

Internal Model of Commercial Bank as an Instrument for Measuring Credit Risk of the Borrower in Relation to Financial Performance (Credit Scoring and Bankruptcy Models)

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Abstract

Commercial banks generally use different methods and procedures for managing credit risk. The internal rating method in which the client has an important position in the process of granting credit provides a comprehensive assessment of client creditworthiness. The aim of this article is to analyze selected theoretical, methodological and practical aspects of internal rating models of commercial banks within the context of models that measures financial performance and to make a comparison of results of real - rating models which are used in the Czech Republic and Slovakia. The results of the chosen credit scoring and bankruptcy methods on selected companies from segments of small and medium-sized companies are presented.

Key words: internal rating model, credit scoring and bankruptcy models, financial performance, quantitative and qualitative indicators, validation model, probability of default, calibration model, cut-off strategy

1. INTRODUCTION

Credit risk is the most important and also the biggest risk for commercial bank given its primary focus, which is the collection of deposits (partially guaranteed) and lending to individual economic entities (firms, households, state, foreign countries). This is the risk, where counterparty fails to fulfill its commitments; this means that the debtor doesn't return borrowed money on time and in full, including interest and fees. The amount of credit risk is determined by the ability and willingness of the contractors to meet its obligations.

By processing this article we have set a hypothesis, that the accuracy of internal rating models (in the term of final score of the company as a percentage of maximum possible score achieved) is less than 90%, various rating model bring different results and there are considerable differences between evaluations of company's financial performance by banks and by credit scoring, respectively bankruptcy models.

2 INTERNAL RATING MODELS TO MEASURE CREDIT RISK IN COMMERCIAL BANKS

2.1 The status, importance and classification of internal rating models for credit risk management

Internal rating models are used for credit risk assessments and they are an important part of credit risk management in commercial banks. These models, which are particularly important in process of risk measurement, have been developed very dynamically and have become an

essential part of credit risk assessment in banks.

Rating systems are used to determine the credit risk of individual borrowers. Using different methods, rating score is assigned to an individual borrower, and it indicates the degree of their creditworthiness. Simultaneously, aggregate risk of individual clients defines the appropriate capital requirement.

The aim of these models is the estimation of risk parameters (probability of default of the borrower, loss given default, exposure at failure), which depends on quantitative and qualitative explanatory variables.

In banking practice, bank's internal rating models are used for more objective approval of loans both through the inclusion of the client in a class rating and setting pricing of loans. Settings of adequate price of loan due to credit risk are determined by the cost of risk (which is calculated on the basis of credit rating and insurance of loan), by cost of refinancing, transaction and determined by requirements on evaluation of the bank's equity, which is earmarked for the particular lending business in terms of capital adequacy rules.

Using internal rating models for credit risk management in commercial banks became possible because of Basel II. Basel II has been used in banking practice of European countries since around 2002 and since 2007 they are used in banking practice in Czech Republic and Slovakia.

2.2 Basic requirements for internal rating models

Supervisory authorities define basic rules for use of internal rating models in the meaning of responsibility, purpose of the models and their use in banking practice. Quality is a primary liability for the bank as well as the way how to use internal rating models. Validation is fundamentally about assessing the predictive ability of bank's risk estimates and the use of ratings in credit processes. Validation should include quantitative and qualitative aspects and validation processes should be a subject to independent review. (Basel Committee on Banking Supervision, 2005, s. 4)

Generally, models for credit risk management have to fulfill a number of requirements.

Fundamental requirements for rating models are as follows:

- Model must be possible to calculate the probability of default.
- Completeness of the model – it must take into account all relevant information about creditworthiness.
- Objectivity – different analysis of rating models should come as similar result as possible by interpretations of different actors.
- Acceptability – rating models should assess the creditworthiness of borrower accurately.
- Consistency – different rating models should not contradict each other. (Oesterreichische Nationalbank, 2004, s. 54)

Technical requirements of the regulator (NBS, 2007, § 50-96):

- Internal rating models (IRM) include all methods, processes, monitoring, data sets and information systems, which support the assessment of credit risk, assigning exposures to classes or pools of risk quality and quantification of probability of default.

