

The quality and accuracy of bank internal rating model. A case study from Czech Republic.

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Abstract— Credit risk is one of the most important risk in commercial banking. The commercial bank uses a range of methods and procedures for credit risk management. To access the credit quality of the clients, internal rating models are used by commercial banks. In this article we define theoretical aspects of quality of internal rating model and evaluate potential risks of rating process. In the case study the accuracy of a concrete rating model has been experimentally confirmed, which is used by commercial bank in the Czech Republic for the segment of small and medium-sized enterprises. Internal rating models represent banks' effort to assess objectively the credit quality of the borrower. Previous experiences from banking sector show that this process is necessary to optimize by adding other activities because the quality of this rating models is limited. Aim of our experiment was to verify the quality of concrete internal rating model, which is used by concrete bank in Czech Republic to assess the quality of borrowers in the small and medium sized-enterprises. Results of our experiment are surprising. The model evaluates an excellent company as a negative subject. The model is less sensitive on significant changes in key financial indicators to determine the loan repayment. Our experiment has been proved the fact, that the most important impact on the level of company's final rating has the financial parameter – profit. Other parameters like assets, revenues and long-term liabilities have demonstrated only minimal impact on the level of company's final rating.

Keywords— credit rating, quality and accuracy of internal rating model, experimental verification of model quality

I. INTRODUCTION

THE aim of this article was to define theoretical aspects of the quality of internal rating model (IRMs) and evaluate potential risks in this process. In the case study, the quality and accuracy of concrete IRMs for small and medium-sized enterprises (SME) has been experimentally verified. This model is still used in the commercial bank in Czech Republic.

Commercial banks use IRMs to evaluate the credit competency of clients [3], [5], [8], [22], [27], [37], [45], [46]. They are based on the accounting documents and examined the possibility of a future bankruptcy of the company. These

problems are mentioned in following sources [7], [18], [19], [25], [26], [28], [30], [34], [35], [36], [37], [38], [39], [44]. IRMs represent the bank's efforts on an objective assessment of credit trades. [41], [42] Credit rating system which is chosen appropriately can increase the financial performance of the bank and add potential economic value to a lender [23]. Key significance of rating models validation is based on its accuracy and effective participation in the loan process [2], [9], [12], [15], [17], [40], [41], [42], [43], [47].

In practice, there are no perfect rating systems [10], [11], [29] their predicative ability is limited in relation to the assessment of the quality of the client and its risk profile [6], [33] because they are not and cannot be perfect. [10]

On the basis of structured interviews with credit analysts of commercial banks in Czech Republic has been confirmed our presumption that the usage of these models is strict (it is K.O. criterion) in banking practice for small and medium-sized segment. This means that the client, who does not pass the rating classification, will not get a loan in the bank.

In the present economic situation, it is necessary to optimize the parameters of the credit process in commercial banks with the emphasis on a correct evaluation of the creditworthiness of the client. Overly tough approach means a negative impact on the financial performance of companies, but also commercial banks. Overly permissive approach to lending means future problems for banks with consequent impact on the entire economic system.

II. PROBLEM FORMULATION

The aim of the article was to define theoretical aspects of the quality of IRM and evaluate potential risks in this process and presents results of experimental verification of quality and accuracy of concrete IRM, which is used in important commercial bank in Czech Republic for small and medium-sized enterprises.

A. Theoretical determination of quality of IRM

IRMs serve to quantify credit risk of individual borrowers. Using different methods, the rating score is assigned to individual borrower and indicates a level of their credit quality. Validation of internal rating model is closely linked with the validation of other risk parameters which are derived from the rating provisions of the Internal Rating Based Approach of Basel II which determine largely the amount of

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required equity of the bank. [10] The objective of IRMs is own estimation of risk parameters Probability of Default (PD), Loss Given Default (LGD), Exposure at Default (EaD) and Effective Maturity (M), depending on quantitative and qualitative explanatory variables.

