209.

Risk Management
Risk Management

‘Mastery of risk: The notion that the future is more than a whim of the gods and that men and women are not passive before nature’

–Peter L. Bernstein

This module emphasises risk measurement and risk-based pricing with some implications for risk management. The reason for this is that the Retail Banking III module, Risk and Capital Management, deals with risk management and risk governance in an integrated fashion. While other modules, such as Retail Banking Overview and Credit Loss Management, consider risk and capital management at a fundamental level, this module looks at some important concepts and principles involved in the more advanced internal approaches that banks have the option to adopt.

To ensure continuity with Retail Banking I, we present a brief review of some key risk management principles.

Introduction and review of key principles

Fundamental principles of risk and capital management are presented in both Retail Banking I and Retail Banking II levels of this programme. The corresponding modules are Credit Loss Management and Retail Banking Overview where the following topics are emphasised.

1. Risk Versus Uncertainty

Webster’s Dictionary defines ‘risk’ as the possibility of a loss or injury while ‘uncertainty’ is ‘not known beyond a doubt’. Both risk and uncertainty are related to the concept of randomness. There is a key difference between risk and (Knightian) uncertainty. Sometimes, banking professionals do not appear to understand the difference. Donald Rumsfeld, former Secretary of Defence of the United States, once said: ‘As we know, there are known knowns. There are things we know we know. We also know there are known unknowns. That is to say, we know there are some things we do not know. But there are also unknown unknowns, the ones we don’t know,

Haldane and Nelson† state that “risk arises when the statistical distribution of the future can be calculated or is known. Uncertainty arises when this distribution is incalculable, perhaps unknown.”

In keeping with this theme, Richard Caballero, chairman of the department of economics at MIT, discussed the potential disastrous consequences when risk managers falsely assume that they are facing risks rather than uncertainty. This is a common error since risk managers are generally armed with sophisticated models and they conclude that the model is truth. Here is an important point to be considered:

“… With uncertainty, when institutions or people don’t truly understand what the risks are, they know or feel something is wrong but don’t know what and how likely it is (i.e., frequency), or how it will impact them (i.e., severity). In this context, the natural instinct is simply to withdraw rather than to fine-tune. Such abrupt behaviour can wreak havoc in a financial system since, all of a sudden, the maturity transformation – the vital role financial systems provide in converting short-term liabilities into long-term assets – has to be undone. But this simply can’t be done when everybody wants to do it at the same time – bank runs are an obvious example of this impossibility – and that further fuels the uncertainty, leading to more panic and fire sales. The financial system is very good at managing risk, but it is awful at handling (Knightian) uncertainty:” Richard Caballero, Chairman, Department of Economics, MIT

In short, risk is specific uncertainty – it involves both the frequency of a random event and the severity of the consequence. For example, when a bank grants a loan to a customer, the bank employees estimate the expected loss should the borrower default on the loan. This is the cost of doing business and does not represent risk. Risk is the unexpected loss should the borrower default on the loan.

(2) Over-reliance on mathematical models (model risk)

Here is an excerpt from an address made by Guy Debelle,‡ Assistant Governor (Financial Markets) of the Reserve Bank of Australia:

“Today I want to talk about the role of risk and uncertainty in the financial crisis. The primary reason why I want to do that is that I believe risk assessment, or more precisely, mis-assessment, has been one of the key elements of the crisis. While that is undoubtedly true in any crisis, I think it has played a more central role in the current episode than in the past. Risk was mis-assessed by financial institutions, risk managers, investors and regulators. There was a false comfort taken from a misplaced belief that risk was being accurately and appropriately measured. To some extent, the technology provided risk managers with a false sense of security. Risk may well have been accurately measured for the particular regime that the economy and financial markets were operating in. But the risk assessment was not robust to a regime change that took the models out of their historical comfort zone. Not enough account was taken of uncertainty.

“One of the messages I want to leave you with is that risk measurement based on historical models can only take you so far. Judgment must play an important role. Ultimately, the future is uncertain, in the sense that it cannot be quantified. The goal should be to design systems that are as robust as possible to this uncertainty. A system with less leverage is one obvious way to enhance robustness.

(This is interesting since Basel III limits the leverage ratio.)

“In discussing risk, I would like to highlight the key distinction between risk and uncertainty: risk

* Donald Rumsfeld, Department of Defence News Briefing, (12 February 2002).
‡ Guy Debelle, Address to Risk Australia Conference, Sydney, (31 August 2010).
is quantifiable; uncertainty is not.”

This is a distinction with a long tradition. Keynes made much of it, as did Frank Knight who lends his name to ‘Knightian' uncertainty, on which he elaborated in Risk, Uncertainty and Profit in 1921.

Knightian uncertainty arises when you don’t know the underlying probability distribution, which makes quantifying the risks impossible. This is called ‘general uncertainty'.

More recently, this distinction has been given prominence by Donald Rumsfeld with his knowns and unknowns, as well as by Satyajit Das in Traders, Guns & Money and Nassim Taleb in The Black Swan.

In addition to the distinction between risk and uncertainty in terms of measurability, Keynes made a similar distinction between cardinal and ordinal probability. Indeed, his Treatise on Probability has this as one of its central concepts. Cardinal probability is quantifiable: the probability of heads in a coin flip is 50 percent. Ordinal probability is qualitative. Model-based risk management handles cardinal probability a lot better than ordinal probability.

(3) Law of large numbers

The law of large numbers is interesting and has important applications in retail banking where there are a lot of transactions that occur over a very short time. This law states, in simple terms, that the larger the pool, the more predictable the amount of losses will be in a given period. The law of large numbers implies that the larger the number of similar credit exposures, the smaller is the uncertainty of portfolio credit risk. To understand this law we discuss some fundamental concepts.

Where do probabilities come from?

In basic statistics, you will learn that probabilities come from three sources – relative frequency, i.e., from experiments such as tossing a coin, theoretical models and from subjective opinion. Let us look at relative frequency in some detail.

Suppose that you toss a coin many times, e.g., 100 times. You define success as the number of heads that will show up. Note that there are two outcomes in each toss – heads and tails. We assume that this a fair coin and that it does not land on its side. We define:

Relative frequency = number of successes, i.e., heads / number of times the experiment is conducted (100 in this case).

In our example, if the number of heads is 55, then the relative frequency is 55/100 = 0.55.

We know that the true (objective) theoretical probability is 0.5. The law of large numbers states that if the experiment is conducted a large number of times (n is large), then the relative frequency will converge to the theoretical probability.

How does this apply to the management of credit risk?

The bank can increase the predictability of loss on its loan portfolio by spreading the risk over many borrowers. This requires that the bank make many small loans to many customers – a typical situation in retail banking. The alternative is large loans to a small number of customers – a typical situation in wholesale banking. The law of large numbers will result in lower variability in loan loss rates, and so the actual default rates will be close to the expected default rates for this type of business – with a requirement of similar borrowers. An important assumption is that individual loan loss rates are independent.

(4) Typical risks in banking as defined by Basel II

The Basel Committee on Bank Supervision (BCBS) categorises banking risks as follows:
Credit risk

When a bank enters into a loan agreement, the bank lends the principal loan amount. The transfer of the funds from the bank to the customer occurs at the time the contract is signed. But the terms and conditions of the contract are defined for repayment over a future period of time. This creates a risk for the bank as lender. The terms and conditions of repayment may not be fulfilled as previously agreed. For example, the borrower may miss a scheduled periodic, e.g., monthly in the case of consumer loans, payment, or may default altogether. This is a description of credit risk.

In other words, it is the risk of failure by a counterparty to a contract. Credit risk factors are those that affect the borrower’s probability of default, loss to the lender given default and the lender’s exposure at default. There may be events that are specific to the individual borrower or market-wide events that affect all borrowers.

Country risk* is a concept associated with credit risk. Country risk is the uncertainty created by unexpected political and economic events that make it more difficult for the borrower to repay the bank. An important part of country risk is transfer risk. One example of transfer risk is when the government has imposed prohibitive exchange restrictions or capital controls that may make it impossible for borrowers to transfer payments to the lender.†

For a retail bank, credit risk is typically located in its banking book where, for example, loans are held to maturity.

Note that credit risk can arise in the bank’s trading book in the form of counterparty risk. For example, bonds are, in fact, tradable loans.

Market risk

As we know from Retail Banking I, a retail bank may create assets by making loans and mortgages to consumers and companies and hence incur credit risk and associated country risk and transfer risk. But the bank may also invest in straight bonds, listed equities, mortgage-backed securities, covered bonds, etc., as well as conducting trading activities. In this way, the bank incurs market risk. Put simply, market risk is defined as the risk that the value of the bank’s investment portfolio will change due to alterations in an underlying market factor, including the price of shares, interest rates, prices of commodities or foreign-currency exchange rates. This immediately implies that the principal sources of market risk are equity risk, interest rate risk, commodity-price risk and foreign-currency risk.

Note that there are factors that may create both market risk and credit risk. For example, a change in interest rate may affect the default probability of a borrower as well as affecting the current market price of a bond.

