитаси, шунингдек битта актив учун кредит рискини баҳолашнинг босқичма-босқич механизми келтирилган.

Аннотация: В статье рассматривается методология CreditMetrics используемый для оценки кредитного риска по официальному техническому документу разработанным J.P.Morgan. Приводится дорожная карта вычисления кредитного риска по данной методологии, а также пошаговый пример механизма вычисления кредитного риска одного актива.

Key words: CreditMetrics, migration of the credit rating, loss rate, default, discount rate, standard deviation.

Калит сўзлар: CreditMetrics, кредит рейтинги миграцияси, йўқотишлар даражаси, дефолт, дисконт ставкаси, ўртаквадратик четланиш.

Ключевые слова: CreditMetrics, миграция кредитного рейтинга, уровень потерь, дефолте, ставка дисконтирования, среднеквадратичное отклонение.

Migration of loans is the basis of the methodology of CreditMetrics, presented in 1997 by JP Morgan, which takes into account the probability of a transition from one credit quality to another, including the state of default, for the given time horizon [1]. CreditMetrics models the distribution of the cost of any loan or bond portfolio, in which the cost of the changes are related only to the migration of loans.

CreditMetrics is a tool for assessing portfolio risk due to changes in debt value caused by changes in obligor credit quality. We include changes in value caused not only by possible default events, but also by upgrades and downgrades in credit quality. Also, we assess the value-at-risk (VaR) – the volatility of value – not just the expected losses. Importantly, we assess risk within the full context of a portfolio. We address the correlation of credit quality moves across obligors. This allows us to directly calculate the diversification benefits or potential over-concentrations across the portfolio. [2]

In comparison with market risk, credit risk has three characteristics. Firstly, the portfolio distribution differs significantly from the normal one. Secondly, measuring the portfolio effect due to diversification is much more difficult than for market risk. Thirdly, information about loans is not complete.

When assessing credit risk, you have to deal with distributions that are significantly sloping and have "weighted tails" (Figure 1).

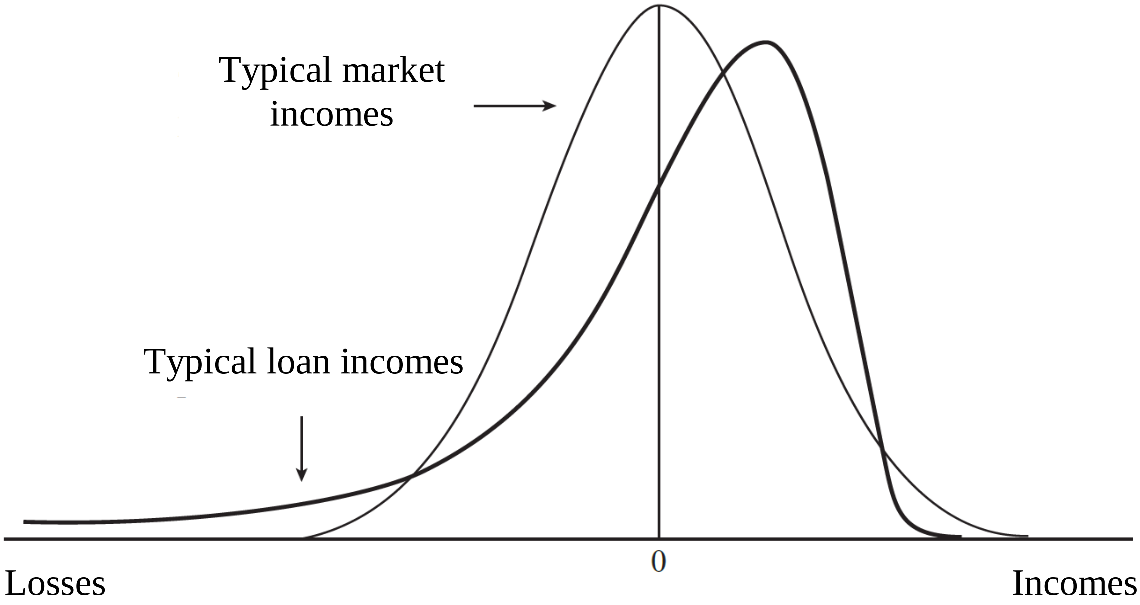

Figure 1. Density probability of market and credit incomes[3]

In this case, the percentages of the distribution that determine their quantiles [3], cannot be estimated only from the mean value and the variance. This situation completely contradicts what is taking place in assessing market risk. Therefore, calculating VaR for credit risk requires simulating a complete distribution of portfolio value changes.

