

# **SPECIMEN EXAMINATION PAPER 1**

## **Suggested Solutions**

Syllabus 2022

### **Subject F107 – Banking Fellowship Principles**

## QUESTION 1

A bank is considering moving from the Standardised Approach to the Advanced Internal Ratings Based Approach for the calculation of its Credit Risk capital requirement.

i. Briefly define the three main components of credit risk measurement for regulatory capital purposes: PD, LGD and EAD.

### Probability of Default

- The PD estimate aims to measure the likelihood of default over a 12-month (one year) time horizon.
- The PD estimate is required to be a Through-The-Cycle (TTC) estimate, which means that it is supposed to be reflective of the default risk over the economic cycle.
- This is as opposed to a Point-In-Time (PIT) estimate, which is reflective of the current position in the economic cycle.

### Loss Given Default

- The LGD estimate aims to measure the ultimate losses on defaulted loans.
- The LGD estimate is required to be a Downturn (DT) estimate, which means that it is supposed to be reflective of the loss experience over a stressed period of the economic cycle.
- One definition of a downturn period could be at least two consecutive quarters of negative growth.
- There are a few arguments as to why a downturn measure is required, some of these includes:
  - An added layer of conservatism.
  - To take into account the PD-LGD correlation which is not present in the regulatory formulation.
- This is as opposed to a long run estimate, which is reflective of the position over the full economic cycle.

### Exposure At Default

- 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 or facilities 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 products such as mortgages and other amortising products, the borrower is generally not able to draw down additional funds once the loan is granted.
- EADs are commonly floored at the current balance of a facility, such that the EAD for regulatory capital purposes cannot be less than the current drawn amount.

[Maximum 7]

ii. Describe the three main approaches for calculating credit risk capital under Basel II Pillar 1 and the suggested requirements for using the more complex approaches.

- The first, the standardised approach (SA), depends on the use of ratings produced by external ratings agencies.
- The second and third are the foundation internal ratings-based approach (FIRB) and advanced internal ratings-based approach (AIRB), which allows banks to develop their own internal ratings, subject to guidelines and requirements.

### Standardised Approach

- The SA is a simple approach, involving external ratings, asset classes, and risk weights.
- The nominal amount of assets is weighted according to a risk weight to obtain risk-weighted assets (RWA). This risk weight is specified in the SA and depends on the external rating and asset class of the client. The RWA can then be used to calculate capital.
- The starting point for capital required against assets is 8% of RWA.
- For example:
  - A R100 million non-SME corporate asset with a rating between AAA and AA- will have a 20% risk weight.
  - The RWA would be R20 million (R100 million  $\times$  20%).
  - This means the bank will have to hold R1,6 million of capital (RWA  $\times$  8%).
- Bank, sovereign, and corporate assets are assigned risk weights using a matrix that maps external ratings to a risk weight. If an entity is unrated, a flat risk weight is assigned.
- Flat risk weights are also assigned for other asset classes (e.g. retail). There are some asset classes that are given specific guidelines; for example, certain real estate assets are assigned risk weights depending on their loan-to-value (LTV) ratio value.

### Foundations IRB Approach

- This approach is more advanced than SA, but less advanced than AIRB.
- Under this approach the banks are allowed to develop their own empirical model to estimate the PD (Probability of Default) for individual clients or groups of clients.
- Under FIRB banks are required to use regulator's prescribed LGD (Loss Given Default) and other parameters required for calculating the EAD (Exposure at Default) and RWA (Risk Weighted Assets).
- The RWA is calculated by using a formula incorporating the credit risk components.

### Advanced IRB Approach

- The most advanced of the three approaches, and requires the bank to have its own internal models for each loan portfolio
- Under the Basel AIRB approach, the Bank has to develop PD, LGD and EAD models.
- Capital results are dependent on the actual riskiness of the exposures underlying them, as opposed to being based on standardised risk weights.

### IRB Requirements

- To use the IRB, a bank must:
- Define a risk grading methodology based on an assessment horizon reflected in the bank's rating philosophy (shorter or longer term).