Also, market risk differs from credit risk in that the latter is duly affected by borrower behaviour.

A bank may also have a trading book‡ that reveals the bank’s trading activities. Basel II defines a trading book as comprising “positions in financial instruments and commodities held either with trading intent or in order to hedge other elements of the trading book”.

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* Country risk is the exposure to a loss in cross-border lending, caused by events in a particular country, which are at least to some extent under the control of the government but definitely not under the control of a private enterprise or individual. P. J. Nagy, Country Risk: How to Assess, Quantify and Monitor It, (London, Euromoney publications, 1984).
† It seems that Basel II restricts country risk to being transfer risk. The Basel Committee explicitly includes transfer risk in the list of criteria on risk assessment of a borrower by stating that a bank should look at the risk characteristics of the country (the borrower) is operating in, and the impact on the borrower’s ability to repay (including transfer risk), where the borrower is located in another country and may not be able to obtain foreign currency to service its debt obligations. (Page 50 of Basel II Accord)
‡ “The bank’s trading book contains instruments that are intended to be held for a short term, and which are taken by the bank to benefit from actual or expected differences between their buying and selling prices” (Basel, 1996)
The basic requirements for trading book treatment are: clearly documented trading strategy; positions actively monitored and managed on trading desk; position limits set and monitored; positions marked to market at least daily and positions reported to senior management. It is clear that the trading book incurs market risk and credit risk. The two main drivers of market risk are a) the bank’s position in a financial asset and b) the expected variability in the price of this asset.

Operational risk

Operational risk is defined as risk of direct or indirect loss resulting from inadequate or failed internal processes, people and systems or from external events. It includes legal risk but excludes reputational and business or strategic risk.

Operational risk arises from banking operations, where banking processes are being managed by people using IT systems (including information databases) to deliver a financial service. This definition identifies the sources of operational risk – people risk, process risk and systems risk.

We further expand on this definition.

Sources of process risk

- Lack of internal controls – internal auditing is seen as a third line of defence after the initial checks by frontline managers and middle-office risk and compliance professionals.
- Inaccurate or incomplete documentation – leads to sloppy risk evaluation, leading to potential adverse selection of borrowers or unacceptable clients, e.g., money-laundering risk, as depositors.

People risk arises from processing and reporting errors, i.e., human error and fraud. Human errors are unintentional. Fraud is a deliberate criminal activity that operates against the interest of the bank’s stakeholders.

Sources of systems risk

Systems risk arises from:

- Virus invasion of database or breach of security. These are system security problems.
- There could be normal problems associated with fire or electrical lapses that lead to data corruption or service-delivery interruption.
- Software may be inflexible and/or not customised for the bank. This could lead to lack of scalability and ignorance on the part of bank IT professionals about the suitability of the third-party software for internal processes.

Bank operations rely heavily on technology – it is the basic delivery system. There is no escaping this. Today, there is no bank that can operate without information technology and information databases. But there are significant risks of technology failure, i.e., systems failure, that render people and processes impotent.

Comment

It is incorrect to conclude that operational risk is derived solely from the asset side of the balance sheet, which creates sources of market and credit risk. Recent events have shown that the bank administration of the liability side of the balance sheet, in particular when dealing with deposits and current account payments, can lead to significant operational risk and hence the potential for significant monetary losses and reputational damage. Here is a case in point:

* But there is a modification in the July 2009 BCBS paper titled “Enhancement to the Basel II Framework” that is presented later in this module.
“A software malfunction is to blame for making RBS and NatWest services unavailable to customers, Computer Weekly understands.

“The IT problems have not only stopped accounts from updating balances but also prevented customers from getting onto their online banking systems.

“A spokesman from RBS said: ‘We will continue working around the clock to fix the technical fault, but we are not going to put a timeframe on it, as we don’t want to create expectations. We apologise to our customers and will get the issue fixed as soon as possible.’

“NatWest was named the most reliable banking website in 2012, when a study from Keynote Competitive Research said it was the only site monitored to have no errors on any page during peak hours.”

Source: ComputerWeekly.com, 22 June 2012

Reputation risk

The Basel Commission on Banking Supervision (BCBS) said in the July 2009 ‘Enhancement to the Basel II Framework’ that

“in order to avoid reputational damages and to maintain market confidence, a bank should develop methodologies to measure as precisely as possible the effect of reputational risk in terms of other risk types (e.g., credit, liquidity, market or operational risk) to which it may be exposed.”

This is an explicit recognition of reputation risk; but the question is:

Open Question #1

Is reputation risk another risk type or is it an ‘impact’ derived from the other three types of Basel II risks?

The follow-up question is: should banks hold capital against reputation risk?

Industry professionals seem to regard reputation risk as an ‘impact’ rather than another risk type. For example:

- “I have always held that reputation risk is an impact value of other risk types. It can only be derived but not profiled independently,” says Eric Holmquist, president of Holmquist Risk Advisory.

- “Reputational risk is not a risk in itself but is driven by events that are also covered by other risk types such as market, credit, operational, liquidity, etc,” says Yusuf Yasin, Singapore-based head of operational risk within wholesale banking at Standard Chartered Bank. “If the banks are already holding capital against these primary risk factors, they should not be subjected to an additional capital surcharge.” Source: Risk.net

- Phillip Martin, Director of the UK-based Institute of Operational Risk, said: “The best way to manage a company’s reputational risk is to focus on the integrity of the company and its employees, ensuring that a proactive, risk-aware culture exists within the company.”

This is an interesting point regarding the management of reputation risk that will be discussed in greater detail in this module.

Liquidity risk

The BCBS (September 2008) report called, ‘Principles for Sound Liquidity Risk Management and
Supervisions’ defines liquidity management as follows: “Liquidity is the ability to fund increases in assets, to meet obligations as they become due, without incurring unacceptable losses.”

Simply put, liquidity is the capacity of the bank to obtain cash when it is needed.

“Liquidity risk is the risk that a firm will not be able to meet its current and future cash flow and collateral needs, both expected and unexpected, without materially affecting its daily operations or overall financial condition. Financial firms are especially sensitive to funding liquidity risk since debt maturity transformation (for example, funding longer-term loans or asset purchases with shorter-term deposits or debt obligations) is one of their key business areas.” (Source: Federal Reserve Bank of San Francisco Economic Letter, October 24, 2008)

Liquidity risk may be categorised into two types. These are:

a) funding liquidity risk, and
b) market liquidity risk.

- Funding liquidity risk refers to the ability of the bank to generate enough funds from its assets on the balance sheet to meet its financial obligations at short notice. Funding liquidity risk is then determined by the amount of cash, cash equivalents and other readily available marketable assets compared to the amount and type of liabilities that may come due.

- In Retail Banking I we provided an example showing the liquidity implications when the tracking speed of funding (e.g., deposits) is different from the repricing speed of assets (e.g., loans).

- Market liquidity risk is about the ability of the bank to make transactions in financial assets (e.g., invest in stocks and bonds) without causing meaningful movement in prices. For example, if there is a large scale de-risking in the balance sheet as a bank seeks to match risk with its available capital, then this action can cause prices to undergo significant downward movement. Banks may find it difficult to find buyers quickly and hence incur market liquidity risk.

* There is also ‘contingency liquidity risk’ which is driven by term or call liquidity risk. This is not considered here.
Chapter 1:
Measuring and Managing Credit Risk

The content of this module is summarised in the diagram shown below.
The identification step in the diagram was already presented in the introduction to this module. We proceed with the next two steps – measure and manage. It is probably important to note at this point that measurement of banking risks as provided for and recommended by Basel II and III involves mathematical complexity which can, at times, be daunting. For this reason, we place algebraic equations and statements of models in footnotes and discuss their implications.

**Credit Risk – Measurement and Management**

According to Basel II, banks can choose between two approaches to measure their credit risk: the standardised approach and the internal ratings-based approach. The standardised approach was introduced in Module 208. In this module, we extend the discussion to the standardised approach and provide details of the Foundation Internal-Ratings (FIRB) and Advanced Internal-Ratings Based (AIRB) approaches.

**Measurement of Risk – Value-At-Risk Approach**

As indicated, Basel considers banking risks in three main risk buckets – market risk, credit risk and operational risk. We have looked at these risks in Module 208 – at least from the perspective of their standardised approaches. But banks may choose an internal ratings-based (foundation or advanced) approach, subject to some constraints set by the national regulator. These latter approaches are centred around complicated procedures, loss distributions and value-at-risk calculations. We examine these in turn after an examination of the concept of value at risk (VaR).

Value at Risk is typically applied to a bank’s market exposure. Some experts have applied this approach to estimate credit risk through a concept called ‘Credit VaR.’ We discuss Credit VaR later in this module.

**Value at Risk (VaR)**

We present VaR in an intuitive fashion and place the technical details in footnotes. We know that in retail banking, small losses, whether from loan portfolios or from back office operations, occur often; while large losses are expected quite infrequently. These infrequent or rare large losses are labelled ‘extreme events’.

