

SOLUTIONS

2023 Paper 2

**Subject F207/B200 – Banking
Specialist Applications**

QUESTION 1

You are part of the Internal Audit function of PeeWee Bank – a full-service Retail bank. After completing the results for Q2 2022, the CFO of the Loans division approaches you with the statistics for the division, shown in the table below.

These are income statement and balance sheet items, as well as the actual and predicted values for the 3 variables that are the inputs for the macroeconomic linkage model used for estimating the forward-looking PD (used in the SICR calculations).

The CFO is concerned there may be an error in the provisioning numbers and is uncertain what the cause might be. The bank's financial period runs in line with a calendar year i.e. from 1 Jan to 31 Dec.

Summarised Statistics From The Loans Portfolio & Forward Looking PD Model Input Variables								
	2021 Financial Year				2022 Financial Year			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Balance Sheet Size - Loans (\$bn)	\$150,0	\$152,3	\$154,5	\$156,9	\$159,2	\$161,6		
Total Provisions Held (\$bn)	\$16,0	\$16,5	\$17,0	\$15,6	\$16,0	\$16,2		
Coverage Ratio	10,7%	10,8%	11,0%	9,9%	10,0%	10,0%		
Year To Date Profits In Each FY (\$bn)	\$3,8	\$7,6	\$11,6	\$17,1	\$4,0	\$8,1		
Actual Inflation Rate (Annual)	4,5%	4,6%	4,0%	2,9%	3,0%	3,1%		
Predicted Future Inflation Rate							3,0%	3,1%
GDP Growth (Annual)	3,0%	3,2%	3,1%	2,9%	3,0%	3,0%		
Predicted Future GDP Growth							3,1%	3,2%
Jobs Created As % Employed Population (Annual)	2,7%	2,6%	2,7%	2,5%	2,7%	2,6%		
Predicted Jobs Created As % Employed Population							2,8%	2,7%

- i. Detail the additional information you would require in order to perform a full audit on the provisioning results for the last 4 quarters. [8]

Performance on this question was above average.

Most candidates noted relevant points related to consideration of models and model changes.

Better candidates highlighted system and data considerations and highlighted the need to understand rules for movement between stages.

Better candidates were able to pinpoint the likely cause of the CFO's concern and shape their response accordingly.

Some candidates proposed full model validation without qualification, which is unlikely to be appropriate as part of a time-sensitive internal audit and should have been performed as part of independent validation and external audit processes.

The numbers within the set of data supplied are generally stable through time for all the different types of data or values. There is only one set of data points that look out of place, and that is for Q4 2021.

There is clearly a change in the actual inflation rate (a material change) and at the same time there is quite a large change in the overall coverage ratio and total overall provisions held. The profits are also a little out of line with the other quarters.

The following additional information for the period would be valuable:

- The staging rules applied over the period should be supplied, to understand which exposures would sit within each of the 3 staging buckets. If there were any changes applied to these rules they should be highlighted.
- This would include the SICR cut-offs applied and how the rules for the SICR calculations has been stored and how it has tracked over time.
- Details should be supplied around the macroeconomic linking model over the period of time. This would include the parameters used, any recalibrations and model validations performed and relevant documentation on the model.
- This should also include how the forward-looking macroeconomic variables are sourced and estimated to ensure consistency and reliability over time.
- The percentage of the portfolio sitting in each stage should be supplied, along with a detailed breakdown of the exposures sitting within any sub-categories sitting within the stages (for example – 1 instalment vs 2 instalments in arrears).
- For exposures in default this would include a breakdown of the age in default.
- It would also be valuable to get a breakdown of the exposures migrating between the stages each quarter which will assist with identifying anomalies.
- The write-off policy over time as well as the written off amounts per quarter should be shared to ensure stability over time.
- The LGD used over the period (per stage) as well as the underlying data used to calculate the LGD (so that this can be validated as well – it would depend on the mandate given to the audit function for this review).
- Actual vs expected PD's for the different stages and sub-populations within the different stages (for a high level sense check in the data and outcomes).
- Depending on the scope of the audit the historical exposure level default data could be supplied such that the audit could include a full review of the PD models used to ensure their accuracy and validity (but this would be a much larger exercise).
- List of changes made to the underlying data and loans management systems which might impact key processes and ultimately key fields used within the provisioning process.
- New business volumes, the expected risk mix and early vintage experience over the period. This should include details on any changes made to risk appetite and when these were made, along with the volumetric impacts caused to new business.
- All audit documents received for audits completed (both internal and external) over the period. This will allow the team to review what was audited previously and give the team a head start on any issues and concerns picked up in the past.

Note Information requested should aim to establish soundness of model construct, data inputs and application run.

An investigation confirms that the provisioning models and calculations over the period were stable and there were no material changes. However, you do discover that the basket of goods used to calculate the inflation rate for the country changed during Q4 of 2021 and that this new inflation basket was used from that point onwards (even for the predicted inflation rates) as inputs into the macroeconomic linking model.

- ii Discuss the steps that the bank should follow in order to rectify the financials for the relevant quarters. [9]

Performance on this question was generally poor.

Better candidates identified the need to restate the financial statements for the prior period because of the error and were able to list sensible considerations related to the practicalities of the restatement process.

Poorer candidates failed to read the question properly, and therefore did not respond to the question based on the facts provided.

Better candidates highlighted the materiality of the difference as a consideration. Better candidates also recognised that there were different options for determining the impact and explained these.