- Maintain at least seven borrower grades for non-defaulted exposures, and one for those in default.
- Assign ratings to all borrowers.
- Review ratings annually.
- Review the model annually.
- Stress test the rating system under adverse economic and market conditions.
- Document the rating system with clear definitions and criteria to enable the replication of ratings by auditors or other independent parties.
- Provide adequate disclosure and data and demonstrate the model's use over 3 years.
- Obtain approval from national supervisors.
- Furthermore, the internal ratings produced must satisfy the "use test". This means they must serve as the basis of decisions made concerning, for example, risk, limits, pricing, provisioning, and capital management, i.e. they must not be simply for regulatory risk capital calculations.

[Maximum 12]

[Total 19]

## QUESTION 2

Describe some of the common tests a bank would perform to assess a capital PD model performance built on internal data.

### Actuals versus Expected Back-testing

- Back-testing is the basis of model validation, and includes comparison of model results against actual historic default rates.
- Comparison is done over period model was expected to predict over. Any trends or one-way bias can then be identified.
- A model which severely underpredicts may require redevelopment, recalibration, or could be adjusted through the use of an overlay.
- This analysis is usually done at the same level of granularity as that of the model.
- Portfolio level back-testing can also be done when deciding whether or not to redevelop models.
- Recalibration or redesign may be less critical where the model over-predicts for one segment, and under-predicts for another segment. Although this is not ideal, it does reduce the risk of the bank's estimates being inaccurate at a portfolio level.

### Gini statistic

- The Gini measures the strength of the model's ability to distinguish between "good" and "bad" risks.
- A model with a low Gini may not be able to adequately differentiate between the riskiness of loans, and hence may assign inaccurate model estimates to these loans.
- A Gini of between 60% and 70% is usually considered strong for a retail portfolio. Where this number is lower than 50%, the model is exposed to the risk of not adequately discriminating between the riskiness of two loans.

- Where the Gini is much higher than 70%, it may indicate that the model has been overfit to historic data, and as a result may be a poor predictor of future experience.
- It is not uncommon to see a Gini < 60% for SME Retail, and Wholesale portfolios.

#### Chi-Square (Hosmer-Lemeshow)

- This goodness of fit test that compares actual vs. expected results.
- Observations are sorted in increasing order of their estimated probability of default.
- The observations are then divided into N groups of the same size based on the percentiles of their estimated probabilities.
- The observed and expected number of defaults is then tabulated for each group.
- The discrepancies between the observed and expected number of observations in these groups are summarised by the Pearson chi-square statistic, which is then compared to a chi-square distribution with  $N - 2$  degrees of freedom.
- A high p-value indicates a model with a good fit.

#### Benchmarking

- Benchmarking of internal estimates against external sources is another useful quantitative review, and can add objectivity to the model estimation process.
- Benchmarking can be performed at a portfolio level, or at more granular segments.
- It is however important to understand the differences between the underlying businesses being compared using benchmarking.
- One organisation may have very different underwriting and credit risk management processes, resulting in different model estimates. A comparison in this instance, without first understanding the areas of difference, could lead to incorrect estimates.

#### Population Stability

- It measures how much the population has changed over time, and can be applied at a group level, by bucketing/ grouping variables.
- Alternatively, the PSI can be applied at an individual variable level.
- As a rule of thumb, a  $PSI < 0.1$  indicates minimal change in the population. 0.1 to 0.2 indicates changes that might warrant further investigation, and a  $PSI > 0.2$  indicates a significant change in the population.
- The PSI does not tell the bank anything about the relationships between the variables and the outcome, but merely that the distribution of the population has changed. If a high PSI is detected, it may be that the scorecard is performing well but the population has changed due to new origination strategies or changes in economic conditions.
- As such, the PSI should not be viewed in isolation, and the reasons for population changes should be investigated.

#### Other comments

- Out of time and out of sample testing is valuable to ensure the model is performing as expected and is not overfit to the data used to build the model.
- The entire validation process should make apparent changes in drivers, trends, and correlations.

