

Integration Of Company's Financial Data In Credit Risk Assessment Using A Multidimensional Model

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Abstract: *This paper is a detailed overview from theoretical and practical perspectives of a scoring system used by a financial institution in assessing the credit risk of a corporate client. The objective of this research was to demonstrate the importance of a scoring system for a credit institution when approving a loan application of a potential borrower. The complexity and importance of the topic makes it a subject of high interest for all type of credit institutions.*

We believe that through this work we were able to bring into discussion only a part of the specific issues related to credit risk management scoring systems and we believe that this work represents a support for future research.

Key words: credit risk, scoring, multidimensional model, database, application, corporate clients.

JEL Classification: G2 Financial institutions and services

1. Introduction

Lending is a core part of banking operations. The loan portfolio holds 50-80% of the assets of a commercial bank, being its main source of revenue and profit. Therefore, performance and risk in lending activity becomes a key component of the market mechanism.

How risk is a general attribute of investments, the lending activity involves a lot of risks and assuming them becomes inevitable and justifies the existence of banks. Taking into account risks such as credit risk, interest rate variation on market risk, currency risk, country risk etc., a bank needs to develop procedures and processes which mitigate the losses associated with these risks. The most important of all banking risks associated with the lending activity is the credit risk, which is defined as the risk of incurring losses arising from the possibility that a counterparty, borrower or an issuer of a financial obligation (bond, note, lease, installment debt etc.) is not able to repay interest and/or principal or any other amount due on a timely basis (also known as Default Risk).

Nowadays there are known and applied many credit risk management techniques, from traditional techniques as exposure assessment, to limit excessive concentration on debtor, business sector or industry level, to new management techniques, such as transactions with swaps and options, adapted to this type of risk¹.

But focusing on credit risk management should not be only a compliance exercise for

¹ Basel II Pillar 3 Disclosure as at December 31, 2009 – UniCredit Group, https://www.unicreditgroup.eu/content/dam/unicreditgroup/documents/en/investors/third-pillar-basel/Basel_II_Disclosure_-_Pillar_III_-_December_31,_2009.pdf, accessed on April 6th, 2015

banks, but also as a way of improving the overall performance and secure a competitive advantage.

2. Banking and credit risk - Theoretical aspects

Credit risk is the primary cause of bank failures.

Credit risk is presented in two main forms: default risk and spread risk. Default risk - the risk that the borrower may not want or may be unable to fulfill its contractual obligations (interest and principal payment) in part or in full. The spread risk - the risk that the market value of the credit to decrease due to changes in credit worthiness. Such situations arise when the counterparty's rating deteriorates significantly as compared to the moment of granting the loan.

Credit risk is calculated based on the potential loss of the loan portfolio, which can be expected and unexpected losses.

Expected losses show the size of losses from lending, which the bank predicts in its loan portfolio on a certain time period. Based on historical data on default probabilities and loss associated to customers classified in certain risk categories, the credit institution can estimate the expected loss of the loan portfolio at a certain moment in time. Expected loss is a cost of lending activity and will be covered by the price of credit (interest, fees) and the degree of provisioning.²

Unexpected loss measures the volatility or the maximum loss of the loan portfolio at a given confidence level (usually between 95% and 99.9%) and a specific time horizon. Unexpected loss will be covered from own resources of the bank. The economic capital of the credit institution must allow covering

² Ioan I. Trenca, Annamaria Benyovszki, "Riscul portofoliului de credite bancare", 2011.

the unexpected losses without affecting the financial stability of the institution.³

Credit Risk Management

According to Stephen Kealhofer, “until the 1990s, corporate credit analysis was viewed as an art rather than a science because analysts lacked a way to adequately quantify absolute levels of default risk. In the past decade, however, a revolution in credit-risk measurement has taken place”⁴.

In order to be effective, the credit risk management must begin with gaining a complete understanding of a bank’s overall credit risk by viewing risk at the individual, customer and portfolio levels.

Credit assessment process has two dimensions: a quantitative dimension and a qualitative one. The quantitative dimension of credit analysis is based on specific activities such as collecting, processing and interpretation of all information on a debtor a financial institution can access. A bank will use the financial data analysis, forecast of future development of a borrower’s activity, repayment capacity assessment through analysis and forecast of future expected flows of revenues and expenses, evaluation debtor’s ability to withstand shocks. The results of these activities are relatively easy quantifiable. Qualitative analysis involves gathering and updating information relating to financial responsibility of the debtor, determining the real purpose of the loan, identifying risks the borrower may face and estimating the debtor’s seriousness and commitment.

