

IFS APPROACH IN CREDIT RISK ASSESSMENT

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Abstract

IFS approach in credit risk assessment is proposed. The credit risk is treated as multicriteria task using a number of factors. The factors are presented as sub-normal IF singletons derived by two groups of experts: for and against. Then risk assessment is calculated using factor dependant min/max procedure. At last a pessimistic and optimistic decisions are recovered from their normal IF singletons.

Keywords

Credit risk assessment, sub-normal IFS, factor dependent min/max procedure.

Introduction

In many works [3, 5, 8, 11] credit risk assessment is defined as multicriteria decision analysis using a definite number of factors, which reflect three sides of a bilateral process, i.e. relations between two partners (lender and borrower). They can be presented in three groups:

1. Estimation of borrower's potential. It consists of three parts:
 - i. volume of available assets (firm, intangible, etc.),
 - ii. level of borrower's production and its realization,
 - iii. human factor of the borrower's manager.
2. Estimation of lender's abilities:
 - i. a quantity of net capital,
 - ii. feasibility in partner's relations.
3. Global economic conditions:
 - i. stability of economical growth,
 - ii. stability of state and international relations,
 - iii. state debt position.

A scheme of these interpreting factors may be found in [6, 7]. In recent investigation we propose that the third group of factors may be expressed in implicit form into first two groups. Therefore we use a simplified hierarchical structure, which reflects following five levels, connecting all the representative factors under consideration (Fig.1). Some of the factors have positive other negative influence to risk assessment, i. e. the bigger factor corresponds to the bigger RA for positive and the bigger factor corresponds to the smaller RA for negative respectively. The seconds are expressed via their complements shown with the symbol $\neg$ before each factor.

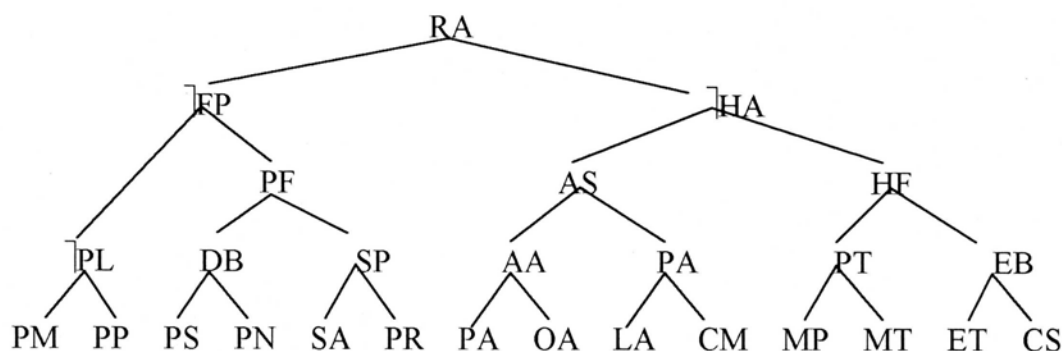


Fig.1

There are accepted the following abbreviations, shown on the Fig. 1:

PM - Polluting Materials	PL - PoLlution	PF - PerFormance
PP - Polluting Production	DB - Dynamic	AS - ASsets
PS - Profit & Sales	Behaviour	HF - Human
PN - Profit Net	SP - Sales &	Factors
SA - Sales	Production	
PR - PRoduction	AA - Active	FP - Future
PA - Property Assets	Assets	Performance
OA - Other Assets	PA - Passive	HA - Human
LA - Liquidity Assets	Assets	Abilities
CM -Continuity of Margins	PT - PoTential	
MP -Mental & Physical potential	EB - Economic	RA - Risk
MT -MoTivation	Behaviour	Assessment
ET - Economical Thinking		
CS - Conformity to Social standards		

Every factor is estimated within unit interval and can be interpreted as normalized rate, percent of participation, level of expectation, etc. due to the concrete context. As you can see some of the estimating factors have crisp numerical evaluation (assets, production, different rates in economics, etc.). Others could be obtained via statistical values based on collected representative samples (anticipated growth, rates of earning, etc.) and thirds are subjective or fuzzy by nature (mainly human factors). Obviously a crisp approach fails to obtain good results in regard to such different parameters. In the most of the cases the factors are estimated by experts within unite interval. On the other hand fuzzy based approach could be applied even by interpretation of statistical information. A great variation of statistical samples urge to apply uncertainty of other type than probabilistic. In [5] there is proposed a fuzzy model, balancing representation of factors of different type. The next attempt of fuzzy based model application utilizes a combined presentation of risk assessment in terms of neuro fuzzy paradigm [7].