- Internal rating model has a rating scale (contained at least seven classes for non-defaulted borrowers and at least one class pro defaulted borrowers), which reflects the quantification of probability of default (PD).
- Bank is obligated to assign rating class to each borrower on the basis of marked and clear criteria, from which are derived the estimation of probability of defaults (PD) in credit approval process.
- Bank has to prove to regulator, that it has a good predictive ability using rating model. For bank it is necessary to establish a procedure for verification of inputs into the model, it proves to regulator the representativeness of using data set, and regularly verify accuracy of the rating model. Using statistical model must be supplement by expert estimates.
- Bank is obliged to implement appropriate stress testing procedure (to identify possible events or future possible changes in economic conditions that could have adverse effects on credit exposure and assessment of bank's ability to resist these changes) and perform stress tests to assess the effects of specific condition of credit risk on its capital requirements regularly.
- Inception of the default occurs in the moment when the bank will come to a conclusion that a borrower probably isn't going to fulfill its obligation correctly (if there are facts indicating probability of breach in this issue then bank doesn't pay interest on credit, bank doesn't make adjustment of outstanding debt's evaluation, bank will undergo the outstanding debt with significant economic loss, bank agrees with temporary debt restructuring and bank or borrower bid a proposal on failure etc).
- If the bank estimates PD with own data set (duration of historical data set has to be more than five years), bank has to prove, that it fill-ups internal rules of lending's procedure, and takes account time differences in rating systems. Bank has to compare realized PD with estimated PD regularly for each class and analyze appropriate differences of these quantities.
- All relevant aspects about IRS (internal rating systems) have to be confirmed by bank's statutory authority, which must be notified about substantial changes, variation and exceptions.
- Credit risk control department is independent from all other business departments in the bank and is responsible for testing and monitoring rating classes, completing appropriate analysis about IRS, verification and documentation of any rating system's changes, verification of rating criteria, monitoring of IRS and revision of rating models.
- Internal rating model of the bank must be audited at least once a year.
- As a part of agreement of IRS usage by any bank there are obligatory attachments of applications containing description of methodology and algorithms of exposure's classification, risk mitigation, calculation of risk weight and capital requirements.

Commercial banks implement different procedure in the process of credit risk management in relation to corporate and retail clients and they create different rating models for different segments and sub-segments, respectively, products.

2.3 Description of procedure for internal rating model's development and rating models used in banking practice

Each particular step of rating model's development is shown in Figure 1:

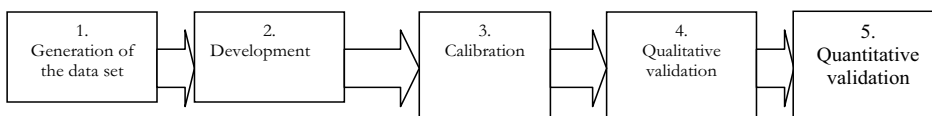


Fig.1 - Steps of rating model's development. Source: Oesterreichische Nationalbank, 2004, p. 61, revised

First step - data selection - begins by defining the time period; in which bank observe objective variables and financial indicators, which determine the creditworthiness of client in relation to particular customer segments or loan products.

Next step is data verification, which examines data cleansing by means of finding absent values in individual variables and by means of analysis of remote contemplation. For example: how many values are located in individual variables, or how high or what type of errors are involved. After defining development sample, this sample should be divided into two parts: first part, which contains 80% of all data, is used for development and validation of rating models. Second part, remaining 20 % of data, is used for testing of data quality in the model. This part of sample has to be completely independent. Introduced steps are based on statistical data analysis of individual characteristics and determine the predictive power and ability of dividing borrowers into good and bad.

Data analysis consists of two parts: *fine classing* – which means finding those characteristics that are most predictive for underlying variables and *coarse classing* – pooling attributes of variables into common categories. WoE (*Weight of Evidence*) is ability of each attribute to divide borrowers in good and bad and estimate the probability of good borrowers, respectively bad borrowers. If the value of WoE is highly negative, it means that the attribute of variable is high risk. If the value of WoE is highly positive, it means that attribute of variable is at low risk. If WoE is close to 0, we can't say unequivocally whether the attribute of variable is high or low risk. WoE serves as the basis for calculation of Information value. *Information value* is characterized by the ability to distinguish between good and bad borrowers. Information value is calculated for all variables accordance with new groups of data set and if these values haven't changed significantly, they can keep them for development. If the Information Value has changed significantly, then it is necessary to perform the coarse classing again.

Requirements for *empirical data* are the representativeness of data set (relevant for segment evaluation) and statistically significant amount of data and quality data (relevant to the model).

Model Development lies in creation and mathematical description of the relationship between objective variable and financial indicators. The final analysis of the rating model is based on expert assessments and statistical outputs.

Calibration of model is a method, which is focused on uniform, homogenous and clearly interpreted results of rating model. In this process, responsible value of rating score is assigned to

each value of probability of defaults, which determine the classification of loan (or the client) to appropriate rating category.

