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FUZZY SETS THEORY FOR LEASING'S CREDIT RISK ASSESSMENT: EMPIRICAL EVIDENCE

Vaidas Paužuolis
(Corresponding Author)
Kaunas University of Technology,
K. Donelaičio g. 73, LT-3006 Kaunas
vaidas.pauzuolis@gmail.com, phone: +370 655 39059

Dr. Aurelijus Cvilikas

Kaunas University of Technology,
K. Donelaičio g. 73, LT-3006 Kaunas
a.cvilikas@yahoo.com

ABSTRACT

Risk management is approached as one of the most important internal activities in finance sector that determines most of the decisions performed by the financial institution. However, in the academic literature there is highlighted the need to create specific models of credit risk assessment that are adapted to services distinguishes with lower risk level, and in this way there is created the possibility to modify the risk assessment process keeping the chosen risk level for the situation. In this publication there is presented the empirical research results of credit risk assessment model application in practice. The results of empirical research enables to state that creditor, applying fuzzy sets theory in credit risk assessment model, is able to assess the credit risk of potential debtor in a quite easy way if automated systems and digital hardware is used.

Keywords*: credit risk, risk assessment, fuzzy sets theory.*

Introduction

Risks in financial sector as a specific business risks category is analyzed by various finance experts (Bessis, 2010; Koch, MacDonald, 2000; Hempel, Simonson, 2008; Schmit, 2003; Berg, 2010, etc.) highlighting the reliability of financial institution activities and possibilities of the business development considering taken risks. Analyzed authors (Varotto, 2011; Bessis, 2010; Fiordelisi, Marques-Ibanez, Molyneux, 2010, etc.) pay most attention to credit risk which is described as most important one for financial institutions and financial services that has both direct and indirect influence on cost of financial operations. High significance of credit risk in financial sector determines the need to seek high accuracy of credit risk assessment which is possible only by using sophisticated quantitative assessment methods that are based on comprehensive analysis of debtor conditions and its results comparison to database of credit risk assessment that reflects the summarized statistical information. This is preferred and developed by S.Varotto (2011), G.Christodoulakis and S.Satchell (2008), A.Frachot, O.Moudoulaud and T.Roncalli (2004), F.Fiordelisi, D.Marques-Ibanez and P.Molyneux (2010), K.Dowd (2008), T.Kiziukiewicz (2004), A.J.McNeil, R.Frey and P.Embrechts (2005), M.Kudinska (2004) who provide quantitative methods of credit risk assessment , as well as development solutions of them. The quantitative assessment of credit risk, despite the big financial specialists' attention to the development of the current credit risk assessment methods, still is a very complicated and demands high qualification of credit risk specialists. Therefore, financial institutions, that are interested in costs reduction, are usually tend to use more ordinary qualitative methods that requires less investment to create the assessment system and require lower labor costs.

However, the usage of qualitative credit risk assessment methods limits the financial institution to assess exactly the debtors' reliability, and, in the same way, the credit risk level that financial institution has taken. The aim to harmonize the interests of financial institution to reach costs economy and efficiency of risk management determines the need to create such credit risk assessment methods that would maintain the simplicity that is typical for qualitative methods and the accuracy that is typical for quantitative methods. Those credit risk assessment methods are very relevant for financial services that experience relatively lower credit risk (comparing with traditional lending), therefore they require lower costs of credit risk assessment as well.

One of such services is leasing (in form of financial leasing in most cases), which is very specific considering credit risk assessment. Therefore, the need to create credit risk assessment methods for this financial product is highlighted by C.Bauselinck (2000), M.Schmit (2003), Y.C.Chen (2001), T.F.Sing and W.L.Tang (2004) and others. Scientists Y.C.Chen (2001), M.Schmit (2003) and M.Cruz and J.Carroll (2000) analyzing the potential of assessment of credit risk in leasing sector, raised an idea about adaptation of fuzzy sets theory to credit risk assessment, considering both quantitative and qualitative assessment elements. Considering this idea the article of the model of credit risk assessment based on fuzzy sets theory was published by A.Vasiliauskaitė and A.Cvilikas (2008), but the theoretical presumptions of fuzzy sets adoption for credit risk assessment in leasing sector are not enough to prove the practical benefit of such tool for leasing sector. For this reason, with the aim to prove the benefits of such model to financial institutions that seek to simplify the procedures of risk assessment and, in the same way, to keep high reliability, the research of practical adoption of the model was performed, which results are presented in this article.

