ICIFSTA'2016, 20–22 April 2016, Beni Mellal, Morocco
Notes on Intuitionistic Fuzzy Sets
Print ISSN 1310–4926, Online ISSN 2367–8283
Vol. 22, 2016, No. 2, 108–118

Intercriteria analysis of the creditworthiness of SMEs. A case study

Lyubka Doukovska[1], George Shahpazov[1] and Vassia Atanassova[2]

[1] Institute of Information and Communication Technologies, Bulgarian Academy of Sciences
Acad. G. Bonchev str., bl. 2, 1113 Sofia, Bulgaria
e-mails: doukovska@iit.bas.bg, atlhemus@abv.bg
[2] Institute of Biophysics and Biomedical Engineering, Bulgarian Academy of Sciences
Acad. G. Bonchev Str., bl. 105, 1113 Sofia, Bulgaria
e-mail: vassia.atanassova@gmail.com

Received: 23 February 2016 **Accepted:** 27 March 2016

Abstract: The latest programming period of the EU, is expected to introduce reforms in the mechanism of EU Budget funding. The subsequent consequences of those reforms, will reflect to the overall European economy, as well as Bulgaria's. The general idea of economy's recovery has to go mainly through asset and know-how modernization of long-term value creating industries. Expected results of the reforms, though with some uncertainty to the direct influence on SME funding, should result into timely implementation of available financial resources to beneficiaries as first.

The creation of additional and more advanced financial instruments, along with increase of % ratio in advance payments to some programs is estimated to provide a lot more stability and reduce the risk of project realization failure. The lack of internal SME available cash positions, could be compensated by those program updates. At the same time, those processes should be synchronized with the necessary updates in most financial institutions methodology of creditworthiness and credit risk assessment analysis and procedures.

The approach of the methodology is to bring up and screen the most important elements in each SME present status. The unification of the approach will provide a positive outcome to the process of analyzation and assessment of credit risk, and creditworthiness of local SME's. The main scope of the unification is to make the assessment more thorough, that way the risk undertaken by financial institution can be minimized. In the article we provide a scoring scheme model, which will analyze majority of important objective and subjective characteristics of SME companies, all applying for financial support under a randomly picked program or instrument suited for small and medium-sized enterprises.

For this purpose, we further employ the intercriteria analysis, as an approach for detection and identification of dependencies between these objective and subjective characteristics of SMEs.

Keywords: Small and medium-sized enterprises, SME creditworthiness, Intercriteria analysis.
AMS Classification: 03E72.

1 Introduction

Most of small and medium-sized enterprises (SMEs) in Bulgaria are going through complicated times, in terms of maintaining the expected business life cycle, and in some cases are not able to reach it's maturity on time. By doing so the expected potential in the business scope is not reached at all. Plenty of reasons are known for the missed opportunities, but most common once are lack of good management and external financing barrier. By introducing a general scoring system, intended for implementation in Financial institutions „tool boxes", utilized as main source of present financial acknowledgement of SME's, the process of eliminating most of negative factors will be gapped down. Once the financing window is regulated and open for promising SME projects, the internal work of developing paths, seeking for expansion can naturally continue in its direction. At present times, our researches show that most of the working SME's are managed by outdated internal structures, and solely expecting results to be product of personal input (one man show type) of skills and knowledge. Our believe is that the implementation of modern business processes, where the input is expected from more than one manager or high ranked officer, will change for the most part decision making structure of top management, and at the same time would significantly affect the way profitability is chased.

In addition to decision making processes, changes should follow in the strategies concerning marketing innovations, and business driving alternatives. At the end, regardless of all in-company alterations made, in order to reach desired levels of success and earnings, most SME's are left highly dependable on external funding.

The discussed problematics has not been so far approached with the newly proposed method of intercriteria analysis, which strength is in detecting possible dependencies between different, heterogeneous, criteria, based on analysis of a large number of objects, evaluated against these. We are interested to see if the analysis of SMEs, using intercriteria analysis, will yield new dependencies, or confirm some existing ones, [9].