Many candidates failed to grasp that a change in the methodology for measurement of inflation does not translate to inflation being incorrect, but rather that the issue is that the models were developed and calibrated on a measure that is not consistent with the measure applied in the impacted periods.

Few candidates commented on the need to improve controls to prevent similar instances in the future.

The first step is to calculate the impact on provisions and the profits as a result of this change at the date the change was effected.

This will allow the business to get a sense of the materiality of the difference and as such make relevant decisions around how best to handle the outcome of the adjusted financials.

At a high level, if one assumes that the coverage ratio should have remained at around 11%, for Q4 in 2021, then the provisions in total should have been around R17.2 bn at the end of 2021. This means the provisions were understated by around R1.6 bn, and thus the profits were overstated by this amount too – which is roughly 9% of the reported profits for this division.

For the division itself, this is likely a material impact. For the bank overall it is hard to tell without seeing details of the overall profits of the bank.

Unfortunately the error took place just prior to the previous financial year end which means that the error was sitting within the published results for the prior year. This means that if the impact is material there will be a requirement to restate the prior financials of the division as well as the bank overall. The level of detail shared in the financials will also be key. For instance if divisional profits and results as well as the banks overall results are made publicly available – then even a material change within the division alone might require a restatement of prior financials.

If the impact is material the restated financials will have to be shared with shareholders and the market as a whole, and with oversight authority with clear explanations of how this came to pass,

coupled with details on control changes.

The bank may also be required to calculate the impacts of the total exposures sitting in the different staging buckets, and again depending on the level of detail shared within the published financials if this change causes a material impact to any of the stated numbers these may have to be restated too.

Depending on how quickly the results are required in order to communicate these changes, there are a couple of options in terms of the approach to be taken for calculating the impacts:

- The quickest option is to calculate the distribution of the book sitting in each of the stages for Q1/Q2/Q3 from 2021. Calculate the coverage ratios for each of those buckets. Then apply these ratios as is to the balance sheet as at Q4 2021, Q1/Q2 2022 to get a sense of the change in provisions held. This set of changes can then be run through the bad debts line in the income statement to calculate the impact on the profits for the quarter and ultimately for the FY (in 2021).
- The next best option which is also fairly quick is for the bank to recalculate or restate the inflation rates for Q4 (2021) and Q1/Q2 (2022) using the previous basket of goods or weightings applied to calculate the national inflation rates. These restated inflation numbers can then be run through the models for the 3 quarters in question to calculate new PD's, volumes of exposures in each stage and ultimately the bad debt and income statement impacts.
- The third option, which is also the long-term option that would be required, is for the bank to firstly restate the inflation rates for the quarters prior to the recalibration of the baskets using the new basket weightings. This might need to be done for 2020 and maybe even 2019 as well. This data can then be used to remodel / recalibrate the forward-looking PD model with this new set of inflation rates to see how the model parameters might change.
- This newly parametrised model can then be applied to the exposures in Q4 2021 and Q1/Q2 2022 to see what the new staging volumes look like, and how the new coverage ratios should look after the adjustments have been made. The changes in the bad debt charge will have to be run through the financials to update the income statement and profits of the division and group in totality.

A possible alternative approach could be for the bank to put an overlay in place to cover the shortfall in the provisions for the current quarter. However the problem is that the error occurred in a prior financial year which means that the profits are overstated in the prior year and will thus be understated in this financial period which is not ideal. If this error had occurred within one financial period then this might have been an option (in place of restating previous quarter's results).

Another result of this finding would be that the bank would need to put additional checks and balances in place to ensure that:

- This oversight is not evident in other books within the bank. If the inflation rate is used within one of the macroeconomic linking models used elsewhere in the bank then there is a risk those models were not adjusted and the provisions and hence financials in that division are incorrect too.
- This oversight or something similar does not occur again. Part of the review of the provisions for all divisions going forward will need to include a check on the inputs used within the macroeconomic model to ensure these are sensible and calculated in a stable and consistent manner.

QUESTION 2

You are the head of risk for Trust Bank. Trust Bank is a large multi-national bank that offers a full suite of personal and business banking products and services. The model development team plans to build and implement a real-time, AI-based tool to improve detection and prevention of fraudulent transactions. This tool would make use of a machine learning algorithm to determine whether a transaction is likely to be fraudulent and, if so, would block the transaction from being processed.

“Machine learning” (ML) uses statistical methods to enable machines to learn from data and improve their performance on specific tasks over time.

- i. Outline the risks associated with the incorporation of machine learning into models and suggest ways in which the bank can ensure that an appropriate governance framework for machine learning models is in place.

[4]

Performance on this question was above average.

Most candidates were able to identify risks specific to ML models. Poorer candidates commented on general model risk without considering additional/enhanced risks associated with machine learning.

Several candidates did not approach the part of the question related to ensuring proper governance frameworks are in place in line with what was asked by the question.

Better candidates considered the steps that would need to be taken/considerations that would be applied in ensuring that the bank has a proper governance framework for machine learning models, considering that the bank is likely to already have frameworks for traditional models in place (given its size and footprint).

Risks associated with ML models

While machine learning models have the potential to provide significant benefits to banks, use of such models carries risk of design, implementation, and use errors.

