Int. J Sup. Chain. Mgt Vol. 8, No. 4, August 2019

Digital Modeling of Economic Processes and Supply Chain Management in the Formation of Cooperative Relations in the Petrochemical Cluster of the Region

BeilinI.L[*1], Homenko V.V[2], AleevaD.D[3]
[1,2,3]*Kazan Federal University,Institute of Management, Economics and Finance 8 Kremlyovskayastreet Kazan 420008, Russian Federation*
i.beilin@rambler.ru

***Abstract*- A study of the state of the theory of fuzzy sets shows that until recently in Russia there were almost no studies in the chemical sector of the economy and finance using fuzzy analysis and forecasting, although by that time all necessary prerequisites for modeling financial systems had been created. The current situation in Russia is characterized by a high degree of science lagging behind the requests of state and commercial supply chain management.Fuzzy sets have not been used to date for financial analysis and planning of chemical corporations, evaluating the investment attractiveness of securities, optimizing the stock portfolio, forecasting stock indices and macroeconomic indices. You can also talk about the lack of software based on fuzzy models, although abroad, such software products and information technologies that solve economic problems using fuzzy-plural and related descriptions already exist.In the 80's, software solutions and information technologies began to emerge, solving economic problems using fuzzy-plural and related descriptions. Thus, under the leadership of C. Zopounidis at the Technical University on the island of Crete, an expert system was developed for detailed financial analysis of corporations. A little earlier in Germany, a group led by H. Zimmerman developed a strategic planning system, in which the positioning of the corporation's business is based on fuzzy descriptions of the competitiveness and attractiveness of the business.As an example of such software, you can use expensive complex systems, which include fuzzy logic, which bankers and financiers use to solve the most complicated problems of forecasting financial indicators. The beginning of this process was laid by the Japanese financial corporation. Having set out to automate the game on the securities market, this company attracted about 30 specialists in artificial intelligence.**

***Keywords*-** *economics, supply chain strategy, economic and mathematical modeling, economic theory, regional economy, innovation management.*

1. Introduction

Before deciding to use the new system in real conditions, it was tested on a two-year sample of financial data. The system with brilliance withstood the test. A special surprise of the examiners was caused by the fact that a week before the stock market crash, the system sold the entire block of shares, which reduced the damage to almost zero. Needless to say, after that, the question of the appropriateness of using fuzzy logic in the financial sphere was no longer raised. A number of works are devoted to the macroeconomic analysis of the stock market on the basis of fuzzy representations: K. Piraeus "Fuzzy-multiple analysis of investment activities of mutual funds"; R. Tryppy "Artificial intelligence in financial and investment activities". Also, fuzzy representations were put in the basis of neural networks for predicting stock indices: "Peculiarities of the practical application of artificial neural networks to the forecast of financial time series". By the current moment, a number of attempts have been made to forecast stock indices and macroeconomic dynamics indices [1-2]. Special attention should be paid to the macroeconomic study devoted to measuring the level of the shadow economy in New Zealand, carried out by R. Draeseke and David Glees. As indicators determining the level of the shadow economy, the authors used only two indicators. The first one was named the effective tax rate, which is equal to the share of taxes collected by the state from the GDP of New Zealand, the second - an index that reflects the degree of state management in the economy (an index that reflects an economy-wide level of regulation). Despite the small number of selected indicators, the estimation of the level of the shadow economy by the method based on fuzzy logic showed a high degree of correlation with the

results obtained on the basis of standard regression analysis. This once again proves that fuzzy-multiple models are very simple to build and give reliable results even in conditions of high uncertainty. However, it is worth noting that most of the works listed above were published abroad and only very recently the interest of the domestic scientific elite in the fields of economics, business and finance, which are based on fuzzy principles, has appeared. Only now the studies are renewed and, moreover, they acquire a clear market orientation. A new international scientific school is being formed in the former post-Soviet space, which includes researchers from Belarus, Ukraine, Moscow, St. Petersburg, and other Russian cities [3-4]. In October 2003 an international conference was held in the city of Minsk, where the whole section was devoted to fuzzy-multiple studies in the economy. From June 18 to June 21, 2005, an international scientific and practical conference "Fuzzy sets and soft computing in economics and finance" was held in St. Petersburg, where over 50 reports of scientists from more than 21 countries of the world were presented[5-7].