2 Problem formulation

The most recent statistics of the Eurostat on SMEs (2012) report that the EU of 28 states (EU28) has more than 22.3 SMEs which are a staggering 99.8% of all companies. Taken together, SMEs generate 67.1% of all jobs and make a 57.5% contribution towards the creation of wealth. Micro and Small businesses make up typically 80 -90% of a country's SME sector. In most countries the majority of small businesses do not have to file any type of audited accounts with a government body save for tax returns. Income (Turnover) data is often understated in these filings, therefore makes it difficult to utilize the data for potential landing services. Typically,

two-thirds of a small business portfolio is non-limited (e.g sole traders/entrepreneurs) with no requirement to register business details. All of the above mentioned facts are a barrier when it comes down the external funding needs.

Most common, but as previous times mentioned underutilized options of fund raisings, are government financial programs. Less than 5% of the companies had access to that type, due to budget limitation and overwhelming requirements. Non-government organizations landing programs had an input of less than 3% on the overall SME segment. Financing via EU structured funds has significant portion (over 46%) of the whole picture, and considerable number of SMEs are striving and making efforts to the new programing period. Again, access to available programs is a subject of meeting a certain number of criteria's and requirements, which becomes a major obstacle to certain percentage of SME's.

Those type of grants are preferable way of financing projects, and gives chance of some start up and all others, to make „the first turn on their business cycle" with a lower level of risk and debt free. Unfortunately, the dependency on EU funding brings an artificial level of comfort, considering that funds are provided as grants to the particular sector of the economy, and are not subject of return if all requirements met. Main obstacle is the programing period of the EU instruments, because once budgets are depleted or timely expired, than internal cash-flow becomes solely dependent on regularity in revenue and proper management.

Considering the unstable economic environment and intercompany debt levels, along with unsatisfactory turnover and profit results, most SME's are unable to rely on own resources. This is valid to such an extent, that financing through own cash flow revenues, has decreased considerably in comparison to some time ago. Reliable and timely financial account information is not automatically available for the majority of small businesses and is a burden to owners, when cash management is applied. In spite of all difficulties that SME's are facing with regards to proper financial documentation and other legal issues that are faced with, the most preferred source of raising external capital remains the bank loan.

In this paper, a glance of the most important steps of the evaluation process is provided, along with an updated version of creditworthiness evaluation model.

The traditional approach to SME lending to a certain extend has been modified into an automated decision process, where manual underwriting has been replaced with an automated one. Main reason for the implemented changes are the improvement of quality and decision making terms.

The key elements to consider are financials, SME capital, and collateral. Those are the so called objective characteristics that carry the most weight in the overall scoring model. Regardless of the fact traditional balance sheet, P&L, management and economic data are not always available and performed for small business, those characteristics are considered the foundation of the decision making processes. The subjective characteristics are used predominantly for the qualitative analysis of each case.

The decision making methodology or process cannot always be optimal for all credit scenarios, as some would favors a predominantly manual process, others an automated one as discussed in the present article.

3 Elements of the SMEs creditworthiness evaluation

The evaluation process of loan applications begins at first level – Branch facility of a financial Institution. Loan projects are initially assessed by at branch level, by manager and supporting team of loan specialist and bank's representatives. Main focus is the gathering of all necessary information, labeled as objective characteristics. Preliminary research and opinion is based on information provided, so as sent to the headquarters can be filtered and loaded into the automated scoring model.

Criteria used in the model are collaboration of the following details and data (Table1):

1. FINANCIAL DATA	2. COMPANY and OWNERS/MANAGERS DATA	3. MACROECONOMICS DATA	4. COLLATERAL AND LTV DATA
1.1. Net revenue; 1.2. EBITDA; 1.3. Capital stock; 1.4. Receivables; 1.5. Liabilities; 1.6. Assets;	2.1. Relationship with financial institutions, credit history statements; 2.2. Managerial skills and experience; 2.3. Legal status and ownership;	3.1. Characteristics and perspectives of the business, prognoses in development; 3.2. Market shares of the SME's business; 3.3. External market environment;	4.1. Analysis of the collateral, along with economic justification, 4.2. Loan type analysis; 4.3. Payment plan analysis.

