UBS

Public

Credit Risk Fundamentals

Dr Grzegorz Goryl PRM
Risk Modeling and Analytics Specialist

March 12, 2018

Table of contents

Section 1

Definition of Credit Risk

UBS

Default Risk

Default risk is that a counterparty does not honour its obligations. The risk of a payment default is called credit risk

- Default Risk is everywhere, because for every transaction there is a risk that one of two parties involved does not deliver.
- Some examples:
  - Default – An obligation is not honoured
  - Payment default – An obligor does not make a payment awhe it is due
    - Repudiation – refusal to accept a claim as valid
    - Moratorium – declaration to stop all payments for some period of time
    - Credit default – payment default on borrowed money
  - Insolvency – Inability to pay
  - Bankruptcy – The start of a formal legal procedure

Credit Loss

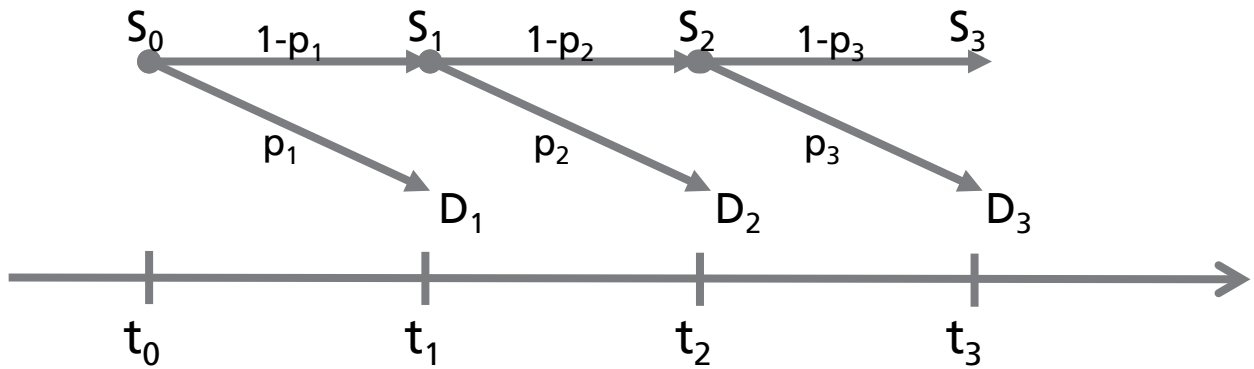
Credit loss, loss due to default of obligor one can express as EAD × LGD, while expected credit loss ECL = PD × EAD × LGD

- The credit risk could be described by following processes:
  - $\mathbf{1}_{\tau}(t)$: The default indicator process, which equals 1 if there was a default by the time t, and 0 if the obligor is still alive
  - **E**(t): The exposure process – exposure at default(EAD), ie. Total amount of payment obligations of obligor at time t
  - **L**(t): The loss process – loss given default, measures a proportion of the exposure to be recovered in bankruptcy proceeding
- The expected credit loss, assuming mutual independency of above processes:
  - ECL = PD × EAD × LGD
- Modelling of PD and LGD factors it is one of the main tasks of Credit Risk Quants

More details on default probabilities

PD usually is time dependent. It depends on specific properties of borrower and the loan itself, however very often it is influenced by economical situation.

- PD language:
  - Cumulative PD : $P(t) = P(\tau \leq t) = E(\mathbf{1}_{\tau}(t))$
  - Marginal PD: $P(t_i,t_{i+1}) = P(t_i < \tau \leq t_{i+1}) = P(t_{i+1}) - P(t_i)$
  - Forward PD, point in time: $p(t_i,t_{i+1}) = P(t_i < \tau \leq t_{i+1} \mid t_i < \tau)$
- Multi step default tree – $p_i = p(t_{i-1},t_i)$:



- $P(t_i) = 1-(1-p_1)(1-p_2)\ldots(1-p_i) = 1-s_1s_2\ldots s_i$, where survival probability (pit) $s_i = 1-p_i$

Section 2

Default Probability estimation

UBS

Credit Ratings – Historical DRs

Credit Rating is the assessment of the credit risk of the obligor. Agency rating it is one of the tools to assess likelihood that an obligor defaults based on historical default rates.

Standard & Poor's reduces the US's credit rating

ICNJ | Aug 07, 2011 07:12PM ET

WORLD NEWS

Standers & Poor's reduced the US's long-term on August 15 to become at AA+ after the credit rating of the United States remains at AAA.

This comes after Moody's Investors Service and Fitch Ratings affirmed their AAA credit ratings for the U.S. on Aug. 2, the day President Barack Obama signed a bill that ended the debt-ceiling impasse which had pushed the Treasury to the edge of default.

