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Introduction

The purpose of this report is to provide information enabling optimal credit risk management in the bank. It is a summary of the analysis carried out with the use of SAS tools and presents in an accessible way data allowing to assess the stability of the portfolio. The presented graphs and forecast are a source of knowledge on the basis of which the persons managing the credit risk policy in the bank will be able to build strategies with a much higher probability of implementation. The use of data processing methods and statistical analysis enabled full automation of complex reporting processes.

The risk of the bank's credit portfolio was decided to examine in terms of the nature of retail loans granted - cash (css) and installment loans (ins) as well as delays in loan repayment of 3, 6, 9 and 12 months in the form of the percentage of unpaid installments (quantitative vintage) or the amount of unpaid installments (quantitative vintage). The analysis was carried out for the entire credit portfolio as well as due to significant characteristics of borrowers. The calculations were based on data from the Bank's internal databases covering the period of two years from 2006-01 to 2008-12.

Data preparation

Available variables characterizing the client's profile as well as other data categories (app_: , act_:, ags:, agr:,) are either nominal or continuous. In case of continuous variables, it was necessary to categorize them using the decision tree with respect to variable 0-1 vintage indicating the client's debt level, which depends on the month in which all loans were disbursed, the number of months after disbursement and the minimum number of delayed installments set at 1, 2, 3. The initial assumptions for the categorization of variables were arbitrarily set maximum 3 categories of the variable as well as a minimum percentage of 5% of observations in one leaf of the decision tree. The selected algorithm of decision tree id3 divides the set based on entropy, i.e. the average amount of information carried by a single message, where the weights are the probabilities of occurrence of values 0 and 1 for vintage variable.

In the next step, using the V-Cramer coefficient, the 5 most powerful vintage variables from each category were selected. They were used to perform vintage analysis and to create reports showing risk distribution for both products and categories of individual variables.

Algorithm for selecting the most important results

The selection of the most important reports was an important step in the analysis, as in the first stage a total of nearly 500 reports and graphs were generated showing the risk distribution for both products taking into account the whole credit portfolio as well as the categories of individual variables. The algorithm consists in assigning appropriate identifiers to tables and names of generated documents for easier searching. The indicator takes a value of 1 or 0, depending on whether the condition concerning the variable class and vin value is met. In this way, the set of reports suitable for further analysis has been reduced to such an extent that arbitrary selection can be made, and based on the V-Cramer value.

Reports and graphs

On the basis of the presented algorithm for selecting the most important results, the generated reports were analysed. For the whole credit portfolio for due=3, vintage volatility was significantly affected:

● '1_ACT_CALL_ACP5Y_'A'_'ins' OR 'css'_3' - the number of all accepted applications within 5 years <=12. The risk for this group is much higher than for the entire portfolio, for all analysed periods it is more than double.

● '1_ACT_CALL_ALL5Y_'A'_'ins' OR 'css'_3'- number of all submitted applications within 5 years <=14. The risk for this group is also twice as high as for the entire portfolio.

● '1_APP_INCOME_'B'_'ins' OR 'css'_3' - income between 544 and 1229. In this case the risk is slightly higher (less than 1%).

● '1_APP_INSTALLMENT_'C'_'ins' OR 'css'_3' - Installment > 207. Same situation, risk higher by about 1%.

● '1_APP_LOAN_AMOUNT_'C'_'ins' OR 'css'_3' - Credit amount > 4980. The risk is approximately 3%.

For a cash loan only, the number of children was important. In the case of borrowers without children ('1_0_APP_NUMBER_OF_CHILDREN_'A'_'css'_2'), the risk is slightly lower for the whole portfolio.

For instalment loans, significant predictors are:

● '1_0_APP_INSTALLMENT_'C'_'ins'_2'- instalments greater than 228, the difference in risk is on average 1-2 percentage points greater,

● '1_0_APP_LOAN_AMOUNT_'B'_'ins'_1' - the vintage amount for customers with revenues between (3072, 8376) is twice as low,

● '1_0_APP_NUMBER_OF_CHILDREN_'A'_'ins'_2' - risk overlap.

Forecast

The following section of the report presents a forecast of vintage3 for 12 months - i.e. how many percent of customers will have a minimum of 3 outstanding instalments after 12 months.

The ARIMA model was used for the forecast. The models of this class are suitable for modelling stationary and non-stationary series, reduced to stationary. They use the phenomenon of self-correlation, i.e. the relationship between the value of the forecast variable and the value of the same variable delayed in time. That is, from historical vintage3 data its future values will be determined.