Research object – the adaption of fuzzy sets theory for credit risk assessment in leasing sector.

Research aim – to prove empirically the adaption of fuzzy sets theory to credit risk assessment in leasing sector.

Research methods – systematic, logical and comparing academic literature analysis, breakeven analysis, fuzzy sets theory.

In this article the results of empirical research of credit risk assessment using fuzzy sets are presented, which confirm the practical usage of such credit risk assessment model.

1. Fuzzy sets theory for credit risk assessment: theoretical aspects

The fuzzy sets theory is widely discussed in academic level as a tool for quantitative assessment of various types of uncertainty. While the assessment of credit risk is not a very common object of those discussions, the characteristics of fuzzy sets motivate to perform deeper analysis of fuzzy sets adoption on credit risk assessment in financial sector.

The credit risk assessment in financial sector is treated as one of the most crucial procedures for risk cost management and receives a lot of attention from risk management specialists. F.Fiordelisi, D.Marques-Ibanez and P. Molyneux (2010) and S.Varotto (2011) state that credit risk is mostly related to the quality of collaterals and the probability of default (which means the client's inability to fulfill financial obligations). The probability of default is related to various factors in client's performance and environment, so the assessment of credit risk is supposed to be a widely overlooked assessment of client's business processes, current liabilities and environment factors. Most of these areas can hardly be assessed clearly and uniquely, and for this reason the specialists of credit risk management constantly improve the existing and create new credit risk assessment methods and models, based on the assessment of individual client's probability of default, credit positions or portfolio risk.

In most cases the problems in credit risk assessment arise from the evaluation of qualitative factors, which condition the uncertainty in the interpretation of the assessment results. R.Leichtfuss et al (2010) state that the quality of qualitative assessment is mostly based on the competences of credit managers, so there is a risk that every credit risk manager may present different final results of same client's credit risk assessment. Such problem requires a strictly standardized and complex procedures and algorithms for credit risk assessment in financial sector, which, in turn, requires high budgets and exclusive competences for credit risk management.

The most of methods and models for credit risk assessment are created for banks' needs and are designed to define the level of client's credit risk as precisely as possible despite the cost and complexion of the assessment process. Such design in most cases is supposed to be a target in the context of high quality credit risk assessment, but, as R.Leichtfuss et al (2010) and S.Kekre et al (2007) state, in specific financial segments such viewpoint might be treated as surplus. Some crediting products like financial leasing, factoring or mortgage lending face the naturally lower level of credit risk, and in this context the important factors for a reasonable credit risk assessment become the simplicity of the assessment process and the ability to assess the client's business performance (the vitality of entire business or specific project). For example, as A.Cvilikas, P.Baršauskas and T,Šarapovas (2007) state, the credit risk assessment in leasing sector can be treated as requiring specific assessment tools because of those two main factors: (a) property rights in leasing agreement remain in disposition of lessor, and (b) the front-end fee exist in leasing, which perform the role of additional financial guarantee. For these reasons the credit risk in leasing sector is mostly connected with non-receiving of estimated inflow, because the risk of possible asset loss is minimized by keeping property right of leased asset.

For such financial products as leasing the fuzzy sets theory becomes an attractive tool for credit risk assessment. Fuzzy set is treated as special subset of real numbers, where the possible boundaries of value's deviance are concretized, depending on value's reliability and nature of usage (Cruz, Carroll, 2000). A very important characteristic of fuzzy sets, stated by S.Gottwald (2005), is the possibility of fuzzy sets theory to convert linguistic rating scale to quantitative expression. It is an important advantage of fuzzy sets usage in

credit risk assessment process, because fuzzy sets create possibility to incorporate expert rating in quantitative assessment while retaining the uncertainty of expert rating.

The benefits of fuzzy sets theory for credit risk assessment in case there is a need to simplify the entire credit risk assessment process and to concentrate on the financial performance of debtor are widely discussed by A.Vasiliauskaitė and A.Cvilikas (2008). The main advantages (also highlighted by: Cruz, Carroll, 2000; Gottwald, 2005; Chen, 2001) of fuzzy sets theory in this case are as follows:

- The ability to merge the qualitative and quantitative criterions in the joint assessment formula. Through the fuzzy numbers the qualitative assessment can be transformed into quantitative values while retaining the uncertainty of qualitative assessment.
- The ability to assess possible deviations from mostly expected results of performance in case of business forecasting. The fuzzy numbers allows assessment of possible deviations for projected income, cost, investment and other factors related with the uncertainty of the business project.
- The ability to simplify the client's credit risk assessment process. Fuzzy sets allow transforming all the criterions into quantitative form, which creates the possibility to automate entire assessment process and to simplify the assessment procedures for an employee. This is important in the context of employees' competences and possibility of mistakes (the automation of the process allows reduction of operational risk).