Consider the following question:

**What is the maximum loss the bank could experience over the next year and how confident is the risk manager about his/her forecast?**

There are three important unknowns facing the risk manager of the bank – the largest loss in the loan portfolio; the chance that this loss will happen; and when it might happen during the time period. Of course, there is the assumption that there will be no extreme events.

Risk management experts have come up with a single measure of the maximum loss the bank could incur in its loan portfolio over the next year. In addition, they can express this with a certain degree of confidence. This concept is called *Value at Risk and is stated as VaR.*

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**VaR is this maximum loss. It is a single (monetary) number.**

For example, in April 2012, JP Morgan reported that its **one-day 99 percent VaR** was equal to US$67 million. This means that the bank was 99 percent confident that its **maximum loss** over the **next day** would not exceed US$67 million **under normal market conditions**, i.e., assuming no extreme events.


Open Question #2

Based on the example presented above, could JP Morgan lose more than US$67 million on the next day?

 Basel II requires that banks calculate a 10-day 99 percent VaR – that is, the pre-specified period is the next 10 days rather than just one day. However, it is possible to obtain the 10-day value after computing the one-day value. As shown in the footnote, just multiply the one-day value by a factor that is equal to the square root of 10. This factor is approximately, 3.16. So from the JP Morgan example where the one-day 99 percent VaR is equal to US$67 million, the equivalent 10-day 99 percent VaR = 3.16 * US$67 million = US$ 211.87 million.

This means that the 10-day 99 percent VaR for JP Morgan cited above is \( \sqrt{10} \times \text{US$67 million} = \text{US$211.87 million} \). This dollar figure implies that the bank is 99 percent confident that there will not be a loss greater than US$211.87 million over the next 10 days.

We illustrate the concept of VaR by means of a graph shown below. It is a familiar ‘bell-shaped’ graph that is called the ‘normal distribution’. To illustrate the graph, we consider an example.

**Example**

Suppose that a current portfolio is $100 million. The risk manager believes that, based on past experience, the portfolio can vary (up or down) on a daily basis by about 0.5 percent. (Statisticians would state a historical daily standard deviation of 0.5 percent.) Here is a graphical depiction of the example.

\[
99\% \text{ VaR} = \text{Portfolio Value} \times 2.33 \times \text{Volatility}
\]

\( Z \sim N(0,1) \)

99% VaR which means the area in the graph to the right of the arrow is 99%. The value on the horizontal axis of the graph at the point of the arrow is called the 99% VaR

**209.2: Daily standard deviation in portfolio**

For a 99 percent VaR, the area in the graph to the right of the arrow is 99 percent or equivalently, 1 percent to the left. The value on the horizontal axis of the graph at the point of the arrow is called the 99 percent VaR.

* The general formula is: \( \text{N-day 99% VaR} = \sqrt{N} \times \text{one-day 99% VaR} \).
The portfolio value and volatility will be determined by the risk manager. The factor 2.33 is fixed when the confidence level is 99 percent and the graph is ‘bell-shaped’. So the one-day 99 percent VaR for the example presented above is $100 million * 2.33 * (0.5/100) = $1.16 million.

This means that the bank is 99 percent confident that the maximum possible loss to its portfolio over the next day is $1.16 million under the assumption of normal market conditions – no extreme events.

**Observations about VaR**

All else being equal:

a) The larger the dollar value of the portfolio, the greater the VaR dollar value;
b) The longer the time period under consideration, the higher the VaR value;
c) The higher the degree of confidence level, the higher the VaR value. This is because the tail becomes smaller when measured in terms of area;
d) The higher the level of portfolio volatility, the higher the VaR value.

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**Open Question #3**

*New York Times* reporter Joe Nocera wrote an extensive piece titled “Risk Mismanagement” on 4 January 2009, discussing the role VaR played in the financial crisis of 2007-2008. After interviewing risk managers, the article suggests that VaR was useful to risk experts, but nevertheless exacerbated the crisis by giving false security to bank executives and regulators.

It is worthwhile noting the comment by Haldane [below] about the implications of assuming a normal (i.e., bell-shaped) distribution where the tails are quite thin and which gives the impression of lower risk.

“Worse still, the fatter the tails of the risk distribution, the more misleading VaR-based risk measures will be. Consider holding a portfolio of world equities and, based on data from 1693 to 2011, calculate the VaR. The 99 percent VaR, assuming the data are normal, gives a loss of $6 trillion at today’s prices. Using the actual data raises the estimated VaR by one third to $7.8 trillion. Finally, calculating the risk conditional on being in the 1 percent tail of the distribution gives a loss of $18.4 trillion. Simple VaR underestimates risk by a factor of 1.5 and 3.”

*This quotation is from page 16 of a speech by Andrew Haldane given on 8 June 2012.†*

Do you agree with this content regarding Value at Risk?

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**Credit Value at Risk (Credit VaR)**

Let us look at a graph of potential credit losses. Firstly, in line with our observation that most losses in a bank’s loan portfolio are relatively small and that very large losses are infrequent, the graph of credit losses is represented as follows:

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* Academics have found several weaknesses with the VaR metric. The interested reader can review these in Appendix A.
In this graph, EL = expected loss on the loan or credit portfolio; UL = unexpected loss and extreme loss is measured in the tail. Notice that this graph is not bell-shaped as we used in our explanation of value at risk. Rather, it shows that small losses are concentrated to the left where the frequencies are higher. Large losses are less frequent and the vertical lines in the graph (i.e., frequencies) are shorter as we move to the right to the region labeled ‘exceptional loss’, which is the tail of the loss distribution.

Expected loss is the cost of doing business and it is the average level of credit losses that the bank can reasonably expect to experience. Because of the shape of the graph, EL is to the right of the highest ‘spike’ in the graph. Expected loss is managed by banks by pricing the credit exposures† and by provisioning.

Unexpected loss (UL) is defined as the volatility of credit losses. While expected loss is the cost of doing business, unexpected loss is the risk that the bank bears in doing business. As previously stated, banks hold capital to protect debt holders against losses that exceed expected losses.

It is clearly seen from the graph that Credit VaR‡ = UL + EL.

This is interesting since the risk manager just has to calculate the unexpected loss on the loan portfolio. But we still need the time period over which the expected loss is calculated as well as the degree of confidence.

Basel II has recommended that risk managers calculate a 99.9 percent Credit VaR over a one-year period. This is equivalent to calculating the unexpected loss, UL, on the credit portfolio over a one-year period where the area in the above graph to the left of the exceptional loss is 99.9 percent.

* Statisticians refer to such distributions as being skewed with a long tail to the right. Recall that bell-shaped (i.e., normal) distributions are symmetric as opposed to being skewed.
† Chapter 4 deals with risk-based pricing.
‡ Unexpected loss (UL) is defined as the difference between expected loss (EL) and the value at risk (VaR) at a given confidence level.
We now show the calculation of unexpected loss, UL.

**Calculation of Credit Loss**

The modelling of a bank's portfolio credit risk requires a specification of credit loss. The literature describes two definitions – the default mode (DM) paradigm and the mark-to-market (MTM)* paradigm.

To measure credit loss, we consider the case of the so-called **default mode paradigm** where default is modelled as a two-state variable – that is, we assume that the borrower will default or will not default.

**The DM Paradigm**

The DM paradigm assumes that the borrower defaults over an assumed time horizon or the borrower does not default. If the borrower does not default, then the credit loss is zero. We create a diagram of the two possibilities under the DM paradigm:

\[
\text{PD} = \text{probability of default (also called, expected default frequency)} \quad \text{which is the probability that the obligor will default at the end of a pre-determined time period (e.g., one year) and expressed as a percentage;}
\]

\[
\text{LGD} = \text{expected loss given default that is also defined as } \text{LGD} = 1 - \text{RR} \text{ where } \text{RR} = \text{expected recovery rate and is usually expressed as a percentage;}
\]

\[
\text{EAD} = \text{expected exposure amount at default, expressed in monetary amount.}
\]

\[
0 \quad T
\]

In algebraic terms, we get that:

\[
EL = (1 - PD) * 0 + PD * (EAD * LGD) = PD * EAD * LGD.
\]

It is important to note that this formula ignores potential correlation between the random variables, PD, LGD and EAD. (We will consider this issue in some detail later in this module).

Credit risk arises from unexpected losses. Recall, it was indicated in Retail Banking I that expected loss is not a measure of risk but is a cost of doing business. Banks provision for expected loss and this is reflected in the bank's income statement.

If the borrower does default, then by multiplying the terms in the bottom branch of the diagram above, we obtain that the expected loss is,

\[
EL = PD * LGD * EAD
\]

* We emphasise the default mode in this module. However, the MTM approach is the second approach to estimate credit loss. As opposed to the two-state model of the DM paradigm, the MTM model assumes a multistate process for credit loss that recognises credit deterioration before default. This is manifested in, for example, changes of credit rating. This is a more dynamic view of credit risk.

† In algebraic terms, we get that:

\[
EL = (1 - PD) * 0 + PD * (EAD * LGD) = PD * EAD * LGD.
\]
We illustrate by means of an example:

**Example (calculation of EL)**

We are given the following information for a loan portfolio

EAD = $10 million; LGD = 10 percent; PD = 15 basis points (i.e., 0.15 percent)

\[
EL = PD \times LGD \times EAD = 0.0015 \times 0.10 \times $10 \text{ million} = $1,500
\]

This means that the portfolio is expected to lose $1,500 at the end of the loan period.