- Outcomes can include revision of risk categories and adjustments to data timeframes.
- Strong risk aggregation capabilities are vital and deficiencies (a problem in the crisis) should be exposed to ensure business grows only as quickly as control infrastructure.
- Business line leaders must have a basic understanding of the models and ensure their risks are fully incorporated into the bank-wide risk process

[Maximum 10]

### QUESTION 3

A bank is analysing the performance of its retail product offerings. The profitability of the current account banking product is shown below.

| South African Rand                   | Relevant information |                |
|--------------------------------------|----------------------|----------------|
|                                      | 2020                 | 2021           |
| Interest income                      | R142 000 000         | R149 000 000   |
| Fee income                           | R411 000 000         | R376 000 000   |
|                                      |                      |                |
| Cost of funding                      | R48 000 000          | R57 000 000    |
|                                      |                      |                |
| Branch costs                         | R125 000 000         | R136 000 000   |
| ATM maintenance costs                | R75 000 000          | R88 000 000    |
| Transaction processing costs         | R23 000 000          | R30 000 000    |
| Direct costs                         | R11 000 000          | R12 100 000    |
|                                      |                      |                |
| Opening Provision balance            | R50 000 000          | R54 000 000    |
| Closing Provision balance            | R54 000 000          | R57 000 000    |
|                                      |                      |                |
| Write offs                           | R35 000 000          | R41 000 000    |
|                                      |                      |                |
| Total capital required               | R271 828 000         | R314 159 000   |
|                                      |                      |                |
| Average Debit Balances for the year  | R775 000 000         | R830 000 000   |
| Average Credit Balances for the year | R1 950 000 000       | R2 200 000 000 |
| Average Client Limits for the year   | R1 666 000 000       | R2 220 000 000 |

i. Define and calculate the following measures for this product: net interest margin, impairment charge (bad debt charge) percentage, profit before tax and return on capital (ROC) for each financial year.

| Metric                                                                                                        | 2020   | 2021   |
|---------------------------------------------------------------------------------------------------------------|--------|--------|
| Net interest margin = $\frac{(\text{Interest Income} - \text{Cost of funds})}{\text{average debit balances}}$ | 12.13% | 11.08% |

|                                                                                                                                       |              |              |
|---------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------|
| Impairment charge percentage =<br>$\frac{((provisions\ at\ end - provisions\ at\ beginning) + write-offs)}{average\ debit\ balances}$ | 5.03%        | 5.30%        |
| Profit before tax = <i>Net interest income + Fee Income – Total costs – Imparment charge</i>                                          | R232 000 000 | R157 900 000 |
| ROC = $\frac{Profits}{Total\ capital\ required}$                                                                                      | 85.35%       | 50.26%       |

[10]

ii. Briefly describe the information that one could gain from these metrics and discuss the year-on-year movements.

- The net interest margin and allows one to see if there is any contraction / increase in this ratio which will talk to changes in either the funding costs / interest rate pricing of the book.
- The impairment charge (bad debt charge) percentage shows the change in bad debts for the year, allowing the bank to understand how the credit risk of the portfolio has changed.
- Profit is a key metric in performance management of the book and understanding yearly financials.
- Return on capital allows one to view the return of this book, compared to the capital employed, relative to other books across the bank and allows one to give a risk adjusted comparison of the book's profitability.

The overall profitability of the bank has decreased, both in absolute terms and looking at the ROC measure. There could be many reasons why this has happened, some of the reasons are discussed below.

NIM has decreased from 12.13% to 11.08%:

The average interest earned dropped from 18.3% to 18.0% which could result from:

- Generally lower risk customers making use of their facilities.
- The book may have been re-priced during the year resulting in the lower interest earned.
- It is possible there have been regulatory pronouncements made impacting fee maximums which could have led to the reductions seen in both of these income statements lines.
- There may have been a change in mandates given to staff allowing concessions on pricing.

The cost of funding increased from 6.2% to 6.9% which could be as a result of:

- Altering the funding strategy (or model) to target more stable long term funding.
- Competition for deposits (especially retail deposits) may have increased, forcing the bank to offer more competitive rates across several product ranges.
- There may be general pressure (increases) on the liquidity premium and treasury running costs which have been passed onto the business / product line.
- It is possible that the underlying FTP rates for this product specifically were amended (as a result of modelling updates / enhancements).