According to the study (Mitchell, J., Van Roy, P, 2007, p.13), the number of rating classes is more significant and relevant than the partial classification and number of rating classes is higher than seventeen bears witness to negligible effects.

In banking practice there dominates an opinion, that twenty classes is the maximum number of rating classes, but usually a lower number is used due to a better transparency. Our collaborating bank has used nine rating classes.

Validation is a rating model's random quality control (hold – out sample validation – is an independent sample with identical parameters; recent sample validation – validation of the current sample). Validation of rating model (qualitative validation) is focused on model design testing, data quality and internal test of model utilization. The quantitative validation is performed by back testing and stress testing of the rating models.

Significant factors of *stress tests* are analysis of portfolio components and general conditions, the completeness of risk factor model, extraordinary changes in risk factors, and the acceptance of rating model, reports, and definition of countermeasures, regular updates, documentation and approval.

Setting of *cut off strategy* means the decision, where the bank is accepting or isn't accepting the client in relation to credit risk. It is determined by calibrated score. In this decision – making process, it is necessary to find an acceptable level between the received applications and the potential risk. Simply because too strict approach of cut – off strategy's setting leads to loss of customers, which could be very profitable for the bank and too lenient approach of cut – off strategy's setting disproportionately increased credit risk of the bank (this approach could be deliberately selected for exact segment or product, for example consumer loans, credit cards, which are typically estimated by high interest rates).

After implementation of rating model, it is obligatory to establish a regular monitoring of rating model to determine whether performance of the rating model is in line with expectations. The main reasons for regular monitoring is control of predictive power of rating model, control of model stability and control of the received applications and expected potential risk.

In banking practice and theory, there are different methodological approaches to assess the client's rating have been used. According to the selected studies (Osterreichische Nationalbank, 2004, s.32), internal rating models are divided into heuristic models (rating questionnaires, expert systems, quality systems, fuzzy logic systems), statistical models (discriminant analysis, regression models and neural networks), causal models (option pricing model, cash flow model) and hybrid models.

Hybrid models are used in banking practice often. They are usually a combination of heuristics and statistical and causal models. *Horizontal combination of models* means combination of heuristic and statistical models, which represents the interconnection of quantitative with qualitative analysis. *Vertical combination of models* represents creation of the proposed model by quantitative and qualitative data and which is modified by credit experts. *Upstream method* is a combination of heuristic knock – out criteria (these criteria could be for example inclusion of the problematic borrowers into the blacklist) and statistical methods. The key element of this combination

is statistical model, which is passed though (is filtered) the knock – out criteria, which are defined by credit experts. If the potential borrower fulfills the knock – out criteria, credit rating doesn't continue downstream to statistical module.

Detailed description of each type of internal rating model is shown in the study of Oesterreichische Nationalbank in 2004. Detailed design of the rating model (financial and nonfinancial indicators and their weights) is business secrets and confidential and therefore to obtain relevant information about rating models is a big challenge for the academic field.

Fig.2 shows internal rating model of a real commercial bank (let's call it RFB). We received this rating model from the bank, which is operating in the Czech Republic and Slovakia. It is slightly modified and is used for area of small and medium - sized enterprises as well as in the credit approval process.