The mentioned advantages makes the fuzzy sets theory an attractive tool for credit risk assessment for the products which are less credit-risky and are more related to the results of debtor's general performance or the success of specific investment project. Further the detailed methodology for the adoption of the model for credit risk assessment via fuzzy sets theory is described and the practical adoption of such model is presented.

2. Methodological notes on the adoption of the model for credit risk assessment via fuzzy sets theory

The practical possibilities of adoption of fuzzy sets theory for credit risk assessment are explored through experimental research – case studio. The research is based on the adoption of the model for credit risk assessment via fuzzy sets theory (which is described by A.Vasiliauskaitė and A.Cvilikas (2008) in details) on particular company for its credit risk assessment negotiating a financial leasing. Leasing was chosen for this research because the analyzed credit risk assessment model is oriented to a simplification of credit risk assessment procedure that is very relevant to a leasing sector, but, however, this model is not always acceptable to commercial banks (Vasiliauskaitė, Cvilikas, 2008). In this case leasing (considered as financial leasing in most cases) is approached as one of business financing sources for which the credit risk assessment is relevant, but may be performed using more ordinary credit risk assessment procedures than in commercial banks. This is determined by leasing features that create lower credit risk, and in the same way, enable to simplify credit risk assessment procedures.

The subject of the research is company X, which performs in recycling of alimentary waste sector. The company was established in 1997 in Kaunas district in Lithuania. Until 2006, the growth of the company was slow, because major investments were made for entrenchment in the market and searching for long-term clients. From 2007 the turnover grew quite quickly because of the booming demand for alimentary waste recycling. Major clients are other companies that possess alimentary waste, mostly food companies in Kaunas. Increasing demand of recycling of alimentary waste allows the company to assess the possibilities of technical equipment modernization. This decision is related to the fact that currently company X satisfies only 70 percent demand, what means that 30 percent of orders are cancelled due to

limited technical facility capacity. Today there are four alimentary waste recycling companies in Lithuania (excluding some of alimentary food producers that could recycle only its alimentary waste). Company X is a market leader with 60 percent market share.

The research is based on the conceptual suggestions for credit risk assessment using fuzzy sets theory in leasing sector, which are presented by A.Cvilikas, P.Baršauskas and T.Šarapovas (2007), and A.Vasiliauskaitė and A.Cvilikas (2008). The main principle of fuzzy sets adaption to assess credit risk is the analysis of breakeven point of the potential debtor considering the projected ratios of debtor's financial activities in both cases – lending and not lending. This method of credit risk assessment is characterized in the model fuzzy sets theory for credit risk assessment (Vasiliauskaitė, Cvilikas, 2008). Under this model, procedure of credit risk assessment could be divided into six stages, which shortly are discussed below. The detailed methodic is presented by A.Vasiliauskaitė and A.Cvilikas (2008), therefore in this article there are provided only the most important aspects of each stage.

Stage 1. Analysis of current breakeven point. The primary assessment of potential client's credit risk through fuzzy sets is the analysis of current breakeven point. The breakeven point describes the minimal turnover (in both value and quantity), that is needed to cover all expenses (Johnson, 2001). The main components of breakeven point analysis are fixed and variable costs and their ratio with turnover. However, in many cases company's fixed costs can be indicated only approximately, therefore it is described as fuzzy numbers (Chen, 2001) Using the principles of fuzzy sets theory, the breakeven point is calculated assessing top and bottom bounds of deviation that depends on indicated variables and bounds of fixed costs. To define the company's X possibility to lease the new equipment, the breakeven point was calculated in two cases:

1. When the new equipment is installed to increase the capacity of recycling. The equipment is purchased via leasing services, and this fact creates an additional credit risk.
2. When the existing capacity of recycling is maintained. This decision would limit company's potential to increase turnover.

Stage 2. Analysis of future breakeven point. The future breakeven point is calculated for two cases: if the loan is granted and if the loan is not granted. For this reason there is a need to define all possible changes in a company's cost structure (in case the loan is granted) that are associated with changes of company's activities or market environment.