Table 1.

1.1. Net revenue – provides us with information about the turnover of sales, in the form of final product or service, made by the SME for a period of time. Financial year to year comparison, can be used as main tool for analysis;

1.2. EBITDA (*Earnings, Before, Interest, Taxes, Depreciation and Amortization*) – this characteristic is the most important and valuable indicator, which provides us with information about overall SME's performance. It analyzes the profitability of the company, as it eliminates the effects of external financing and accounting decision;

1.3. Capital stock – is a characteristic which is a collaboration of, actual in company capital (cash), General reserves, Retained earnings from previous year, and losses for previous years. This indicator is a reflection of the actual financial discipline of the SME;

1.4. Receivables – gives us information on SME's rhythm of sales performed, and at same time its timely collection. This characteristic as a subject of detailed analysis and breakdown of the maturity of origination. In some cases, provision of bad receivables can be applied, and figures reduced;

1.5. Liabilities – is a characteristic which is a collaboration of, financial obligations, goods or services provided be trade partners, taxes payable, and other liabilities. As with receivables, main indicator for this characteristic is origination of obligation and ability of the SME to cover payments.

1.6. Assets – it indicates what type of long and short term assets are recorded and accounted for in the balance sheet of the Company. Fixed assets such as Land, Buildings, Technical Plant and Machinery, are so called long term assets. In short term assets, fall available goods on

stock, petty cash on hand, funds available in accounts and trade receivables, which for the purpose of the article is screened as separate characteristic.

Those characteristics are considered the driving force of all objective characteristics, with main weighted input in the scoring model.

2.1. Relationship with fin. Institutions, credit history statements – this characteristic values correctness and loyalty of the customer (SME) to the Bank. Important factors are the number of utilized banking products and services, readiness to provide required information by the financial institution;

2.2. Managerial skills and experience – past experience, age, skills and organizational structure, reputation and efficiency in decision making processes are most valuable factors in this characteristic;

2.3. Legal status and ownership – it covers the period of establishment of the Company, reached results, overcoming of crisis periods, frequent changes of main scope of activity. Owners and breakdown of ownership of the SME has its input in final decision makings;

3.1. Perspectives of the business, prognoses in development – this characteristic analyses the activity of the company, and the options for realization of different projects at deck. Main business and ideas of either producing certain products, or providing services are the directions of the analysis;

3.2. Market shares of the SME's business – provides the score with information about geographical place of operation or good final destination. Competition, analysis of sales made, channels of realization of goods and services;

3.3. External market environment – it analyzes the overall macroeconomic environment in the economy, or the sector which the SME is operating.

The analyzed data from the second and third characteristics provides a less weighted input in the scoring model, due to the reason that results are collaboration of subjective factors.

4.1. Analysis of the collateral, along with economic justification – main focus is the type of collateral provided, value and liquidity. The provision of a realistic business plan, where expected results and tasks are reachable with regards to the influence of the external market and the environment of the economy are key;

4.2. Loan type analysis – the main task of the characteristic is to differentiate the risks of the type of loan, provided/requested by the SME. Main scope is to bring the actual cash flow of the Company to a rhythm, which will give ability of the company to maintain a normal business cycle.

4.3. The analysis of the payment plan as a characteristic, is part of the above analyzed indicator.

The last 4 characteristics, utilized in the scoring model, are with secondary importance as part of the objective characteristics, and maintain a stronghold weight in the model.

4 Methods: InterCriteria Analysis

The concepts of intercriteria analysis is based on the apparatus of index matrices (IMs) [4] and intuitionistic fuzzy sets (IFSs) [1, 2, 3]. The approach is specifically developed for situations in multicriteria decision making, where some of the criteria come at a higher cost than others, for instance are harder, more expensive, more human resource or time consuming to measure or evaluate. While these criteria are considered unfavourable, the method aims to identify high enough levels of correlation between these criteria and others that are easier, cheaper or quicker to measure or evaluate, in order to disregard the unfavourable ones from the further decision making process [5, 6].