IFS representation

All these models rely on expert assessment and the best performances reflect nearest coincidence with them. In other words we accept the expert estimates as perfect as ideal approximation and lead the model representation to them. One logically can state a question: "What is the best expert assessment?" If we have many expert estimates of the same factors a simple way is to accept mean values of every factor as representative. Another way is to meet and compare two meanings: for and against, and to look for compromising decision. In the paper we use a well known advantage of IFS in free representation of both accepted and non accepted confidence to our assessment using expression [1]:

$$\mu(x) + \nu(x) \leq 1 \quad (1)$$

$x = 1, \dots, N$, where: $\mu(x)$ and $\nu(x)$ are IFS singletons representing the grade of acceptance and non acceptance of factor x ; N is number of factors.

Applying such strategy of assessment we gain in more realistic representation and interpretation of results. The problem in obtaining the both values for every factor is that for many experts it is difficult to express their grade of acceptance and non acceptance, i.e. $\mu(x)$ and $\nu(x)$ at the same time without violation of inequality (1). In our case we propose acceptance of two estimates for every factor, which are given by different experts. So that there are two groups of experts: one of them estimating $\mu(x)$ other - $\nu(x)$. By this way the both estimates are not influenced by experts. As a result we have three cases in factor representation:

1. Inequality is performed. We use pure intuitionistic representation,

2. Equality is performed - the case is fuzzy set,
3. The both are violated.

The second is partial case of IFS, when $\mu(x) + v(x) = 1$. In the third case we can apply some of techniques, which maps images from the right upper plane into the left low plane in the terms of IFS geometrical representation, see for example [2]. Such techniques transform IFS in normal type. The drawback of such approach is that it concave initial expert estimates and we lose its explanation strength. Otherwise the both acceptance and non acceptance are overlapped. This means contradiction in overlapping regions of both expert estimates. In the common case we have:

$$0 < \mu(x) + v(x) < 2 \quad (2)$$

Obviously $\mu(x) + v(x) = 0$ means full ignorance, while $\mu(x) + v(x) = 2$ - full contradiction. A partial contradiction is obtained within $1 < \mu(x) + v(x) < 2$. Thus overlapping regions are defined as dubious regions. They become equal to: $\pi(x) = \mu(x) + v(x) - 1$. In this case we call $\pi(x)$ information deficiency since it contradicts to other expert estimation. $\pi(x)$ belongs simultaneously to both $\mu(x)$ and $v(x)$, but we are not sure to which, because it contradicts at the same time to one of the two expert estimates. A correct compromise decision is to subtract this dubious region from the both acceptance and non acceptance regions. Therefore the consensus seeking estimation between both experts denotes a diminishing of each values with information deficiency $\pi(x)$:

$$\mu^*(x) = \mu(x) - \pi(x) \text{ and } v^*(x) = v(x) - \pi(x), \quad (3)$$

where $\mu^*(x)$ and $v^*(x)$ are new non contradictory estimates. In this consideration we obtain in a natural way, from the expert estimates, a generalization of IFS qualifiers $\mu(x)$ and $v(x)$, which we call sub-normal IFS. By this way we obtain expert estimates on the low level of risk assessment structure as intuitionistic fuzzy singletons. In the following it is naturally one to use IFS representation and to gain from it, estimating the next level as IFS singletons. For convenience the adjacent factors are chosen to be similar in meaning. The assessment in every level is taken as min or max operation between two factors. These two operations are interchangeable from level to level, i.e.:

$$RA = \min_{op} [\max_{mn} [\min_{kl} [\max_{ij}(x)]]] \quad (4)$$

where: i, k, m, o are appropriate odd numbers at every level and j, l, n, p are their correspondingly adjacent even numbers. Obviously in such consideration it is accepted that the influence of every factor is the same within every level. In more realistic case the situation is changed and we have to accept different extreme level operation at the same level. The (4) transforms into:

$$RA = \text{ext}_{op} [\text{ext}_{mn} [\text{ext}_{kl} [\text{ext}_{ij}(x)]]] \quad (5)$$

where **ext** stands for **max** or **min** depending on context of the corresponding factors. Applying consecutively **max/min** operations for IFS singletons we derive as a result RA in the form $\langle \mu^*(x), v^*(x) \rangle$. Now we can recover actual $\mu(x)$ and $v(x)$ of RA using (3). As a result there are two interpretations: optimistic: $\mu(x)$ and pessimistic: $1 - v(x)$.

An experiment

As an example of above described strategy we present risk assessment of 20 firms using two groups of experts: for and against, i.e. their assessments of all the factors are based on $\mu(x)$ - acceptance and $\nu(x)$ - non acceptance. The algorithm of RA consists of the following steps:

1. Definition of initial factors using (3) if necessary,
2. Applying (4) or (5) for every level,
3. Recovering of $\mu(x)$ and $\nu(x)$ if necessary,
4. Definition of final RA

On Tabl.1 and Tabl.2 using common initial data are shown the both assessments: via ($\mu(x)$) and $\nu(x)$) respectively. Blackened numbers denote where inequality (1) is violated. In these points factors are corrected using (3) and RA is calculated by (4). Comparing the results of RA based on the two groups of experts (for and against) we can see that in the most of the cases RA in $\mu(x)$ is lower than RA in $\nu(x)$. The first we call optimistic assessment. (see Tabl.3) Such assessment supports the notion of the experts as a whole group. If we take a complement of $\nu(x)$ a pessimistic assessment can be derived at the expense of dubious interval $\pi(x)$. (Tabl.4) Consequently the final decision may be taken as a compromise between pessimistic and optimistic decision.

Acknowledgements

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RA($\mu(x)$)

No.	PM	PP	PS	PN	SA	PR	PA	OA	LA	CM	MP	MT	ET	CS	RA
01.	.18	.12	.50	.33	.12	.65	.50	.62	.12	.26	.50	.25	.66	.87	.18
02.	.02	.50	.25	.32	.17	.63	.63	.62	.75	.25	.38	.66	.37	.84	.35
03.	.75	.25	.16	.65	.37	.87	.75	.52	.37	.50	.84	.50	.25	.12	.43
04.	.00	.00	.66	.83	.50	.36	.50	.37	.50	.62	.86	.62	.50	.50	.00
05.	.25	.75	.84	.52	.37	.37	.84	.25	.62	.75	.65	.75	.62	.62	.37
06.	.50	.50	.52	.18	.62	.75	.87	.12	.75	.86	.75	.65	.50	.37	.42
07.	.25	.25	.53	.22	.25	.25	.76	.50	.87	.50	.84	.50	.37	.51	.25
08.	.75	.75	.33	.31	.87	.86	.61	.49	.37	.62	.66	.62	.51	.84	.69
09.	.75	.00	.18	.78	.75	.75	.50	.36	.50	.87	.50	.75	.66	.76	.36
10.	.50	.50	.20	.34	.33	.32	.51	.18	.62	.62	.76	.86	.84	.50	.44
11.	.25	.00	.33	.82	.74	.75	.86	.60	.75	.53	.65	.87	.37	.65	.25
12.	.00	.25	.35	.36	.14	.86	.76	.75	.75	.36	.86	.62	.76	.49	.25
13.	.75	.50	.83	.49	.86	.14	.60	.87	.87	.62	.65	.62	.41	.62	.32
14.	.50	.50	.81	.30	.26	.75	.52	.25	.87	.62	.75	.37	.65	.37	.25
15.	.00	.25	.50	.65	.74	.37	.85	.37	.62	.51	.66	.62	.53	.12	.25
16.	.25	.00	.52	.32	.36	.12	.52	.12	.62	.49	.60	.50	.26	.56	.25
17.	.75	.75	.79	.84	.15	.32	.60	.36	.50	.62	.75	.62	.38	.62	.38
18.	.25	.25	.65	.66	.14	.25	.84	.50	.76	.25	.64	.75	.75	.75	.25
19.	.50	.25	.52	.50	.25	.75	.62	.62	.76	.75	.83	.87	.84	.50	.22
20.	.00	.25	.33	.32	.62	.32	.75	.36	.87	.50	.84	.63	.78	.62	.25

