<u>**Coding Test**</u>

Problem Statement

You work for a UK bank based that has an outstanding pool of residential mortgages and wants to understand how much credit support they should keep to cover any losses. You as an analyst are tasked with the calculation of this figure.

To calculate the credit coverage required, you need to calculate the weighted average foreclosure frequency ($WAFF$) for the loan pool (i.e. the number of loans that are expected to default), and the weighted average loss severity (the loss that the bank will suffer due to foreclosures) *(WALS)*. The credit support required will be the product of the above two factors ($CC = WAFF \times WALS$). So, if for a mortgage pool of $100 million, if we expect 12% of loans to default, and 50% of loss per defaulted loan, then the support required would be $12\% \times 50\% = 6\%$ of 100 million, i.e. 6 million.

The historical trend suggests that the WALS (weighted average loss severity) for the given pool should be taken as 40%. You need to now calculate the WAFF (Weighted Average Foreclosure Frequency) for the loan pool using the criteria developed by the SMEs which is presented below.

Instructions

You are free to code in either R or Python and free to use any libraries that you may require.
You need to submit your script (it could be .R or .py file or a RMD / Jupyter notebook file ONLY) that will take the sample dataset provided and give the required credit coverage for the given pool.
Please get in touch if you need any clarifications on the assignment.

WAFF Calculation

Start with the assumption that the base foreclosure frequency for a hypothetical loan pool is 12%. From here on, we examine the given pool and make adjustments to this base foreclosure frequency. (Thus $ff_i = 12\%$)

$$WAFF = \min\left(100\%,\ \left(\frac{\sum_{i=1}^{N} ff_i \cdot adjusted.bal_i}{\sum_{i=1}^{N} adjusted.bal_i}\right) \cdot small\ pool_{adj}\right)$$

where

$WAFF$:	Model output, weighted average foreclosure frequency
ff_i :	Loan level foreclosure frequency of i-th loan in the pool
N :	Number of loans in the pool
$adjusted.bal_i$:	Adjusted current balance of i-th loan
$small\ pool_{adj}$:	Small Pool Adjustment

The foreclosure frequency for a particular loan i will be calculated by taking the base ff and multiplying it with all the adjustments.

$$ff_i = \left\{min\left(100\%,\ ff_{base} \cdot \prod_{k=1}^{K} factor_{i,k}\right)\right.$$

The following 4 adjustment factors need to be calculated for each loan to calculate the ff_i. We use the following notation to describe each adjustment below:

Convention:

$$variable = \begin{cases} value1 & condition1 \\ value2 & condition2 \\ value3 & condition3 \end{cases}$$

This equation is equivalent to:

If *condition1* is true, then *variable* = *value1*
Else if *condition2* is true, then *variable* = *value2*
Else if *condition3* is true, then *variable* = *value3*

1. Property Occupancy Adjustment

This is an adjustment factor that penalizes mortgages that are taken for non-primary homes:

$$occupancy.type.adjust_i = \begin{cases} 1.2, occupancy.type_i = \text{sh (Second home)} \\ 1.3,\ occupancy.type_i = \text{"}btl\text{" (But to Let)} \\ 1, otherwise \end{cases}$$

where

$occupancy.type.adjust_i$: Property occupancy adjustment factor
$occupancy.type_i$: Property occupancy type of *i*-th loan

2. Payment Shock Adjustment

Loans that are exposed to a possible payment shock such as a loan with compulsory switch from a fixed to a floating interest rate, an amortizing loan with a discounted promotional interest period, typically attracts an adjustment. An adjustment factor is applied as given by:

$$payment.shock.adjust_i = \begin{cases} 1.5\ , interest.product_i = \text{"discount"}\ \&\ payment.shock.time_i = \text{"le6m"} \\ 1, otherwise \end{cases}$$

where

$payment.shock.adjust_i$: Payment shock adjustment factor
$interest.product_i$: Interest rate product of *i*-th loan
$payment.shock.time_i$: Time since the interest switch date of *i*-th loan, see

$$payment.shock.time_i = \begin{cases} \text{"pastgr6m"}, \\ (int.switch.date_i \neq \text{"1970-01-01"})\ \&\ \left(\frac{asofdate - int.switch.date_i}{365}\right) \cdot 12\ > 6 \\ \text{"le6m"}, \\ (int.switch.date_i \neq \text{"1970-01-01"})\ \&\ \left(\frac{asofdate - int.switch.date_i}{365}\right) \cdot 12\ \leq 6 \\ \text{"missing"}\ , otherwise \end{cases}$$

where

$payment.shock.time_i$: Time since the interest switch date of *i*-th loan
$asofdate$: 31/03/2020
$int.switch.date_i$: Interest rate switch date of *i*-th loan

3. Geographic Concentration Adjustment

We assume that loans are diversified geographically. When loans are concentrated in some regions, a penalty is applied to the loans in these regions. The geographic concentration for a given region 's' is calculated by:

$$geo.concentration(s) = \frac{\sum_{i=1}^{N_s} adjusted.bal_{i,s}}{\sum_{i=1}^{M} adjusted.bal_i}$$

where

geo.concentration(s):	Geographic concentration measure of region 's'
$adjusted.bal_i$:	Adjusted current balance of *i*-th loan, see
$\sum_{i=1}^{N_s} adjusted.bal_{i,s}$:	Total adjusted current balance for loans in the region 's', N_s is the number of loans in the region 's'
$\sum_{i=1}^{M} adjusted.bal_i$:	Total adjusted current balance of the pool, M is the number of loans in the pool

Where a loan is in a region that has a concentration greater than 20%, apply an adjustment of 1.5

$$Geographic.Adjust_i = \begin{cases} 1.5, & geo.concentration(s) > 20\% \\ 1, & otherwise \end{cases}$$

4. Small Pool Adjustment

When a pool has fewer than 250 loans, an adjustment is applied on the pool level. The adjustment multiple is given by:

$$small.pool.adjust = \begin{cases} 40 & N = 1 \\ \dfrac{16.0839}{\ln(N)} & 1 < N \leq 250 \\ 1 & N > 250 \end{cases} \qquad (2.1.41)$$

where

$small.pool.adjust$:	Small pool adjustment factor
N :	Number of loans in the pool
ln (.) :	Natural logarithm function

Credit Coverage Requirement

Finally, the credit coverage required is calculated as mentioned before

$$\boxed{CC = WAFF \times WALS}$$

where

CC : Credit Coverage of the pool

$WAFF$: Weighted average foreclosure frequency

$WALS$: Weighted average loss severity

Note: *Please note that the entire case study & its data have been manipulated with random numbers and have no relation with the actual data whatsoever. Please do take any assumptions, if deemed necessary at your end and mention the assumption taken in your solution sheet. We expect you to complete the case study well within 2 hours of time. We wish you all the best for your hiring process at CRISIL*