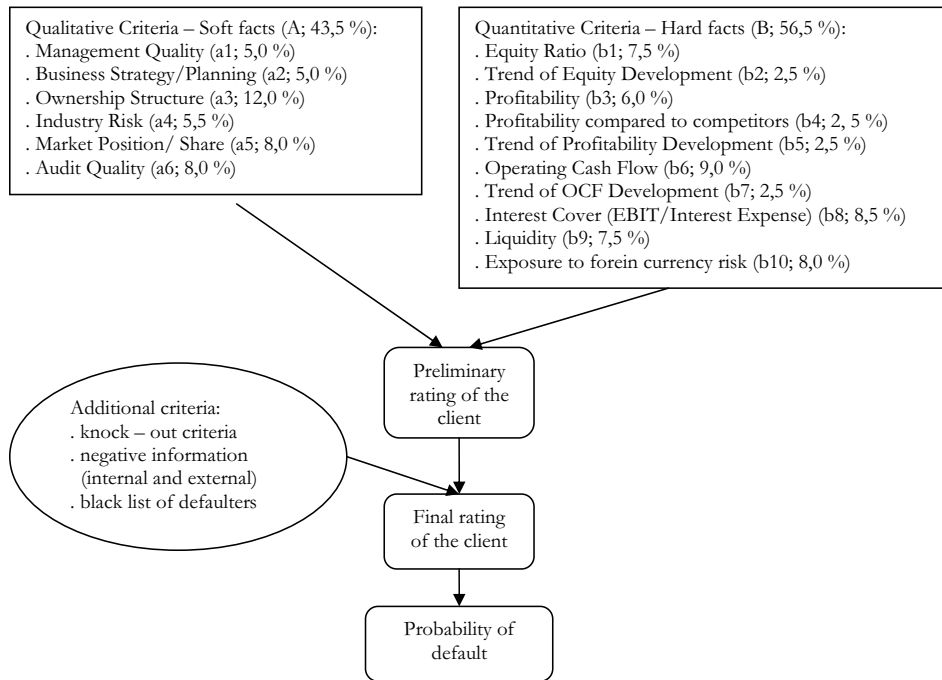


Fig. 2 – Qualitative and quantitative criteria and rating weights in the rating model of RFB. Source: Internal sources of RFB bank (revised)

$$R_c = (A + B) = \sum_{n=1} a_n \cdot w_n + \sum_{m=1} b_m \cdot v_m$$

where:

R_c – preliminary rating of the client (if there are additional criteria with zero weight, it is simultaneously the final rating of the client)

a_n – qualitative indicator of the rating

w_n – particular weights of qualitative indicators

b_m – quantitative indicators of the rating

v_m – particular weights of quantitative indicators

Quality of ensuring instruments and past experiences with client's credit discipline are important aspects, which are taken into consideration in rating process (credit reinsurance is taken into account, when loan is being approved and it affects the final loan conditions).

Bank applies the following rule in such rating process: bank attaches greater importance to the „hard facts“ in the rating model when the company is relatively large and „soft facts“ are operated more intense in the rating models for smaller company (personality of entrepreneur and its impact on the company's performance are very important indicators by assessing in small enterprises).

2.4 Criticism of internal models for credit risk management

Using rating models to manage credit risk is very sophisticated and „fashionable“ issue in banking sector of Czech and Slovak Republics. Despite well-known and advantageous benefits of the rating models, which are often judged as optimistic in the economic literature, we can present some weaknesses and respectively problems of the rating models as well as to point out, that using of rating models doesn't automatically mean eliminating or minimizing bank's credit risk from the client.

Previous analysis of internal rating model's focus, procedures, and requirements allows defining selected theoretical, methodological and practical imperfections that need to be minimized in such models by means of additional credit practices.

Main risk of each rating models is a model risk, which is associated with many factors such as errors in model design, its implementation, the model's inputs, respectively with usage of such a model. (Sivák, 2006, p.140 - 141)

Rating models of credit risk management are there to define and measure complex economic processes with different methodological approaches such as using of empirical, mathematical or statistical models, which are based on company's accounting data. The complexity of the economic system which is determined beside quantitative economic factors and important non-quantifiable variables such as attitudes, expectations and preferences of individual economic entities could not be shown properly even though these models are highly sophisticated and in the same time the weights of individual factors are variable.

These models work with accounting data. Criticism of traditional indicators for evaluation of business performance follows from the conceptual barriers between the market valuation of the company and performance measured by accounting data. Accounting policies and procedures have been developed for other purposes. (Pavelková, Knapková, 2005, p.39)

Rating models may have different methodological shortcomings as comes from technical complexity of this topic and technical parameters such as miscalculation of PD, wrongly specified individual indicator's weights, subjective evaluation of some indicators, indicator's misdirection, inappropriate application of outputs to credit procedures are required.

Risk management will always contain subjective elements. (Holman, 2009, p.3) For example a subjective change in the rating parameters is an actual problem as well as change in the final

rating of the client relates to the current problem in banking practice. This may cause that client will get worse rating with good financial performance but in another time period. Such an approach may seriously endanger the credibility of rating system and also quality of future cooperation with this bank's client. For example, our cooperating bank has changed the ratio of qualitative and quantitative criteria in rating model used by RFB from the original ratio of 43,5: 56,5% to 30:70%, as the impact of the current crisis. There are frequent cases, where the client with good performance is granted with higher risk level just because of changes in aggregate indicators of the industry, in which the company operates. This phenomenon is quite common issue in World's banking practice. The clear disadvantage of this approach is sweeping behavior towards the clients and pro-cyclical approach of credit risk management (low rate of individualization of loan products).

There are no perfect rating systems in banking practice (Deutsche Bundesbank, 2003, p.62) and their explanatory ability in relation to quality evaluation of the client is very limited. Some studies indicate existence of significant differences between outputs of individual models. According to Mitchell and Van Roy (Mitchell, Van Roy, 2007, p. 9), approximately 20 % of all analyzed companies had vastly different credit risk assessment, when they were assessed with different models, and that means that one rating model has assigned these companies to the rating class with bad borrowers and other rating model has put the same analyzed companies to the rating class with good borrowers. These results highlight that rating outputs must be treated carefully.