In process of credit risk management the commercial bank develop different rating models for many segments and sub-segments, respectively products within each segment and sub-segments. The process also depends on the type of provided loans. [47]

Segment SME which is the object of our interest has specific characteristics. SMEs are an important part of the economic system and key source of economic growth, dynamism and flexibility. Significant issue of SME is “financial gap”, i.e. many companies which are included in this segment have limited approach to external financial sources. Generally, except large companies, many different small enterprises are operating in the economic environment and they operate mostly with equity capital and owner of the company is also in the manager position.

Neuberger a R athke examined loan financing of microenterprises. Authors state that microenterprises are especially prone to adverse selection and moral hazard and hence to credit rationing. Smaller firms tend to be characterized by higher information opacity and credit risk. The bank-customer relationship is affected by the lending technology, which may be characterized by relationship lending or transaction lending. Relationship lending relies primarily on soft information (personality and character traits, quality management, business strategy, ownership structure etc.), which the bank acquired in direct contact with a company and a local community and observing company’s performance and evaluating relationships in the long term. Transaction lending is based primarily on hard quantitative data (such as equity ratio, profitability, operating cash flow, interest cover, liquidity etc.) According to authors, direct proxies for credit risk do not matter significantly in the segment of small enterprises. An explanation is that small companies tend to have low credit risk, because they are small, have a legal form with unlimited liability, and provide business and personal assets as collateral. [31]

In the rating process, the following applies: the smaller firm, the more intense soft skills affect. [21] The personality of the owner is very important in relation with the company’s performance, which is determined the level of credit risk in the term of small companies. [4] Witzany states that regarding small businesses, it usually turns out that accounting numbers have a very low explanatory power, and an expert judgment is very important. [47] In this context, Altman, Sabato and Wilson indicate to use non-financial variables as predictors of company failure to significantly improve the prediction model’s accuracy. [1]

Deutsche Bundesbank considers validation of internal rating models as a key challenge for banks and regulators of banking business. Validation of IRMs has an important task in

credit risk management and consists of two parts: qualitative and quantitative validation. [11] A similar approach applies the Basel Committee on Banking Supervision where quantitative validation is called validation of the rating system and qualitative validation is called validation of rating process, where the position of supervisor is emphasized as very important statement in this process. [3]

Key criteria of quantitative validation of IRMs include discriminatory power, stability and calibration of the rating model. Discriminatory power presents the ability of rating model to ex ante distinguish differences between default and non-default borrowers with high probability based on identifiers receiving weight and final score. High quality scoring system can additionally distinguish between several levels of good quality clients. Discriminatory power can be rejected through various statistical methods such as: Cumulative Accuracy Profile (CAP), Gini coefficient, and Receiver Operating Characteristic (ROC). [11]

CAP curve is determined by distribution of cumulative percentage of all borrowers (alarm rate) on the horizontal axis and cumulative percentage of all defaulted borrowers (hit rate) on the vertical axis, which can be seen in Fig. 1. For example, if 30 % of all claims with the lowest credit rating score include 70 % of all defaulted borrowers, point (0.3, 0.7) lies on the CAP curve. The CAP curve is steeper at the beginning, the more accuracy rating process is. A perfect rating model would assign to their defaulted borrowers the lower score and CAP curve would be linearly picked up initially it become horizontal. Another extreme is the random mode. In this case, rating model wouldn’t have any discriminatory power. Expected CAP curve would be identical with the diagonal. In fact, rating models are not perfect and neither accidental at all. Therefore, the CAP curve is moved between these two extremes. Discriminatory power of a rating model can be aggregated into a signal number, called the Gini coefficient. Gini coefficient is known as “accuracy ratio” and represents a

ratio $\frac{a_r}{a_p}$, where “ar” is the area located between actual rating

and random rating; “ap” is the area that lies between random and perfect rating. Gini coefficient ranges from -1 to +1. This value is closer to +1, more accurate rating model there is.