The impairment charge has increased from 5.0% to 5.3%:

- This could be a general deterioration of the book over the year.
- Could be as a result of a bad economic environment.
- Impairment models might have gone through a recalibration, for example an update of the forward-looking component.
- Write-offs as a percentage of the book increased slightly.
- Coverage ratios seems reasonably flat over the two periods.

The fee income has decreased, this could be due to:

- A deliberate strategy of the bank to move customers onto the correct product (client retention).
- The bank may have decreased some of its pricing either for individual transactions or bundles (due to competition).
- Customers banking smarter – moving to bundles when they have high transaction usage and moving away from bundles when they have low utilisation.

Total costs have increased:

- ATM and processing costs increased year on year. This could be either due to increased customer utilisation (typically a good thing if usage is priced correctly).
- Could also be due to inefficiencies and perhaps misallocation of the internally allocated costs to this product (either model used was amended or was incorrect).
- There were also large increases in limits during the year, and the costs of these sales would have resulted in some costs to generate the sales.
- Not a bad increase provided the increased numbers of customers and limits offered are ultimately utilised.

Capital as a percentage of average balances increased from 35.1% to 37.9%:

- Any one (or more) of the contributors to the products overall capital requirements may have increased (credit / market / operational capital risk).
- Credit Risk:
  - The underlying capital models could have been adjusted (for instance to a different approach e.g. Advanced from standardised approach) as the relative capital increase in one year was quite large
  - Could be change in regulatory requirements (e.g. definition of default), and this caused the capital requirements of this specific product to increase.
  - There are several parameters that are estimated for the capital models in use (PD / LGD / EAD ) for retail products and it is possible that in the most recent calibration of these parameters that they moved in a direction that caused the credit risk capital to increase.

[11]

[Total 21]



## QUESTION 4

i. Explain the three approaches for calculating Operational Risk capital under Basel II.

- The basic indicator approach (BIA);
- The standardised approach (TSA);
- The advanced measurement approach (AMA).

### Basic Indicator Approach

- Most simplistic of the three approaches, and does not require the Bank to have its own internal models for Operational Risk.
- This sets the operational risk capital equal to the bank's average annual gross income over the last three years multiplied by 0.15.
- Figures for any year in which annual gross income is negative or zero should be excluded from both the numerator and denominator when calculating the average.
- The BIA may be recommended for banks without significant international operations.
- A formula for the BIA could be represented by:

$$K_{BIA} = \frac{\sum_{n=1}^3 (GI_n \times \alpha)}{3}$$

### The Standardised Approach

- This approach is more advanced than BIA, but less advanced than AMA.
- Under the Standardised Approach, banks' activities are divided into eight business lines: corporate finance, trading & sales, retail banking, commercial banking, payment & settlement, agency services, asset management, and retail brokerage.
- Within each business line, gross income is a broad indicator that serves as a proxy for the scale of business operations and thus the likely scale of operational risk exposure within each of these business lines.
- The capital charge for each business line is calculated by multiplying gross income by a factor (denoted beta) assigned to that business line.
- Beta serves as a proxy for the industry-wide relationship between the operational risk loss experience for a given business line and the aggregate level of gross income for that business line.
- The total capital charge is calculated as the three-year average of the simple summation of the regulatory capital charges across each of the business lines in each year.
- In any given year, negative capital charges (resulting from negative gross income) in any business line may offset positive capital charges in other business lines without limit.
- A formula for the TSA could be represented by:

$$K_{TSA} = \frac{\sum_{n=1}^3 \max(\sum_{i=1}^8 (GI_i \times \beta_i), 0)}{3}$$

- In order to qualify for use of the standardised approach, a bank must satisfy its regulator that, at a minimum:

- Its board of directors and senior management, as appropriate, are actively involved in the oversight of the operational risk management framework;
- It has an operational risk management system that is conceptually sound and is implemented with integrity; and
- It has sufficient resources in the use of the approach in the major business lines as well as the control and audit areas.