The internal rating calculating algorithm is practically unknown to all bank's employees and may be inaccurately configured or setup improperly, which could restrict the loan products of the bank when it is not necessary (the bank could refuse creditworthy clients, or would accept the default application, which means that bank can lose good borrower because of incorrect risk profile, etc.).

According to Ozdemir (Ozdemir, 2009, p.51), validation of internal rating models isn't a problem of the backstage. Validation is almost useless when it's limited only by technical performance tests with results, which would remain mostly in the validation group. That's why rating systems are typically used in the wrong way and mainly because of organization and business reasons. Understanding what is wrong and how to fix that means that bank would have to secure strict connection between validation's staff and other banking functions, which means the right mix of people in validation group that could communicate in the language of banking business.

Analyzed models are derived from the previous development of financial indicators in relation to particular segments (economic growth, stability and performance parameters of banking sector, the performance of corporate clients, incomes and employment of the client, property situation etc.). Such designed models aren't prepared to face the impact of different economic shocks, despite regular stress testing. At the same time, they are focused on short-term estimates of probability of default that means increased risk of long-term credit operations.

In the context of global financial and economic crisis, there is more and more critics coming from the professionals regarding risk management (pro-cyclicality of rating models, procedure approaches with the rating models etc.). (Holman, 2009), (Kráľ, 2009)

Stable financial system presents almost impossible and at least very difficult issue. Reason of this matter lies in imperfection of the current models of credit risk management, which give very unreliable results. The advanced usage of statistical models in order to measure and predict credit risk contributes to the growth of endogenous system's risk nowadays. They encourage pro-cyclical changes in the financial leverage of the bank and contribute to pro-cyclical tendencies of entire financial system. (Tózsér, 2010, p. 24)

Models for credit risk management are largely pro-cyclical, which means that they are too lenient in good times of economic growth and too hard in the worse period of economic downturn (some analysts say with some degree of exaggeration that these models work only if we don't need them), and so they may impair the development of bank's sector. This trend is confirmed by the knowledge gathered from the impact of financial and economic crisis. Before the crisis has started, many banks were pushing lots of loans to their clients but after its inception banks have often tightened credit conditions without any reason (e.g. limit shortened, early repayment of loans demanded etc.).

In general, rating models can't protect the bank against banking crisis (despite model validation or stress test), because the extent and intensity of future economic imbalances, shocks and their impacts can't be correctly predicted with high probability of success. In this context it's clear, that the bank should prefer reasonable and conservative approaches to measure credit risk in every step of the economic cycle.

Rating models are very important for the bank, but they shouldn't be like a credit machine, because these models fail in non-sensitive treatment, resp. they are unable to respond flexibly to complex business processes and specific business environment. Practical experiences from the bank's market are confirming this hypothesis, because personnel of many banks are not able to individualize rating results to client in appropriate level. To maintain objectivity, it should be added that this process requires an optimal settings of managing parameters of the bank's credit policy, considerable professional experiences of credit specialists, proper evaluation of information, intuition, or even luck, because many aspects of the future development can't be assumed and predicted (for example, extreme increase of competition, unexpected and strong shock in the industry, special events etc.).

Repayment depends not only on client's ability to repay, but also on their willingness, which is determined by personality and character, resp. client's corporate culture. These attributes aren't included in the final rating and the quality of the credit relationship is limited. In general, commercial banks attach very little weight to client's willingness to repay the loan on the beginning of the relationship between the client and the bank (formation of the credit relationship). For example, ability as trouble-free repaying debt hasn't entered into the final rating of our RFB model in the past and this ability has only two points from total possible sixty-two points by assessing credit risk of the client and whole credit rating business with the client. (Belás, 2010, p. 287)

3. SELECTED CREDIT SCORING AND BANKRUPTCY MODELS COMPARISON WITH COMMERCIAL BANK'S OBTAINED RATING MODEL

3.1 The selected models to evaluate business performance

There are numbers of different rating models, which are trying to assess the financial performance of companies. Here belong bankruptcy and creditworthiness indicators that are used for quick orientation in company's health or company's default regarding the investors and creditors or they are used to divide companies into classes according to their quality (performance and reliability), based on fundamental analysis of financial statements. (Kotulič, Király, Rajčániová, 2007, p. 113)

The aim of bankruptcy models is to identify if the company falls to default in the near future or not. These models are based on the assumption, that the analyzed companies have liquidity problems, difficulties with working capital and troubles with return on invested capital. Here belong Z-score (Altman model), IN index (Confidence index) or Taffler model.