**Important Assumption**

It is important to note that this formula for expected loss assumes that the three variables, PD, LGD and EAD are not related. But this may be misleading (this problem is considered later in this module).

So far we have calculated expected loss. But credit risk arises from unexpected losses. We note above that expected loss is not a measure of risk but is a cost of doing business. It is obvious that unexpected loss cannot be anticipated and hence cannot be adequately accounted for in the pricing of the credit exposure (e.g., loan). Under the DM paradigm, unexpected loss is the volatility of actual credit loss.

Using a calculation from statistics, we can derive a formula for unexpected loss, UL. This formula is presented in the footnote at the bottom of this page. Before we comment on the implications of this formula, we present an example to illustrate its calculation.

**Example**

We are given the following information:

EAD = $10m; LGD = 10 percent; PD = 15 basis points (0.15 percent) and VaR (LGD) = 8 percent

From this data, we calculate, PD \times (1-PD) = 0.0015 \times (1-0.0015) = 14.98 basis points

\[
UL = $10 \text{ million} \times \sqrt{PD \times \text{var}(LGD) + LGD^2 \times PD \times (1-PD)} = $116,181
\]

We present some comments on the properties of the formula for UL.

- Note the DM paradigm ignores a deterioration of credit rating short of default, and hence is sensitive to the chosen time horizon. The longer the time horizon (i.e., the longer the average maturity of the loan portfolio), the more likely there will be changes in the probability of default that was calculated at the time of the loan origination. The management of changing credit risk usually requires a risk manager who monitors the portfolio for risk changes.

- The DM model is based on the assumption of independence of LGD and PD. This is probably not realistic. There is evidence that these two variables are likely to be correlated. For example, during periods of economic downturn, it is expected that credit risk on a retail loan portfolio will deteriorate since borrowers are likely to lose their jobs as unemployment increases. At the same time, capital markets are likely to deteriorate so that the recovery rate of collateral will fall. Equivalently, loss given default will increase. Hence it is likely that default risk (PD) and loss given default (LGD) are correlated and not independent of each other.

- But there is a body of research that provides evidence of a negative correlation between PD and LGD. This is likely a manifestation of the fusion of credit risk and downturn risk that was discussed in the Retail Banking I module Credit Loss Management. When there is an

\[
UL = EAD \times PD \times \text{var}(LGD) + LGD^2 \times PD \times (1-PD)
\]

Where \text{Var} = \text{variance.}
economic downturn, there is a migration to a higher level of default (PD rises); but asset quality also deteriorates with a likely impairment of collateral leading to a lower recovery rate (RR). This is a likely pathway for the negative correlation. But since LGD and RR are negatively correlated, then we may conclude that LGD and PD are positively correlated. In an economic downturn, PD rises and LGD also rises.

Yet it is interesting to note that popular proprietary models are based on the assumption of a lack of correlation between recovery rate (RR) and LGD. Here is a report from BIS* (Bank for International Settlements).

<table>
<thead>
<tr>
<th>Model</th>
<th>Assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Metrics®</td>
<td>RR is independent of PD</td>
</tr>
<tr>
<td>Credit Portfolio View®</td>
<td>RR is independent from PD</td>
</tr>
<tr>
<td>Credit Risk®</td>
<td>Constant RR independent of PD</td>
</tr>
<tr>
<td>KMV Credit Manager®</td>
<td>Stochastic variable RR independent of PD</td>
</tr>
</tbody>
</table>

If PD and LGD are affected by the same economy-wide (systematic) factors, then they are likely to both increase during economic downturns and decrease during economic expansions. This magnifies expected and unexpected loss†.

**Comment‡**

Note that to calculate UL, the risk manager must obtain robust estimates of PD, LGD and EAD as well as the volatility of PD and LGD. It is also interesting to note that in implementing Foundation IRB, banks provide their own estimates of PD but rely on supervisory estimates for LGD, EAD and maturity of credit portfolio.

In the Advanced version of IRB, banks provide their own estimates of PD, LGD, EAD and maturity. But the IRB model is specified by Basel. Banks do not generate their own IRB formula.

The main difference between the foundation and advanced IRB approaches lies in the definition of the input variables. Both approaches rely on banks’ PD estimates, but banks’ internal estimates of LGD, EAD and loan maturity are only taken account in the advanced IRB approach. Although banks rely on their own PD estimates, in both approaches, they are obliged to use a minimum probability of default of 0.03 percent for PD.

**Open Question #4**

Here is a statement from a risk manager:

“If probability of default rises significantly, then expected loss will rise and unexpected loss will actually fall.”

Do you agree?

---


† The assumption that PD and LGD are correlated is considered in Module 203, SME Lending.

‡ Foundation and Advanced IRB are considered in RBIII.
Open Question #5

The BCBS document, ‘Sound credit risk assessment and valuation of loans – final document, June 2006’ states:

“Banks should have a system in place to reliably classify loans on the basis of credit risk”.

Why is this recommendation important for credit risk management?

Credit risk monitoring tools are discussed in the RBI module - Credit Loss Management. At this point we note that concentration risk is considered in some detail in Module 203 - SME lending. In this context, BCBS states that concentration of exposures in credit portfolios is an important aspect of credit risk. It may arise from two types of imperfect diversification. The first type, namely concentration, relates to imperfect diversification of idiosyncratic risk in the portfolio either because of its small size or because of large exposures to specific individual obligors. The second type arises from sector and geographic concentrations of asset exposures.

Advice for Senior Management

Identify and monitor on a regular basis the bank’s large credit risk exposures to individuals or groups of related counterparties. The definition of a ‘large credit risk exposure’ will be determined by the risk appetite statement of the bank. Recommended metrics to monitor are:

- A counterparty or group of similar counterparties with a total loan amount more than $x$ percent of the total value of the loan portfolio (counterparty concentration of credit risk).
- Loans to a particular sector with a total amount more than $y$ percent of the total value of the loan portfolio (sector concentration of credit risk).

Comment

While sector concentration of credit risk exposes the loan portfolio to significant impairment of loans, loan officers can achieve significant advantages in terms of ‘knowing your client’ and the customer’s business. This can lead to better customer selection and pricing.

We now consider the second of Basel II risk buckets – operational risk.
Chapter 2:
Measuring and Managing Operational Risk

In Balance Sheet Management (Module 208), we presented the basic indicator approach and the standardised approach for the calculation of an operational risk charge as proposed by the BCBS. We report these approaches here for reference to the more advanced approach.

The Basic Indicator and Standardised Approaches

Basic Indicator Approach (BIA)

This approach is simple to implement and probably does not measure operational risk – and if it does, it is only in an indirect manner.

A bank’s required operational risk capital = alpha * (average gross income of the three previous years with adjustments made for negative and zero income values). First alpha of 15 percent is a fixed percentage set by BCBS. Also, if the bank earned zero or negative gross income for a particular year, the sample value is omitted from the denominator and numerator.

So if the average three-year gross income for a bank (assuming all positive values) is $50 million, the capital that will be allocated for operational risk is 15 percent * $50 million = $7.5 million.

The main problem with the basic indicator approach is that it assumes that the bank with a higher average of gross income will experience higher operational risk – in a fixed proportional manner. This can be misleading since operational risks depend on the type of business that the bank engages in. A bank may have a lower average of gross income and yet have a higher level of operational risk.

The Standardised Approach (SA)

The standardised approach is similar to the BIA except that SA deals with lines of business rather than the bank’s gross revenue as a whole. The standard approach recognises that operational risk varies by business unit.
Here is a table of beta factors for each line of business:

<table>
<thead>
<tr>
<th>Business Unit</th>
<th>Beta Factor (Fixed Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate Finance</td>
<td>18%</td>
</tr>
<tr>
<td>Payment and Settlement</td>
<td>18%</td>
</tr>
<tr>
<td>Trading and Sales</td>
<td>18%</td>
</tr>
<tr>
<td>Agency Services</td>
<td>15%</td>
</tr>
<tr>
<td>Commercial Banking</td>
<td>15%</td>
</tr>
<tr>
<td>Asset Management</td>
<td>12%</td>
</tr>
<tr>
<td>Retail Banking</td>
<td>12%</td>
</tr>
<tr>
<td>Retail Brokerage</td>
<td>12%</td>
</tr>
</tbody>
</table>

**Advanced Measurement Approach (AMA)**†

The Advanced Measurement Approach permits banks to utilise their own models to estimate their operational risk charge.

We consider two (sub) approaches, i.e., alternatives, under the AMA for operational risk. We consider the Internal Measurement Approach (IMA) and the Loss Distribution Approach (LDA) alternatives. We present details of the first approach and details of the more complicated LDA approach are found in Appendix B.

**The Internal Measurement Approach (IMA)**

The IMA is similar in principle to the IRB for credit risk.

