

AMATH 546/ECON 589
Overview of Risk Quantitative Risk
Management

Eric Zivot

April 1, 2013

Outline

- Risk Concepts
- Risk Measurement vs. Risk Management
- Financial Risk Regulation
- Why Manage Financial Risk
- Quantitative Risk Management

Reading

- QRM chapter 1

Risk Concepts

Definition 1 (*Oxford English Dictionary*) *Risk is a hazard, a chance of bad consequences, loss or exposure to mischance*

Here the emphasis is on “downside risk” or risk of loss.

For financial risks, suitable definitions might be

“any event or action that may adversely affect an organization’s ability to achieve its objectives and execute its strategies”

or

“The quantifiable likelihood of loss or less-than-expected returns”

Important Types of Financial Risk

- Market Risk
- Credit Risk
- Operational Risk
- Liquidity Risk
- Model Risk
- Systemic Risk

Market Risk

The risk of a change in the value of a financial position due to changes in the value of the underlying components on which that position depends, such as stock and bond prices, exchange rates, commodity prices, etc.

This course will focus mostly on market risk.

Credit Risk

The risk of not receiving promised repayments on outstanding investments such as loans and bonds, because of the “default” of the borrower.

Note: Credit risk models build on market risk models but are more complicated. We will discuss models for credit risk at the end of the course.

The course AMATH 547 deals exclusively with credit risk models.

Operational Risk

The risk of losses resulting from inadequate or failed internal processes, people and systems, or from external events.

Examples:

- Hedge funds investing in feeder funds run by Bernie Madoff
- Rogue trader Nick Leeson bringing down Barings Bank

We will not discuss operational risk.

Liquidity Risk

The risk stemming from the lack of marketability of an investment that cannot be bought or sold quickly enough to prevent or minimize a loss.

- Lack of liquidity was a major cause of the 2008 financial crisis
- Markets don't work properly during liquidity crises - market participants refuse to trade with each other.

Liquidity risk is often high in times of financial crisis - market risk can be greatly influenced by liquidity risk

Model Risk

The risk of using a misspecified model for measuring risk.

Examples:

- Using the Black-Scholes option pricing model when asset returns do not follow a geometric Brownian motion (e.g. normally distributed log returns with constant volatility)
- Computing VaR using the normal distribution when asset return do not follow the normal distribution

Systemic Risk (not systematic risk)

This risk refers to the likelihood and degree of negative consequences to the larger body. With respect to federal financial regulation, the *systemic risk* of a financial institution is the likelihood and the degree that the institution's activities will negatively affect the larger economy such that unusual and extreme federal intervention would be required to ameliorate the effects.

Example: The collapse of Lehman Bros. impacted the entire financial system and led to losses at many other financial institutions.

We will discuss systemic risk toward the end of the course.

Risk and Randomness

- Risk relates strongly to uncertainty, and hence to the notion of randomness
- Probability theory formalizes the notion of randomness
- Statistics provides the tools of inference on probability models from observed data
- Probability theory and statistics provide the foundation of quantitative risk management

Risk Measurement vs. Risk Management

Risk measurement involves quantifying the likelihood of loss. Examples of risk measures are

- Daily volatility of portfolio return
- Daily 1% value-at-risk of portfolio value
- Daily 1% expected shortfall or expected loss of portfolio
- Maximum drawdown of portfolio over the year.

Risk management is a discipline for living with the possibility that future events may cause adverse effects.

- Involves the sophisticated use of derivative securities like forwards, futures, options and swaps to hedge, manage or control financial risk
- Involves repackaging risks and transferring them to markets in customized ways

Importance of Risk Management

Historical events have highlighted the importance of risk management:

- Creation of organized futures and options markets
- Academic development of the mathematics of derivatives pricing (e.g. Black-Scholes option pricing model)
- Advances in computer technology
- Periods of financial crisis

- - Great Depression, Oil Price shocks of the 70s, Savings and Loan crisis, 1987 stock market crash, Asian Crisis, 2008 financial crisis

- Financial Scandals

- Enron, Barings bank, Madoff etc.

- Organizational blow-ups

- Orange county, Long-Term Capital Management, Lehman Bros., Washington Mutual

- Abolition of Bretton-Woods system of fixed exchange rates

- Financial deregulation of 1990s (e.g. repeal of Glass-Steagall Act)
- Growth of OTC derivatives market and shadow banking system

Financial Regulation and the Basel Accords

- Basel Committee of Banking Supervision was established by the Central-Bank Governors of the Group of Ten (G-10) at the end of 1974
- Does not possess any formal supranational supervising authority but formulates standards and guidelines for best practice
- Three Accords: Basel I, Basel II and Basel III

Basel I (1988)

- Took an important step towards an international minimum capital standard for banks
- Main emphasis was on credit risk
- Approach was coarse and measured risk in an insufficiently differentiated way

Birth of Value-at-Risk (VaR)

- In 1993, the G-30 published a report addressing off-balance products (e.g. derivatives) in a systematic way
- JPMorgan set the standard for a one-day, one-page summary of bank market risk based on VaR
- JPMorgan's RiskMetrics group set the standard for calculating VaR
- 1996 Amendment to Basel I prescribed value-at-risk (VaR) as the standardized model for market risk, but allowed banks to use their own VaR model

Basel II (2004)

- Focus on credit risk and operational risk
- Ensure that capital allocation is more risk sensitive
- Enhance disclosure requirements which will allow market participants to assess the capital adequacy of an institution
- Ensure that credit risk, operational risk and market risk are quantified based on data and formal techniques
- Attempt to align economic and regulatory capital more closely to reduce the scope for regulatory arbitrage

Basel III (in process)

- Developed in response to the deficiencies in financial regulation revealed by the late-2000s financial crisis
- Global regulatory standard on bank capital adequacy, stress testing and market liquidity risk

Why Manage Financial Risk?

- Modern society relies on the smooth function of bank and insurance systems and has a collective interest in the stability of such systems
 - Basel accords have evolved to focus on the sustainability of the financial system (e.g. Basel III focuses on systemic risk)
- See quotes from Alan Greenspan on pages 15-16 in QRM.
- Good risk management can increase the value of a corporation and hence shareholder value

Quantitative Risk Management - The Discipline

- Give concise definitions and mathematical treatments of risk concepts such as profit and loss distributions, risk factors, capital allocations and risk aggregation
- Address unexpected, abnormal or extreme outcomes rather than the expected, normal or average outcomes that are the focus of many classical applications
- Model the interdependence and concentration of risks, especially the phenomenon of dependence between extreme outcomes. In extreme cases, the normal workings of many models break down (e.g. diversification fails during market crashes).

- Utilize ideas and techniques from several quantitative disciplines - mathematical finance, statistics, financial econometrics, financial economics and actuarial mathematics.