Credit scoring models are based on scoring to determine financial health of selected departments of the enterprise. Company is graded to the category class on the basis of scored points. Aggregate indicators such as Tamari model or Kralick Quick Test are included in this group of credit scoring models. (Knápková, Pavelková, 2010, p. 131)

3.2 Comparison of selected credit scoring and bankruptcy model's accuracy

to assess the company's performance using internal rating models

The aim of this analysis is to evaluate the credit scoring and bankruptcy model's accuracy in relation to their ability to assess accurately the financial performance of companies and compare the results of selected models with results of internal rating model of our commercial bank, which is operating in Czech Republic and Slovakia. Real rating model is assessing the client's creditworthiness in small and medium-sized enterprises segments, and has been given us by the bank that doesn't wish to be named, because of long-term cooperation and consultation in credit risk management. Those real rating models, which are used in commercial segment, are subject to commercial confidentiality for all banks; therefore they are obtained only with great difficulty. We have divided the analytical process of this analysis into several steps.

In the first step, we have focused on selecting the appropriate model, which would be based on literary sources (Sedláček, 2001), (Kotulič, 2010), (Knápková, Pavelková, 2010). To our analysis, we have selected following credit scoring models: Tamari model, Kralick Quick Test and Simplified multivariate discriminant analysis and following bankruptcy model: Altman Z-score, Taffler model, Springate model and Fulmar model. We have tested these models on accounting data provided by Czech company and these data were obtained from annual reports from the year 2008 and 2009.

Then, we have chosen the criterion for comparing value of each rating model, which is representing as a ratio of actual scored points and the maximum possible scored points in a given model in order to achieve consistent and comparable outputs from the models.

In Table 1 are presented own results of model's accuracy from Czech company's example:



Tab. 1 – The results of selected company by selected models. Source: Own source

Credit scoring models	Results of rating	The final score of the company as a percentage of maximum possible score achieved (%)
Grünwald model	Good health	64%
Tamari model	High index	93%
Kralick Quick Test	Very good	80%
Simplified multi-variate discriminant analysis	Highly solvent company	90%
Bancruptcy models		
Taffler model	Creditworthy but near breaking point	70%
Springate model	Insolvent	41%
Fulmar model	Highly creditworthy	85%
Altman Z- score	Financially strong	90%
Modification of Z-skóre	Gray zone	52%

In the next step, we have selected appropriate models for our next analysis. We have reviewed the results of quantitative and qualitative analysis and from our next analysis we have eliminated the models, which had the same quality deficiencies and extreme value showed in percents – these are Grünwald model, Tamari model, Springate model and Altman Z – score.

As a third step, we have defined sharp accounting data of three companies from segment SME (small and medium-sized enterprises segments) in order to calculate their rating score using the above selected models. We have compared the final results with real internal rating model.

Tab. 2 – Accounting data of three selected companies in the SME segment. Source: Own

Balance sheet item	A 2010 - trading company	A 2009	B 2010 – company providing services	B 2009	C 2010 – small production company	C 2009
Assets	20109	21320	6300	6900	10400	11000
Current assets	15000	15600	4500	4800	5100	5400
Average numb. of claims	10	15	-	-	1000	900
Inventories	14600	14230	500	550	4000	4300
Money	50	64	20	25	110	100
Short-term receivables	-	-	-	-	800	750
Short-term securities	-	-	-	-	-	-

Financial assets	50	50	-	-	-	-
Cash flow	650	700	200	220	350	380
Sales	18450	19500	2100	2300	200	300
Yields	20500	21300	2100	2300	4500	4600
Performances	2000	2200	4500	4200	4200	4300
Production consumption	13500	14500	1500	1600	3100	3250
Interest expense	200	250	100	120	80	70
EAT	1300	1200	600	500	1900	1800
EBT	1573	1425	726	605	2299	2178
EBIT	1773	1675	826	725	2379	2248
Short-term liabilities	1200	1010	1190	1350	3100	3800
Long-term liabilities	14899	16110	4000	4500	5300	5100
Liabilities total	16099	17120	5190	5850	8400	8900
Equity	4010	4200	1110	1050	2000	2200

In the next part of our analysis, we have calculated the rating score of selected models and real internal rating model of commercial bank. In Tab.3 and Tab.4 are shown the results of our calculation.