Recall that expected credit loss = PD * LGD * EAD. Similarly, expected operational loss is equal to probability of a loss event (PE) * loss given the events (LGE) * operational risk exposure indicators (EI).

In symbolic form, \( EOL = PE \times LGE \times EI \) where,

\[
EOL = \text{expected operational loss},
\]

\[
LGE = \text{loss given the events},
\]

\[
EI = \text{exposure indicators}.
\]

Recall that unexpected loss, UL, for a credit portfolio depended, in part on the same factors as the expected loss, EL. These similar factors were PD, LGD and EAD. In a similar vein, regulators apply a “gamma multiplier”‡ to the expected operational loss to a measure of unexpected operational loss:

\[
UOL = \gamma \times EOL \quad \text{where} \quad UOL = \text{unexpected operational loss (i.e., operational risk)}
\]

If we assume that expected operational loss is covered by some level of internal bank reserving, as is the common case of provisioning for expected credit loss, then we may state that:

\[
\text{Required capital} = \gamma \times EL \quad \text{where} \quad EL = \text{the average annual loss amount.}§
\]

† More details on the AMA approach are presented in RBIII.

‡ BCBS states that, “The scale of gamma will be determined and fixed by supervisors for each business line/loss type. In determining the specific figure of gamma that will be applied across banks, the Committee plans to develop an industry wide operational loss distribution in consultation with the industry, and use the ratio of EL to a high percentile of the loss distribution (e.g., 99 percent)”

§ There is no presumption that the gamma multiplier is constant. In fact, gamma is – under some conditions – inversely proportional to the square root of the number of loss events.
This value is calculated from the bank’s own data set of loss frequency and severity. However, the implementation of this formula can be challenging. A solution is proposed by the observation that:

$$EL = \text{expected number of loss events} \times \text{average loss amount}.$$ 

**Open Question #6**

BCBS states in its document, ‘Principles of Sound Management of Operational Risk’, June 2011 that:

“It is the responsibility of the board of directors to ensure that a strong operational risk management culture exists throughout the whole organisation… In all cases a bank’s operational risk governance function should be fully integrated into the bank’s overall risk management governance structure.

“It provides advice to the board of directors on creating an operational risk management culture.”

*Discuss.*

**Operational Risk Assessment and Monitoring Tools†**

Retail banks typically rely on *three lines of defence* as the basis for risk governance in general and for operational risk management in particular. The first line of defence is business line management, which is responsible for identifying and managing the risks inherent in products, services and other activities. The second line of defence is independent, corporate operational risk management that complements and monitors the first line of defence to ensure that the board of directors’ risk appetite framework is not breached. The third line of defence is an independent body (e.g. corporate audit) that evaluates the operational risk framework established by both the first and second lines of defence.

There are typically four approaches for identifying, assessing and monitoring operational risk‡. These methods are:

- Loss Collection Data;
- Risk Self-Control Assessments;
- Key Risk Indicators (KRIs);
- Scenario Analysis.

We describe these in turn, with emphasis on the role of KRIs as monitoring tools.

**Loss Collection Data**

An example of this type of analysis is ‘incident reporting’, which provides an understanding of the actual costs of operational risks and, by implication, an indication of potential weakness in existing controls.

*It is important that business line managers report immediately, to the second line of defence, incidents that have large financial impact, can damage the bank’s reputation or which involve illegal conduct.*

Included in this collection of loss data are those events that are ‘near miss’. A near miss is an incident without any direct consequences for the bank. It may be that the event was not foreseen.

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† Some of this content reflects presentations at a conference by ING Corporate Operational Risk Management (CORM) on 02/04/08. Dr. A. Rahman presented at this conference.

‡ Principle 6 of the Basel Committee on Banking Supervision’s Sound Practices for the Management and Supervision of Operational Risk states that “senior management should ensure the identification and assessment of the operational risk inherent in all material products, activities, processes and systems to ensure the inherent risks and incentives are well understood”.

---
and so no control was in place. The event was prevented by mere chance. It is useful to keep track of near misses and the potential loss – the amount that would have been lost had the incident not been prevented.

A typical framework for assessing operational risks is to consider a matrix based on frequency and size of impact of operational risk exposure: a Risk Map. Here is an illustration:

![Risk Map Diagram]

209.5: Risk Map: This matrix indicates that Risk = Frequency of Event X Size of Impact

Low frequency and low impact events have the potential for minor losses and so may be deemed to be low priority. High frequency and low impact events represent recurring events with low losses. This may suggest a deficiency in the bank’s processes. Low frequency and high impact events represent a major challenge to operational risk managers. These events are difficult to predict and the risk exposure is challenging to assess and monitor. Finally, operational risk managers must pay particular attention to events with medium frequency and medium impact since they could aggregate to significant financial losses and damage to customer satisfaction.

Key Risk Indicators (KRIs)

By definition, a risk indicator is a metric that monitors the bank’s risk exposure over time. It is a key risk indicator if it tracks an important source of risk exposure with minimum ambiguity. For example, customer complaint incidence is a tool for identifying and monitoring deficiencies and errors in the bank’s processes and systems. It is a KRI since the number of customer complaints is related to people’s errors and mistakes as well as the system’s deficiencies – all important sources of operational risk.

The Institute of Operational Risk (IOR) asserts* that KRIs can serve as early warning signals of operational risk and hence can permit management to take appropriate control actions. Specifically, it states that KRIs can identify trends in emerging operational risk, current exposure levels and events that happened in the past and are likely to reoccur. IOR also provides additional examples: “staff turnover (which may be linked to risks such as fraud, staff shortages and process errors), the number of data errors (process errors) and the number of virus or phishing attacks (IT systems failure)’’.

* Operational Risk Sound Practice Guidance: Key Risk Indicators, Institute of Operational Risk (November 2010).
Risk Self-Control Assessment (RSCA)

RSCA facilitates day-to-day monitoring of sources of operational risk. This is called an open-end method in that it assesses a large scope of risk exposures. Closed-end methods use questionnaires and checklists to assess specific risks such as IT risks.

Scenario Analysis

There are limitations in using quantifiable data to identify and assess operational risk. These limitations can be severe for low frequency-high impact events where small data samples are the norm. Scenario analysis converts quantitative and qualitative data, the latter based on experience and expertise into more objective data that is then used to assess the bank’s operational risk exposure.

The next chapter deals with market and liquidity risks.
Chapter 3: Measuring and Managing Market Risk and Liquidity Risk

This chapter deals with the measuring and managing of market risk and liquidity risk. As discussed in Module 208, Pillar I of Basel III has recommended two liquidity standards for banks with several monitoring tools. This chapter expands the discussion on the governance of liquidity. First we consider issues related to market risk. It is worthwhile taking note of the following: With credit risk, market risk and operational risk, management of a retail bank can lose a lot of money; With liquidity risk, management can lose the retail bank. As stated in the introduction, while the main sources of market risk are interest rate risk, equity risk, foreign exchange (FX) risk etc, the main drivers are the bank’s position in the market and the expected variability in the underlying price of the asset. A standard method for measuring risk is value at risk (VaR).

BCBS specifies that the normal market risk VaR is based on the following specifications:

- A 99 percent confidence level
- 10-day holding period
- Calculation on a daily basis
- Data is based on historical observations for at least one year
- Data sets are updated at least once per month

The calculation of VaR under stressed conditions, i.e., scenario analysis, is presented in the footnote below.*

In appendix A, we outline three weaknesses of VaR and hence the application of VaR as a risk metric must be viewed with caution. Another weakness of VaR is related to market liquidity risk

- **VaR does not readily capture liquidity differences among instruments.** In a general sense, liquidity is the capacity of the bank to obtain cash when it is needed. Hence, liquidity risk

* The stressed VaR is calculated at least once weekly. The specifications are similar to those for the normal VaR, and the bank’s portfolio is subject to stressed financial variables, e.g., interest rates, equity prices, commodity prices. Consequently, the bank is subject, on a daily basis, to a capital requirement that is determined as follows: Required capital = Max(VarL, k * Var_60) + Max(VarSt, l * sVar_60)

where VarL = VaR of the previous day, Var_60 = average VaR for the previous 60 business days.

There is a similar explanation for sVar. The minimum value of both k and l is +3 and the actual values are typically set by the relevant supervisory authorities. This is the so-called BCBS 1996 formula. A more general formula is presented in the Retail Banking III module, ‘Risk and Capital Management’.
may be viewed as a *consequential risk* in the sense that it arises from the bank taking on credit risk and market risk.

To examine market liquidity risk in more detail, we appeal to a concept in traditional finance literature where the bid-ask spread is taken as a proxy for market-liquidity risk and the difference between the bid price for an asset and the ask price is the cost of illiquidity risk.

For the interested reader, we present details of a liquidity adjusted VaR in Appendix C.

### Funding Liquidity Risk Management

Funding liquidity risk is a major risk facing banks. The interconnection of markets presents challenges for the measurement and management of liquidity risk. Indeed, as we pointed out, during periods of market stress there is an amplification of market and credit risk that could have consequences similar to Knightian uncertainty. Indeed as far back as 2006, the Bank of England warned that “the severe crystallisation of credit, market and liquidity risk in combination could lead to a material erosion of UK banks’ capital, with potential knock-on effects to supporting markets, institutions and infrastructures”.