To evaluate the accuracy of IRM, it is used concept of receiver operating characteristic (ROC). For both concepts it is possible to summarize the information concerning the quality of a rating system with a single number, namely with the accuracy ratio and the area below the ROC curve. The accuracy ratio is just a linear transformation of the area below the ROC curve. [14] If the AUC (Area under the Curve) value is in the range from 0.8 to 0.9, in general, such a rating model is considered as a model with an excellent discriminatory model. Rating model with AUC from 0.7 to 0.8 is considered as model with acceptable discriminatory power. [29]

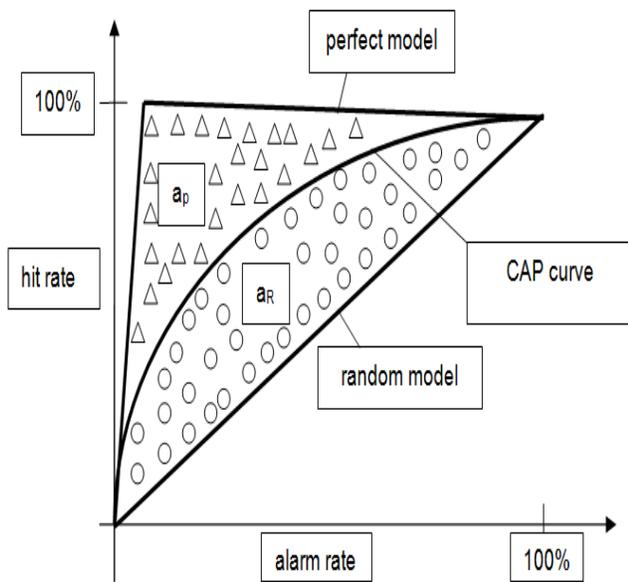


Fig. 1: Cap curve and Gini Coefficient [14]

An important part of the discriminatory power measurement is setting of cut-off strategy (Fig 2). Decision which clients will be accepted by banks and which will be not in the term of credit risk is on the bank. In the decision making process of the bank, it is necessary to find reasonable level between amount of accepted loan applications and potential risk of defaults. Because too strict approach to cut-off strategy settings effectively means losing customers who would be profitable for the bank and too lenient approach means excessive risk growth (this approach can be deliberately chosen by bank for selected segment or product type such as consumer loans, credit cards, which are usually valued by higher interest rate).

Cut-off strategy is used to determine the average relative frequency of defaulted and non-defaulted borrowers, which were wrongly evaluated. Part of defaulted borrowers which were considered as credible one but they reached limit of value C is shown in Fig 2; it is represented by the right area from point C under the curve of distribution of defaulted borrowers. Part of non-defaulted borrowers who were wrongly evaluated as credit unreliable is located to the left area from the point C under the curve of distribution of non-defaulted borrowers. Minimum error rate of the rating model is calculated as the sum of error rates for each score C which is between minimum and maximum score. The lower minimum classification of error rates, the rating system is more accurate. Cut-off point is calculated by using Kolmogoroff-Smirnoff statistics which measure maximum difference between two scores of distribution functions.

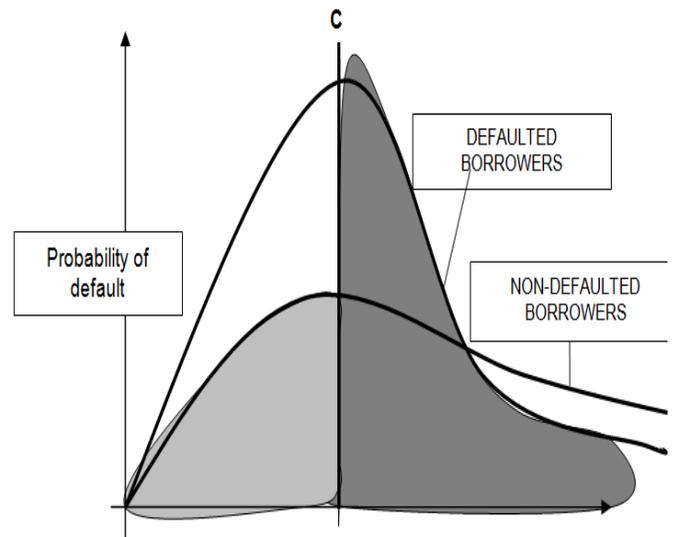


Fig. 2: Probability of densities and classification of error rates [10]