Tabl.1

RA (v(x))															
No.	PM	PP	PS	PN	SA	PR	PA	OA	LA	CM	MP	MT	ET	CS	RA
01.	.62	.73	.50	.66	.28	.42	.58	.43	.25	.74	.38	.46	.45	.24	.50
02.	.95	.63	.36	.74	.87	.46	.56	.54	.32	.66	.64	.35	.54	.32	.32
03.	.34	.46	.84	.33	.58	.43	.26	.50	.64	.42	.29	.62	.73	.84	.42
04.	.82	.82	.54	.72	.45	.72	.45	.48	.26	.31	.43	.56	.42	.38	.62
05.	.77	.21	.24	.57	.64	.43	.35	.41	.62	.37	.42	.38	.18	.53	.52
06.	.46	.62	.49	.88	.42	.31	.39	.76	.42	.53	.35	.72	.45	.49	.50
07.	.34	.45	.63	.78	.64	.59	.27	.47	.82	.31	.66	.43	.64	.55	.36
08.	.26	.34	.82	.65	.41	.35	.25	.55	.64	.51	.27	.43	.25	.38	.25
09.	.25	.82	.78	.36	.42	.15	.56	.56	.45	.78	.62	.37	.35	.29	.55
10.	.64	.56	.84	.78	.68	.76	.45	.75	.31	.55	.28	.32	.44	.38	.33
11.	.66	.80	.82	.32	.42	.36	.41	.52	.36	.45	.49	.33	.29	.41	.60
12.	.92	.72	.64	.71	.82	.35	.43	.35	.31	.66	.72	.43	.45	.51	.36
13.	.36	.44	.32	.54	.19	.85	.56	.34	.26	.33	.48	.53	.42	.55	.44
14.	.66	.38	.25	.66	.31	.24	.72	.65	.31	.42	.34	.56	.29	.71	.44
15.	.92	.39	.24	.38	.42	.77	.31	.83	.46	.68	.44	.54	.72	.32	.51
16.	.74	.23	.64	.78	.46	.82	.44	.88	.46	.58	.31	.43	.89	.35	.32
17.	.33	.45	.21	.32	.84	.66	.45	.67	.36	.55	.34	.65	.32	.38	.25
18.	.45	.67	.32	.54	.87	.34	.44	.67	.43	.65	.44	.27	.45	.18	.50
19.	.36	.46	.64	.45	.33	.65	.43	.45	.37	.65	.21	.32	.22	.34	.36
20.	.92	.75	.43	.67	.44	.55	.27	.64	.34	.44	.27	.52	.39	.38	.45

Tabl.2

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Optimistic RA($\mu(x)$)