#### The Advanced Measurement Approach

- Most advanced of the three approaches, and requires the bank to have its own internal models for frequency and severity of operational risk losses
- Banks can use this approach only subject to approval from their local regulators. Once a bank has been approved to adopt AMA, it cannot revert to a simpler approach without supervisory approval.
- Capital results are dependent on the actual riskiness of the exposures underlying them, as opposed to being based on standardised risk weights.
- To use the IRB approach, a bank must:
  - Its board of directors and senior management, as appropriate, are actively involved in the oversight of the operational risk management framework;
  - It has an operational risk management system that is conceptually sound and is implemented with integrity; and
  - It has sufficient resources in the use of the approach in the major business lines as well as the control and audit areas.

[9]

ii. Explain some of the common methodologies for calculating the frequency and severity of an operational risk loss model that could be used at a bank.

- Given that data sufficiency is a major challenge for the industry, annual loss distribution cannot be built directly using annual loss figures.
- Instead, a bank will develop a frequency distribution that describes the number of loss events in a given year, and a severity distribution that describes the loss amount of a single loss event.
- The frequency and severity distributions are assumed to be independent. The convolution of these two distributions then give rise to the (annual) loss distribution.

#### Frequency Distribution

- The frequency distribution aims to capture the number of operational risk events that are expected to occur in a fixed time horizon, usually one year.
- One common methodology for estimating the frequency is to develop a Poisson distribution (which assumes the inter arrival times between loss events are exponentially distributed) which aims to count the cumulative number of events that occur.
- Similarly, the bank may also make use of a Negative Binomial model to count loss events where the mean and variance of the number of loss events per time period are not the same.

- The model parameters will need to be estimated, using a combination of internal and external loss data or expert judgement based on expected return periods.

#### Severity Distribution

- The severity distribution aims to measure the ultimate losses on operational risk events.
- The severity estimate is usually a positively skewed distribution such as a LogNormal, Weibull or Gamma distribution.
- For extreme losses above a certain threshold, losses converge to the Pareto distribution.
- The majority of operational risk loss events will occur within a middle range of the distribution, but since capital is required to be set at the tail of the distribution, the bank may choose to use a spline to obtain a fatter tail for the distribution.
- Loss data at the tail of the distribution will be rare, and the bank is likely to be required to substitute their internal loss data with external data.
- The bank may also consider applying expert judgement to estimate the tail losses.

[8]

[Total 17]

### **QUESTION 5**

- Briefly describe the concept of ‘Twin Peaks’ financial regulation and the advantages and disadvantages of such a type of regulation.

The twin peaks regulation is a comprehensive and complete system for regulating the financial services industry in a number of jurisdictions. This system entails the creation of two regulatory bodies that provide oversight of the financial system. A prudential entity and an entity looking after market conduct are created.

#### Advantages

- By having two entities, more specific and clear roles and objectives can be created for each entity.
- Having these entities exclusively committed to a particular role can help ensure greater oversight and reduce the risk of market abuse by market participants.
- Market confidence is improved by having a dedicated entity overseeing financial\market conduct.
- Overall financial system stability is improved by having an entity dedicated to monitoring adherence to prudential regulations.
- Having two entities focused on separate objectives helps to reduce the potential lack of market oversight that arises due to internal conflict and conflicting objectives that may be present were these roles contained in a single entity - i.e. consumer protection may be at odds with a bank’s financial strength at the time.
- There is more flexibility and greater ease to adapt to changing market conditions versus a larger regulator.

#### Disadvantages

- By siloing roles and responsibilities between the entities, certain regulatory items may fall in a “no-mans-land” as they may not fall clearly within a specific entity. As such, market abuse may slip through.
- Additional expertise and costs are associated with splitting a single large regulatory body.
- By having two entities, there may be unnecessary costs resulting from regulatory overlap between them. Additional processes and costs may be associated with ensuring clear communication channels between the entities.

[7]

ii. Briefly outline the concept of Conduct Risk in banking and give four different examples of potential Conduct Risk events.