Intuitionistic fuzzy sets (IFSs) are one of the most popular extensions of Zadeh's concept of fuzzy sets. Fuzzy sets extend the classical notion of set by introducing membership function, allowing the gradual assessment of the membership of elements to a set with values from the [0; 1]-interval. Furthermore, Atanassov's intuitionistic fuzzy sets extend the concept of fuzzy sets by introducing an additional function of non-membership, evaluated in the same interval, with the requirement that both degrees are in the unit interval, and their sum also belongs to that interval. Briefly, the IFS is formally denoted by $A = \{\langle x, \mu_A(x), \nu_A(x)\rangle \mid x \in E\}$, where $\mu_A(x)$ defines the membership of an element x to the set A, evaluated in the [0; 1]-interval; $\nu_A(x)$ defines the non-membership of the element x to the set A, where $\mu_A(x) \in [0; 1]$, $\nu_A(x) \in [0; 1]$, and $(\mu_A(x) + \nu_A(x)) \in [0; 1]$.

Comparison between elements of two IFSs, involves pairwise comparisons between the degrees of membership and non-membership of the elements of both sets.

Let us have an index matrix (IM) with elements $a_{p,q}$, $p = 1, ..., m$, $q = 1, ..., n$,

$$M = \begin{array}{c|ccccccc} & O_1 & \dots & O_k & \dots & O_l & \dots & O_n \\ \hline C_1 & a_{C_1,O_1} & \dots & a_{C_1,O_k} & \dots & a_{C_1,O_l} & \dots & a_{C_1,O_n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \ddots & \vdots \\ C_i & a_{C_i,O_1} & \dots & a_{C_i,O_k} & \dots & a_{C_i,O_l} & \dots & a_{C_i,O_n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \ddots & \vdots \\ C_j & a_{C_j,O_1} & \dots & a_{C_j,O_k} & \dots & a_{C_j,O_l} & \dots & a_{C_j,O_n} \\ \vdots & \vdots & \ddots & \vdots & \ddots & \vdots & \ddots & \vdots \\ C_m & a_{C_m,O_1} & \dots & a_{C_m,O_j} & \dots & a_{C_m,O_l} & \dots & a_{C_m,O_n} \end{array},$$

where C_p is a criterion, taking part in the evaluation; O_q is an object, being evaluated; $a_{p,q}$ is the evaluation of the q-th object against the p-th criterion, and it is defined as a real number or another object that is comparable according to relation R with all the rest elements of the index matrix M, so the relation ($R(a_{C_kO_i}, a_{C_kO_j})$ holds for each i, j, k. The relation R has dual relation $\overline{R}$, which is true in the cases when relation R is false, and vice versa.

If the number of cases for which the relations ($R(a_{C_kO_i}, a_{C_kO_j})$ and $R(a_{C_lO_i}, a_{C_lO_j})$ are simultaneously satisfied is $S_{k,l}^{\mu}$ and the number of cases for which the relations $R(a_{C_kO_i}, a_{C_kO_j})$

and its dual $\overline{R}(a_{C_l O_i}, a_{C_l O_j})$ are simultaneously satisfied is $S^{\nu}_{k,l}$, then

$$0 \le S^{\mu}_{k,l} + S^{\nu}_{k,l} \le \frac{n(n-1)}{2},$$

since the total number of pairwise comparisons between the object is $n(n-1)/2$. For every k, l, such that $1 \le k \le l \le m$, and for $n \ge 2$ two numbers are defined

$$\mu_{C_k,C_l} = 2\frac{S^{\mu}_{k,l}}{n(n-1)}, \nu_{C_k,C_l} = 2\frac{S^{\nu}_{k,l}}{n(n-1)},$$