No.	PM	PP	PS	PN	SA	PR	PA	OA	LA	CM	MP	MT	ET	CS	RA
01.	.18	.12	.50	.33	.12	.65	.42	.57	.12	.26	.50	.25	.55	.87	.18
02.	.02	.37	.25	.86	.13	.54	.44	.46	.68	.25	.36	.65	.37	.68	.35
03.	.66	.25	.16	.65	.37	.57	.64	.50	.36	.50	.71	.38	.25	.12	.43
04.	.00	.00	.46	.28	.50	.28	.50	.37	.50	.62	.86	.57	.44	.50	.00
05.	.23	.75	.76	.43	.36	.37	.65	.25	.38	.63	.58	.62	.62	.47	.37
06.	.50	.38	.51	.18	.58	.69	.61	.12	.58	.47	.65	.28	.50	.37	.42
07.	.25	.25	.37	.22	.25	.25	.73	.50	.18	.50	.34	.50	.36	.45	.25
08.	.74	.66	.18	.31	.59	.65	.61	.45	.36	.49	.66	.57	.51	.72	.69
09.	.75	.00	.18	.64	.58	.75	.44	.36	.50	.22	.38	.63	.65	.71	.36
10.	.36	.44	.16	.22	.32	.24	.51	.18	.62	.45	.72	.58	.56	.50	.44
11.	.25	.00	.18	.68	.58	.64	.59	.48	.64	.53	.51	.67	.37	.59	.25
12.	.00	.25	.35	.29	.14	.65	.57	.65	.69	.34	.58	.57	.55	.49	.25
13.	.64	.50	.68	.46	.81	.14	.44	.66	.74	.62	.52	.47	.41	.45	.32
14.	.34	.50	.75	.30	.26	.75	.38	.25	.69	.58	.66	.37	.65	.29	.25
15.	.00	.25	.50	.62	.58	.23	.69	.17	.54	.32	.54	.46	.28	.12	.25
16.	.25	.00	.36	.22	.36	.12	.52	.12	.54	.42	.60	.50	.11	.56	.25
17.	.67	.55	.79	.68	.15	.32	.55	.33	.50	.45	.66	.35	.38	.62	.38
18.	.25	.25	.65	.46	.13	.25	.56	.33	.57	.25	.56	.73	.55	.75	.25
19.	.50	.25	.36	.50	.25	.35	.57	.55	.63	.35	.79	.68	.78	.50	.22
20.	.00	.25	.33	.32	.56	.32	.73	.36	.66	.50	.73	.48	.61	.62	.25

Tabl.3

Pessimistic RA ($1 - v(x)$)

No.	PM	PP	PS	PN	SA	PR	PA	OA	LA	CM	MP	MT	ET	CS	RA
01.	.62	.73	.50	.66	.28	.42	.50	.38	.25	.74	.38	.46	.34	.24	.50
02.	.95	.50	.36	.68	.83	.37	.37	.38	.25	.66	.62	.34	.54	.16	.68
03.	.25	.46	.84	.33	.58	.13	.25	.48	.63	.42	.16	.50	.73	.84	.58
04.	.82	.82	.34	.17	.45	.64	.45	.48	.26	.31	.34	.38	.42	.38	.38
05.	.75	.21	.16	.48	.63	.43	.16	.41	.38	.25	.35	.25	.18	.38	.48
06.	.46	.50	.48	.88	.38	.25	.13	.76	.25	.14	.25	.35	.45	.49	.50
07.	.34	.45	.47	.78	.64	.59	.24	.47	.14	.31	.16	.43	.63	.49	.64
08.	.25	.25	.67	.65	.13	.14	.25	.51	.63	.38	.27	.38	.25	.16	.75
09.	.25	.82	.78	.22	.25	.15	.50	.56	.45	.13	.50	.25	.34	.24	.45
10.	.50	.50	.80	.66	.67	.66	.45	.75	.31	.38	.24	.14	.16	.38	.67
11.	.66	.80	.67	.18	.26	.25	.14	.40	.35	.45	.35	.13	.29	.45	.40
12.	.92	.72	.64	.64	.82	.14	.24	.25	.25	.64	.14	.38	.24	.51	.64
13.	.25	.44	.27	.51	.14	.85	.50	.13	.13	.33	.35	.38	.42	.38	.56
14.	.50	.38	.19	.66	.31	.24	.58	.65	.13	.38	.25	.56	.29	.63	.56
15.	.92	.39	.24	.35	.26	.63	.15	.63	.38	.49	.32	.38	.47	.32	.49
16.	.74	.23	.48	.68	.46	.82	.44	.88	.38	.51	.31	.43	.75	.35	.68
17.	.25	.25	.21	.16	.84	.66	.40	.64	.36	.38	.25	.38	.32	.38	.75
18.	.45	.67	.32	.34	.86	.34	.16	.50	.24	.65	.36	.25	.25	.18	.50
19.	.36	.46	.48	.45	.33	.25	.38	.38	.24	.25	.17	.13	.16	.34	.64
20.	.92	.75	.43	.67	.38	.55	.25	.64	.13	.44	.16	.37	.22	.38	.55

Tabl.4