Many forms of credit risk — especially those associated with larger institutional

³Idem.

⁴ Stephen Kealhofer, “Quantifying Credit Risk I: Default Prediction”, 2003, pg. 1.

counterparties — are complicated, unique or are of such a nature that it is worth assessing them in a less formulaic manner.⁵ Even if complex mathematical and econometrical systems are used by the banks in computing credit scoring for clients, the final decision is taken by a person, called credit analyst, which will review the information about the counterparty⁶.

The measurement of credit risk has changed dramatically in the past few years. Among those changes have been the development of early warning systems for default, the evolution of a portfolio approach to credit risk, the development of new models to price risk, and the development of better models to measure the risk of off-balance-sheet loans.

The main activities involved by the credit risk management are the followings:

- a. “Measuring the extent and resources of exposure;
- b. Charging each position a cost of capital appropriate to its risk;
- c. Allocating scarce risk capital to traders and profit centers;
- d. Providing information on the firm’s financial integrity to bank’s external parties, such as regulators, rating agencies and investors
- e. Evaluating the performance of profit centers in light of the risk taken to achieve profits
- f. Mitigating risks by various means and policies.”⁷

⁵ Risk Encyclopedia, “Credit Risk”, http://www.riskencyclopedia.com/articles/credit_risk/, accessed on April 8th, 2015

⁶ Ibidem

⁷ Duffie Darrel, Singleton J. Kenneth, “Credit Risk: Pricing, Measurement and Management”, Chapter 2

According to E.I. Altman and A. Saunders in "Journal of Banking & Finance", "one approach is the univariate accounting based credit-scoring systems, in which the credit institutions' decision-maker compares various key accounting ratios of potential borrowers with industry or group norms. When using multivariate models, the key accounting variables are combined and weighted to produce either a credit risk score or a probability of default measure. If the credit risk score, or probability, attains a value above a critical benchmark, a loan applicant is either rejected or subjected to increased scrutiny."⁸

Models of credit risk

Credit scoring, one of the most successful application of data mining, is traditionally assessed from a binary classification perspective. Classification or regression methods are used to create a system that generates a numerical output (a score) representing the probability of a borrower being a "good" or "bad" (1 or 0 in binary system) credit risk over a given forecast horizon. Good credit risks are those that repay their debt to the terms of the agreement, bad credit risks are those that default or display otherwise undesirable behavior.

Rating is a usual method for assessing the creditworthiness of potential customers. The method consists in assessing a grade of the applicant's attributes, which are then aggregated into an overall score. In accordance with the requirements of Basel III the rating system of a credit institution shall include: comprehensive assessment of borrower's characteristics and of the loan facility

⁸ E.I. Altman, A. Saunders, "Journal of Banking & Finance - Credit Risk Measurement: Developments over the last 20 years", 1997 .

requested, meaningful differentiation of risk and the granularity of the rating scale, reasonable accuracy and consistency over time of the quantitative estimates used for measuring the credit risk.

There are several scoring methods that could meet regulatory requirements, of which the most common are heuristic analysis and statistical models. Heuristic analysis is based on the information structured by the practical experience (expertise, knowledge) of credit analyst in assessing the capacity of loan applicant to reimburse the loan. Statistical models involve finding a functional relationship between a binary dependent variable (default) and a number of independent variables with discriminatory power. Once found, this relation applied to a given borrower allows forecasting his future situation, i.e. if it will be, or not in default at a certain moment in time. The most important approaches to statistical models are linear discriminant analysis, logistic regression, neural networks and survival functions such as "Cox proportional hazards".⁹

3.Application CISS (Credit Institution Scoring System)

Unlike commercial rating systems that are intended to mark the companies in a general sense, the rating systems used by credit institutions intend to evaluate a loan application, with the purpose of predicting the loan probability of default.