Characteristic feature of stable rating system is the fact that the relationship “cause-effect” between risk factors and credit worthiness is appropriately modeled and is avoiding false dependencies, which are based on empirical correlations. Calibration is indicated a level of probability of risk parameters (such as the probability of default) in relation with each rating grades. Rating system is well adjusted (calibrated) if estimated PF is slightly deviated from actual default rate. In a wider sense calibration of rating system includes mapping additional risk parameters such as LGD and EaD. [11]

Within the validation of internal rating model banks are used different approaches. Systematic review of internal models for credit risk management is indicated by source [32].

Quality and reporting ability of IRM is different. Used models for risk measurement are not perfect and give unreliable results, respectively contribute to the pro-cyclical tendencies of entire financial system. [10] Some studies indicated a significant difference in results of individual rating models. According to Mitchell and Van Roy approximately 20 % of total number of companies that have been evaluated by various rating models, have vastly different assessment, i.e. one rating model assessed companies as bad one while the other rating model has seen them as a good clients. [29] Engelman, Hayden and Tasche examined differences between two rating methods (Altman’s Z-score and Logit score) depending on the size of credit portfolio. For the total portfolio they find that the difference of both rating methods is highly significant. [14] Altman, Sabato and Wilson investigated that the accuracy of individual rating models for SME is ranged from 73 % to 80 %. [1]

Even with a modern automated rating system, form any of the segments, the credit process usually allows for overriding by a competent credit officer. Any system needs a careful periodical monitoring of performance, and an unbiased comparison with other possible rating methodologies. [47]

In banking practice hybrid models by combination of heuristic and statistical models or causal models are often

used. Horizontal linkage of models is for example combination of heuristic and statistical models which is presented by connection of quantitative and qualitative analysis. Vertical linkage model means that the quantitative and qualitative data establish the proposed rating, which is modified by credit analyst. Upstream inclusion presents a combination of heuristic knock-out criterion (for example classification in the blacklist of defaulters) and statistical methods. A key element of this kind of combination is statistical model, which is filtered through the knock-out criteria defined by credit professionals. If a potential borrower fulfills knock-out criterion, credit assessment doesn't continue downstream into the statistical module [32].

The optimal approach of creditworthiness of the client in the small and medium-sized segment is described in Fig. 3. A characteristic feature of these models is a comprehensive approach to credit quality assessment of the customer and therefore it can be assumed that the final rating score of the client is very respectable and largely objective.