$$0 \le S^{\mu}_{k,l} + S^{\nu}_{k,l} \le \frac{n(n-1)}{2}.$$

The pair, constructed from these two numbers, plays the role of the intuitionistic fuzzy evaluation of the relations that can be established between any two criteria C_k and C_l. In this way the index matrix M that relates evaluated objects with evaluating criteria can be transformed to another index matrix M^* that gives the relations among the criteria

$$M^* = \begin{array}{c|ccc} & C_1 & \cdots & C_m \\ \hline C_1 & \langle \mu_{C_1,C_1}, \nu_{C_1,C_1} \rangle & \cdots & \langle \mu_{C_1,C_m}, \nu_{C_1,C_m} \rangle \\ \vdots & \vdots & \ddots & \vdots \\ C_m & \langle \mu_{C_m,C_1}, \nu_{C_1,C_m} \rangle & \cdots & \langle \mu_{C_m,C_m}, \nu_{C_m,C_m} \rangle \end{array}.$$

Alternatively, it is practical to work with two index matrices M^{μ} and M^{ν}, rather than with the index matrix M^* of IF pairs.

The final step of the algorithm requires defining the values of thresholds for both the membership and the non-membership, against which we evaluate the precision of the ICA decision making. We call that two criteria are in relation of either 'positive consonance', or 'negative consonance', or 'dissonance', depending on their intercriteria pair's comparison with these two defined threshold values. Let $\alpha, \beta \in [0; 1]$ be the threshold values, against which we compare the values of μ_{C_k,C_l} and ν_{C_k,C_l}. We call that criteria C_k and C_l are in:

- (α, β)-positive consonance, if $\mu_{C_k,C_l} > \alpha$ and $\nu_{C_k,C_l} < \beta$;
- (α, β)-negative consonance, if $\mu_{C_k,C_l} < \beta$ and $\nu_{C_k,C_l} > \alpha$;
- (α, β)-dissonance, otherwise.

5 Data analysis and results

We will use an anonymized dataset of 10 companies, evaluated against 15 criteria (Table 2). The companies are all SMEs, but from different sectors and backgrounds.

We will remind the reader that in this set of criteria, the first six are objectively measured, hence the huge differences between their values, while the next nine are subjectively evaluated within the {1, 2, …, 6} range. From the point of view of the intercriteria analysis method, the smaller number of possible values, which the evaluation against a given criterion yields, leads to higher degrees of uncertainty, since more objects are evaluated with the same value, thus

reducing the discriminative power of the criterion. Also, the bigger number of objects helps raising the precision of the algorithm, so that another run of the algorithm over 100 objects will definitely yield improved results, compared to the dataset of 10 objects.

	C 01	C 02	C 03	C 04	C 05	C 06	C 07	C 08	C 09	C 10
(1) Net Revenue	286	108	220	201	165	120	210	482	130	195
(2) EBITDA	113	74	140	10	19	20	90	241	6	46
(3) Capital stock	157	130	170	15	34	39	101	202	11	71
(4) Receivables	17	9	0	0	1	17	33	214	40	45
(5) Liabilities	16	5	20	15	16	12	21	107	33	30
(6) Assets	11	0	0	20	2	13	0	26	0	123
(7) Relationship with financial institutions, credit history statements	6	5	3	6	6	4	3	4	3	6
(8) Managerial skills and experience	4	4	4	5	6	4	4	5	4	6
(9) Legal status and ownership	3	4	4	5	5	5	4	4	3	6
(10) Characteristics and perspectives of the business, prognoses in development	5	5	4	4	4	3	3	6	2	5
(11) Market shares of the SME's business	4	5	4	4	5	2	2	5	3	5
(12) External market environment	5	5	4	4	4	2	2	5	3	4
(13) Analysis of the collateral, along with economic justification	6	6	6	6	6	4	3	4	6	6
(14) Loan type analysis	6	6	6	6	5	4	3	4	6	6
(15) Payment plan analysis	6	5	4	6	6	4	3	5	6	6