The calculation of the future breakeven point is performed through the factual breakeven point and the change of breakeven in percentage. The changes of future breakeven point are projected considering qualitative assessments of experts that are transformed into assessment through fuzzy numbers in general scale [0; 1]. Questionnaires were used to evaluate the opinions of experts. Experts were asked to assess separate components of costs keeping in mind that changes are depended on the decision to borrow or not. Therefore fixed costs could be divided into:

- Production costs (due to new equipment there is predicted changes of these costs).
- Non-production costs (due to the financing of new equipment purchase the company X will have to pay leasing payments).

As well as, there were defined three components of variable costs:

- Wages of workers (due to new technological equipment the turnover and demand for workforce will increase).
- Stock costs (due to growing turnover, the demand for stock material will increase).
- Other variable costs (expenses that depends directly on production scale, but does have very little influence on total costs of company X).

The bounds of values of qualitative assessments transformed into fuzzy numbers must fit into interval [0; 1]. Therefore the partial calculations of changes of breakeven point are performed necessary for normalization of values that does not fit into this interval. For the normalization the simple additive weighting method was used. Normalization of assessment values enables to maintain the primary principle of transformation of qualitative assessment scale into quantitative scale and save the proportions of fuzzy number summands (Gottwald, 2005).

Stage 3. Construction of client's utility matrix. Client's utility matrix is the dual assessment of potential debtor operating profit:

- Comparing company's turnover growth and average market growth rates.
- Evaluating company's turnover growth in optimistic, realistic and pessimistic cases.

The first stage to construct the utility matrix is the assessment of the growth of company X that was provided by both the company X itself and experts of leasing provider. Experts were asked to assess the potential of company growth considering two factors: 1) the decision of leasing granting, 2) growth of the whole market of recycling of alimentary waste. Assessments were provided considering three cases – optimistic, realistic and pessimistic.

The assessment of possible growth of turnover allows calculation of projected turnover in different cases, which are expressed in the form of projected turnover matrix. In the projected turnover matrix, the projected turnover of company X is expressed in fuzzy numbers and this enables to assess the indeterminacy of experts' opinions. Upper and lower bounds of fuzzy numbers are indicated as 95 percent and 110 percent respectively from the most probable value.

Parallel, the client's utility matrix is constructed as a combined operating profit, expressed as a difference between projected turnover and breakeven point expressed in value. Considering the aim to assess the changes of the company that are associated with potential loan, there are constructed two matrixes of client's utility: 1) when the loan is granted and 2) when the loan is not granted (Chen, 2001). The construction of two matrixes of client's utility is based on probable different growths of the company considering if the loan is granted or not.

Stage 4. Construction of changes' possibilities matrix. The forecast of future cash flows is the final result that is provided considering the probability of each scenario. That means that the expected (average) ratio is estimated (Schmit, 2003; Giesecke, 2004). Through the process of credit risk assessment via fuzzy sets there is estimated the probability of each scenario, which is expressed as a matrix of non-fuzzy numbers (Chen, 2001).

The most probable utility is calculated considering the experts opinion-based assessment of company's X and market's income growth probabilities, which were provided by representatives of company X and leasing company. Experts were asked to express their opinion on each scenario probability assessing it in scale of 1-to-5 grades (where 5 is the highest probability). This scale was used to simplify the opinions of experts, but, however, it is not the most suitable for the calculation of company's X utility. The usage of such experts' opinion-based assessment methodology is based on the idea that the sum of probabilities for pessimistic, realistic and optimistic scenarios is supposed to be equal to 1 (because the most expected value is determined as the weighted average of all scenarios values). As well as, recalculation of experts' opinion enables to maintain the projections of experts' assessments and does not distort the results of experts' opinions.

Stage 5. Estimation of expected operating profit. As projected turnovers and the scenarios' probabilities are indicated, the matrix of probable operating profit when the loan is granted and not granted is constructed using the principles described by A.Vasiliauskaitė and A.Cvilikas (2008). In this step the expected operating profit is expressed in form of matrix with two crediting cases (leasing is granted or not) and three scenarios of company's growth in the context of the whole market.

Stage 6. Assessment of the credit risk. When the operating profit is assessed the credit coefficients are indicated (in both cases – when the loan is granted and not granted) using the principles described by A.Vasiliauskaitė and A.Cvilikas (2008). The final calculations return two credit reliability coefficients for every company's growth in the context of the whole market scenario: U_{ib}^{T} – credit reliability coefficient in case leasing is granted, and U_{ia}^{T} – credit reliability coefficient in case leasing is not granted.