To measure the diversification of the portfolio, it is necessary to assess the correlation in the changes of credit quality for all the debtors. However, such correlations are not directly observed. CreditMetrics bases its assessment on the joint probability of stock returns, which entails some simplifying assumptions about the debtor's capital structure. The only uncertainty in the methodology of CreditMetrics is related to credit migration that is the process of moving up and down through the credit spectrum.

The procedure for assessing the credit risk using the methodology of CreditMetrics includes three main steps.

Step 1. Determination of the probability of bond's credit rating migration.

Step 2. Estimation of the level of losses in case of default or when the asset is shifted up or down the credit spectrum.

Step 3. Calculation of credit risk based on the first two steps.

Here is a guide or so-called road map for calculating credit risk using CreditMetrics methodology (Figure 2).

Let's illustrate each step of the methodology of CreditMetrics using the example of a five-year bond with the BBB rating. The bond is paid an annual coupon of 6%, and the estimated horizon is equal to one year.

Step 1. Migration of credit rating. At this step, a left part of the road map is defined, which is shown schematically in Figure 2. In the adopted model, the risk is formed not only in the transition to default, but also from the change of the value due to variation in gradation. Thus, it is important to assess not only the probability of default, but also the chance of migration to any possible state of credit quality on the considered horizon. As a result, the default is viewed as only one of several "states of the world" that can exist.

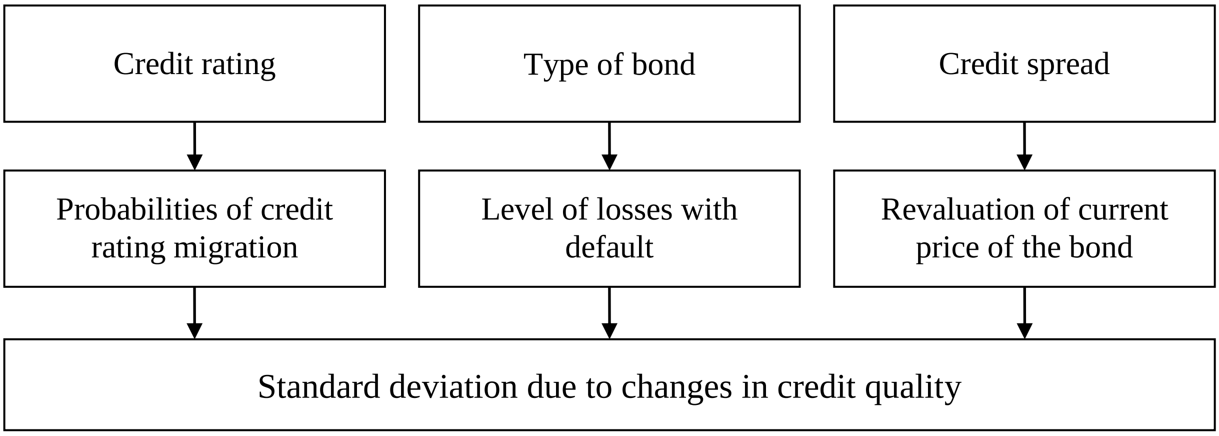

Figure 2. Road map of CreditMetrics analysis [4]

The probability of migration of the credit rating in the coming period is determined by the borrower's credit rating. Figure 4 shows the probabilities of migration of credit quality for a borrower which characterized by current ratings of A, AAA and BBB. For the considered example, bonds with BBB rating should use the diagram on the right part of this figure.

For example, from Figure 4 it can be seen that there is a probability of 5.30% of the transition of the BBB credit rating down to BB within one year.