Table 2. A set of companies, evaluated against a set of criteria

We input the above dataset into the intercriteria analysis software, developed by Mavrov, see [10], and as a result obtain two tables (Tables 3. and 4.) staying for the resultant table of intuitionistic fuzzy pairs, giving the positive consonance, negative consonance or dissonance, relating each pair of evaluation criteria. We are interested in the pairs of highest positive consonance, defined as definite correlation between a pair of criteria, while negative consonance represents definite lack of correlation, and dissonance – uncertainty. Obviously, along the main diagonal all consonance values are $\langle 1.00, 0.00 \rangle$, i.e., in Table 4 are 1.00 and in Table 5 are 0.00, since each criterion correlates with itself perfectly.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)	1.00	0.76	0.73	0.53	0.67	0.53	0.38	0.33	0.29	0.58	0.42	0.53	0.20	0.29	0.36
(2)	0.76	1.00	0.98	0.56	0.56	0.44	0.31	0.27	0.29	0.64	0.47	0.56	0.16	0.24	0.20
(3)	0.73	0.98	1.00	0.53	0.53	0.44	0.33	0.27	0.29	0.67	0.49	0.58	0.18	0.27	0.22
(4)	0.53	0.56	0.53	1.00	0.73	0.51	0.29	0.36	0.31	0.49	0.42	0.42	0.13	0.22	0.33
(5)	0.67	0.56	0.53	0.73	1.00	0.44	0.31	0.38	0.31	0.42	0.40	0.36	0.22	0.27	0.40
(6)	0.53	0.44	0.44	0.51	0.44	1.00	0.62	0.67	0.62	0.53	0.44	0.40	0.27	0.33	0.42
(7)	0.38	0.31	0.33	0.29	0.31	0.62	1.00	0.53	0.51	0.53	0.51	0.51	0.56	0.49	0.71
(8)	0.33	0.27	0.27	0.36	0.38	0.67	0.53	1.00	0.56	0.42	0.51	0.36	0.36	0.33	0.44
(9)	0.29	0.29	0.29	0.31	0.31	0.62	0.51	0.56	1.00	0.38	0.40	0.27	0.24	0.24	0.38
(10)	0.58	0.64	0.67	0.49	0.42	0.53	0.53	0.42	0.38	1.00	0.69	0.80	0.42	0.44	0.42
(11)	0.42	0.47	0.49	0.42	0.40	0.44	0.51	0.51	0.40	0.69	1.00	0.69	0.47	0.42	0.49
(12)	0.53	0.56	0.58	0.42	0.36	0.40	0.51	0.36	0.27	0.80	0.69	1.00	0.49	0.47	0.49
(13)	0.20	0.16	0.18	0.13	0.22	0.27	0.56	0.36	0.24	0.42	0.47	0.49	1.00	0.87	0.67
(14)	0.29	0.24	0.27	0.22	0.27	0.33	0.49	0.33	0.24	0.44	0.42	0.47	0.87	1.00	0.58
(15)	0.36	0.20	0.22	0.33	0.40	0.42	0.71	0.44	0.38	0.42	0.49	0.49	0.67	0.58	1.00