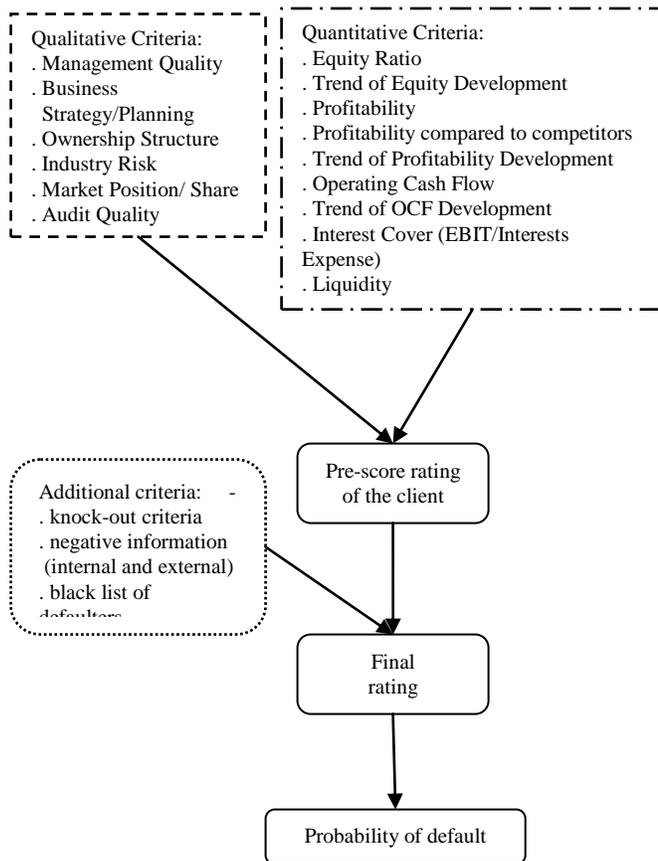


Fig. 3: Hybrid internal rating model of the commercial bank [21]

The case study is based on an experiment to assess the quality (accuracy and sensitivity) of IRM which is used by one of Czech commercial banks in the SME segment.

B. Experimental verification of quality and accuracy of specific IRM

This experiment builds on our previous researches. [4]

Some results of our previous research demonstrated that creditworthiness and bankruptcy models [24] and the internal rating model [20] evaluate creditworthiness of companies very differently. The final score of three randomly selected firms measured as percentile value of the maximum possible score by models of bankruptcy and creditworthiness was varied from 45 % to 95 %. This means that some models defined company as eligible of loan and other models predicted bankruptcy of the same company. Internal rating model of bank nevertheless ranked all firms in the category of eligible loans (percentile: 55.60, 59.30, and 73.12). [4]

In developing the article, we set three hypotheses:

H1: Internal rating assigns the highest rating to company with above-average financial performance.

H2: The largest impact on achieving rating indicators are assets, long-term commitments, sales and profit.

H3: Internal rating model can flexible response to financial indicators change.

In determining the objectives of this research we based on the current need to optimize the parameters of the loan process in a changed economic environment. At the same time we respond to an input from the corporate practice, where many smaller companies express disagreement with the rating of banks (assessment is deemed too rigid, point to the fact that banks subjective rating declines, even if the development of improved financial indicators, etc.).

To obtain the relevant software application, was the prerequisite for solving the problem. The internal rating model is used by a major bank in the Czech Republic.

Experimental verification of the quality of IRM was performed through the following steps:

1. step - we define a company in SME segment with extremely good financial situation by empirical methods and we rate this company by Kralicek Quicktest, Credit Solvency Index and IRM,
2. step – we changed the value of financial ratios by method of random selection to identify the most significant impacts (key variables) on the final rating on an example of a selected firm,
3. step - we changed values of the key variables of this model by method of random selection in order to achieve maximum value of internal rating of our company.

We have defined the company in the SME segment: the company did its business in the sphere of retail sales, it showed extremely good financial performance, because during the period T +1 there was a 100% increase in major financial indicators (assets, sales, profit). The company worked only with its own capital and demanded from the bank a loan in the amount of 3,000,000 CZK. The financial parameters of the company are listed in Table I.

Table I: Financial indicators of the company

FINANCIAL INFORMATION		
in thousand CZK	Period T	Period T+1

TOTAL PROPERTY	5 000	10 000
Standing property	2 500	5 000
Of which: long-time intangible property	2 500	5 000
Circulating property	2 500	5 000
Supplies	1 500	3 000
Long-term receivables	0	0
Short-term receivables	0	0
Financial accounts	1 000	2 000
EQUITY	5000	10000
Liabilities	0	0
Reserves	0	0
Long-term liabilities	0	0
Short-term liabilities	0	0
Bank loans and overdrafts	0	0
of which: bank long term loans	0	0
Data in thousands CZK	T	T+1
Sales of goods	5 000	10 000
The added value	0	0
Depreciation of intangible and tangible assets	0	0
Profit from operations	1 500	3 000
Interest expense	0	0
Profit from ordinary activities	1 500	3 000
Profit from extraordinary activities	0	0
Profit for the period	1 500	3 000
Profit before tax	1500	3 000

We have calculated the creditworthiness of the company by selected models (Kralicek Quicktest, Credit Solvency Index), which according to our previous studies [4] correctly assess the financial performance of the company.

