Basic Concepts in Risk Management

Afsaneh Sherafatipaydar

Seminar of Quantitative Risk Management in SS 2018
Prof. Dr. Zoran Nikolic
Universität zu Köln

20. April 2018

Verwendete Literatur:

[MFE] A.F.Mcneil, R.Frey, P.Embrechts *Quantitative Risk Management Concepts, Techniqes and Tools*,United States of America, 2015.

Preface

Risk Management for a Financial Firm

Assets, Liabilities and the balance sheet

- A balance sheet is a financial statement of assets and liabilities
- Assets describe the financial institution's investments
- Liabilities refer to the way in which funds have been raised and the obligation that ensue from that fundraising

The stylized balance sheet of a typical bank

Bank ABC (31 December 2015)			
Assets		Liabilities	
Cash (and central bank balance)	£10M	Customer deposits	£80M
Securities	£50M	Bonds issued	
– bonds		– senior bond issues	£25M
– stocks		– subordinated bond issues	£15M
– derivatives		Short-term borrowing	£30M
Loans and mortgages	£100M	Reserves (for losses on loans)	£20M
– corporates			
– retail and smaller clients		*Debt (sum of above)*	£170M
– government			
Other assets	£20M		
– property			
– investments in companies		*Equity*	£30M
Short-term lending	£20M		
Total	£200M	Total	£200M

- value of assets = value of liabilities = debt+ equity

The stylized balance sheet of a typical insurer

Insurer XYZ (31 December 2015)			
Assets		Liabilities	
Investments		Reserves for policies written (technical provisions)	£80M
– bonds	£50M		
– stocks	£5M	Bonds issued	£10M
– real estate	£5M		
Investments for unit-linked contracts	£30M	*Debt (sum of above)*	£90M
Other assets	£10M		
– property			
		Equity	£10M
Total	£100M	Total	£100M

- value of assets = value of liabilities = debt + equity

Two approaches:

- fair-value accounting
- book-value

- The practice of *fair-value accounting* attempts to value assets at the prices that would be received if they were sold and to value liabilities at the prices that would be paid if they were transferred to another party.
- The *book-value* would typically be an estimate of the present value (at the time the loans were made) of promised future interest and principal payments minus a provision for losses due to default.

Risk Management for a Financial Firm

Risks Faced by a Financial Firm

- ***Risk for a bank***
- Market risk
- Losses from securities trading
- Credit risk
- Maturity mismatch

- ***Risk for an insurance company***
- Insolvency
- On the asset side the risks are similar to those for a bank
- On the liability side the main risk is that reserves are insufficient to cover future claim payments

- ***Bank capital***
- Equity (or book) capital
- Regulatory capital
- Economic capital

Risk Management for a Financial Firm

Capital

- **Equity Capital**

  It is a measure of the value of the company to the shareholders

- **Regulatory Capital**

  It is the amount of capital that a company should have according to regulatory rules

- **Economic Capital**

  It is an estimate of the amount of capital that a financial institution needs in order to control the probability of becoming insolvent

Modelling Value and Value Change

Mapping Risks

- Probability space $(\Omega\ ,\ \mathcal{F},\ \mathrm{P})$
- A collection of stocks or bonds, a book of derivatives or a collection of risky loans
- Value of the portfolio at time t is V_t, (V_t ist known)
- Risk-management time horizon $\triangle t$
- Simple formalism for talking about value, value change and the role of risk factors:
  - the portfolio composition remain fixed over the time horizon,
  - there are no intermediate payments of income during the time period.

Modelling Value and Value Change

Mapping Risks

- The value of the portfolio at the end of the time period: V_{t+1}
- The change in value of the portfolio: $\triangle V_{t+1} = V_{t+1} - V_t$
- *loss of short time interval*: $L_{t+1} := - \triangle V_{t+1}$
- *loss of long time interval*: $V_t - V_{t+1}/(1 + r_{t,1})$

  $r_{t,1}$ is the simple risk-free interest rate that applies between times t and t+1; this measures the loss in units of money at time t
- The value V_t is typically modelled as a function of time and a d-dimensional random vector $Z_t = (Z_{t,1}, \ldots, Z_{t,d})'$ of risk factors

  i.e.

$$V_t = f(t, Z_t) \tag{1}$$

  for some measurable function $f : \mathbb{R}_+ \times \mathbb{R}^d \to \mathbb{R}$
  the random vector Z_t takes some known realized value z_t at time t and the portfolio value V_t has realized value $f(t, z_t)$

- We define the random vector of *risk-factor changes* over the time horizon to be $X_{t+1} := Z_{t+1} - Z_t$
- Assuming that the current time is t and using the mapping (1), the portfolio loss is given by

$$L_{t+1} = -(f(t+1, z_t + X_{t+1}) - f(t, z_t)) \tag{2}$$

  which shows that the loss distribution is determined by the distribution of the risk-factor change X_{t+1}
- If f is differentiable, we may also use a first-order approximation $L_{t+1}^{\triangle}$ of the loss in (2) of the form

$$L_{t+1}^{\triangle} := -\left(f_t(t, z_t) + \sum_{i=1}^{d} f_{z_i}(t, z_t) X_{t+1,i} \right) \tag{3}$$

- The quality of the approximation (3) is obviously best if the risk-factor changes are likely to be small and if the portfolio value is almost linear in the risk factors

Modelling Value and Value Change

Valuation Methods

- Book-value approach
- Fair-value approach:
  - Market-consistent Valuation
  - Risk-neutral valuation

- *Market-consistent valuation*: the amount for which an asset could be exchanged or a liability settled, between knowledgeable, willing parties in an arm's length transaction, based on observable prices within an active, deep and liquid market.
- *Risk-neutral valuation*:
  it is a special case of fair-value accounting that is widely used in the pricing of financial products such as derivative securities.

Modelling Value and Value Change

Loss Distribution

- $[t, t+1]$,

$$L_{t+1} = - \triangle V_{t+1} = - \left(f(t+1, z_t + X_{t+1}) - f(t, z_t) \right),$$

determine the loss distribution:

(I) Specify a model for the risk-factor changes X_{t+1} (projection models),

(II) Determine the distribution of the rv $f(t+1, z_t + X_{t+1})$ (valuation models).

- There are three kinds of method that can be used to address these challenges:
  - *Analytical method*
  - *Historical simulation*
  - *Simulation approach (also known as a Monte Carlo method)*

Modelling Value and Value Change

Loss Distribution

- **Analytical method**
  in this method we attempt to choose a model for X_{t+1} and a mapping function f in such a way that the distribution of L_{t+1} can be determined analytically.
- **Historical simulation**
  instead of estimating the distribution of L_{t+1} in some explicit parametric model for X_{t+1}, the historical simulation method can be thought of as estimating the distribution of the loss using the empirical distribution of past risk-factor changes.
- **Monte carlo method**
  Any approach to risk measurement that involves the simulation of an explicit parametric model for risk-factor changes is known as a monte carlo method.

THANK YOU FOR YOUR ATTENTION