Table 3. The membership parts of the IFS intercriteria pair

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)	0.00	0.24	0.27	0.42	0.31	0.33	0.40	0.29	0.49	0.27	0.36	0.24	0.31	0.36	0.38
(2)	0.24	0.00	0.02	0.40	0.42	0.42	0.47	0.36	0.49	0.20	0.31	0.22	0.36	0.40	0.53
(3)	0.27	0.02	0.00	0.42	0.44	0.42	0.44	0.36	0.49	0.18	0.29	0.20	0.33	0.38	0.51
(4)	0.42	0.40	0.42	0.00	0.20	0.31	0.44	0.27	0.42	0.36	0.36	0.36	0.38	0.42	0.36
(5)	0.31	0.42	0.44	0.20	0.00	0.40	0.49	0.22	0.44	0.40	0.36	0.40	0.31	0.36	0.36
(6)	0.33	0.42	0.42	0.31	0.40	0.00	0.16	0.09	0.16	0.18	0.20	0.24	0.24	0.31	0.18
(7)	0.40	0.47	0.44	0.44	0.49	0.16	0.00	0.04	0.13	0.18	0.13	0.18	0.09	0.16	0.07
(8)	0.29	0.36	0.36	0.27	0.22	0.09	0.04	0.00	0.02	0.13	0.02	0.18	0.09	0.20	0.04
(9)	0.49	0.49	0.49	0.42	0.44	0.16	0.13	0.02	0.00	0.29	0.20	0.38	0.18	0.27	0.27
(10)	0.27	0.20	0.18	0.36	0.40	0.18	0.18	0.13	0.29	0.00	0.07	0.04	0.20	0.22	0.24
(11)	0.36	0.31	0.29	0.36	0.36	0.20	0.13	0.02	0.20	0.07	0.00	0.04	0.09	0.18	0.16
(12)	0.24	0.22	0.20	0.36	0.40	0.24	0.18	0.18	0.38	0.04	0.04	0.00	0.11	0.13	0.20
(13)	0.31	0.36	0.33	0.38	0.31	0.24	0.09	0.09	0.18	0.20	0.09	0.11	0.00	0.00	0.02
(14)	0.36	0.40	0.38	0.42	0.36	0.31	0.16	0.20	0.27	0.22	0.18	0.13	0.00	0.00	0.07
(15)	0.38	0.53	0.51	0.36	0.36	0.18	0.07	0.04	0.27	0.24	0.16	0.20	0.02	0.07	0.00

Table 4. The non-membership parts of the IFS intercriteria pairs

In addition, following the recent researches in the theory of intercriteria analysis, [8], the obtained results can be plotted onto the intuitionistic fuzzy interpretational triangle, see Fig. 1. The interpretational triangle visualizes the results of the intercriteria analysis, as an IFS constructed of the points, representing all possible pairs between criteria, where for each point its coordinates are respectively the membership and the non-membership elements of the IF

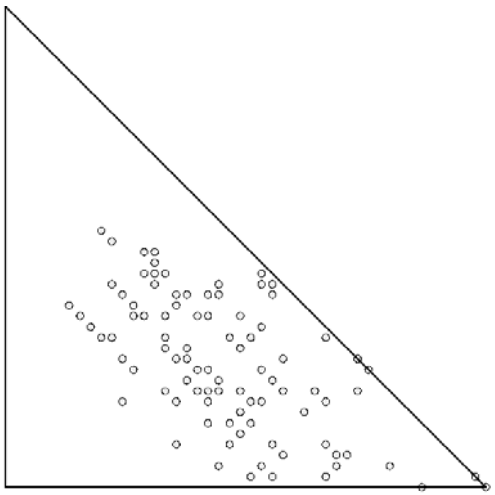

Figure 1.

pair. Then, the points, which are closest to the (1,0) point of the triangle are those featuring the highest positive consonance (in this case, the desired ones), while those closest to the (0,1) point exhibit the highest negative consonance, and those closest to the (0,0) points – the highest uncertainty, i.e., dissonance, [8]. In the present application, the highest positive consonance is demonstrated between the following criteria: 'EBITDA'/ 'Capital stock': ⟨0.98; 0.02⟩, 'External market environment'/ 'Characteristics and perspectives of the business, prognoses in development': ⟨0.80; 0.04⟩, and 'Analysis of the collateral, along with economic justification'/'Loan type analysis': ⟨0.87; 0.00⟩.