The credit reliability coefficients are estimated and their qualitative assessment could be described as follows:

- If $U_{ib}^{T} < U_{ia}^{T}$, risk is high.
- If $U_{ib}^{T} = U_{ia}^{T}$, risk is average.
- If $U_{ib}^{T} > U_{ia}^{T}$, risk is low.

To assess the company's growth ratios in the context of the market it should be considered if the analyzed company is the leader or outsider in the market. In a case of market leader the credit risk is much lower than in a case of market outsider. The final decision depends on both the current situation and the projected income growth ratios throughout the loan period in the context of the average market growth ratios.

3. Company's credit risk assessment via fuzzy sets theory for credit risk assessment

Considering the algorithm of credit risk assessment model via fuzzy sets theory, further the calculations of company's X credit risk are provided.

Stage 1. Analysis of current breakeven point. The calculations needed to estimate the current breakeven point are provided in table 1. The financial statement and inner documents of 2010 were used to calculate the current breakeven point. Through fuzzy numbers the annual turnover in liters and cost structure are analyzed.

Because the analyzed primary information is approximate (there are features of indeterminacy), the upper and lower bounds are set. The turnover in value is precise, therefore its bounds coincide with real assessment.

Table 1. Calculations of company's X breakeven point

Ratio	Value in fuzzy numbers
Annual turnover, in units	(2 070 545; 2 134 582; 2 198 619)
Annual turnover, Lt	(4 760 118; 4 760 118; 4 760 118)
Average production price, Lt	(2.17; 2.23; 2.30)
Total costs, Lt	(3 662 911; 3 855 696; 4 048 480)
Fixed costs, Lt	(1 353 349; 1 503 721; 1 654 093)
Variable costs, Lt	(2 008 817; 2 351 974; 2 695 131)
Variable costs per unit, Lt	(0.91; 1.10; 1.30)
Breakeven point, Lt	(2 245 950; 2 972 369; 4 147 802)

Other information needed to assess the current breakeven point is calculated via fuzzy numbers methodic.

Results of breakeven point calculation could be interpreted as: the calculated most likely value of breakeven point is 2 972 369 Lt, however, it features with very high indeterminacy, because the bounds of this number are very big (the lower deviation is 24 percent of the most likely value; the upper value deviation – 40 percent). Therefore, the breakeven point of company X is 2 972 369 Lt and it should be considered on certain conditions regarding errors of the estimation.

The provided interpretation of breakeven analysis shows that fuzzy sets theory for credit risk assessment is superior to qualitative or quantitative methods, because in case of qualitative methods the indeterminacy of ratios is not assessed and the quantitative methods does not assess the bounds of data.

As the current breakeven point of company and its bounds are assessed, it is needed to estimate ratios, which are necessary to estimate the future breakeven point, projections and tendencies considering the experts opinions.

Stage 2. Analysis of future breakeven point. To calculate the future breakeven point there are needed the qualitative opinions of experts of both leasing company and company X about changes of turnover, average services price and costs (table 2). These ratios are transformed into fuzzy numbers considering the scale provided in the methodic chapter. Opinions of experts are provided considering two cases: 1) company X will purchase new equipment via leasing services 2) company X will not purchase new equipment.

Table 2. The assessment of company's X growth perspectives

Ratio	The probability of growth purchasing new equipment		The probability of growth not purchasing new equipment	
	Opinion of experts	Assessment in fuzzy numbers	Opinion of experts	Assessment in fuzzy numbers
Turnover (in units)	High	(0.50; 0.75; 1.00)	Average	(0.25; 0.50; 0.75)
Average price of services	Average	(0.25; 0.50; 0.75)	Average	(0.25; 0.50; 0.75)
Fixed costs:				
Production	Low	(0.00; 0.25; 0.50)	Low	(0.00; 0.25; 0.50)
Non-production	Average	(0.25; 0.50; 0.75)	Low	(0.00; 0.25; 0.50)
Variable costs:				
Wages	High	(0.50; 0.75; 1.00)	Average	(0.25; 0.50; 0.75)
Stock costs	Average	(0.25; 0.50; 0.75)	Low	(0.00; 0.25; 0.50)
Other variable costs	High	(0.50; 0.75; 1.00)	High	(0.50; 0.75; 1.00)

Considering provided opinions of experts, the expected breakeven points were calculated in both cases – as the leasing is granted and leasing is not granted. Calculations are provided in table 3.