2. Methods

The multi-criteria selection problem is formulated as follows. It is required to determine the best alternative. When solving it, the main difficulty lies in the ambiguity of choosing the best solution. To eliminate it, two groups of methods are used. The methods of the first group seek to reduce the number of criteria, for which they introduce additional assumptions related to the procedure of ranking criteria and comparing alternatives. In the methods of the second group, they strive to reduce the number of alternatives in the original set, eliminating obviously bad alternatives.The methods of the first group include the convolution method, the main criterion method, the threshold criterion method, the distance method. It should be noted that there is no rigorous justification of these methods and their application is determined by the conditions of the problem and the preference of the decision maker. The convolution method consists in replacing the initial criteria (they are also called local or partial) Kj by one general criterion K. This operation is called convolution or aggregation of particular criteria[8-10]. It is expedient to apply the method if according to the conditions of the task partial criteria can be arranged in descending order of importance, so that the importance of each pair of neighboring criteria does not differ much, or if the alternatives have significantly different grades according to different criteria. The most commonly used types of convolutions are: additive, multiplicative, distance to the ideal. Algorithm of linear convolution method:

1. We determine the coefficients of importance (weights for each function). For this we use the method of proportional coefficients.
2. Replace the signs of the functions in order to move from the minimization problem to the maximization problem.
3. Perform the normalization of the criteria for the formula.4. We build the function of weighted additive convolution and investigate it.

3. Results and Discussion

A great achievement for Russia in the field of fuzzy analysis and modeling can be considered that software products containing elements of fuzzy logic created by domestic scientists have already begun to be sold. Thus, the Pension Fund of the Russian Federation acquired a solution to optimize the stock portfolio from Siemens Business Services Russia[11]. The next important step in the development of this science for Russia can be considered the registration of the Russian representative office of the International Fuzzy Economics Lab IFEL, headquartered in Moscow at the end of last year, and the laboratory registered its own printed publication -practical orientation - the magazine "Banks and Risks." The Russian market began to appear software products for personal computers, designed for their mass use. It is from this point on that most of the everyday tasks, in which the need arises to approximate the conditions and, accordingly, to obtain equally approximate results, has become possible to solve quickly and with acceptable accuracy without resorting to the help of programmers. The mathematical apparatus that provides such capabilities, described in detail in the specialized literature and fully implemented in software packages, is hidden behind the scenes, which makes the process of mastering these tools more accessible and intuitive for any user[12]. In Russia, the most popular software products: FuziCalc firm FuziWare; CubiCalc from HiperLogic and Matlab from SoftLine.Rapid computation with fuzzy specification of source data makes it possible to produce a FuziCalc spreadsheet [13-15]. The FuziCalc package is relatively young, but managed to gain popularity as

an inexpensive tool that allows quick (preposterous) calculations in various business areas and results with a quite acceptable degree of accuracy.The CubiCalc package is well known to specialists dealing with dynamic management tasks [16-18]. The effectiveness of using CubiCalc in these tasks is such that the US Department of Defense until recently imposed severe restrictions on the distribution of this package in order to ensure that new American technologies do not increase the foreign military-industrial potential. Also with the help of CubiCalc, dynamic management tasks in financial planning, process management, modeling of economic processes with constantly changing parameters, and comparative-appraisal tasks are successfully solved. And with the help of the Matlab package, both small tasks and dynamic management tasks are successfully solved [19-23].A matrix of initial data is generated in the table. In this case, the elements of the initial data matrix for subsequent modeling within each criterion are expressed in different units of measurement, that is, the chosen method to units of measurement is invariant, which opens the possibility for reducing the initial data from one measurement scale to another, more convenient for subsequent calculations.