6 Discussion

As seen in the graphic above, noticeable are colorations formed mainly by the characteristics, which are considered in this article as objective once. Dependencies are strongly shown among the 'Revenue', 'EBITDA', and 'Capital stock' criteria, due to the fact that in any financial statement consistency between the above is expected. Nevertheless if an SME is working with a low ore close to 0 % of margin, it is expected to automatically reflect in those three criteria, even with a negative value. One exception is observed with the relatively high membership value of 0.71 of in the intercriteria pair between the 'Banks' and 'Payment plan analysis'. As previously mentioned in the research, the actual conclusion made on the basis of the conducted research is the following. A randomly picked SME, which has been customer of a financial institution for some time and is known be experts from inside even though has not used financial product up until, have a greater chance of identifying and suiting a payment plan, which will not burden the business cycle, when a loan is provided. Even though both indicators are considered objective, the connection between is a subject of variations, such as the example given above.

Certain levels of positive consonance in the research are observed in the intercriteria formed between two subjective criteria: 'Perspectives of the business, prognoses in development' and 'External market environment'). The higher degree of consonance is a result of the possibility for flexible conduct of a certain SME, which will adopt its business rhythm to a newer/different economy environment.

In general, the relatively high uncertainty featured in the results of the application of the intercriteria analysis method means that no distinctively strong correlations appear between them, which can be interpreted in the sense that each of the criteria has its own specifics and has been adequately selected for the purpose of the decision making process. On the other hand, increasing the pool of analysed companies is anticipated to further improve the results from the analysis.

Finally, the lack of positive consonance between the subjective criteria (seen from Tables 3. and 4.) is also result of the limited evaluation frame, excepted at present time. Additionally increasing the evaluation range, e.g. by refining the decimal division (for example from 1–6 to 1.1–5.9) will provide finer discrimination among the objects, as evaluated against the criteria, and can be formulated as one of the recommendations for the future.

Acknowledgments

The authors are thankful for the support provided by the National Science Fund of Bulgaria, under grant DFNI-I-02-5/2014 "InterCriteria Analysis – A New Approach to Decision Making".

References

[1] Atanassov, K. (1986) Intuitionistic fuzzy sets. *Fuzzy Sets and Systems*, 20(1), 87–96.

[2] Atanassov, K. (1999) *Intuitionistic Fuzzy Sets: Theory and Applications*, Springer, Heidelberg.

[3] Atanassov, K. (1999) *On Intuitionistic Fuzzy Sets Theory*, Springer, Berlin.

[4] Atanassov, K. (2014) *Index Matrices: Towards an Augmented Matrix Calculus*, Springer, Cham.

[5] Atanassov, K., Atanassova, V., & Gluhchev, G. (2015) InterCriteria Analysis: Ideas and problems. *Notes on Intuitionistic Fuzzy Sets*, 21(1), 81–88.

[6] Atanassov, K., Mavrov, D., & Atanassova, V. (2014) Intercriteria Decision Making: A New Approach for Multicriteria Decision Making, Based on Index Matrices and Intuitionistic Fuzzy Sets. *Issues in Intuitionistic Fuzzy Sets and Generalized Nets*, 11, 1–8.

[7] Atanassova, V. (2015) Interpretation in the Intuitionistic Fuzzy Triangle of the Results, Obtained by the InterCriteria Analysis, *16th World Congress of the International Fuzzy Systems Association (IFSA), 9th Conference of the European Society for Fuzzy Logic and Technology (EUSFLAT)*, 30 June – 3 July 2015, Gijon, Spain, 1369–1374.

[8] Atanassova, V., Vardeva, I., Sotirova, E. & Doukovska, L. (2016) Traversing and ranking of elements of an intuitionistic fuzzy set in the intuitionistic fuzzy interpretation triangle, Chapter, *Novel Developments in Uncertainty Representation and Processing*, Vol. 401, Advances in Intelligent Systems and Computing, 161–174.

[9] Doukovska, L., V. Atanassova, G. Shahpazov, F. Capkovic (2015) InterCriteria Analysis Applied to EU Micro, Small, Medium and Large Enterprises. *Proceedings of the 5th Int. Symposium on Business Modeling and Software Design*, Milan, Italy, 284–291.

[10] Mavrov, D. (2015) Software for InterCriteria Analysis: Implementation of the main algorithm, *Notes on Intuitionistic Fuzzy Sets*, 21(2), 77–86.