Tab. 3 – Final score of three companies as a percentage of maximum possible score achieved. Source: Own source

Credit scoring models	Company A – trading company	Company B – company providing services	Company C – small production company
Kralick Quick Test	45%	60%	75%
Simplified multivariate discriminant analysis	90%	45%	66%
Bancruptcy models			
Taffler model	95%	60%	60%
Fulmar model	95%	40%	65%
Modification of Z-score	70%	51%	38%

Tab. 4 – The results of real internal rating model. Source: Internal source of commercial bank, own source

	Final rating score
Company A – trading company	55,60%
Company B – company providing services	73,12%
Company C – small production company	59,30%

The results of our analysis showed that companies' rating evaluation by selected rating models weren't consistent and were significantly different from each other.

Firstly company A, which was trading company, was evaluated by modification of Altman Z – score (especially for condition of Czech market) and showed that this trading company wasn't stable as well as it wasn't in bad financial condition in the same time. Trading company was located in the so-called “gray zone” with neutral results; where there were no statistical forecasts to determine the financial future position existing. That's why we weren't able to establish whether this company was creditworthy or insolvent. Comparing Z – score and Taffler model, we obtained different result. Using Taffler model, we obtained that this company achieved high score, which means that trading company's probability of default was very low. Fulmar model showed that company A was very solvent and its final score was far from breaking point of probability of default.

Using credit scoring models, “company A” got very bad rating in the evaluation of Kralick Quick Test, which means that “company A” doesn't reach even average score and it leads to bankruptcy. However, using simplified multivariate discriminant analysis, this analysis showed that “company A” achieved very good results with the positive outlook for the future.

During calculating the particular scores of rating model, there were some interesting facts observed. For example, the overall rating score of simplified multivariate discriminant analysis increased by one whole degree, when the profit raised only by 10 % and also in the case, when the performance increased by 10 %, the overall rating score of the given model would be declined by one full grade. Kralick Quick Test was another case, where the overall rating score increased by one full grade, when the equity went up by 10 % or EAT raised by 15 %. In the case of bankruptcy model, such as Altman Z – score, Taffler model, we have found out that these models weren't so easily influenced by changes in company's balance sheets. In Fulmar model, there was questionable only one item – change in assets by 10 % - what was rapidly changing the overall rating score.

When we have focused on “company B”, which is company providing services; we found out, that this company is in the poor condition by using Altman Z - score, which may lead to bankruptcy in the future. According to Taffler model, “company B” was ranked as creditworthy (its rating score ranged on the border between group of solvent companies and group of companies with high probability of default). According to Fulmar model, “company B” achieved positive rating, which indicated that it was financially healthy. However, “company B” had in fact worse position in compare with “company A”; results of “company B” of Fulmar model were about 75% worse than the results of “company A”, but both companies showed positive values, and both companies by Fulmar model were doing well, which might be misleading for the analyst to make right decision. According to Altman Z – score, values of “company B” were well guaranteed financially with average results.

It is interesting that simplified multivariate discriminant analysis has evaluated “company B” as doubtful, because company's value ranged between group of very good companies and group of good companies. During the examination of other companies, value of ratings was rated with high score by using simplified multivariate discriminant analysis.

In the case of balance sheets items it is interesting to observe that according to Kralick Quick Test the whole rating grade level was changed, when equity increased by 20 %. The same can be observed in the case of cash flow's changed by 20%.

“Company C” is a small production company, which had the worst score from all three analyzed companies according to Altman Z – score, because it was placed in an area with high probability of default and had very poor financial results. According to Taffler model, “company C” had also high probability of default and its financial health was undermined. Despite previous bankruptcy models, there is only one rating model, Fulmar model, which evaluated “company C” positive with good prospects in the future and this model ranked it as the second healthiest enterprise. Credit scoring models judged “company C” very positively, unlike bankruptcy models. Kralick Quick Test appreciated “company C” as very good. Assessment of these three companies by bankruptcy models demonstrated, that “company C” had the best results from all three companies. Change of performance or profit by 10 % led to overall change of one full grade in the rating score. “Company C” showed very good performance by simplified multivariate discriminant analysis.

According to bank’s real internal rating model, the best rating score was achieved by “company B”, followed by “company C” and the worst rating score reached by “company A”.

When we were comparing the final score of bankruptcy and credit scoring models, “company A” was ranged between 45 – 90 % of total rating score by credit scoring models and between 70 – 95 % of total rating score of bankruptcy models. Bank’s real internal rating model evaluated “company A” with 55,6 % of final rating score. This means that the assessment of bank’s real internal rating model (RFB) was very conservative what has led to rejection of good borrowers or overcharging risk premium. Ratio of average value of rating scores of bankruptcy, credit scoring models and score of bank’s real internal rating model was 1,42 that means that the difference between their scores was 42 % - results of rating model weren’t consistent.