Risk associated with machine learning models

- **Lack of transparency:** The risk that an algorithm is so complex that it becomes near impossible to explain how the result of the model was obtained
- **Resilience risk/model drift:** The risk that a model becomes less effective over time **without notice** as the underlying data changes or as the model is exposed to new data
- **Fairness/Bias risk:** The risk that models perpetuate bias and discrimination, either as a result of models being trained on biased data or due to bias in the algorithms themselves
- **Cybersecurity risk:** ML models may be vulnerable to cyber-attacks and other security threats (hosted on new generation software)

Appropriate governance framework

- Regulations are expected to evolve to provide guidance to better manage these new risks. Any regulatory requirements should be taken into account when setting the governance framework
- The bank should develop an enterprise-wide ML definition to enable identification of ML models and support effective management of the associated risks

- Existing model risk management and governance frameworks could be enhanced to address ML-specific risks
 - An operating model for responsible ML adoption which assigns clear roles and responsibilities for the development, deployment and monitoring of models, should be implemented
 - Investment can be made in capabilities that support ML adoption and risk management, such as investment in appropriately skilled resources for model development and validation, investment in supporting tools
- ii. Suggest types of data that should be considered for use in development of the ML algorithm, outlining why this data may be relevant in the context of fraud detection, and discuss the considerations that should be applied when selecting, extracting and preparing the data.

[10]

Performance on this question was generally good.

Candidates that understood supervised and unsupervised learning approaches and were able to apply this in their responses performed better.

Better candidates considered the use of data in the context of ML and listed non-traditional data sources and their relevance.

Poorer candidates did not answer all parts of the question, listing data without supporting arguments for relevance, or not discussing considerations in selecting the data.

Types of data to consider including rationale

- Data regarding previous confirmed fraudulent transactions.
 - This would allow the initial model to be trained on relevant historical data
- Transactional data, including data related to each transaction such as amount, location, time and frequency.
 - Transactional data can be used to identify abnormal patterns of behaviour such as higher than normal transaction volumes or transactions occurring in unusual locations
- Customer/demographic data, such as customer age, income and geographical area
 - This data can be used to determine whether activity is outside of the norm in relation to typical spending patterns for a group of customers
- External data, such as data from public records, data related to online activity or social media data.
 - This data can support identification of potential fraudsters through analysis of behaviour or identification of individuals with criminal records
- Device data, which would include information on the device used to perform the transaction, such as IP and geolocation.

- This can be used to identify unusual activity such as transactions initiated on a device never used by a customer before
- Type of authorisation of certain transactions: e.g. SMS, Application, PIN
- Network data, to establish if customers interact with other users who do have an elevated risk profile.
 - This can be used to identify transactions initiated from within network with a high degree of suspicious activity

Considerations for selecting, extracting and preparing data

- The quality of the data to be used, including the accuracy, completeness and stability of the data should be considered and assessed
- It needs to be determined whether the volume of available data is sufficient for use in the ML algorithm. Since Trust bank is a large, multi-national bank, data volumes should not be a problem
- The length of available data history and the consistency of data over time should be considered
- It should be considered whether historical fraud experience is relevant to future experience, in the context of evolution in fraud modus operandi
- Subject matter experts should be consulted regarding relevance of data to be considered within the model
- It needs to be ensured that the data to be used for model development is representative of the population to which the model will be applied
- Data privacy and related regulatory requirements should be considered
- Any potential bias in the data should be tested for. The methods that will be used to test data for bias and the actions that will be taken if bias is identified need to be considered.
- The availability of data to run the solution in real-time once implemented should also be considered
- Since Trust bank is a multinational bank that operates across multiple jurisdictions, consideration needs to be given to whether there are differences in data availability and constructs or in regulations across the different jurisdictions, and how any differences should be treated (e.g. through model segmentation).

- iii. Describe the risks associated with implementing the proposed tool as suggested, and propose ways in which these risks can be managed or mitigated

[12]

Performance on this question was average.

Few candidates considered risks uniquely associated with a real-time ML model and commented on risks associated with fraud detection models in general.

Better candidates considered operational and IT risks in their responses, in addition to risks related to model performance.

Model risk

- There is a risk that the model will not perform as expected once implemented due to limitations in model design, model implementation or model use
- Model design risk is the risk that the model design is flawed, either from a technical perspective or when assessed against the model's use case
 - Model design risk can be mitigated through implementation of robust model risk management frameworks and supporting governance processes to provide oversight and sign-off prior to model implementation
 - This would include clear roles and responsibilities for model risk management, peer review of models, effective challenge of models through technical committees and independent model validation
 - Model design risk can also be reduced by including relevant experts in the model design and approval process to ensure that the problem statement is properly addressed and that the relationships inferred by the model make sense
- Model implementation risk, which is the risk that errors are made in implementation of the model, is typically increased for ML models due to their complexity
 - Robust implementation controls are required to ensure that the model is implemented as intended. This would include pre- and post-implementation testing, and change controls to ensure that unapproved changes cannot be made to the model once implemented.
 - Model implementation risk can also be mitigated by running the model on a pilot population first (or a parallel run) before rolling out across the entire base.