Company has been evaluated by Kralicek Quicktest as exceptionally creditworthy one (total point value=1).

Discriminating function for calculating the solvency index (B) has the form [24]:

$$B = 1.5 * X1 + 0.08 * X2 + 10 * X3 + 5 * X4 + 0.3 * X5 + 0.1 * X6 \quad (1)$$

where: X1 = cash flow/loan capital

X2 = Total capital/loan capital

X3 = EBT/assets

X4 = EBT/income from production

X5 = inventory/revenues from production

X6 = income from production/property.

By substituting into formula (1) we will gain a final value of $B = 10 * 0.3 + 5 * 0.3 + 0.3 * 0.3 + 0.1 * 1 = 4.69$. The final company's financial situation is extremely good by using Credit Solvency Index.

By substituting of financial indicators, which are listed in

Table I to IRM the evaluation of the company was as follows: a value rating was C (an average risk), the company reached 58.12% from the maximum number of rating points.

In this experiment, we performed a total of 500 trials, of which 300 trials were intended to determine the most important variables of the model and about 200 experiments were focused on obtaining the best rating of the company.

III. PROBLEM SOLUTION

A. The calculation of IRM, depending on changes in the company's financial indicators

In this part of the experiment, we modeled the most important financial indicators of the company (assets, liabilities, revenues and profit) to determine the effects of parameters changes. (Table II)

In the calculation of internal rating company, we proceeded as follows:

- the property of the company in period T +1 gradually increased by 500,000 CZK to its twice value, and then decreased on the value of 1,000,000 CZK at the constant amount of the commitment (0), profit (3,000,000 CZK) and sales (10,000,000 CZK),
- long-term liabilities of the company gradually increased from zero up to 2,000,000 CZK at the constant value of assets (10,000,000 CZK), profit (3,000,000 CZK) and sales (10,000,000 CZK),
- the revenues of the company grew sequentially by 500,000 CZK from the level of 5,000,000 CZK to the level of 10,000,000 CZK and then gradually decreased to the level of 1,000,000 of CZK at constant values of assets, liabilities and profit,
- profit grew from zero to the value of 9,000,000 CZK at constant values of assets and liabilities and revenues.

On the basis of experimental calculations of a rating (Table II), we have formulated some partial conclusions which we used for the final phase of the experiment:

- the impact of property change on the final rating was rather limited, because the highest rating was achieved by the firm with the property value from 1,000,000 up to 6,500,000 CZK (58.13%), with a higher asset value, the rating fell down to 55.63%,
- the growth of long-term liabilities had no effect on the rating level and reached a constant value of 55.63% for any value of long-term liabilities,
- revenues of the company from the lowest value of 1,000,000 CZK up to the value of 8,500,000 CZK meant the highest value of the rating (60.00%), in sales growth above this level rating declined (at the extreme value of sales 12,000 thousand of CZK the rating is 55.00%),
- profit showed the most significant effect on the rating, because by zero rating was 47.50% and by

profit of 3,000,000 CZK (which is the desired loan amount) the company achieved the rating of 57.50% by profit of 3,500,000 CZK the rating the company achieved was 60.00%, which did not change at extreme levels of profit 10,000,000 CZK 15,000,000 CZK and 20,000,000 CZK, in the case of the loss from 500,000 CZK up to 5,000,000 CZK has the rating been constant: 45.63%.