As for the Standard & Poor's, which said this downgrade reflects our opinion that the fiscal consolidation plan that Congress and the Administration recently agreed to falls short of what, in our view, would be necessary to stabilize the government's medium-term debt dynamics.

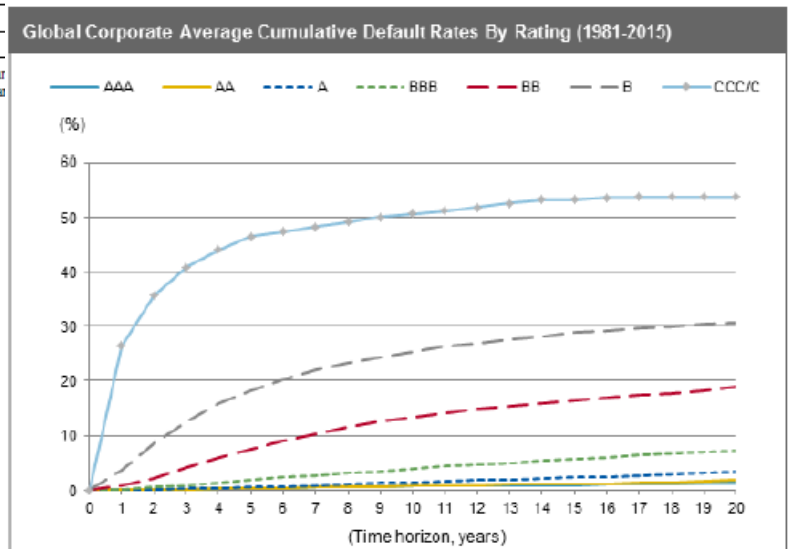
https://www.investing.com/

Table 33

Average Multiyear Global Corporate Transition Matrix (1981-2015) (%)

	--One-year transition rates--								
From/to	AAA	AA	A	BBB	BB	B	CCC/C	D	NR
AAA	87.08	9.00	0.53	0.05	0.08	0.03	0.05	0.00	3.18
	(7.14)	(7.16)	(0.83)	(0.25)	(0.25)	(0.17)	(0.35)	(0.00)	(2.44)
AA	0.53	86.69	8.06	0.53	0.06	0.07	0.02	0.02	4.02
	(0.52)	(5.32)	(4.28)	(0.69)	(0.20)	(0.21)	(0.07)	(0.08)	(1.94)
A	0.03	1.81	87.65	5.39	0.33	0.13	0.02	0.06	4.58
	(0.09)	(1.02)	(3.55)	(2.14)	(0.39)	(0.27)	(0.07)	(0.11)	(1.81)
BBB	0.01	0.11	3.55	85.43	3.82	0.52	0.12	0.19	6.24
	(0.04)	(0.16)	(1.68)	(3.80)	(1.56)	(0.72)	(0.23)	(0.26)	(1.63)
BB	0.01	0.03	0.13	5.08	76.78	6.96	0.64	0.73	9.63
	(0.06)	(0.09)	(0.27)	(1.89)	(4.47)	(3.21)	(0.77)	(0.87)	(2.46)
B	0.00	0.03	0.09	0.21	5.25	74.27	4.39	3.77	11.99
	(0.00)	(0.09)	(0.22)	(0.22)	(2.07)	(4.37)	(2.25)	(3.37)	(2.25)
CCC/C									