Operational risks

- There is a risk that operational breakdowns could lead to the model not operating as intended
 - The real-time data feeds required to run the model might break down. Depending on the implementation design, this could either result in the model not running or in the model running on outdated/incomplete data
 - The system/platform on which the model is deployed might be down, which would result in the model not running
 - To mitigate this risk, real-time monitoring of data feeds and system uptime is required, and mechanisms should be in place to immediately alert the required stakeholders if there are any breakdowns
 - Automated controls to address any operational failures should also be implemented. Examples include 'kill switches', which stop the model from running when issues are identified, back-up solutions that can be switched to if the model is not operational

Reputational Risk

- Reputational risk could arise if the model generates false positives, causing customer frustration by blocking legitimate transactions. Similarly, false negatives could result in transactions going through that should have been blocked, resulting in reputational damage. False negatives could also lead to financial losses for the bank and its customers

- This risk could be mitigated by pre-implementation testing and real-time monitoring of performance metrics
- The implementation design could also be adjusted to mitigate this risk by, for example, asking a customer to confirm that a transaction is fraudulent before blocking it or requiring human oversight/intervention for borderline cases
- Reputational risk could also result from inherent bias within the model or the data that informs it, which could result, for example, certain population groups being flagged for fraud more frequently than others.
 - This risk can be managed through pre- and post-implementation testing for bias in model data and model outcomes, with ongoing monitoring for bias implemented and pre-defined actions taken if bias is identified
 - Consider thresholds depending on type of customer before stopping a transaction

Cybersecurity and Data Privacy Risk

- A real-time ML-based fraud detection model would need access to large volumes of sensitive customer data. There is a risk that this data could be compromised, which would lead to regulatory breaches and reputational damage.
- Should the platform that the model resides on not be properly protected, there is also a risk of the model being corrupted through malicious attacks.
- These risks can be managed by ensuring that access to the model and data is robustly managed, and that other cybersecurity controls and monitoring are properly implemented.

Risk of Model Drift

- There is a risk that the model could become less effective over time due to changes in the data distribution or the underlying fraud mechanisms being modelled.
- Regular monitoring of model performance through metrics for measurement of model accuracy, precision and recall can help to identify when model drift occurs
- Frequent retraining of the model on the latest available data assist in managing the risk of model drift
- Automated re-training of the model introduces additional risks that would also need to be mitigated, such as the model being retrained on low-quality data or on data that contains inherent biases
- Where automated retraining is implemented, automated performance monitoring should also be implemented so that any issues introduced can be quickly identified.
- Model version control can be implemented, with earlier model versions retained, so that roll-back to an earlier version of the model can be initiated should concerns with an updated model version be identified.

[½]

[Total 26]

QUESTION 3

CorpCoBank is a large multinational bank that focuses on the corporate lending market. Loan applications in CorpCoBank's international portfolio are assessed using a purely qualitative scorecard. This assessment is performed centrally out of the bank's head office. As part of CorpCoBank's continuing expansion, the bank's management have become concerned about the bank's ability to appropriately assess credit experience in this portfolio, especially in light of global macroeconomic uncertainty, rising inflation and rising interest rates.

The bank has engaged you as an independent consultant and the Head of Credit Risk has asked you to explore the use of a more statistical approach to credit assessment at origination.

- i. Briefly discuss the data challenges associated with building models for corporate portfolios. [8]

Most candidates were able to articulate points regarding scarcity and heterogeneity of data for corporate clients.

Better candidates considered the difficulty of obtaining suitable and comparable financial statement information for use in quantitative modelling. Better candidates also considered difficulties in obtaining suitable data across multiple jurisdictions.

Poorer candidates focused their responses on challenges with developing quantitative models rather than challenges with obtaining suitable data for use in the modelling process.

Lack of audited financial data for use as potential rating factors

- Non-Retail scorecards often make use of financial statements data to derive variables such as debt to equity ratios, company turnover and other pertinent financial ratios and metrics
- While most large Corporates produce financial statements, not all of these may be comparable, especially in international markets where auditing and financial statement practices may be inconsistent or at different levels of maturity
- Depending on timing conventions in different jurisdictions, the financial information may often be outdated and so impair ranking ability (where results are only disclosed half yearly or annually and then more than three months after close of financial period)

Limited historical timeseries

- Corporates operating in international markets may not have a reliable historic timeseries of potential rating factors and experience data available.

- Developing models using too short a period may affect the reliability of trends identified or limit the potential use of the models.
- Changes to companies' operating models and/or accounting standards adopted may affect the comparability of their financial information over time and needs to be explicitly allowed for

Data quality

- Data systems may also not be sufficiently mature or well developed, and there may be significant reliance on paper sources, or data obtained across a multitude of sources.
- Furthermore, due to the diversity of regulations, business practices and multiple differences for scale and maturity of Corporates in international markets, there is also a higher likelihood of information being captured in an inconsistent manner.
- As a result, there is a higher risk of incorrect, incomplete or unreconciled data being used for model development.

Volatility inherent to low default portfolios

- Large corporate portfolios tend to contain significantly fewer customers and hence fewer exposure and loss event data points to model
- Completeness of default record, especially in instances where debt was successfully re-arranged without loss to creditors may lead to uncertainty in classifying loss events
- In addition, due to limited historical timeseries, and the volatility in different industry sectors (more sensitive to changes in business cycles), observed historical trends may be more volatile.
- Observed trends in results may also be counter-intuitive and would require judgmental interpretation and moderation
- As a result, developing a quantitative model may be challenging where clear trends and intuitive relationships are not observed.

Segmentation of customers

- Retail portfolios tend to be made up of a large number of relatively homogenous customers (by risk segment).

- Due to the diversity in the industries, operations, size and scale of corporate portfolios, segmentation of customers into homogenous risk groups may be a challenge.
- Corporate models also tend to include revenue or size metrics and some of these customers may change in size from one year to the next, especially in international markets, making revenue or turnover based segmentation more volatile than for a domestic Large Corporate model.
- Consistency between different markets and especially local economic conditions may limit the ability to aggregate experience over many geographies

- ii. As part of moving to a more quantitative modelling approach, the bank has requested that you explore making use of "Facility Rating" approach in underwriting and pricing.