Table II: Change in internal rating caused by change of the financial indicator of the company

Property in thousand CZK	Rating in %*	Long-term commitments	Rating in %	Revenues in thousand CZK	Rating in %	Profit in thousand CZK	Rating in %
5000	58,1	0	55,63	5000	60	0	47,5
5500	58,1	200	55,63	5500	60	500	52,5
6000	58,1	400	55,63	6000	60	1000	55
6500	58,1	600	55,63	6500	60	1500	55
7000	57,5	800	55,63	7000	60	2000	55
7500	57,5	1000	55,63	7500	60	2500	55
8000	55,6	1200	55,63	8000	60	3000	57,5
8500	55,6	1400	55,63	8500	60	3500	60
9000	55,6	1600	55,63	9000	59	4000	60
9500	55,6	1800	55,63	9500	58	4500	60
10000	55,6	2000	55,63	10000	58	5000	60
4500	58,1	-	-	4500	60	5500	60
4000	58,1	-	-	4000	60	6000	60
3500	58,1	-	-	3500	60	6500	60
3000	58,1	-	-	3000	60	7000	60
2500	58,1	-	-	2500	60	7500	60
2000	58,1	-	-	2000	60	8000	60
1500	58,1	-	-	1500	60	8500	60
1000	58,1	-	-	1000	60	9000	60

Note: * represents a ratio of rating points achieved the maximum possible number of rating score (in order to protect trade secrets of the bank).

In this phase of the experiment we conducted a sensitivity test of the model on changes all of the parameters in period T +1. When we reduced all the endpoints (assets, equity, revenue and profit) by 20%, the company reached the rating of 58.13%. The company also achieved the same level of rating by decreasing of all the endpoints by 50%.

B. Experimental search for the highest value of rating score of the company

Based on the observed trends in ratings, we searched for the best rating for the company at the current change of three most important variables of the model. The results are shown in Table III.

Table III: Maximal rating score of the company

Profit in thousand CZK	Revenues in thousand CZK	Property in thousand CZK	Firms rating in %
3500	5000	5000	60,63
4000	4500	5500	60,63
4500	4000	6000	60,63
5000	3500	6500	60,63
5500	3000	7000	60,63

Table III shows that for any combination of major financial indicators of the company the highest possible value of rating was 60.63% from the maximum possible number of rating points.

This approach did not work because the value of internal rating was only 60.63% from total marks.

In the final part of the experiment we conducted about 200 tests with the parameters changed (e.g. change of the structure of current assets, liabilities entry, accounts receivable, changes in revenues, and decline in credit growth and the mutual combination of financial indicators). Based on data in Table I, we gradually modified financial indicators, which we applied into the model.

Result: we achieved the highest rating score (89.38%) with this combination: we modified the indicators of company's financial performance by the growth of outstanding debts in the amount of 2,000,000 CZK (including overdue receivables of 500,000 CZK), the growth of liabilities by 2,000,000 CZK and profit growth by 1000,000 CZK. In this case, rating of the company increased by 31.25% to 89.37%, which represents an A rating, compared to the baseline according to Table III.

We were not able to achieve a higher value of rating in the experiment.

IV. CONCLUSION

The present paper tried to define theoretical aspects of quality of IRM, evaluate the risk in this process. In the case study we have experimentally verified the quality and accuracy of the concrete IRM for segment SME, which is used a specific commercial bank in Czech Republic.

Usage of internal rating system is currently debated issue because these rating models have significantly contributed to the acceleration of the global financial crisis through lower capital requirements. Trend of their implementation to credit risk management in banks were intense in the recent past a therefore we expect some treatment of IRM from regulator's side.

Rating models for credit risk management supported

cyclical trends in lending services. Before crisis starts, many banks in Czech Republic intruded loans to its clients. After crisis beginning, banks often unreasonably tightened credit conditions (passed their limits, demanding early repayments of loans etc.). In this context it is clear that banks should prefer a conservative approach in the credit providing at each stage of the economic cycle, but this is contradictive with a speculative motives of banking business.