Table 3. Calculations of company's X expected breakeven point

Ratio	Value in fuzzy numbers	
	Leasing is granted	Leasing is not granted
Projected growth of fixed costs	(0.13; 0.38; 0.63)	(0.00; 0.25; 0.50)
Projected growth of total variable costs	(0.42; 0.67; 0.92)	(0.25; 0.50; 0.75)
Projected growth of variable costs of a product	(0.42; 0.89; 1.83)	(0.33; 1.00; 3.00)
normalized	(0.13; 0.28; 0.58)	(0.08; 0.23; 0.69)
$\Delta V/\Delta P$*	(0.18; 0.57; 2.34)	(0.10; 0.46; 2.77)
normalized	(0.06; 0.18; 0.76)	(0.03; 0.14; 0.83)
$1 - \Delta V\backslash\Delta P$	(0.24; 0.82; 0.94)	(0.17; 0.86; 0.97)
Projected growth of breakeven point	(0.13; 0.46; 2.59)	(0.00; 0.29; 2.95)
normalized	(0.04; 0.14; 0.81)	(0.00; 0.09; 0.91)
Breakeven point, Lt	(2 339 576; 3 401 682; 7 523 610)	(2 245 950; 3 238 190; 7 924 662)

* ΔV – growth of variable costs for a unit; ΔP – growth of average price.

Provided calculations of expected breakeven point indicate that considering the opinion of experts, the probable value of breakeven point as the leasing is granted is 14,4 percent higher than the current breakeven point and 5,0 percent higher than expected value as leasing is not granted.

Therefore, the company X should increase the turnover to maintain the same credit risk level which is expressed as ratio of turnover and breakeven point. Considering assessing this ratio there is constructed client's utility matrix that shows expected difference between turnover and breakeven point in subject to expected growth of both a company X and the whole market of recycling of alimentary waste.

Stage 3. Construction of client's utility matrix. The projected growth of company X in optimistic, realistic and pessimistic scenarios then leasing is granted or not is presented in table 4. In case the leasing is granted, the optimistic growth of company's turnover is expected to be 1.4 times and the pessimistic growth 1.2 times, if the company succeeds to grow faster than market's average. If company fails to reach the average growth of the market, then the optimistic growth of turnover is expected to be 0.97 times, which means the reduction of turnover. In case the leasing is not granted, the expected growth rates are lower because the modernization of equipment is supposed to have a positive impact on company's performance.

Table 4. Projected growth of company X, times

		Growth of company turnover					
		Leasing is granted			**Leasing is not granted**		
		Optimistic	Realistic	Pessimistic	Optimistic	Realistic	Pessimistic
Company's growth considering the whole market	Higher than market	1.40	1.30	1.20	1.30	1.20	1.10
	Average	1.25	1.15	1.05	1.15	1.10	1.05
	Lower than market	0.97	0.95	0.93	0.97	0.95	0.93

The projected turnover matrix presented in table 5 expresses the expected turnover using above discussed expectations from experts in optimistic, realistic and pessimistic scenarios and in case leasing is granted or not. The expected turnover is expressed as fuzzy number and this allows defining the possible tolerance limits for every case forecasted.

Table 5. Matrix of company's X projected turnover, Lt

		Growth of company turnover		
		Optimistic	Realistic	Pessimistic
Company's growth considering the whole market	**Leasing is granted**			
	Higher than market	(6 330 957; 6 664 165; 7 330 582)	(5 878 746; 6 188 153; 6 806 969)	(5 426 535; 5 712 142; 6 283 356)
	Average	(5 652 640; 5 950 148; 6 545 162)	(5 200 429; 5 474 136; 6 021 549)	(4 748 218; 4 998 124; 5 497 936)
	Lower than market	(4 386 449; 4 617 314; 5 079 046)	(4 296 006; 4 522 112; 4 974 323)	(4 205 564; 4 426 910; 4 869 601)
	Leasing is not granted			
	Higher than market	(5 878 746; 6 188 153; 6 806 969)	(5 426 535; 5 712 142; 6 283 356)	(4 974 323; 5 236 130; 5 759 743)
	Average	(5 200 429; 5 474 136; 6 021 549)	(4 974 323; 5 236 130; 5 759 743)	(4 748 218; 4 998 124; 5 497 936)
	Lower than market	(4 386 449; 4 617 314; 5 079 046)	(4 296 006; 4 522 112; 4 974 323)	(4 205 564; 4 426 910; 4 869 601)

Company's X utility matrix (table 6) shows the difference between turnover and breakeven point. The results provided in company's X utility matrix indicates that in each case (independently from market growth and decision of leasing granting) there is projected positive difference between turnover and breakeven point. However, the indeterminacy of results expressed in fuzzy numbers shows the possibility of excess of breakeven point over turnover. This aspect of assessment must be analyzed considering company's credit risk. As well as, it should be highlighted that the utility for company X is higher when leasing is granted. This shows the leasing could have a very positive impact on further business development.

