INTERNATIONAL ACTUARIAL ASSOCIATION

1. Practical Application: Expected Credit Loss Modelling where actuarial and statistical principles are heavily applied.

Expected Loss = PD x LGD x EAD

Estimating Probability of Default ("PD")

- One common methodology for estimating the PD is to develop a rating scorecard, which aims to assign scores to borrowers based on a list of factors. These scorecards can be "application" or "behavioural" in nature, and hence the factors captured will reflect different characteristics. Application scorecards are used at the point of origination, and therefore look to capture the default risk on new loans, while behavioural scorecards look to capture risks on loans that have been on the book for at least 6 months.

- Scorecard models are usually based on regression equations with a logit link, so as to restrict the PD between 0 and 1. Alternatively, a linear or non-linear equation can be used to derive the score, which is then mapped to the Bank's estimate of PD using a matrix. For example, a score of 700 may refer to a PD of 2%.

- Another common methodology is to use a roll-rate or transition matrix approach. Under this approach, the Bank will measure the migrations (between credit ratings, or delinquency indicators) over a fixed observation window. The same group of loans is therefore monitored from the start of the period to the end to obtain the proportions moving from one state to the next. The Bank is then able to estimate the likelihood of a loan in any state moving to another state, in this case default.

Estimating Loss Given Default ("LGD")

- One common methodology for estimating the LGD is to develop a discounted cashflow model of recoveries on defaulted assets. This works particularly well for retail portfolios where there is sufficient default and loss data to allow for the development of the model. The LGD is then taken as the value of the exposure at the point of default less the discounted future recoveries.

- Another possible methodology is to use a chain-ladder or run-off triangle approach to project recoveries from the date of default onwards. This methodology is suitable for unsecured portfolios where recovery cashflows occur regularly from month to month. For secured portfolios, such as Mortgages, this approach is not considered suitable, as the main recovery will be as a result of the disposal of the asset (house in this case) which will result in large and lumpy recoveries distorting the development patterns in the triangle.

- The third methodology is to use a combination of expert judgement and benchmarks. . In particular for Corporate Loan exposures, where the Bank may have very limited actual loss experience, the Bank may choose to rely on external data such as that from Moody's or PECDC in setting its LGD estimates. The bank may also consider applying expert judgement to estimate the haircut to apply to collateralised exposures in a downturn.

- LGD models are also usually segmented by risk drivers, such as Loan-To-Value ("LTV") or Borrower Income for retail portfolios, or by Secured / Unsecured or Industry for Corporate

loans. The reason for segmenting the estimates is to ensure that the loans are as homogenous as possible prior to estimating model parameters.

Exposure at Default ("EAD")
- The EAD estimate aims to measure the additional drawdown in balance from the current point in time to the point of default. This is more important for loans where the borrower is able to draw down additional funds before being flagged as a default by the bank. This includes Credit Cards, Revolving Products, and some Corporate loans. For mortgages and other amortising products, the borrower is generally not able to draw down additional funds once the loan is granted.
- One common methodology for estimating the EAD is to develop estimates of Utilisation of Credit Conversion Factors. These factors are usually calculated by identifying defaulted loans, and tracking them backwards in time (in accordance with the PD model observation window) to measure the additional drawdown from the start of this period up until the point of default.
- CCF is usually taken as the ratio of Defaulted Balance / Balance at Start of Observation period. A CCF of greater than 1 implies that there is additional drawdown of funds before the customer defaults.
- Utilisation at Default is measured in a similar manner, but considers instead the proportion of the facility that is utilized by the borrower at the point of default as compared to the start of the observation period.
- Another possible methodology is to use the maximum of the current loan balance and facility limit. This approach is considered conservative as it assumes that the customer will use their entire facility before defaulting.

2. Practical Application: Key risks in a bank and how they can be managed

Credit risk

Credit risk can be described as follows:
- Credit risk is simply the risk that, having extended a loan to another party, it is not repaid as agreed. Therefore, techniques can be examined that can be used to assess the probability that third parties default (i.e., fail to repay) as well as the loss given default. These techniques can be applied to individual third parties (known as counterparties) or the industry within which they operate, or even the country within which they are based. This is because the likelihood of a counterparty defaulting is strongly correlated with the success of their industry, and the economic state of their home country.

- Concentration risk in credit portfolios arises through an uneven distribution of bank loans to individual issuers or counterparties (single-name concentration) or within industry sectors and geographical regions (sectorial concentration).

  - If a bank is overly dependent on a small number of counterparties – single-name concentration risk – then, if any of those counterparties default, the bank's revenues could drop by a significant amount.
  - Over-concentration at the country, sector or industry levels also holds risk for a bank. If, for example, the country in which it is overly concentrated suffers an economic downturn, then its revenues will again be adversely affected compared to competitors who are better diversified.