IRM are for banks very important instruments for credit risk measurement, but they should not have a function of credit automat. Rating models help to better evaluate credit profile of borrowers because they examine essential attributes of financial performance. Also they present more objective method for credit approval and determination of their reasonable price. These models are not very accurate, they often fail because of insensitive usage, and respectively they are not able to respond flexibly on complex economic processes or on parameters' changes in long term period. In this context, Glennon and Nigro indicated that default is a dynamic time-dependent process and, if not properly captured within the modeling framework, may result in relatively poor default and loan-loss predictions. [16]

The experimental verification of the quality of specific IRM was motivated by the desire to verify the accuracy of the model and its sensitivity to changes of the client's financial situation.

Results of our experiment haven't confirmed our hypothesis No.1. The model is insufficient, because it evaluates a great company negatively and also evaluates negatively a variety of negative changes in the financial performance of the company with the same rating.

Hypothesis No.2 has been partially accepted. Our experiment verified that the most significant impact on the level of the final rating has a profit (range 12.5 % in Table II). Other two parameters show minimal impact on the level of the final rating: assets (range 2.5 %) and revenues (range 2 %). In the case of any modification of long-term liabilities, the resulting rating was constant. A surprising finding was the fact that the company achieved the lowest rating when its value of property was the highest one.

Hypothesis No.3 has been rejected. The model is less sensitive to significant changes in the key financial indicators to determine the loan repayment, which is particularly evident when assessing the profitability of different variants, respectively of loss-making company. The studied model is unable to respond appropriately to changes in financial indicators of the company. For example, the change of the parameters whose economic effects are virtually neutralized (assets growth and liabilities by the same amount) causes a growth of credit rating by more than 28%. When we put the profit growth by 1000,000 CZK into this combination, the rating will increase to extreme value of 89.38%. By the partial profit change of the company (without changing other parameters), the credit rating value is practically unchanged.

This model is not resistant for non-standard economic

situation. For example, model can assign higher points of rating model in the case where the value of profits is higher as value of sales. Model is not sufficiently flexible in the case of changes of revenues and profits. In the case of changes of long-term liabilities, the rating model was completely inflexible.

The maximum value of rating 89.38%, which is grade A, we were able to achieve by a change of the parameters of financial performance, that virtually negate their effects, but the testing model is extremely sensitive for this combination.

Based on the experiment, it can be stated that its explanatory capacity is considerably limited. According to our opinion if a bank wants to assess the credit quality of the client effectively, it is necessary to optimize conditions for its use in the banking practice. This means that this model cannot serve as a K.O. criterion for lending and the bank needs to complete its own operational procedures, not to work too hard in the credit process. In this process is important to assess other important factor which are affected the quality of borrower (cooperation with the bank, upcoming activities of the company, personal qualities of the borrower, the amount and quality of collaterals, etc.)

Repayment respectively probability of default depends not only on the client's financial ability to repay the loan but also on its willingness which is determined by the personality and character traits or by client's corporate culture. These properties cannot be measured by the presented model. In general, commercial banks attribute to "customer willingness to repay" a very low weight when determining the amount of the client's creditworthiness.

According to our opinion banks use all available tools to improve their own performance in Czech Republic. Our experiment proved that the rating model provides clients with an excellent financial position to reach a value of rating 58.12% of the total number of points, representing grade C. This means that the bank offers unreasonably high interest rates even to top clients.

The results of our experiment are significantly different from the many published papers to this topic. While many studies show the same imperfection of internal rating models, our results are surprising. The experiment results confirm the view of those professionals who are in the minority and who say that a good deal of skepticism with regard to procedures for commercial banks in the credit risk is justified.

Our future research will be focused on optimizing the process of IRM in the SME segment. Its aim is to design a new model of higher quality and accuracy for Czech banking sector.

ACKNOWLEDGMENT

This paper was supported by Project No. IGA/FaME/2012/12: Optimization of internal rating model parameters of commercial banks in the small and medium enterprises.

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