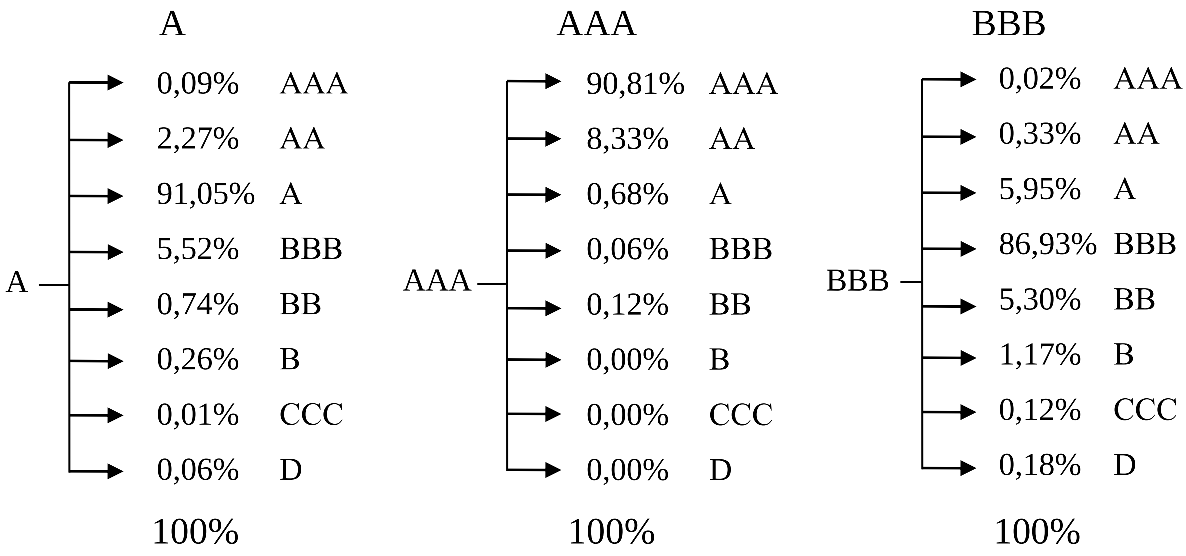

Figure 4. Examples of credit quality migration [4]

There are several general considerations for the given examples. Obviously, the most likely credit rating for the year is the current credit rating. The next most likely are ratings that are one letter up or down. The only reliable rule about migration of credit quality is that the probabilities in the sum should be 100%, as they cover all possible gradations.

Instead of showing the probability of migration of each rating separately, it is more convenient to place them in a square table (transition matrix), as shown in Table-1. To work with this table it is necessary first to find the initial credit rating in the left column and then move along this line to the column that displays the rating of the risk horizon. For example, the number of 0,22 in the bottom-left part of Table-1 indicates that there is a probability of 0,22%, with which the CCC credit rating will migrate to the AAA rating by the end of the year. Of course, migration from CCC to AAA within one year is most likely unrealistic and represents only a single example in historical data (over 15 years of S&P).

Table-1

Rating transition matrix [5]

Initial rating	**Rating by the end of the year,%**							
	AAA	**AA**	**A**	**BBB**	**BB**	**B**	**CCC**	**Default**
AAA	90,81	8,33	0,68	0,06	0,12	0	0	0
AA	0,70	90,65	7,79	0,64	0,06	0,14	0,02	0
A	0,09	2,27	91,05	5,52	0,74	0,26	0,01	0,06
BBB	0,02	0,33	5,95	86,93	5,30	1,17	1,12	0,18
BB	0,03	0,14	0,67	7,73	80,53	8,84	1,0	1,06
B	0	0,11	0,24	0,43	6,48	83,46	4,07	5,20
CCC	0,22	0	0,22	1,30	2,38	11,24	64,89	19,79

Step 2. Estimation of loss levels. In step 1, the probabilities of migration to any possible credit quality state of the risk horizon were found. In step 2, we find the values of the bond value on the same horizon for the same credit quality states.

At the same time, first the values for each migration gradient are calculated, which leads (in our example) to eight revaluations of the bond.

Revaluations can be divided into two categories:

1) under default, the level of losses is estimated based on the rating categories of the bond;

2) when the gradations go up or down the credit spectrum, the change in the credit spread is determined.

Evaluation in the state of default. Here, middle part of the "road map" is defined, which is shown schematically in Figure 2. If the result of the rating migration is the state of default, the residual value due to the losses will depend on the class (gradation) of the bond. In CreditMetrics methodology, several historical studies of such dependencies were conducted. Table-2 shows the levels of losses in the state of default for different classes of bonds.