A facility rating approach is one where the overall rating is based on a dual-matrix approach, which incorporates both probability of default and loss given default and the overall rating is based on expected loss. The table below illustrates a potential facility rating model.

Facility rating table:

Borrower rating	LGD dimension				
	[0%-10%]	[10%-20%]		[50%-60%]	
AAA	0.0005%	0.0038%		0.0149%	
AA+	0.0005%	0.0038%		0.0230%	
AA	0.0019%	0.0160%		0.0636%	
.....					
B	0.2675%	2.0521%		8.6511%	
C	1.0896%	9.2042%		25.3492%	

Where:

Expected Loss	
Low risk	
Moderate Risk	
High Risk	

Discuss the key considerations in moving to a Facility Rating approach.

[13]

Performance on this question was poor.

Many candidates did not display an understanding of the nature of corporate lending, and assumed models and considerations would be like those used for retail portfolios. Candidates also did not convey adequate understanding of pricing models.

Poorer candidates did not answer the question in the context of origination and pricing (per the question) but assumed that the model would be used for modelling capital and provisions.

Most candidates failed to generate sufficient content for the marks allocated to the question.

Better candidates considered the complexities involved with considering diverse types of collateral in LGD calculations, and those introduced by lending to corporates in different jurisdictions.

Modelling

- The Facility Rating approach will require the development of underlying PD and LGD models.
- The Bank can make use of its current rating systems, or may look at this as an opportunity to redevelop those models as well.
- It is important for subject matter expertise to be obtained at each step of the development and implementation process.
 - E.g. during the experience data selection process, during factor selection, model selection, PD and LGD groupings and cut-offs.
- It is important to ensure the consistency of PD estimates across different rating model sub-segments, especially to ensure PD estimates are consistent with country specific and/or industry specific outlooks.
 - For example, an “A” rated entity operating in a territory undergoing economic turmoil may have a higher PD estimate than an “A” rated entity operating in a favourable environment
 - Given the profile of the bank’s customers (operating across multiple international markets and industries), it may not be possible to use a single model for all countries.
- Different matrices would also need to be developed for transactions of tenures beyond 12 months to allow for any term structure in loss experience
 - Both from a PD estimate and an LGD estimate point of view
 - A single LGD rating for transactions where the value of the security varies considerably with term (appreciating or depreciating assets) would require the input

of the PD structure of the entity which is not catered for explicitly in the dual matrix

- Similarly security values which may be affected by the credit quality of the underlying entity may cause a correlation between PD and LGD not explicitly allowed for in the matrix
- The LGD model needs to be flexible to allow evaluation of different structuring of the transaction the with respect to security and exposure development
- Both the PD and LGD estimates should ideally be accompanied by a measure of certainty surrounding the estimate
 - especially for entities/ transactions where the rating is based on sparse information or sparse historical experience

Application in origination and underwriting

- Development and incorporation of a dual rating system and methodology will impact policy and processes along with the technology needed to incorporate the dual risk ratings.
- A Facility Rating approach enables improved risk vs. return decision-making during credit underwriting as compared to a pure judgmental process insofar as it provides quantifiable benchmarks for differences in perceived credit risk .
- Decision makers/ credit officers using this tool as part of their sanctioning process needs to be informed and aware of the tool's strengths and weaknesses when using this inputs to inform underwriting decisions
- In instances where the modelled expectation is uncertain/ has higher variability due to low exposure volumes discretion for subject matter experts to adjust the expectations would be appropriate
 - Record of these adjustments would aid transparency and future re-evaluation
- Credit strategy will enabled by a measurable portfolio target loss and to provide and objective measurement of risk taken against the desired risk appetite
- The tool may be used to inform mandate levels for different underwriting decision makes based on the absolute ECL presented by a transaction can vary by the internal risk grades (PD and LGD metrics).
 - In the above example, dark grey areas will have significantly higher ECL, and therefore may not be accepted without significant additional approvals and criteria.
 - Conversely, light grey areas may result in simpler approval processes.

Expected Loss / Pricing

- Inclusion of PD/LGD as a risk rating system and with economic scenarios will have a large impact on how the ECL is calculated.
- Therefore, using this approach will allow the Bank to incorporate the ECL into the pricing explicitly.
- This approach should also enhance the Bank's credit strategy and customer acquisition to be more relevant to the bank's portfolio loss target.
- In the above example, dark grey areas will have significantly higher ECL, and therefore may not be accepted unless an adequate price can be charged.
- Conversely, light grey areas may result in more competitive pricing.
- A single ECL metric would not be appropriate for use to inform economic and/or regulatory capital since different combinations of PD and LGD may have the ECL but will have different capital requirements.
- A separate approach and/or matrix would be required if this approach is to be used to price for the full cost of credit risk (ECL+ Cost of credit capital).

- iii. Outline the considerations to ensure a successful implementation of this model in the application process.

[11]

Performance on this question was poor.

Most candidates failed to generate sufficient content for the marks allocated to the question.

Better candidates considered successful implementation to include aspects related to initial implementation (and associated practicalities), model use (displaying knowledge of corporate origination and pricing processes), and ongoing use, monitoring, and updates.

Poorer candidates focused responses on limited aspects of the implementation process and thus did not generate a full response.