Note: Numbers in par
Research and Standa

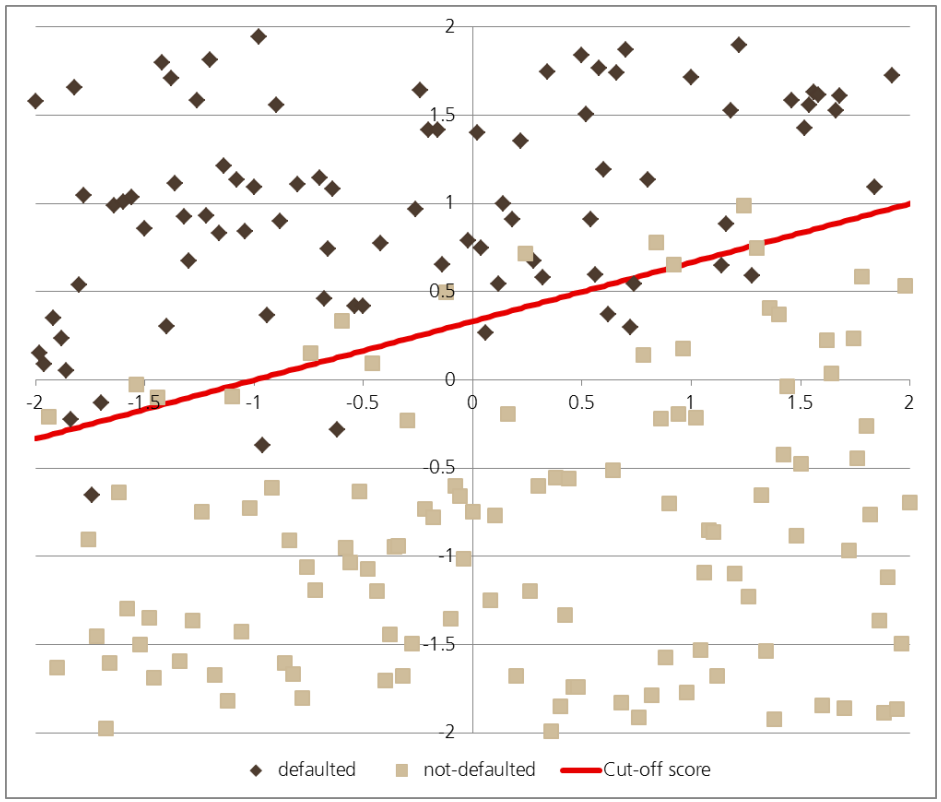


Vazza D., Kraemer N. K; *2015 Annual Global Corporate Default Study And Rating Transitions*; www.standardandpoors.com/ratingsdirect

Credit Scoring

The ratings from agencies are published only for relatively large corporates. Therefore banks need to prepare internal ratings based (IRB) approach for determining PDs for small and medium enterprises as individual clients too .

- Altman's Z-Score
  - the first credit scoring models and relies on accounting ratios:
    - Working Capital / Total Assets (A)
    - Retained Earnings / Total Assets (B)
    - Earnings before Interest and Taxes / Total Assets (C)
    - Market Capitalization / Debt (D)
    - Sales / Total Assets (E)
  - **Z** = 1.2A + 1.4B + 3.3C + 0.6D + E
  - If Z<1.8 the obligor is likely to default and a loan should be denied.
- Credit score is used also to rank obligors: higher score => better credit quality
- Accounting ratios are used to measure: indebtedness, cash flow available for debt service, profitability.



Estimation of PD

Another way of credit risk measure is the direct default probability estimation via assumed functional relationship: $p = F(\beta_0 + \beta_1 X_1 + \ldots \beta_n X_n)$

- Probit model:
  - $F(x) = \Phi(x)$, ie. cumulative normal distribution function
- Logit model:
  - $F(x) = (1 + \exp(x))^{-1}$
- In general, one can use F(x) function as mapping from something like Z-score into default probability space
- Let e is a standard normally distributed noise component, then we can define the credit index:

  $-(\beta_0 + \beta_1 X_1 + \ldots \beta_n X_n) + \varepsilon$
  - Assuming that obligor defaults when his credit index drops below zero, the default probability of the obligor is exactly equal to the p given by probit model

Structural Model - Merton's Model

The economic value of default can be measured as a value of put option on the value of firm's asset. Therefore it can be expressed with option-like formula

- Let's define followings:
  - V(t): value of company's assets
  - E(t): value of company's equity
  - D(t): amount of debt interest and principal due to be repaid
  - $\sigma_v(t)=\sigma_v$: volatility of assets
  - $\sigma_E(t)$: instantaneous volatility of equity
- If V(T)<D(T) in theory it means the company should default on debt at time T and E(T)=0. If V(T)>D(T) the value of equity E(T)=V(T)-D(T) and company should make the debt repayment:

  $E(T) = \max(V(T)-D(T), 0)$
- Therefore, the loss for the company's lender is:

  $L(T) = \max(D(T) - V(T), 0)$
- And default probability $F(-d_2)$, where $d_2=\{\ln[V(0)/D(T)]+(r-\sigma_v^2)T\}/(\sigma_v\sqrt{T})$
- And $\sigma_E(0)E(0)=\Phi(d_1)\ \sigma_V V(0)$

Section 3

Summary

UBS

Summary

Credit Quant role in the bank is to help credit officers decide if a loan should be granted. Then, after positive decision, credit quants prepares a methodology for risk monitoring and estimation of credit losses, what is needed for capital requirements forecasting

- One of crucial tasks for credit quants is to prepare a methodology for estimation of probability of default.
- Latter is used for credit losses estimation via formula:
  - $ECL = PD \times EAD \times LGD$
- PD can be estimate using external ratings or via internal models
- In general internal model try to find the best set of parameters (loan and economical situation related) which fit historical observations

Contact information

Dr Grzegorz Goryl PRM
Risk Methodology / Credit Methodology - Retail
+48 12334 6528
grzegorz.goryl@ubs.com

UBS Poland Service Centre
UBS Service Centre (Poland) Sp. z o.o.
Krakow Business Park 800
Ul Krakowska 280
32-080 Zabierzow k/Krakow
Tel. +48-12-399 7000

www.ubs.com