Until a few decades ago, the decision to grant or deny a loan was taken by credit analysts from banks based on personal knowledge. Success or failure in such an

⁹ Moinescu Bogdan, Codirlasu Adrian, "Strategii si instrumente de administrare a riscurilor bancare".

action would depend on how well the creditor known the potential customer and how much trust had in it. However, with time, the bad experiences of banks failures, along with the regulatory pressure from authorities, forced banks to extend this practice to a less personal appreciation, but still a subjective one.

Nowadays, banks besides the financial analysis prepared on the basis of the latest financial statements of the client, will also be interested to obtain as much information as possible from authorized sources about the loan applicant's management and marketing activity.

The most important objective of credit risk measurement analysis is to gain knowledge from past periods about the client in order to be able to accurately forecast its development and future performance.

Scoring systems vary from one bank to another and their complexity depends on one hand on the dimension of the credit institution and on the other hand on the risk profile and credit risk management approach it undertakes.

The IT system designed is named **CISS** (Credit Institution Scoring System) and it fulfills some of the features of a credit scoring system used by financial institutions when rating loan applicants. It is intended to support credit decision and grow profitability. Use of this system will increase the speed and quality of lending decisions, with direct impact in the financial service quality and cost of credit.

We developed **CISS** as a web application using HTML + MySQL + PHP solutions due their advantages, such as:

- friendly interface and easy integration of the database in the web application;

- application security;
- gratuity of the products;
- the possibility to create a well-structured application, easy to develop and maintain;
- the possibility to optimize the databases.

Due to its characteristics, the support provided by PHP language interacting with a MySQL database server offer a rapid solution for creating dynamic Web sites.

To obtain dynamic pages with rich content, a valid solution is the use of databases. The information will be extracted from the database according to specific user needs and then formatted in order to be properly displayed. Also, a web application allows the user to insert relevant information in the database, which is stored on a server.

Among the most important features of **CISS** system are the followings:

- fast and reliable processing of large volumes of data;
- friendly interface;
- easy access of menus;
- preconfigured reports which give a good image about the borrower's past performance;
- system responds to credit institution's needs in terms of qualitative lending decisions.

The **CISS** system was developed in order to assess loan applications based on a combined score obtained from the followings:

- a quantitative score (a number from 0 to 100) with a weight of 50% in the final combined score;
- a qualitative score (a number from 0 to 70) with a weight of 30% in the final combined score;
- a Loan-To-Value score (a number from 0 to 100) with a weight of 20% in the final combined score.

Thus, the combined score of a loan applicant will be a number between 0 and 91, with the average being a score of 46.

A loan applicant obtaining less than 45 present high credit risk and the credit institution will refuse its credit application. A loan applicant obtaining a combined score between 46 and 75 still present important credit risk and loan officer should request additional collateral (i.e. increase its Loan-To-Value) and, if the borrower will be have the possibility to fulfill these new conditions, the assessment should be reformed. A loan applicant obtaining a score above 76 should not be considered risky and the lending will be approved.

Financial scoring

The financial scoring will be computed based on the financial performance determined by computing a set of financial indicators with the data extracted from borrower's financial statements. Based on these financial statements, the credit analyst performs a ratio analysis for determining overall financial condition of a customer's business. Generally, financial ratios are calculated for the purpose of evaluating aspects of a company's operations and fall into the following categories:

- liquidity ratios gives a measure of the firm's ability to respect its current obligations: Working Capital Ratio, Quick Ratio;
- profitability ratios indicates management's ability to have a control over the company's expenses and to earn a return on the resources committed to the business: Return On Sales, Return on Assets, Gross Profit Margin;
- leverage ratios indicates how well are protected the suppliers of long-term funds

and also if the firm is able to raise and pay on time additional debt: Total Debt to Assets, Capitalization Ratio, Debt to Equity Ratio, Interest Coverage Ratio, Long Term Debt to Working Capital;

- efficiency, activity or turnover ratios measure the management's ability to control expenses: Cash Turnover, Receivables Turnover in sales days, Inventory turnover, Payables Turnover (days).

These financial indicators will be computed based on the latest annual financial statements of the loan applicant or, in some cases, even bi-annually or quarterly approved financial statements.

Based on the historical data collected and general market trends, the credit institution will set some scoring intervals for the financial indicators computed. The CISS system will determine the assigned score of each indicator in order to compute the aggregated financial score.