Data

- Need to ensure the build, calibration and application data sets are consistently defined.
- This needs to be considered across the underlying PD and LGD models, as well as for the overall Facility rating model.
- All input data needs to be cleaned, validated and reconciled before use in rating a transaction.
- The treatment of missing information in the ratings process needs to be explicit

Systems

- There may be significant system development required to allow a Dual Rating / Facility Rating approach.
- As underlying model ratings change, it will be important for this to be updated into the overall system to enable real-time monitoring of changes in facility rating.
- Additionally, reporting and monitoring templates may need to be updated and enhanced.
- Where new underlying scorecards are developed (e.g. a quantitative PD model), new data fields may need to be stored and incorporated into systems.
- Record of final ECL levels agreed by underwriters vs model results needs to be stored

Implementation testing

- The model may be implemented incorrectly/ inaccurately due to coding errors affecting the calculation of characteristics/ features or aggregation or translation into PDs.
- This can be mitigated by step-by-step comparison of results on sample records ensuring exact replication of the model into the production system.
- Given the number of permutations possible, it is advisable to create a sample universe that can cover many possible outcomes to automate the comparison (as opposed to case by case manual tests).

Business use and feedback

- Clear decision on implementation approach for use in decisions needs to be agreed; be it in pilot mode, parallel mode or otherwise.
- For example by limiting number of new customers originated on the new model, or limiting originations to a certain value of total originations. This way, if there are any issues, they don't affect the entire new portfolio.
- This also allows for refinements to be made as more data comes in.
- Allows evaluation of the model objectives (e.g. does the new model enhance/ adds transparency to the decision making and/or improves measurement of credit quality)
- There may be some risk appetite thresholds that need to be created at a customer level if these do not already exist within the framework (for instance total debt to income, or max overall unsecured debt exposures relative to income or risk bands).

Outcome testing

- The actual expected approval rates and projected ECL rates may differ from the profile of business approved before implementation of the model
- This would indicate that either the application population has changed considerably and/or
- that the tool has influenced decision making considerably
- Experience may also differ if the population of loans rated changed significantly from the model development sample, for example a change in profile of SME customers, indicating risk of ECL estimates not being appropriate

- Population stability metrics need to be tracked at application stage to evaluate and possible changes and allow for response.
- In context of major changes to decision-making outcomes post implementation, these changes needs to be evaluated by the management team for appropriateness

QUESTION 4

Green Leaf Bank is a full-service bank based in an emerging market. You are the Actuarial Head overlooking the lending divisions of the bank, both retail and commercial market segments.

Two solar installation companies have independently approached the bank, requesting that a commercial arrangement is set up between Green Leaf Bank and the companies in order to facilitate finance arrangements for their customers.

Currently solar installation customers pays in full once the installations are completed, with neither company offering credit terms. Both companies have completed customer surveys and discovered many customers cannot afford the quote and often resort to loans in order to finance the cost.

Both solar installation companies believe that their news business turn-over would materially increase should Green Leaf provide favourable finance terms, both from a price and an “access to finance” perspective.

The solar companies will compile and send applications for finance to Green Leaf for a fee per application (the fee will still need to be negotiated) and the companies will promote the bank on their websites and other marketing initiatives as their partner of choice.

Both companies are banked with a competitor in the local market.

Your team has gathered the below information from the two companies.

Information on quotes provided

	# Employees	# Quotations in 2022	Total Value Of Quotations In 2022 (\$'m)	Average Quotation Value	Smallest Quotation Value	Largest Quotation Value
Sunny Solar	500	33 750	6 075	180 000	100 000	3 200 000
New Age Solar	50	9 000	1 080	120 000	45 000	90 000
Totals	550	42 750	7 155	167 368		

Information on installations completed provided

	# Employees	# Installations In 2022	Total Value Of Installations In 2022 (\$'m)	Average Installation Value	Smallest Installation Value	Largest Installation Value
Sunny Solar	500	18 750	2 531	135 000	80 000	1 300 000
New Age Solar	50	3 000	240	80 000	35 000	75 000
Totals	550	21 750	2 771	127 414		

The table below reflects the current balance sheet size of the Retail asset book of Green Leaf

Summarised Balance Sheet Of Green Leaf Bank			
Retail Division	Book Size In \$'m	# Active Facilities	Average Facility Size
Credit Card Portfolio	68 000	2 000 000	34 000
Unsecured Loans Portfolio	44 000	790 000	55 696
Mortgage Portfolio	700 000	360 000	1 944 444
Overdraft Portfolio	22 000	550 000	40 000
Total Retail Credit Book	834 000		

- i. Detail the benefits to Green Leaf of entering into an arrangement with these companies

[5]

This question was generally well-answered, with most candidates able to generate a suitable list of benefits to the bank.

Better candidates considered benefits related to servicing both retail and commercial customer bases, and the opportunity to switch partners and their staff to the bank.

Some candidates assumed the partners would be paying the banks a fee to assess the credit applications, which would not be sensible given the context provided. Some candidates also misread the table provided as the bank having no unsecured loans on book.

- average installation sizes and the span of installation sizes indicates that both retail and commercial type installations are completed. Green Leaf does support both Retail and Commercial clients so both types of customers could be serviced by the bank.
- This partnership would represent another potential lead stream for the bank for credit applications. Not only to offer these customers credit (for the solar installation) but also to potentially switch the customer's other banking products that they might hold elsewhere to Green Leaf.
- The value of the quotes that were not fulfilled for the year amounts to around \$4.5 bn which is a sizable potential value if a large portion of this could be fulfilled by the bank. If this value translates into sales of \$4.5 bn per annum this would represent 10% growth for the retail loans book overall.
- There may be an opportunity to contact customers that have previously installed solar and required credit to facilitate the transaction. These customers could also be switched across to Green Leaf as part of the partnership agreement.
- If these loans / facilities are ringfenced it will allow the bank to report on them separately and allow the bank to disclose these as an additional contribution that they are making towards carbon reduction. This will reflect positively on the bank from a corporate social responsibility perspective.