Table 6. Matrix of company's X utility, Lt

		Growth of company turnover		
		Optimistic	Realistic	Pessimistic
Company's growth considering the whole market	**Leasing is granted**			
	Higher than market	(-1 192 653; 3 262 483; 4 991 006)	(-1 644 864; 2 786 471; 4 467 393)	(-2 097 075; 2 310 459; 3 943 780)
	Average	(-1 870 970; 2 548 465; 4 205 586)	(-2 323 181; 2 072 454; 3 681 973)	(-2 775 392; 1 596 442; 3 158 360)
	Lower than market	(-3 137 161; 1 215 632; 2 739 470)	(-3 227 603; 1 120 430; 2 634 747)	(-3 318 045; 1 025 228; 2 530 025)
	Leasing is not granted			
	Higher than market	(-2 045 917; 2 949 963; 4 561 019)	(-2 498 128; 2 473 951; 4 037 406)	(-2 950 339; 1 997 940; 3 513 793)
	Average	(-2 724 233; 2 235 946; 3 775 599)	(-2 950 339; 1 997 940; 3 513 793)	(-3 176 445; 1 759 934; 3 251 986)
	Lower than market	(-3 538 214; 1 379 124; 2 833 096)	(-3 628 656; 1 283 922; 2 728 373)	(-3 719 098; 1 188 720; 2 623 651)

As realistic, pessimistic and optimistic cases of company X utility are calculated, the most probable utility is calculated dependently on market growth ratios.

Stage 4. Construction of changes' possibilities matrix. The identified different scenarios of company's growth require defining the probabilities of every scenario. These probabilities, set with the help of experts, are presented in changes' possibilities matrix (table 7). The results presented in changes' possibilities matrix show that the mostly expected scenario of company's turnover growth is realistic, which is equal to 0.5 in case the company's growth is higher or equal to market, and 0.4 if company fail to reach the average growth of the market.

Table 7. Changes' possibilities matrix

		Growth of company turnover		
		Optimistic	Realistic	Pessimistic
Company's growth considering the whole market	Higher than market	0.3	0.5	0.2
	Average	0.2	0.5	0.3
	Lower than market	0.2	0.4	0.4

As probabilities of changes are assessed, the most probable company's X operating profit can be calculated to define the expected operating profit.

Stage 5. Estimation of expected operating profit. The expected operating profit of company "X" in cases of different income growth and leasing granting or not is presented in table 8.

Table 8. Projected company's X operating profit, Lt

		Leasing is not granted	**Leasing is granted**
Company's growth considering the whole market	Higher than market	(-2 452 907; 2 521 553; 4 089 767)	(-1 599 643; 2 834 072; 4 519 754)
	Average	(-2 972 950; 1 974 139; 3 487 612)	(-2 368 402; 2 024 852; 3 629 612)
	Lower than market	(-3 646 744; 1 264 881; 2 707 429)	(-3 245 692; 1 101 390; 2 613 803)

The results of expected company's X operating profit calculation show that in all analyzed cases the positive results (the operating profit) are expected. In cases the company's income growth will be higher than market or average, the granting of leasing guarantees the higher expected operating profit than in case the leasing is not granted. But if the company's X income growth is lower than average, the leasing granting may cause the reduction of operating profit.

Then the matrix of company's X expected operating profit is analyzed it is important to take into account the limits of fuzzy numbers alterations, which is some cases show the possible deviation 3 times larger than the most probable value (in case the leasing is granted if company's income growth is lower than market). Besides, in all cases the lower limit of expected operating profit is negative, and this shows the probability of loss.

Using the presented assessment of expected operating profit in different income growth scenarios and in cases leasing is granted and leasing is not granted, it is possible to assess the company's X credit risk for the leasing provider.

Stage 6. Assessment of the credit risk. The level of credit risk in the credit risk assessment model via fuzzy sets theory is shown by credit reliability coefficient, which numerically expresses the expected operating profit in cases leasing is granted and leasing is not granted.