ADDITIONAL ASSUMPTIONS TO THE TASK:

The choice of the prediction model was made taking into account the macroeconomic situation in Poland. On the basis of the current Financial System Stability Report published by the National Bank of Poland, conclusions can be drawn about the stability of the banking sector in Poland. The analysis stressed that domestic financial markets function smoothly and the credit cycle is at the turn of the recovery and expansion phase. For the banking sector as a whole, the quality of the portfolio is gradually improving, with a large portfolio of foreign currency mortgages being a weak point for many commercial banks. To sum up:

The burden on banks' performance due to credit risk costs has not changed significantly recently, which gives grounds for using historical models in the prediction,

● There are no foreign currency mortgages in the analyzed portfolio, which are currently the most risky.

APPLICATION OF PROC ARIMA

The basis for the preparation of the ARIMA model giving reliable results is the examination of non-stationarity and seasonality, i.e. identification of P and Q parameters. For this purpose, the AUTOREG procedure and the MINIC method were used.

FORECAST RESULTS

The quantitative Vintage of the entire portfolio for due 3 will remain stable at 8.2-8.4% over most of the forecast period, falling below 7.8% in the last month of 12.2018. At the same time, the volume Vintage of the due 3 portfolio will average 1,440,000, rising to 1,470,000 last month despite the decline.

2 The volume and volume Vintage of the entire portfolio for due 1 is characterised by significantly higher volumes and fluctuations. The observed trends as in the case of vin3 are characterised by stability over the period under review and a decrease in volume and volume Vintage and increase in volume Vintage in the last month of the forecast.

The quantitative Vintage of the product 'css' for due 3 will show significant fluctuations between 15-17% over the forecast period. As predicted, its value will eventually fall below 15%, but it should be noted that this still indicates a high percentage of outstanding loans and high risk. The total outstanding liabilities on this account will be relatively stable and will oscillate around 1,000,000.

The quantitative Vintage of the 'ins' product for due 3 will only amount to just over 3.4% at the end of the period under review, also in the previous months remaining at a low level of about 3.5%. The quantitative Vintage of the product 'ins' for due 3 will increase by 9.5% but will still be only 460,000.

Conclusions and recommendations

On the basis of the results of the forecast and the analysis of selected variables, conclusions were drawn and the following actions are recommended:

A decrease in statistics taking into account the number of loans with delays while increasing the value of these loans suggests that greater stability of the portfolio could be achieved by increasing the restriction of granting loans with higher amounts.

Cash loans show a higher risk level and less stability over time than instalment loans. A comparison of the two available products, i.e. cash loans (css) and instalment loans (ins), clearly shows a better performance of the latter. Therefore, it may be beneficial to increase marketing efforts to promote instalment loans and at the same time tighten the criteria for granting cash loans.

In conclusion, according to the theory of portfolio diversification, the effective portfolio is the one that gives the highest rate of return at a given risk or the one with the lowest risk at a given rate of return. Taking into account the favourable financial situation on the banking market and the results of the analysis and forecasts which say that, although fluctuations over time, smaller or larger depending on the product, are forecast, relative stability of the portfolio over time is expected. It is recommended that the bank should focus its activities on increasing the scale of installment loans, while reducing the amount of granted cash loans, generating greater fluctuations in the entire portfolio. This will ensure a guaranteed rate of return with reduced risk.

For both cash and installment loans, it is recommended to limit the number of loans granted to the segment of applicants who have submitted at most 14 applications in the last 5 years, of which a maximum of 12 were accepted. The risk in this group is

twice as high as for the entire portfolio. Moreover, the number of granted loans should also be reduced to applicants with income lower than 1229, applying for loans above 4980 and whose instalment will be higher than 207.

In the case of cash loans, it is acceptable to increase the number of granted loans to applicants who do not have children. On the other hand, in the case of installment loans, it is allowed to increase the number of loans granted to applicants with income in the range (3072, 8376) - this is a segment of customers, among whom there is a similar percentage of customers with debt to the whole portfolio, whereas they decide to have significantly lower loan values (and to unite installments), which translates into a twice lower amount vintage ratio than for the whole portfolio. It is only when the instalment amount exceeds 228 that the risk is higher than for the entire portfolio.

Due to the fact that, as a rule, instalment loans are more suited to the characteristics of particular groups of customers, one of the proposed ways of reducing risk in the portfolio is to set individual loan amounts, number of instalments or repayment period.

To sum up, according to the theory of portfolio diversification, the effective portfolio is the one that gives the highest rate of return at a given risk or the one with the lowest risk at a given rate of return. Given the favourable financial situation on the banking market and the results of the analysis and projections carried out, which say that although fluctuations over time, smaller or larger depending on the product, are forecast, relative stability of the portfolio over time is expected. It is recommended that the bank should focus its activities on increasing the scale of installment loans, while reducing the amount of granted cash loans, generating greater fluctuations in the entire portfolio. This will ensure a guaranteed rate of return with reduced risk.