In the table above, bond classes are defined as some conditional rating categories determined by the given characteristics. The second and third columns of Table-2 are average values and standard deviation of probable losses in case of default. The given values are based on historical data.

Table-2

Levels of losses within default, % of nominal [5]

Class of bond	Average, %	Standard deviation,%
High	53,80	26,86
Above the average	51,13	25,45
Average	38,52	23,81
Below the average	32,74	20,18
Low	17,09	10,90

Let's assume that the considered example of a BBB bond category is equivalent to the "above average" class, for which the average loss under default will be 51,13% of the nominal value ($100). The historical estimate of the probability of default of a BBB bond category is 0.18% (according to Table-1). Then the expected loss will amount to: $0{,}0018 \times 51{,}13\% = 0{,}092\%$, which, taking into account the nominal value, gives 9,2 dollars. This process is repeated for each bond class.

Evaluation at the rating migration. Here, a right-part of the "road map" is schematically shown in Figure 2. In a situation where there is a migration of credit quality, but not to the state of default, the exposure to risk is assessed by other methods. To find such estimates, the following actions are performed.

1. For each rating category there is a dependence of the change in discount rates by the end of each year.

2. With the help of the received data, the value of bonds for each rating category is reevaluated.

Let's illustrate these actions on the example of a bond with the BBB rating. Recall that this bond has a five-year maturity and is paid an annual coupon of 6%. Let's assume that we know the changes in discount rates by the end of each year (Table-3).

Table-3

Changes in discount rates, % [5]

Category	1st year	2nd year	3rd year	4th year
AAA	3,60	4,17	4,73	5,12
AA	3,65	4,22	4,78	5,17
A	3,72	4,32	4,93	5,32
BBB	4,10	4,67	5,25	5,63
BB	5,55	6,02	6,78	7,27
B	6,05	7,02	8,03	8,52
CCC	15,05	15,02	14,03	13,52

We calculate the value of the bond value with the BBB rating, assuming that the bond has risen to Category A:

$$V = 6 + \frac{6}{(1 + 3{,}72\%)} + \frac{6}{(1 + 3{,}72\%)^2} + \frac{6}{(1 + 3{,}72\%)^3} + \frac{6}{(1 + 3{,}72\%)^4} = 108{,}66$$

In this formula, the data for category A were used from Table-3. To calculate the value of a bond for other rating categories, it is necessary to substitute the corresponding values from Table-3 as a result of which we obtain the values given in Table-4.

Table-4

Cost of bonds for different ratings [5]

Rating by the end of the year	Cost, USD
AAA	109,37
AA	109,19
A	108,66
BBB	107,55
BB	102,02
B	98,10

CCC	83,64
Default	51,13

Step 3. Credit risk assessment. At this step, the last bottom-part of the "road map" is defined, which is schematically depicted in Figure 2. Now we have all the necessary information for estimating the volatility of value due to a change in credit quality by the example of a single bond: the probability of all possible transitions and the distribution of values within each graduation. The latter values were obtained in steps 1 and 2, respectively, and are given in Table-5 (second and third columns).

Table-5

Volatility due to changes in credit quality [5]

Rating by the end of the year	Probability, %	Bond price plus coupon, USD.	Weighted probabilistic price, USD.	Deviation from the average, USD.	The square of the probability of weighted deviation
AAA	0,02	109,37	0,02	2,28	0,0010
AA	0,33	109,19	0,36	2,10	0,0146
A	5,95	108,66	6,47	1,57	0,1474
BBB	86,93	107,55	93,49	0,46	0,1853
BB	5,30	102,02	5,41	5,06	1,3592
B	1,17	98,10	1,15	8,99	0,6446
CCC	0,12	83,64	1,10	23,45	0,6598
Default	0,18	51,13	0,09	55,96	5,6358

1. Calculation of standard deviation as a measure of risk.

First it is necessary to find the average value using the following formula: [6]

$$\bar{\mu} = \sum_{i=1}^{n} p_i \mu_i \,, \qquad (1)$$

Where p_i, μ_i are determined from the second and third columns of Table-5.