- There may be some incentives available to the end user and additional sources of funding to the bank where funding providers have an explicit “green” mandate and as such there might be an additional financial benefit for this portion of the asset base.
- Green Leaf will also receive some level of marketing / increased brand awareness by entering into these relationships.
- Both solar companies are currently banked by another financial institution. Part of the agreement could be to switch the full banking suite of products utilised by both companies, along with their payrolls, to Green Leaf.
- In addition, the 550 odd staff complement (which may grow) could also be migrated across to Green Leaf (at least their cheque account relationships). This provides another relatively easy switch opportunity between the entities.
- Depending on how the new business is originated and how much of the application process is managed by the solar companies on behalf of Green Leaf, the relative cost of acquiring these credit facilities might be lower than if the bank were to originate the business completely on their own.

ii. Explain how to estimate the size of the credit business opportunity.

[5]

Performance on this question was average.

Many candidates did not explain the approach they would follow at a level of detail commensurate with the marks allocated to the question.

Better candidates used the values provided to calculate a starting point for estimating the size of the opportunity. Better candidates also considered the possibility of increasing the size of the opportunity to bring additional providers on board.

Poorer candidates did not make use of the information provided to answer the question, but made broad, unsupported assumptions instead.

Few candidates commented on possible ways in which data available to the bank could be used to assist in deriving an estimate.

- Based on the stats provided there is potentially an annual total pay-out value of around \$4.5 bn. Some quotes would not have been fulfilled at all (due to limited savings held by the customer) and in some instances customers may have installed smaller systems in line with their savings on hand.
- In addition to this some of the clients that paid cash may also wish to use some line of credit to help support the installations they purchased (to retain more liquidity for future use).

Green Leaf bank could run all the quotes received through their origination scorecards to see how many customers qualify for Credit and how much credit they qualify for (the rand value) based on the risk limits in place at the bank for the relevant products. This would be done for all quotes, both those fulfilled and those that were not.

- These amounts can then be compared to the installation amounts (for customers that completed the installation) and to the unfulfilled quotes to see what the possible opportunity set would be. The bank would have to make some assumptions around available income to afford instalments payable.
- The relative size of the installations could be linked to KWh's generated and the potential relative savings that could be made on electricity tariffs. This saving could help towards funding the installations and the instalments payable once the facility is set up.
- The bank would also need to see which customers from the set of quotes already bank with Green Leaf (can use internal income estimates) versus those that are brand new to Green Leaf.
- Green Leaf could also try to understand the size of the total solar market (by contacting other installers) and by trying to estimate the potential market for solar products.
- This could be estimated by starting with its own banked client base, using a combination of deeds data, municipal payments data and geolocation data to understand a possible overall opportunity set.
- Based on the calculations the bank might look to expand this partnership with other large solar providers and will encourage the set-up of this partnership to be easily scalable.
- It is likely that some of Green Leaf's existing new business is already used to finance such solar installations and the reduction in this type of new business in favour of the new arrangement and source needs to be considered.
 - The extent of this could be approximated by comparing the timing of 2022 new installations and loans provided to current customers during 2022 accompanied by an error assumption.

iii. Detail any additional risks one would need to consider before entering into a relationship with these two providers.

[3]

Performance on this question was above average.

Most candidates commented on potential reputational risk associated with supplier reliability.

Few candidates commented on risks associated with product warranties.

- Customers may have some level of expectation that Green Leaf has vetted the quality of the products being installed as well as the workmanship which may lead to reputational risk in event inferior product and/or workmanship.
 - It would be valuable to understand if there are any guarantees / warranties linked to the workmanship and products installed. Depending on client affordability it would be desirable that the repayment term could be linked to the warranty period as there is likely a higher risk of default should a customer's installation stop working.
 - It also means any affordability created from KWh savings will be reversed once the system stops working.
 - The bank needs to ensure that they are positioned as a possible credit provider, subject to the usual risk limits and credit rules applied similarly to any other credit application. To ensure that there is no unreasonable expectation that a credit facility will be guaranteed.
 - both from the solar suppliers and prospective loan applicants
 - There is a risk of anti-selection in the applications received. Should Green Bank not be the sole credit provider being considered anti-selection against the bank relative to other banks that may have been creating offers for these clients too.
 - However the walk in population may be of a poorer quality than the typical client base of Green Leaf.
- iv. Outline how the new business process could be set up between Green Leaf and the solar companies

[5]

Performance on this question was below average.

Few candidates commented on the differences in process requirements for retail and commercial customers, or on the different considerations applicable to different types of installations (standard vs complex).

Better candidates listed multiple options from a process perspective.

- Green Leaf will need to understand how the new business process for the two providers currently works and will need to establish where it makes the most sense for the credit application process to take place.
- Understanding this will help determine how best to approach each provider and set up the application process. Green Leaf should also look to set these providers up in a way that is scalable should more opportunities of this nature arise.
- The suite of installation options available would need to be understood and evaluated in context of the finance application process.