We now consider Basel III liquidity standards (LCR and NSFR) as well as liquidity monitoring tools as recommended in the BCBS document: *Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools* (January 2013).

### Liquidity Ratios

Basel III has introduced two standards of liquidity risk – Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR) that are discussed fully in Module 208 with the latest updates. We present the essential details here.

#### Liquidity Coverage Ratio (BCBS Consultative Document, 16 April 2010.)

**Objective**

This metric aims to ensure that a bank maintains an adequate level of unencumbered, high-quality assets that can be converted into cash to meet its liquidity needs for a 30-day time horizon under an acute liquidity-stress scenario specified by supervisors. At a minimum, the stock of liquid assets should enable the bank to survive until day 30 of the proposed stress scenario, by which time it is assumed that appropriate actions can be taken by management and/or supervisors, and/or the bank can be resolved in an orderly way.

Eligible assets include two levels:

- **Level 1 assets** comprise cash, central bank reserves and high-quality government debt.
- **Level 2 assets** include high-quality (AA - and better) corporate and covered bonds. Level 2 assets are subject to 15 percent haircuts and limited to 40 percent of LCR liquid assets.

*Asset-backed securities (ABS) are excluded from LCR, making them less attractive for banks especially versus covered bonds.*

\[
	ext{LCR} = \frac{\text{stock of high-quality liquid assets}}{\text{net cash outflows over a 30-day time period}} \geq 100\%
\]

---

‡ In June 2011, the Dutch National Bank introduced an Internal Liquidity Adequacy Assessment Process (ILAAP) whereby Dutch banks must thoroughly and systematically evaluate their respective liquidity management functions.
**Net Stable Funding Ratio**

The net stable funding ratio (NSFR) measures the amount of longer-term, stable sources of funding employed by an institution relative to the liquidity profiles of the assets funded and the potential for contingent calls on funding liquidity arising from off-balance sheet commitments and obligations. The standard requires a minimum amount of funding that is expected to be stable over a one-year time horizon based on liquidity risk factors assigned to assets and off-balance-sheet liquidity exposures. The NSFR ratio is intended to promote longer-term structural funding of banks’ balance sheets, off-balance-sheet exposures and capital markets’ activities.

The objective is to create incentive for bank to fund illiquid assets with stable funding.

\[
\text{NSFR} = \frac{\text{available amount of stable funding}}{\text{required amount of stable funding}} \geq 100\%
\]

**Open Question #7**

“In our view, an overly prescriptive approach to liquidity standards which focuses solely on quantitative requirements would not deliver the requisite level of proportionality or necessary flexibility in managing liquidity. Furthermore, it would divert the regulators’ focus from the crucial higher level oversight of a firm's liquidity governance and its strategies, policies and practices which we believe are equally as important as a focus on numbers and ratios.” – Joint Industry Trade Associations’ Response to the BCBS Principles for Sound Liquidity Risk Management and Supervision

Do you agree with this assessment of the Basel liquidity measures, LCR and NSFR?

It is interesting to note that Basel III NSFR proposes weighting factors for assets that vary from zero percent to five percent for cash and government bonds, to 65 percent for mortgages, 85 percent for retail loans and 100 percent for other assets. The liabilities weighting scheme varies from 100 percent for Tier 1 capital to 90 percent for core retail deposits and 50 percent for unsecured wholesale funding.

Since available stable funding (ASF) focuses on the liability side, we see a bias in favour of core retail deposits (weighting of 90 percent) and against unsecured wholesale funding (weighting of 50 percent).

**Liquidity Risk Monitoring Tools**

While LCR and NSFR are liquidity standards, BCBS proposed several liquidity monitoring tools that, as stated in paragraph 174, are intended to obtain “information related to the bank’s cash flows, balance sheet structure, unencumbered collateral and certain market indicators”.

The BCBS liquidity risk monitoring tools are:

1. Contractual maturity mismatch;
2. Concentration of funding;
3. Available unencumbered assets;
4. LCR by significant currency; and
5. Market-related monitoring tools.

We provide explanations for each monitoring tool.

---

Contractual maturity mismatch

The objective of this metric is to identify potential gaps between inflows and outflows of liquidity within specified time bands. Supervisors will define the time bands for each institution so as to enable a complete understanding of the bank’s cash position. The raw data will be submitted to the supervisor with no assumptions included in the data. This is because the metric is based on contractual maturity mismatch, which will not include assumptions related to ‘going concern’.

Advice for Senior Management

For internal liquidity risk purposes, it is advisable for the bank to conduct its own maturity liquidity mismatch based on normal and stressed conditions. A robust risk management process requires analyses based on a going concern assumption.

Concentration of funding

The objective of this metric is to identify concentrated sources of funding, the unexpected withdrawal of which can trigger liquidity problems for the bank. As stated by the Dutch National Bank, “As the liquidity position of an institution is sensitive to calls on concentrations of deposited funds, a separate system is in force to monitor the funds deposited by a single customer (or group of associated customers) that exceed a given percentage of all deposited funds. This is known as the large-exposures (liquidity) reporting system for banks and clearing institutions.”

This metric encourages the diversification of funding while NSFR leads to a bias in favour of funding by retail deposits.

BCBS (paragraphs 191 to 195) recommends that a bank consider the following metrics to track potential concentration of funding. These are:

- a) Counterparties with more than one percent of the bank’s balance sheet (counterparty concentration);
- b) An instrument/product or groups of similar instruments/products that account for more than one percent of the bank’s balance sheet (instrument/product concentration);
- c) Liabilities denominated in a particular currency that amount to more than five percent of the bank’s total liabilities (currency concentration)

BCBS (paragraph 196) requires that the data required in a), b) and c) above be reported in time buckets ranging from less than a month, 1-3 months, 3-6 months, 6-12 months and longer than 12 months.

Advice for Senior Management

Implement a monitoring process that regularly examines funding concentrations by counterparty or type of instrument/product. Both the absolute percentage of the funding exposure, as well as significant increases in concentrations should be monitored. Funding concentrations by time buckets give a more accurate picture of potential liquidity risks. (BCBS, paragraph 189)

Available Unencumbered Assets

These assets may be used as collateral to secure high quality liquid assets (HQLA) or may be eligible at central banks and so can provide additional sources of liquidity for the bank. Hence unencumbered assets available at banks serve two potential functions: secured funding or additional source of HQLA. As such, the bank’s stock of available unencumbered assets represents

* The Canadian regulator utilises a Net Cumulative Cash Flow (NCCF) metric to identify potential contractual maturity mismatch. This procedure is similar to a mismatch maturity analysis in the CAMELS approach in Module 210.
the ability of the bank to boost the LCR should this ratio fall below a specified threshold.

**LCR by Foreign Currency**

BCBS (paragraph 213) recommends that the bank calculates a Foreign Exchange LCR as a monitoring tool similar to the method for calculating the standard LCR. The foreign exchange LCR is intended to assess liquidity risk in a significant currency in times of stress (defined above).

**Market-related Monitoring Tools**

Liquidity Monitoring Tools include market-wide information (e.g., equity markets, debt markets, FX markets); information on the financial sector (e.g., yield spreads); and bank-specific information (e.g., credit default swap prices, money market yields).

The final section of this module considers an application of risk exposure to pricing of bank products. In particular, the degree of risk tolerance of the bank affects the capital allocated and hence risk-adjusted return on capital (RAROC). To attain a minimum level of RAROC, the pricing of assets (e.g., loans) will be duly affected.
Chapter 4: Risk-Based Pricing

Risk-based pricing is a pricing paradigm whereby pricing of risky bank products is based on the valuation of the marginal risk to the bank’s portfolio of specific borrower attributes. In terms of microeconomics, it is a form of price discrimination that is based on the concept of marginal risk contribution. It is important to note that for pragmatic reasons, risk-based pricing in retail banking, as opposed to wholesale banking, is not typically based on an individual borrower basis. The high-volume nature of retail banking would preclude this approach. Rather, customers are typically segmented on a risk-class basis, and risk-based pricing is then applied across these different risk classes.

The principal goal of risk-based pricing is to determine the minimum required rate of return for a new transaction that is consistent with the incremental transaction’s risk and shareholder return. This approach sets a minimum price for risk, while being constrained by a minimum shareholder return. In summary, risk-based pricing establishes a minimum risk-adjusted return on the transaction while meeting a bank objective on risk-adjusted return on (economic) capital – RAROC.

Setting a Risk-Based Price for a Risk Exposure

We make the following assumptions:
- \( X \) = bank’s exposure
- \( k \) = cost of equity capital
- OPEX is a fixed percentage of the bank’s exposure (OPEX = \( a \times X \))
- Provisions is a fixed percentage of exposure (PROV = \( b \times X \))

\[ r_f \] = risk free rate
\( i \) = cost of funding the exposure
EC = Economic capital

As we demonstrate in Appendix D, the price of the exposure is given by the formula:

\[
\frac{r}{X} > i + a + b + (k - r_f) \times \frac{EC}{X}
\]

* The details of the calculation in obtaining the final formula are presented in Appendix D.
This equation is the basis for risk-based pricing.