- Larger counterparties are credit-rated by firms known as ratings agencies: the higher the rating the better the credit risk – or to put it another way, the lower the likelihood of default. Smaller

firms are not rated by an agency, and so lending institutions have to perform their own assessment of the likelihood of default. This is also true for retail customers.

- Another important consideration when assessing credit risk is the quality of any assets that have been used as collateral in the event of default. The higher the quality, the less concerned the lending institution is about default because the underlying security (perhaps the house of one of the borrowing company's directors) can be sold to recoup the loss. For most banks, loans are the largest and most obvious source of credit risk. However, other sources of credit risk exist throughout the activities of a bank, including in the banking book and in the trading book, and both on and off the balance sheet.

- These sources include:
  - The extension of commitments and guarantees;
  - o Inter-bank transactions;
  - o Financial instruments such as futures, options, swaps and bonds;
  - o The settlement of these and other transactions.

Banks manage credit risk in multiple different ways:
- Loan underwriting and approval
  - The bank may set approval limits, and require the customer to provide information such as their income etc. to help them assess the riskiness of the loan. Only loans which meet their approval criteria are originated.
  - Where the Bank changes its underwriting criteria over time, the Bank is exposed to different cohorts of risk. These will then need to be managed separately from a credit risk point of view.

- Incentives for Credit Control officers
  - The bank may design reward schemes for its credit control officers which incentivises credit control officers to pro-actively manage credit risk in their portfolios.
  - This can be done through ensuring high quality loans are originated, good quality collateral is required, and deterioration in credit performance (e.g. late payment of instalments) is identified and acted upon early.

- Collateralisation

  - The Bank may require the customer to put down collateral as security against the loan. This reduces the risk of loss, as the bank has recourse to the customer's assets in the event of customer default. Collateral can consist of non-financial assets (such as property or vehicles), or financial collateral (such as cash, bonds or equities).
  - The bank may also require the bank to put up additional collateral in the event of significant deterioration of credit risk, or where the value of the original collateral pledged has decreased since origination.

- Portfolio monitoring
  - The credit risk management team will be responsible for monitoring credit risk behaviour over time. This will include factors such as delinquency (days past due and number of payments missed), average loan to value, average behavioural score, etc (model and credit risk driver behaviour) over time. Where the Bank identifies a worsening trend, it will be able to take corrective action sooner rather than later, and hence limit potential credit risk losses.

- o This is dependent on the availability of data at the right level of granularity. For example, it is only possible to track loan-to-value over time where this information is captured for each loan / group of loans on a regular basis, which would require a model for the revaluation of collateral.

- Provisioning
    - o Provisions can be set aside for expected credit losses (depending on the local accounting standards). By setting aside provisions for bad debts, the bank will ensure that it does not prematurely recognize income and profits, and hence limit volatility in its P&L.
    - o Where the Bank expects credit risk to deteriorate, larger provisions can be set aside.
    - o This control can only be used once deterioration has already occurred.

- Capital Management & Stress testing
    - o Additional funds can be set aside for credit losses over and above those expected under local provisioning rules
    - o The Bank will assess credit losses based on economic scenario forecasts and models linking these to credit losses.
    - o These models assume that the historic loss behaviour based on the position in the economic cycle will be reflective of future loss behaviour. I.e. the past financial crisis is a good indicator of the next one. This is not the necessarily a realistic assumption.

Market risk

Market risk can be sub-divided into the following types:
- **Volatility risk:** the risk of price movements that are more uncertain than usual affecting the pricing of products. All priced instruments suffer from this form of volatility. This especially affects options pricing because if the market is more volatile, then the pricing of an option is more difficult and options will become more expensive.

- **Liquidity risk:** in the context of market risk, this is the risk of loss through not being able to trade in a market or obtain a price on a desired product when required. This can occur in a market due to either a lack of supply or demand or a shortage of market makers.

- **Currency risk:** this exists due to adverse movements in exchange rates. It affects any portfolio or instrument with cash flows denominated in a currency other than the base currency of the business underpinning the financial instrument and/or where an investment portfolio contains holdings in investments priced in non-base currencies.

- **Interest rate risk:** this exists due to adverse movements in interest rates and will directly affect fixed income securities, loans, futures, options and forwards. It may also indirectly affect other instruments.

- **Equity price risk:** the returns from investing in equities comes from capital growth (if the company does well the price of its shares goes up) and income (through the distribution by the company of its profits as dividends). Therefore, investing in equities carries risks that can affect the capital (the share price may fall, or fail to rise in line with inflation or with the performance of other, less risky investments) and the income (if the company is not as profitable as hoped, the dividends it pays may not keep pace with inflation; indeed they may fall or even not be paid at all. Unlike bond coupons, dividend payments are not compulsory.).