Data table1. for choosing the best partner for the production of polymer material "Copolymer +"

α	Annual net profit	Numberemployees, people	Productivity index,%	Time of break-even existence on the market, years	Cost of project implementation, thousand rubles.	Productivity in Russia, tons per year	Support for anti-Russian sanctions of the producer's country, points	Time of return of investments,months.
j	4	8	5	6	2	1	7	3
ω	0,14	0,03	0,11	0,08	0,19	0,22	0,06	0,17
1	€33090	4272	0,07	12	450	8	2	36
2	€11630	11230	0,10	21	790	2	4	21
3	$24520	63000	0,03	18	910	0	10	48
4	$11270	14348	0,19	8	840	3	6	18
5	€237530	85200	0,26	15	680	4	8	26
6	€45670	4567	0,04	20	520	4	1	32
7	$62180	22000	0,19	10	710	6	3	29
8	€45630	18654	0,371	6	490	1	2	41

To fill the table, it is necessary to reflect the significance for the interested person who makes the decision of the requirements (indicators, criteria, goals) - in the context of the model task - the potential buyer of one of the three houses [24-29]. Priorities of the person making the decision can be expressed in the form of weights accepted for consideration criteria that satisfy the normalization condition: $\Sigma\, \omega j = 1.00$.

In the first approximation, before determining the priorities of the person making the decision regarding the criteria for the optimal choice, let us take them to be equivalent: $\omega 1 = \omega 2 = \omega 3 = \omega 4 = \omega 5 = \omega 6 = \omega 7 = \omega 8 = \omega = 1 / m = 1/8 = 0.125$.For unrelated ranks, the translation into an interval scale is performed according to the expression:

$$\omega_j = \frac{2\cdot(m - j + 1)}{m\cdot(m+1)}$$

Weighing involves the expression of preferences on the part of the decision-maker: what is the most important [30-31], the less important of the declared values, and so on (fig. 1,2).Further, if the quantitative indicators indicate an improvement in the quality of the criterion, the formula (1) is applied; if the higher the quantitative indicators, the lower the quality of the criterion, the formula (2) is applied:

$$u_{ij} = \frac{c_{ij} - c_{ij}^{min}}{c_{ij}^{max} - c_{ij}^{min}} \cdot 100\%, \quad (1)$$

$$u_{ij} = \frac{c_{ij}^{max} - c_{ij}}{c_{ij}^{max} - c_{ij}^{min}} \cdot 100\% \quad (2)$$

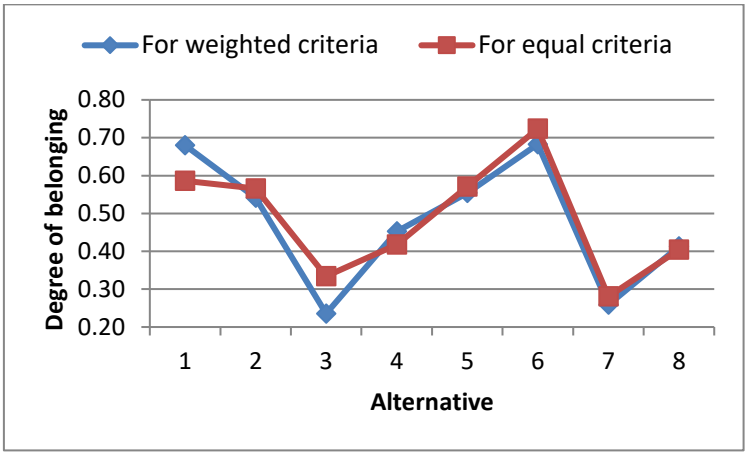

Figure1. Degrees of belonging to alternatives to the term "The best partner for the production of polymer material" Copolymer +"(a).

You can arbitrarily vary the rank of all alternatives depending on the situation, risks, availability of raw materials and other factors. The degree of belonging will change in the same dynamic mode[32,33].