The operating profit for company X was calculated in case of three different income growth levels, so the credit reliability coefficients are also different for every income growth scenario. The credit reliability coefficients for company X are presented in table 9.

Table 9. The qualitative assessment of company's X credit reliability

Company's growth in market context	Credit reliability coefficients	
	Leasing is not granted	**Leasing is granted**
Higher than market	0.591	0.634
Average	0.612	0.629
Lower than market	0.625	0.620

The calculated credit reliability coefficients are interpreted according to qualitative assessment. The calculation of company's X credit reliability coefficients show that leasing company should make a positive decision for crediting company X only in case if forecasted company's annual income growth is higher or equal to market's average. In such way the credit reliability coefficient in case the leasing is granted is higher than the leasing is not granted and this shows that the granting of leasing causes the better company's X financial state and company in such case would be able to fulfill its obligations to leasing provider.

If company's X income growth is slower than market's average, then the situation of company after the leasing is granted would be worse than in case without the leasing. In this situation the probability of company's X abilities to fulfill obligations to leasing provider is treated as insufficient and the leasing company should make a decision not to provide the leasing service for company X.

4. Discussion

The credit risk assessment model enables to forecast possible changes of client's creditability considering the changes of client's business. For commercial banks that seek to actively manage risk this credit risk assessment model could be not very suitable due to the too little aspects included in the assessment. Therefore, such credit risk assessment model is suitable to other credit products providers that distinguish with lower credit risk level, and this model could simplify the credit risk assessment procedures for such credit products providers. One of such credit products is financial leasing, which typically faces the lower level of credit risk because of the specifics of provided service. To confirm this statement the empirical research was performed in which, using the model of credit risk assessment via fuzzy sets theory, the abilities to use leasing service from credit risk viewpoint of specific company are being analyzed.

The presented example of credit risk assessment in leasing sector shows that leasing provider with the help of credit risk assessment model via fuzzy sets theory may quite easily and precisely assess the credit risk of potential debtor. But in this case it is important to take into account that the credit risk assessment model via fuzzy sets theory can be easily adopted and used only in case the proper software is used in leasing company, because the calculation of the credit reliability coefficients requires automated calculations. Those calculations may be performed using standard calculations software such as MS Excel, OpenOffice Calc or similar, but the preparation of suitable calculation forms are required.

The other important characteristic of presented model is the ability of model's parameters correction. One of the main parameters in this model is the principal assessment indicator. In the presented example the principal assessment indicator is the difference between income and breakeven point (in value terms), which might be transformed into other indicator if leasing provider considers it to be a better alternative (for example, the profitability of performance, profitability of assets, etc.). The other possibility to correct the presented model's parameters is the change of elements in client's utility matrix, where the market growth might be changed to other important indicators in specific situation (for example, the supply of qualified labor force, if there is a need to finance the modern technologies implementation or similar).

The presented credit risk assessment example allows concluding that the credit risk assessment model via fuzzy sets theory is an efficient tool for credit risk assessment in case there is a need to combine qualitative and quantitative analysis of company's and its environment's indicators, and to take into account the uncertainty of indicators' values. The credit risk assessment model via fuzzy sets theory allows transformation of qualitative assessment in normalized numeric values. This attribute of presented model is one of the main advantages in comparison with other credit risk models, where the uncertainty of assessment is eliminated or the limits of uncertainty are not clearly determined.

Conclusions

The credit risk assessment model via fuzzy sets theory, whose aim is the assessment of potential debtor's credibility using the breakeven point analysis, is useful when there is a need to simplify the process of quantitative credit risk assessment and to preserve the same reliability of assessment, which would be acceptable for assessor.

Because of the limited number of factors, which are included in the process of credit risk assessment, the credit risk assessment model via fuzzy sets theory can be adopted more efficiently in case of services with lower level of credit risk. For this reason the credit risk assessment model via fuzzy sets theory is a potential tool in leasing sector where the credit risk level is relatively lower than in other credit companies.

As the performed empirical research shows the one of the main advantages of credit risk assessment model via fuzzy sets theory usage for credit risk assessment is the possibility to combine the qualitative and quantitative ratios and indicators of specific company and its environment. Moreover, the presented model allows assessment of such ratios and indicators while preserving the uncertainty of their values expressing entire assessment in numerical values.

The credit company, which uses credit risk assessment model via fuzzy sets theory, may quite easily and precisely assess the credit risk of potential debtor. But in this case it is important to note that the condition of easy and precise assessment is valid only in case the proper software is used allowing the automation of calculations.

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