The scoring intervals for each financial ratio are determined considering the industry's good practice, for example a working capital ratio below 1 indicates a negative working capital and could indicate short term liquidity problems, while a ratio above 2 means that the company is not investing excess assets or a interest coverage ratio of 1.5 or lower indicates that a company's ability to meet interest expenses may be questionable, while a ratio less than 1 may indicate that the company is not generating sufficient revenues to satisfy its interest expenses.

Qualitative scoring

The credit institution also focuses on some qualitative criteria, related to the management competence, the attitude of the

debtor toward bank, the quality of planning and controlling, the state-of-art of equipment and the market position of the company.

The qualitative factors considered in CISS are:

- Management's education or experience or competence or intuition, assessed by the credit analyst from valid sources;
- Information policy towards bank: company's willingness to provide information to the credit institution regarding its past, current and future activity;
- Accounting / Planning: relevant information for the credit institution regarding the accounting and planning activity of the potential borrower will be the use of forecasts in order to manage the company.
- Quality of Planning / Controlling: how well the management forecasts were achieved.
- State-of-the-art equipment: how modern and how well are maintained the equipment used by the company in order to produce the goods or services.
- Market development: the future development of the market on which the company performs its activity, especially information regarding the market development of the debtors significantly in comparison with the general market development / GDP increase.
- Market position: recognition / brand reputation as a result of marketing efforts, potential development opportunities, possibility to extend and diversify, the company's market reputation.

Collateral Scoring

Loan-To-Value (LTV) represents the ratio between the mortgage value and the loan

amount requested by a potential borrower. The credit analyst will be interested in the Loan-To-Value ratio, considering that, in case of a default, the lender will have a better chance of selling the mortgage in foreclosure for at least as much as they are owed.

Application use

The web application CISS has 3 main functionalities:

1. **Borrowers:** module in which the credit analyst can insert a new potential customer or update the information of an existing borrower. Main information to be included relates to: client name, tax identification number, NACE code, size, group, initial loan value in RON, loan current exposure in RON.

2. **Scoring:** module in which the credit analyst introduces the financial and qualitative information for a borrower and the system automatically computes the scoring. The credit analyst will introduce based on the latest financial statements of the borrower the main financial statements lines (e.g. fixed assets, inventories, receivables etc.) and will assess based on the information gathered from valid sources the qualitative characteristics above-mentioned. The collateral pledged in favor of the bank, including its type, its description and the market value assessed by an independent valuator will also be inputted in this module.

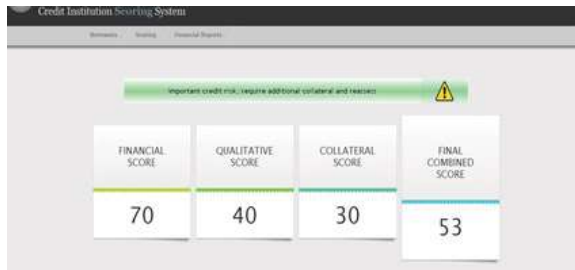
After pressing the "Compute scoring" button, the system will automatically compute the financial, qualitative, collateral and combined final scoring.

Figure 1 – Low credit risk

If the final combined score is above 76, the credit risk is assessed as low and the lending should be approved (as shown in Figure 1).



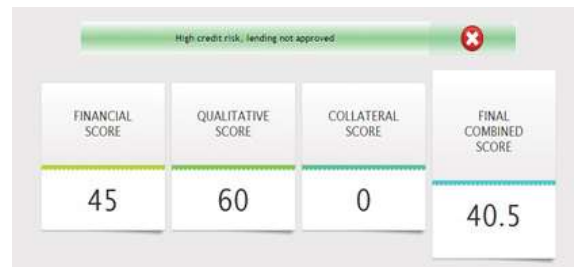
Figure 2 – Medium credit risk



If the final combined score is between 46 and 75, the credit risk is assessed as significant and the credit analyst should require additional collateral from the borrower and reperform the analysis (as shown in Figure 2).