After substituting these values, we get:

$\bar{\mu} = 0{,}0002 * 109{,}37 + \ldots + 0{,}0018 * 51{,}13 = 107{,}09.$

The standard deviation is calculated by the following formula: [6]

$$\sigma = \sqrt{\sum_{i=1}^{n} p_i {\mu_i}^2 - \bar{\mu}^2} = 2{,}9. \ (2)$$

Thus, the obtained value of the standard deviation can serve as a measure of risk. It is necessary to note the following: the above formula for the standard deviation assumes that the bond takes only the average value within each category. In general, this is not the case, because a bond may have some distribution within each category, which can lead to uncertainty about losses in case of default. In order to take this into account, the calculation formula requires the introduction of the σ_i component, which characterizes the uncertainty of the loss level under the condition of default *i*=8. The transformed formula for determining the standard deviation takes the following form: [6]

$$\sigma = \sqrt{\sum_{i=1}^{n} p_i({\mu_i}^2 + \sigma_i^2) - \bar{\mu}^2}. \quad (3)$$

The result of the calculation gives the standard deviation value which equal to 3,18, that is 6,3% higher than the previous value of 2,99. Thus uncertainty in the level of losses increases the risk.

2. Calculation of the quantile as a measure of risk.

We estimate the 1% quantile for a bond, often called the percentile, representing a level below which the value of the portfolio will fall with a probability of 1%. Quantile levels are more significant statistics for large portfolios and for such portfolios it is necessary to carry out a simulation to calculate the percentile levels. Nevertheless, here, for example, we calculate such levels for a single bond.

Table-5 shows the probabilities with which the bond will be in any credit category, and the value of the bond will be in the same grades. We begin with the default state and will move up through the second column of this table to the side of the AAA category. In doing so, we will calculate the accumulated sum of probabilities. The value at which this amount becomes equal to or greater than 1%, then this value will be a 1% percentile. Let’s describe this procedure in detail.

1. The probability of being in a default state equals to 0,18%, which is less than 1%, so we move up to the CCC category.

2. The accumulated probability of default states or CCC is 0,30% (= 0,18% + 0,12%), which is less than 1%, so we move further up to category B.

3. The accumulated probability of default states, categories of CCC or B is 1,47% (= 0,18% + 0,12% + 1,17%), which is already over 1%.

4. On category B we stop moving up and calculate the corresponding value from the third column. This value, equal to 98,10 dollars, and is 1% percentile, which is below the average value by 8,99 dollars. Thus, we established a measure of risk in the form of a 1% percentile.

In conclusion, CreditMetrics is a significant innovation for risk managers seeking to apply recent advances in portfolio theory and value-at-risk methodology to credit risk. Recognizing the need for an industry benchmark for credit risk measurement, J.P.Morgan&Co developed this framework set out to provide as good a methodology for capturing credit risk as the practical constraints of available data quality will currently allow. In our opinion this methodology, based on “Migration Analyses” and default event, should be appropriately implemented in a practical environment for credit risk management.

Once implemented, the methodology has several powerful applications, with important implications for the way in which institutions think about pricing, trading and carrying credit risks. The applications include prioritizing and evaluating investment and risk-mitigating transactions, setting rational, risk-based limits, and ultimately, the maximization of shareholder value based on risk-based capital allocation.

REFERENCES

1. Gupton G.M. CreditMetrics – Technical Document/G.M. Gupton, C.C. Finger, M.Bhatia. JPMorgan, 1997.

2. CreditMetrics™ – Technical Document Copyright © 2007 RiskMetrics Group, Inc. All rights reserved. First published in 1997 by J.P. Morgan & Co.

3. In statistics and the theory of probability, quantiles are cut points dividing the range of a probability distribution into contiguous intervals with equal probabilities. https://en.wikipedia.org/wiki/Quantile

4. Кричевский М.Л. Финансовые риски: учебное пособие / М.Л.Кричевский. – 2-е изд., М. : КНОРУС, 2013. – 248 с.

5. Ph.Jorion Financial Risk Management Handbook/ N.Y.: John Wiley&Sons, 2003.

6. Энциклопедия финансового риск-менеджмента / под ред. А.А.Лобанова, А. В.Чугунова; М.: Альпина Паблишерз, 2009.