- E.g. standard installation (bundles where the cost is relatively well understood upfront) or may be looking to install a system to allow them to run 100% off their own generated power (this will likely require a site visit and a detailed quote to be created).
- Ideally for a semi standard installation it will be ideal if a credit assessment can be concluded timeously to allow the customer to determine their available credit, whereas for quotes requiring an onsite visit there is a little more time available to Green Bank in order to run the assessments.
- The size of the installation and the market segment linked to the applicant will also determine the lead time from requesting a quotation to when it can be delivered, with commercial type projects requiring a lot more time and planning and hence these projects will also give Green Leaf more time to complete its risk assessments.
- The bank could pre-score customers that bank with them and promote leads towards the solar providers.
- Large commercial initiatives will have to be more accurately and closely assessed by the Commercial Credit process and pre-scoring is probably less of a viable option.
- Once a request for a quotation has been received, the solar providers can potentially assist with obtaining customer information and capturing the application on the customer and banks behalf (in order to earn their finder's fee).
 - Consideration (in terms of the fee flow) would need to be made in instances where Green Leaf promotes the solar installation companies to existing clients.
- The bank will need to ensure that any personal information passed back and forth between the solar provider and Green Leaf is securely encrypted and submitted to ensure no data and security breaches take place as a result.
- An alternative option is to direct the customer to Green Leaf's current credit application process (so the customer can apply using normal channels).
- In this instance the customer will need to have a way of indicating that this application is in connection with solar installations if this will result in better rates for the customer (this may result in some additional development on Green Leaf's side or manual rate adjustments post pay-out).
- Once successful the credit facility / loan amount could be paid to the customer or could be made directly to the solar provider once installation is complete.
- Direct payment to the provider will ensure the loan is used as intended – this will be particularly relevant if better pricing is offered for using the loan for this purpose and to ensure the credibility of reflecting these loans as carbon positive loans.

- v. Detail how the pricing may differ on this offering versus the standard offerings provided by the bank.

[5]

Performance on this question was below average.

Most candidates considered the impact of using the solar panels as collateral on loan pricing.

Better candidates considered the impact of the fee charged and the impact of cost reductions on the price. Better candidates also considered the potential for preferential pricing.

Poorer candidates provided broad comparisons to pricing for other products on book without explaining the drivers of potential differences.

- The solar providers have both requested a fee for the business they are referring. This upfront cost could ultimately be a flat fee or a percentage of the facility amount (subject to some sort of cap).
- The amount of this fee still needs to be negotiated however this might be an additional cost that is incurred which may not be offset by acquisition cost savings being brought about by this partnership.
- The volume of new business may make a meaningful contribution to fixed cost recovery.
- Depending on the size of this incremental cost and the scale benefit to cover fixed costs the bank will need to make adjustments to their standard pricing model for this offering.
- It should also be noted that they have initially requested that this fee is payable for all leads generated, not just for successful applications. So the relative cost of unsuccessful applications will be higher as a result.
- Both providers may harbour an expectation that customers will receive some sort of reduced or beneficial rate if this product is offered to them. In reality all of the standard elements of pricing and the cost of doing this business are likely to be very similar to a standard application.

However depending on the structure of the product there may be some factors that can mitigate / reduce the credit risk losses and this will allow for more favourable pricing:

- There is mention of a strong second-hand market for the solar products being installed. The bank should perform an investigation to understand how realistic this is and what kind of second-hand price might be available for these products. Depending on the rate of the depreciation of the products (possibly linked to geolocation) and how this compares to the amortisation of the credit facility, there might be a much lower LGD for this product if it is secured against the value of the installed products. This might prove to be much lower than a standard unsecured LGD and as such might allow a significantly improved rate offering for the product.

- Installation of this product should free up some cashflow for the customer on a sustained basis as a result of savings made on their electricity needs. This free cashflow can be used to pay off the debt and would provide an incentive the client to keep paying for the installation as they will ultimately be cash positive down the line.

There may be some tax, funding or capital incentives on offer to encourage banks to more widely facilitate funding for such green initiatives. The amount of these incentives and how they materialise might allow for a lower level of capital or some tax reductions, and in turn these benefits could be partially passed onto the customer in the form of slightly lower rates or fees (as the ROE and tax impacts within the pricing calculation will be slightly lower in this instance).

- vi. Outline the considerations (from a customer point of view) in deciding between a traditional finance product as compared a solar specific loan, to finance such installations.

[2]

Performance on this question was above average, with some candidates not completing the question.

Most candidates were able to raise relevant additional considerations from a customer perspective.

Most candidates only considered the question from the perspective of retail customers and not commercial customers.

- Green Leaf has multiple credit products that could be used to facilitate credit for these installations. Customers will have the option of applying for and using the credit as they would for any other use case, or the customer could specify the application is in lieu of a solar installation (which might result in a more favourable rate and credit scoring outcome).
- Access to finance: customers who need the savings from the solar system and/or the business resilience afforded by solar would benefit from access to specific solar finance should they not qualify for alternative finance.
- Liquidity: customers may prefer to retain the liquidity afforded by the current credit lines and explicitly seek further debt to optimally gear their business.
- Interest cost: Funds available in a secured agreement (the mortgage) is likely to be available at lower interest rate as opposed to an unsecured loan agreement as the solar finance likely would be
 - This interest benefit needs to be evaluated against any costs associated with re-arranging a mortgage bond
- Total cost of credit: while longer dated credit lines, like a mortgage bond, may result in lower monthly costs, the total cumulative cost may not be a desirable client outcome in context of the expected life of the solar installation
- Convenience: clients with revolving credit lines (card or overdraft) may prefer the convenience of using these facilities, be it likely at a higher cost