Figure 3 – High credit risk

If the final combined score is below 45, the financial condition of the borrower is weak and approving the loan will significantly bring an important credit risk to the financial institution, so it shouldn't be approved (as shown in Figure 3)



3. Financial Reports: module in which the credit analyst can observe the variation of the main financial statements lines from one period to another. The user will select the borrower and the period under analysis and the

system will display a report which compares and compute variations on the main financial statements lines, as shown in Figure 4:

Figure 4 – Report on evolution of main financial statements lines

FSDate	2012-12-31 00:00:00	2013-12-31 00:00:00	Variation %	
FixedAssets	116228	96414	-17.05%	➡
Inventories	36691	44392	20.99%	⬆
Receivables	119479	126192	5.62%	➡
OtherAssets	6103	8340	36.65%	⬆
LiquidAssets	921	10592	1050.05%	⬆
OwnersEquity	28271	35548	25.74%	⬆
LongTermDebt	38715	20974	-45.82%	⬇
ShortTermDebt	81632	91775	12.43%	➡
AccountsPayable	100811	99166	-1.63%	➡
OtherPayables	40544	38465	-5.13%	➡
Revenues	517385	560018	8.24%	➡
CostOfSales	252445	304419	20.59%	⬆
OtherIncomes	11347	6944	-38.6%	⬇

Description of database

The CISS application benefit from a MySQL database model containing all the needed logical and physical design choices and physical storage parameters.

The main tables in the database are:

CLIENTS (**ClientID**, ClientName, TaxIdentificationNumber, NACECode, ClientSinceDate, ClientSize, ClientGroup, LoanInitialValueRON, LoanCurrentExposureRON)

FINANCIAL STATEMENTS (**FinancialStatementsID**, ClientID, FSDate, FSType, FixedAssets, Inventories, Receivables, OtherAssets, LiquidAssets, OwnersEquity, LongTermDebt, ShortTermDebt, AccountsPayables, OtherPayables,

Revenues, CostofSales, OtherIncome, Depreciation/AmortizationExpense, Taxandsimilarchargesexpense, Interestexpense, Otherexpenses, CITexpense)

FINANCIAL INDICATORS

(**FinancialIndicatorID**, FinancialIndicatorName)

QUALITATIVE INDICATORS

(**QualitativeIndicatorID**, QualitativeIndicatorName)

COLLATERALS (**CollateralID**, CollateralType, CollateralDescription, CollateralMarketValueRON, ClientID, LoanToValue)

CLIENTS FINANCIAL STATEMENTS INDICATORS

(**FinID**, FinancialStatementsID, FinancialIndicatorID, FinValue)

CLIENTS QUALITATIVE INDICATORS (**QindicatorID**, FinancialStatementsID, QualitativeIndicatorID, Qvalue)
 FINANCIAL INDICATORS SCORING (**FinScoringID**, FinancialIndicatorID, MinValue, MaxValue, Score, FlagColor)
 QUALITATIVE INDICATORS SCORING (**QScoringID**, QualitativeIndicatorID, QualitativeIndValue, Qscore, QualityColor)
 COLLATERALSCORING (**ColScoringID**, LTVMin, LTVMax, ColScore, CollateralID)
 CLIENT HISTORY (**HistoryID**, FinancialStatementsID, QualitativeScore, FinancialScore, LTVScore, CombinedScore)
 SCORING INTERVALS (**ScoringIntervalID**, MinScoring, MaxScoring, Status, HistoryID)

Conclusion and future research

This research is a proof of concept consisting of a web application named CISS (Credit Institution Scoring System). It was intended to fulfill some of the features of a credit scoring system used by banks or other credit institutions when rating the loan applications of corporate clients. The application was developed using HTML + MySQL + PHP solutions. The final output of CISS system is a combined score obtained as an aggregate of quantitative, qualitative and collateral scores.

In order to meet all the characteristics of a scoring system used in day-to-day activities by any bank or other financial institution, the system should be further developed in order to assist the analysis of private individual clients.

A private person requesting a loan from a financial institution is analyzed based on different indicators than a corporate client. For a private individual, are essential both financial and qualitative information.

A scoring system for private individuals will incorporate information such as:

- age of the potential borrower;
- education;
- work experience and current profession;
- employer's industry;
- available income amount and income source;
- indebtedness ratio;
- gender and marital status, etc.

Also, a complex scoring system like the ones used by large international banks are based on logistic regressions which are developed in order to have predictive power and differentiate between good and bad customers.

It is my intention to further develop the web application in order to meet all the characteristics of a scoring system used by large banks.

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