If we rephrase this pricing equation in terms of RAROC, and assuming that the bank has a strategic target minimum RAROC rate (y%), then we have the inequality:

\[ r > i + a + b + (y - r_f) \cdot \frac{EC}{X} \]

Let us apply this formula for the pricing of a bank’s exposure.

**Example**

Exposure (X) = 1000  
Economic capital = 100  
Minimum RAROC = 15%  
Operating cost (% of X) = 1%  
Expected loss (% of X) = 3%  
Cost of funding = 3%  
Risk-free rate = 1%

**Answer**

Using the last equation, we see that the price of the bank’s exposure for a minimum level of RAROC is \( 3% + 1% + 3% + (15\% - 1\%) \cdot \frac{100}{1000} = 8.4\% \). Margin over the cost of funding = 5.4%.

* Of course, this implies that the minimum RAROC rate (y%) exceeds that bank’s cost of equity capital (k%).
Summary

Fundamental principles of risk and capital management are covered in two earlier modules - Credit Loss Management and Retail Banking Overview – where the following topics were emphasised: Risk and Uncertainty; Model Risk; Law of Large Numbers and Basel Risks.

These topics were reviewed in the introduction that includes reputation risk and liquidity risk. Chapter 1 covered the measurement and management of credit risk. The concept of Value at Risk (VaR) was introduced and discussed in a non-technical fashion. The weakness of VaR as a measure of risk was then discussed with mathematical technicalities relegated to an Appendix. Credit VaR was then discussed and a critique of the main assumption of the standard default mode paradigm presented. Chapter 2 covered the measurement and management of operational risk with a review of the basic indicator and standard approaches culminating with the Advanced Measurement Approach (AMA). We presented details of the Internal Measurement Approach (IMA) while the Loss Distribution Approach (LDA) is referenced in an Appendix.

The measurement and management of market risk and liquidity risk were discussed in Chapter 3. There was more emphasis in this chapter on liquidity risk – especially funding liquidity risk with reference to Basel core principles for liquidity management. The liquidity-VaR is presented in an Appendix.

Finally, this chapter concluded with the elements of risk-based pricing. The principal goal of risk-based pricing is to determine the minimum required rate of return for a new transaction that is consistent with the incremental transaction’s risk and shareholder return. We presented an illustration that derives the margin over the cost of funding for a minimum level of RAROC.
Multiple Choice Questions

1. With respect to the management of operational risk, which one of the following statements is incorrect?

   a) Complaints from customers may indicate deficiencies in a bank’s processes and systems.
   b) Incident reporting permits awareness of actual costs of operational weaknesses in the bank.
   c) Directors’ and officers’ liability is a category of operational risk that is transferred to the insurance market.
   d) The financial impact of reputation risk is typically not included in operational risk assessment.

2. Consider the following statements about value at risk (VaR).

   a) The larger the dollar value of the bank's portfolio, the greater is the dollar value of VaR.
   b) The higher the degree of confidence level, the higher is the dollar value of the VaR.
   c) If a one-day 99% VaR is $20 million, then the 10-day 99% VaR is $200 million.
   d) The higher the volatility of the portfolio, the higher is the dollar value of VaR.

   Which statement is incorrect?

3. Based on the risk-based formula for the pricing of loans, which one of the following statements (all else being equal) will lead to a higher loan rate for customers?

   a) Treasury reported that the cost of funding the loan has declined.
   b) Efficiency actions taken by management led to a decline in operating cost.
   c) Senior management required a lower level of RAROC.
   d) Risk management calculated a higher expected loss.

4. Consider the statement: “debt maturity transformation (for example, funding longer-term loans or asset purchases with shorter-term deposits or debt obligations) is one of a bank’s key business areas”. This statement reflects which category of bank risk?

   a) Credit risk
   b) Operational risk
   c) Funding liquidity risk
   d) Business risk

5. The following statements relate to the Liquidity Coverage Ratio (LCR). Which one of these statements is correct?

   a) LCR gives preference to covered bonds over asset-backed securities.
   b) Level 1 assets are subject to a 15 percent haircut.
   c) Level 2 assets comprise cash, central bank reserves and high quality government debt.
   d) Level 1 assets are limited to 40 per cent of LCR liquid assets.

6. Pillar I of Basel III specified two measures of liquidity (LCR and NSFR) and four monitoring tools. Which one of the following is not one these monitoring tools?

   a) Contractual maturity mismatch
   b) Concentration of funding
   c) Available unencumbered assets
   d) Key Risk Indicators
7. In relation to risk management governance, which is an example of a ‘line of defence’ that evaluates the operational risk framework established by the other two lines of defence?

a) Business line management  
b) Corporate audit  
c) Corporate risk management  
d) Board of directors

8. Customer complaint incidence is an example of which one of the following approaches to assessing and monitoring operational risk?

a) Scenario analysis  
b) Internal loss data  
c) Risk Self-Control Assessments  
d) Key Risk Indicator

9. Which of the following is not one of the metrics recommended by BCBS to track potential concentration of funding?

a) Counterparties with more than one percent of the bank’s balance sheet  
b) An instrument/product or groups of similar instruments/products that account for more than one percent of the bank’s balance sheet  
c) Liabilities denominated in a particular currency that amount to more than five percent of the bank’s total liabilities  
d) Calculation of a foreign currency LCR similar to the standard LCR proposed by Basel III

10. A liquidity monitoring tool recommended by BCBS is the amount of ‘available unencumbered assets’ on the bank’s balance sheet. In relation to liquidity management, what are two potential functions of these assets?

a) They provide secured funding for the bank  
b) They are a source of available funding in the calculation of the net stable funding ratio (NSFR)  
c) They provide an additional source of high quality liquid assets (HQLA)  
d) They support balance sheet expansion in loan products

Answers

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Appendix A: Weaknesses of VaR

The academic and professional literature has documented several deficiencies of the VaR metric. We now present a discussion on these weaknesses:

- **VaR is a point estimate or a quantile of the loss distribution. Hence it does not give any information about the severity of losses beyond the VaR level.**

  There is considerable evidence that financial markets do not strictly conform to a normal or log-normal distribution, but empirical distributions exhibit fatter tails relative to those expected under normal distributions. Hence, under the assumption of a distribution with fat tails, the probability of a loss exceeding the VAR is greater than would be indicated. The net result is that VaR based on normal distributions may give a false sense of security to bank executives.

  Indeed, in the April 1997 debate about the usefulness of VaR with Professor Phillipe Jorion, Nicholas Taleb expresses opposition to the use of the normal distribution in estimating VaR. He stated, “the simplified mean-variance paradigm was designed as a tool to understand the world, not to quantify risk.”

  It is not surprising that this source of model risk has been recognised by regulators who recommend a 10-day VaR as a measure of market risk. However, the market-risk capital to support this risk is magnified by a multiple \( k \) where \( k \) is at least 3.0.

  Furthermore, the problem of ‘fat tail’, and tail behaviour in general, is widely recognised. Indeed Taleb puts it succinctly:

  “The validity of VaR is linked to the problem of probabilistic measurement of future events, particularly those deemed infrequent (more than two standard deviations) and those that concern multiple securities. I conjecture that the methods we currently use to measure such tail probabilities are flawed.”

  In summary, the chance of a black swan is ignored.

- A second deficiency is related to the assumption of ‘normal market conditions’.

- **VaR does not measure ‘event’ (e.g., market crash) risk. That is one reason why stress tests are recommended to supplement VaR.**

  It is most likely the case that VaR measures ‘normal’ risk (i.e., not too far into the tail of the distribution) and in ‘normal’ market conditions (i.e., those that are well explained by volatility). But in the context of event risks VaR probably falls short. Normal VaR does not address tail and jump effects. Hence, scenario analysis which includes stress testing would be a desirable complement to the normal VaR. By definition, stress tests are techniques used by financial firms to gauge their vulnerability to exceptional, but plausible, events. These are tail events. Indeed, Basel 2.5 levies a charge for market risk based on a 10-day VaR at the 99 percent confidence level. The stressed VaR charge would be added to this, based on a similar 10-day, 99 percent VaR that incorporates a one-year period of historical market data.

- **VaR does not satisfy the sub-additivity function of a coherent risk measure**

  This technical property is one of the attributes of a coherent risk measure. Sub-additivity means that the diversification of a portfolio should not make the portfolio riskier.

* See the article, ‘Is VAR a useful tool in volatile markets?’ by Patricio Contreras in Risk Magazine, 5 October, (2010).
Unless we require that daily portfolio returns follow a normal distribution,* then VaR fails the sub-additivity test. Technically, the sub-additivity of VaR means that: $\text{VaR} (A+B) \leq \text{VaR} (A) + \text{VaR}(B)$. The violation of this property is perplexing because the modeling of economic capital is treacherous and the concept of diversification breaks down.†

Given this extensive discussion on the weakness of VaR as a measure of market risk, it is no wonder that recent reports indicate that BCBS is considering alternatives.‡

Appendix B: Loss Distribution Approach (LDA) approach

Quoting Basel, “A more advanced version of an internal methodology is the loss distribution approach. Under the LDA, a bank, using its internal data, estimates two probability distribution functions for each business line (and risk type); one on single event impact and the other on event frequency for the next (one) year. Based on the two estimated distributions, the bank then computes the probability distribution function of the cumulative operational loss. The capital charge is based on the simple sum of the VaR for each business line (and risk type).”