Banks manage market risk in multiple different ways:

- The bank may set approval limits for taking on market risk.
  - Limits which are documented and approved by the board
  - Limits which are regularly reviewed and reassessed by taking into account the latest market conditions and business strategies
  - Clearly communicated with the relevant units and staff engaged in risk-taking, risk management and control units

- Hedging
  - The Bank may be able to hedge certain positions using financial instruments.
  - Valid example of a hedge

- Measurement of Market Risk and Monitoring
  - By monitoring the extent of exposure and risk driver behaviour over time, the Bank will be able to take corrective action sooner rather than later.
  - Value-at-risk limits – A type of sensitivity limit designed to restrict potential loss to an amount equal to a board-approved percentage of projected earnings or capital.
  - Loss control limits – A type of limit that requires specific management action if they are approached or breached. The limits setting documentation should require closing out of position or special approval from designated management or committee in order to maintain the exposures. They are usually used to foster communication, rather than limit the risk-taking unit's ability to maintain a position.
  - Tenor or gap limits – A type of limit designed to reduce price risk by limiting the maturity and/or controlling the volume of transactions that matures or re-prices in a given time period.
  - Notional or volume limits – A type of limit that is effective for controlling operational capacity and, in some cases, liquidity risk.
  - Options limits – A type of limit specific to option exposure for banks with sizable option positions. Such limits should consider the sensitivity of positions to changes in delta, gamma, vega, theta, and rho. Generally, this type of analysis requires modelling capabilities.
  - Product concentration limits – A type of limit useful to ensure that a concentration in any one product does not significantly increase the price risk of the portfolio as a whole.

- Banks should have adequate systems and capability to measure the sensitivity of valuation, profit and loss or other risk measurement against a change in one or a combination of risk factors (e.g., exchange rate and equity prices).

- Banks should also conduct stress tests to:

  - Identify remote but plausible market events or changes that may be adverse to the overall risk profiles and financial positions of the banks
  - Address existing and potential risk concentration
  - Facilitate the development of risk management tools and risk mitigating measures or contingency plans across a range of stressed conditions

Operational Risk

- Operational risk arises from the potential that inadequate information systems, operational problems, breaches in internal controls, fraud, or unforeseen catastrophes will result in unexpected losses.

- Although operational risk does not easily lend itself to quantitative measurement, it can result in substantial costs through error, fraud, or other performance problems. The growing dependence of banking organizations on information technology emphasizes one aspect of the need to identify and control this risk.

- There is very little commonality between people or processes or IT systems or external events (such as bomb threats or power cuts). The techniques used to understand and manage operational risk are therefore very diverse.

- In addition to managing expected operational risks, firms also need to hold capital against unexpected losses. Firms can choose between one of three regulatory methods for calculating their operational risk capital requirement.

- The methods are associated with increasing levels of risk management sophistication, and moving up the levels results in firms having to hold less capital. The three method levels are called:

  - The basic indicator approach (BIA);
  - The standardized approach (TSA); and
  - The advanced measurement approach (AMA)

Banks manage operational risk in multiple different ways:

- As well as working out the known risks and holding capital for the unknowns, firms also need to remain vigilant to changes in their risk profile. The two common methods of achieving this are the creation of key risk indicators, and the capture and analysis of loss data.

- Banks also have choices to make on how to keep their operational risk exposure within their operational risk appetite.

  - This can be achieved firstly by avoiding the risk altogether, for example by choosing to withdraw a product which has proved too complex to administer at an acceptable cost without repeated processing errors.
  - A second method for reducing the risk profile to within appetite is to transfer the risk to a third party. This can take several forms including:
  - Outsourcing an area of the company, such as back office administration, to another company who specializes in this type of business;
  - Taking out insurance against certain events such as fraud or loss of premises through flooding.

- The ability of a bank to bear operational risk is linked to a certain extent to the amount of capital it possesses and the losses it can absorb. Basel II requires banks to keep capital for operational risk. This is the risk of losses from situations where the bank's procedures fail to work as they are supposed to or where there is an adverse external event such as a fire in a key facility. The impact of the Basel II credit risk calculation is to reduce the credit risk capital requirements for most banks and the capital charge for operational risk has the effect of restoring the total capital level to roughly where it was under Basel I.

- Control processes and procedures should include a system for ensuring compliance with policies. Examples of principle elements of a policy compliance assessment include:

a) top-level reviews of progress towards stated objectives;
b) verifying compliance with management controls;
c) review of the treatment and resolution of instances of non-compliance;
d) evaluation of the required approvals and authorisations to ensure accountability to an appropriate level of management; and
e) tracking reports for approved exceptions to thresholds or limits, management overrides and other deviations from policy

- Effective use and sound implementation of technology can contribute to the control environment. For example, automated processes are less prone to error than manual processes. However, automated processes introduce risks that must be addressed through sound technology governance and infrastructure risk management programmes.

- Operational risk can also be mitigated through the use of disaster planning and recovery planning (including detailed and enforced policies and procedures)

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