“Company B” achieved smaller variance of rating scores by bankruptcy and credit scoring models (range was between 40 – 60 %), while the score of bank’s real internal rating models was extremely high (73%). Ratio between scores of rating models and bank’s real internal rating model was 0,7 that means that the difference between score was 30 %. The consistency of rating model’s results wasn’t as high as in the case of “company A”.

Range of rating score of “company C” was oscillating between 38 – 75 %, while the score of bank’s real internal rating model reached 59 %. Consistency of all three companies was the smallest. The gap between rating score of rating models and bank’s real internal rating model was only 3 %, because ration between their average scores was 1,03.

Sensitivity assessment of financial indicator’s changes was very important component of qualitative valuation of rating model.

To determine the sensitivity of our analyzed rating model, it is necessary to change the selected balance sheets items and then monitor how the final rating score of this model would change.

Tab. 5 – The sensitivity of internal rating model's results. Source: Own source

	Rating on the beginning	Rating after liabilities increased by 10 %	Rating after liabilities decreased by 10 %	Rating after sales increased/decreased by 10 %	Rating after fixed assets increased by 10 %	Rating after inventories increased by 10 %
Company A	55,60%	54,37%	56,75%	53,12%/55,62%	55,62%	54,37%
Company B	73,12%	72,5%	73,12%	71,87%/73,12%	73,12%	73,12%
Company C	59,30%	58,12%	59,37%	58,12%/60,62%	59,37%	58,12%

In the table above, we can observe changes of rating score, which were caused by changes of balance sheets items.

When we increased/decreased liabilities by 10 %, rating score would only change slightly (decrease/increase).

The fact is noteworthy that increased sales caused credit rating deterioration. In the case of increasing long-term fixed assets, there wasn't any big impact on credit rating except liabilities and inventories.

It is interesting to mention, that according to above mentioned table and our transferred analysis of bank's real internal rating model, when we were increasing sales (sales of own products and sales), the overall rating score was reducing rapidly. Internal rating model has thirteen financial indicators, which are the part of our bank's real internal rating model and on their basis total rating score was determined. Reason of this assessment was in three of these ratios, which had sales' items in denominator such as return on sales, collection of trade receivables and inventory turnover.

In this case, the reality is striking and changing the whole perception of financial management of the company in relation to loans.

Increasing inventories haven't changed rating score so significantly as in the case of sales item. Rating score of rating models decreased with gradual pace, when we would increase inventories by 100 % and were covered by liabilities. In the case of coverage of inventories by company's resources, or item of fixed assets, the overall rating score hasn't changed at all.

4. CONCLUSION

The aim of this article was to analyze selected theoretical and methodological and furthermore practical aspects of internal rating models of commercial banks in relation to measure the company's performance and compare the final rating scores of bank's real internal rating models with bankruptcy and credit scoring models.

Theoretical analysis has been showed that there are many risks, which are associated with development and usage of internal rating models in banks despite their high sophistication and there are many methodical and methodological issues, which cause, that different rating mod-

els work with different accuracy and therefore banks are losing the possibility of loan product's individualization and opportunity to increase their day-to-day profits.

On the beginning of practical analysis, we have set the hypothesis that the accuracy of internal rating models was less than 90 %, various assessments would bring different results and there were considerable differences between evaluation of the company's financial performance by bank's real internal rating model and bankruptcy, credit scoring models.

Results of this analysis showed that different rating models evaluate the same company differently (from minimum 20 % gap for "company B" to the maximum difference of 50 % for "company A") and accuracy of internal rating model in relation to credit scoring and bankruptcy models is very low (from 3% to 42 % for particular companies). This means that our hypothesis was confirmed.

Bankruptcy and credit scoring models produce results that aren't quality sufficient for credit decisions. The final decision about proposal to qualified loans should be based on expert estimates of credit analyst, which should assess whether the company is able to withstand the temperature rise or it's threatened by insolvency on the basis of detailed financial analysis. Base of efficient rating model should focus on compilation of equity capital cost's calculation, probability of default's calculation and subjective evaluation (human factor) of individual mortgages. On the one hand, human factor is very inaccurate criterion of bank's valuation of risk assets, and on the other hand, it's indispensable contribution to the correct valuation.

Internal rating models don't have high explanatory ability and therefore we shouldn't rely in the results of "credit machines (rating)". In our analysis we have showed that each particular rating model presents different rating score, which means that the same company can be evaluated as highly solvent by one model and achieved high probability of default by other model. Another factor is the inadequate sensitivity of financial indicator in the rating model. It is interesting to observe how easy is to change the rating score of the company, when we are increasing/decreasing certain balance sheet items by few percent.

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