- Conduct risk is broadly defined as the risk that a bank’s conduct will result in poor outcomes for customers.
- Drivers of conduct risk can be summarised as:
  - Inherent: information asymmetries, biases and heuristics, inadequate financial capability
  - Structures and Behaviours: ineffective competition, culture and incentives, conflicts of interest
  - Environmental: regulatory and policy changes, technological developments, economic and market trends
- Potential example of conduct risk events:
  - Banks putting profits ahead of ethics, such as mis selling of products
  - Treating disclosure at the point of sale as the end of the responsibility of the bank
  - Improper trading activities from internal information
  - A bank employee sharing non-public material information
  - Taking tick box and legalistic approaches in dealing with customers, where compliance is limited to the letter rather than the spirit of the law.
  - *Any relevant example.*

[8]

[Total 15]

## QUESTION 6

i. State the definition of market risk and name common sources that market risk can arise from in a bank.

- Market risk is defined as the risk of loss from movements in prices in the financial markets.
- Market risk is primarily regarded for components in the trading book.
- Some banking assets, such as loans and deposits, are regarded as “held until maturity” and are held in the banking book.
- Other assets, such as securities and derivatives, may be regarded as “held for sale” in what is known as the trading book.

- Market risk can arise from any position, on- or off-balance sheet, in cash, securities, derivatives, or from customer lending, market making or trading.
- Market risks tend to arise from movements in interest rates, foreign exchange rates, and market prices such as the prices of commodities and equities.

[5]

ii. Outline the components of the new standardised approach for market risk capital.

The standardised approach is the methodology that was developed by the Basel Committee on Banking Supervision. The minimum capital requirement is the sum of three components: a sensitivities-based method capital requirement; a default risk capital (DRC) requirement; and a residual risk add-on (RRAO) capital requirement.

To calculate the capital requirement under the sensitivities-based method, the aggregate of three risk measures is required:

- Delta: a risk measure based on the first-order sensitivity of a financial instrument to the price of the underlying.
- Vega: a risk measure based on the first-order sensitivity of a financial instrument to its implied volatility.
- Curvature: a risk measure that captures higher-order sensitivities of a financial instrument to the price of the underlying not covered by delta.

The DRC requirement is intended to capture jump-to-default (JTD) risk that may not be captured by credit spread shocks under the sensitivities-based method. The following approach must be followed for each risk class subject to default risk:

- The gross JTD risk of each exposure is computed separately. With respect to the same obligor, the JTD amounts of long and short exposures are offset.
- Net JTD risk positions are then allocated to buckets.
- Within a bucket, a hedge benefit ratio is calculated using net long and short JTD risk positions. This acts as a discount factor that reduces the amount of net short positions to be netted against net long positions within a bucket.
- Bucket level DRC requirements are aggregated as a simple sum across buckets to give the overall DRC requirement.

The residual risk add-on (RRAO) is to be calculated for all instruments bearing residual risk separately in addition to other components of the capital requirement under the standardise approach. The RRAO calculation is calculated as follows:

- The RRAO is the simple sum of gross notional amounts of the instruments bearing residual risks multiplied by a risk weight.
- The risk weight for instruments with an exotic underlying is 1,0%.
- The risk weight for instruments bearing other residual risks is 0,1%.

[7]

iii. In order to use the internal models approach, a bank needs approval from its regulator. What minimum requirements should a bank have before obtaining regulatory approval?

The relevant regulator or supervisory authority will only approve a bank's use of internal models to determine market risk capital if, at a minimum:

- The regulator is satisfied that the bank's risk management system is conceptually sound and is implemented with integrity;
- The bank has, in the regulator's view, a sufficient number of staff skilled in the use of sophisticated models not only in the trading area but also in the risk control, product control (finance), audit and, if necessary, back office areas;
- The bank's trading desk risk management model has, in the regulator's judgement, a proven track record of reasonable accuracy in measuring risk;
- The bank regularly conducts stress tests; and
- The positions included in the bank's internal trading desk risk management models for determining minimum market risk capital requirements are held in trading desks that have been approved for the use of those models.

[6]

[Total 18]