While the descriptions of IMA and LDA give the impression of clarity, the implementation of either of these approaches can be quite difficult. This is especially the case when there is (as is usual) limited data to estimate the tail of the distribution.

To consider issues related to data bias, we restate the following:

“[A] bank’s operational risk measurement system must use relevant external data (either public data and/or pooled industry data), especially when there is reason to believe that the bank is exposed to infrequent, yet potentially severe, losses.” (Basel Committee on Banking Supervision (BCBS), 2006, Paragraph 674.)

This directive from the Basel Committee can create some important biases in the implementation of AMA.

Reporting Bias§

A major problem with publicly available external loss data is a phenomenon of under-reporting low-severity events and hence a bias in favour of reporting large-severity events that are normally highlighted in the public press. Hence, when using external data to augment internal loss data, there is a risk of biasing operating risk capital upward.

Basel also makes a comment on the application of internal loss data. “Internal loss data is crucial for tying a bank’s risk estimates to its actual loss experience.” (Basel Committee on Banking Supervision, 2006, Paragraph 670.)

The problem is that banks may not have loss data that is consistent and over a sufficiently long time period to facilitate the estimation of frequency and severity distributions. This can be a major problem and explains the need to supplement internal data with external data. But as stated above, there is a reporting bias and a potential lack of compatibility with internal data

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* VaR is known to be sub-additive in some special cases, such as when asset returns are normally distributed. A more general list is elliptical distributions. This is however not the case, since there is an impressive list of empirical research publications that demonstrate that asset-return distributions exhibit fat tails – leptokurtosis.
† A Retail Banking III module deals with risk and capital management. Later in this module, we discuss the role of economic capital and RAROC as they relate to risk-based pricing. The key point is that the allocation of economic capital for risk includes the role of risk diversification, which is absent in risk measures such as VaR not being sub-additive. We will introduce the concept of conditional VaR also called expected shortfall.
‡ Headlines such as ‘Basel Committee Proposes Scrapping VaR’ in Risk Magazine (3 May 2012) is typical of recent press releases. Apparently, the replacement for VaR would be expected shortfall that measures expected value of losses above a given confidence level.
Appendix C: Liquidity Adjusted VaR for Market Risk

Assuming a constant spread, the liquidity adjusted VaR (LVaR) is given as follows: \( LVaR = VaR + LC \) where \( LC \) is the cost of liquidity that is given as:

\[
LC = 0.5 \times \text{Spread} \times \text{Portfolio Value}.
\]

Example:

Suppose that the current portfolio value is $10 million; standard deviation of daily returns is 2 percent and the current mean bid-ask spread (assumed to be constant) is 4 percent.

Under the assumption of zero mean daily return, the one-day 99 percent VaR = Portfolio Value \( \times Z(0.01) \times \text{standard deviation} \)

\[
= $10 \text{ million} \times 2.33 \times 0.02 = $0.466 \text{ million}.
\]

The LC = 0.5 \times \text{spread} \times \text{Portfolio Value} = 0.5 \times 0.02 \times 10 \text{ million} = $0.10 \text{ million}. So the LVaR = VaR + LC = $0.466 + $0.10 = $0.566 \text{ million}.

The general formula for LVaR, under constant spread assumption is:

One-day 99 percent LVaR = Portfolio Value \( \times [- \text{expected daily return} \% + \text{standard deviation} \% \times Z(0.01) + 0.5 \times \text{bid-ask spread} \%] \).

Observation:
A larger spread leads to higher market liquidity risk and hence a higher value of LVaR.

Example:

We present an example that is typical for the financial risk management (FRM) examination (Part I & II) conducted by the Global Association of Risk Professionals (GARP).*

Suppose that your market position is $5,000 in the shares of a company. The daily historical mean of the stock return is 1 percent and the corresponding standard deviation is 4 percent. The normal one-day 99 percent VaR is:

a) $390
b) $480
c) $416
d) $400

Answer:

One-99% VaR = $5000 \times (-0.01 + [2.33 \times 0.04]) = $416.
So the correct answer is c).

Example:

Using the information from the previous example, and in addition, that there is a constant spread of 1 percent. What is the LVaR?

a) $400.5
b) $390.5
c) $441

d) $482.8

Answer:

\[ LC = 0.5 \times \text{spread} \times \text{Market Position} = 0.5 \times 0.01\% \times 5000 = $25 \]

So the \( \text{LVAR} = \text{VaR} + LC = $416 + $25 = $441 \) which is option c).

In the previous example, we assumed that the spread was constant. Now we consider the case where the bid-ask spread is random – in particular, we assume that the spread is normally distributed with mean \( \mu \) and standard deviation \( \sigma \).

In this case, the liquidity cost (LC) is given by the formula:

\[ \text{LC} = \text{Market Position} \times \left[ 0.5 \times (Z(0.01) \times \sigma(\text{spread}) + \mu(\text{spread})) \right] \]

Example:

Suppose that the bank’s market position in a portfolio of risky securities is $10 million. The daily historical mean of the portfolio is 1 percent, and the corresponding standard deviation is 2 percent. Suppose that bid-ask spread is normally distributed with mean 0.1 percent and standard deviation of 1 percent.

The \( \text{LVAR} \) is:

- a. $0.366 million
- b. $0.061 million
- c. $0.451 million
- d. $0.427 million

Answer:

\[ \text{LC} = 10 \text{ million} \times 0.5 \times (0.001 + 2.33 \times 0.01) = $0.061 \text{ million} \]

\[ \text{The VaR} = 10 \text{ million} \times (-0.01 + 2.33 \times 0.02) = $0.366 \]

\[ \text{LVAR} = \text{VaR} + \text{LC} = 0.366 + 0.061 = $0.427 \] so the answer is option d.

Appendix D: Setting a Risk-Based Price for a Risk Exposure

As we demonstrated in Retail Banking I, underlying income for given risk exposure \( X \) is given by the equation:

\[ I = (r - i) \times X - \text{OPEX} - \text{PROV} \], where \( \text{UI} = \text{underlying income}; r = \text{rate charged on the exposure}; i = \text{cost of the funds that fund the exposure}; \text{OPEX} = \text{operating expenses and PROV} = \text{provisions for expected loss (EL)} \).

We now introduce the effects of incorporating economic capital (EC). Recall that economic capital is capital required to cushion the risks introduced into the bank’s portfolio by the new transaction with an estimated exposure, \( X \). There are two modifications to the underlying income equation presented above. These relate to a capital benefit and the cost of capital. Capital benefit\(^\dagger\) is the return earned on the economic profit invested at the risk-free rate. Hence capital benefit = \( r_f \times \text{EC} \). In addition, there is a cost for raising economic capital that is set as, \( k \times \text{EC} \) where \( k = \text{cost of equity} \). For simplicity, we set OPEX and EL (i.e., provisions) as a percentage of the exposure \( X \).

That is, \( \text{OPEX} = a \times X \) and \( \text{EL} = b \times X \). Incorporating these changes into the underlying income equation, now obtains a formula for economic profit (EP):

\[ \text{EP} = (r - i) \times X - a \times X - b \times X + r_f \times \text{EC} - k \times \text{EC} \]

\(^\dagger\) Capital benefit is the cost saving for refinancing assets by using (economic) capital instead of debt. It is invested into a risk-free asset, generating a return that is equivalent to the capital benefit. Hence, capital benefit = risk-free rate \( \times \) economic capital.
But from a shareholder perspective, economic profit should be positive for shareholder value-added (SVA). Hence, for $EP > 0$, then after dividing by $X$, we get:

$$r > i + a + b + (k - r_f) \frac{EC}{X}$$

This equation is the basis for risk-based pricing. It states that the price of the exposure is equal to the cost of funding for the exposure plus a risk premium that is directly proportional to the risk that the bank will bear for the exposure $X$. This risk is represented by the economic capital that is required for the exposure. Of course, the percentage operating and provisioning costs are included. But the key point is that the price of the exposure is directly proportional to the economic capital that is allocated for the exposure. All else being equal, higher risk means higher price for the exposure.

If we rephrase this pricing equation in terms of RAROC, we see that:

$$RAROC = \frac{\text{Risk - adjusted return}}{EC} = \frac{r * X - i * X - a * X - b * X + r_f * EC}{EC}$$

Assume that the bank has a strategic target minimum RAROC rate: $y\%$.

Then, we have the inequality:

$$r * X - i * X - a * X - b * X + r_f * EC > y * EC;$$

or

$$r > i + a + b + (y - r_f) \frac{EC}{X}$$

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* Of course, this implies that the minimum RAROC rate ($y\%$) exceeds that bank’s cost of equity capital ($k\%$).