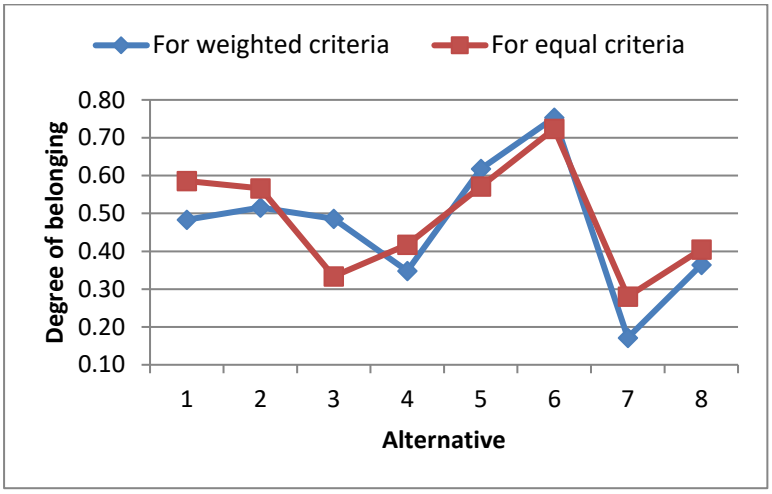

Figure2. Degrees of belonging to alternatives to the term "The best partner for the production of polymer material" Copolymer +" (b).

4. Summary

One of the most effective means of economic and mathematical modeling of the systems under study is the use of modern computers. The methods of economic analysis and mathematics allow us to form models whose analytical analysis is impossible. In this case, the only available means of research is numerical modeling of the studied processes on a computer.Mathematical methods are the most important tool for analyzing economic phenomena and processes, building theoretical models that make it possible to map existing relationships in economic life, to predict the behavior of economic agents and economic dynamics.Separate classes of economic tasks were formulated and solved under the assumption of the availability of complete information. They can be attributed to a set of decision-making tasks in certainty.

5. Conclusions

In real economic conditions, it is necessary to solve individual problems with limited, inaccurate initial information about the object itself and the external environment in which it operates.When making management decisions about the operation and development of an economic facility, it is necessary to take into account an important characteristic of the environment - uncertainty.Under the uncertainty should be understood the absence, incompleteness, lack of information about the object, process, phenomenon or uncertainty about the accuracy of the information.The choice of solution occurs most often under conditions of certainty, risk and uncertainty. The difference between these states of the environment is determined by the amount of information, the degree of knowledge of decision-makers (decision makers), the essence of phenomena,

conditions of decision-making.If an enterprise makes a certain decision related to the production of a product or the sale of a certain product, then the final result (for example, the company's profit) depends not only on the decision made by it, but also on many other factors: decisions made by other firms, buyers behavior , legislative action, exchange rates, etc.

Acknowledgements

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

References

[1] Juan R. Castro, Oscar Castillo, Luis G. Martínez. *Interval Type-2 Fuzzy Logic Toolbox*. № 8,2007.

[2] Nilesh N. Karnik, Jerry M. Mendel. *Operations on type-2 fuzzy sets*.№ 4, 2000.

[3] Beilin I.L. *Economic-mathematical modeling of the total costs of innovative chemical enterprise methods of fuzzy set theory* , Journal of Engineering and Applied Sciences, Volume 12, Issue 19, 4865-4869, 2017.

[4] Beilin I.L., Khomenko V.V. *Theoretical bases of project management in conditions of innovative economy based on fuzzy modeling* ,Journal of Physics: Conference Series 1015 (2018) 032013,2018. doi :10.1088/1742-6596/1015/3/032013.

[5] Beilin I.L. *Economic optimization in chemical enterprises* , International Journal of Economic Perspectives, Volume 11, Issue 4, 670-677, 2017.

[6] ErdalKayacan, Ph.D. *Candidate. Contributions to Type-2 Fuzzy Sets. Theory and Applications in Control Engineering and Robotics*. № 10, 2009.

[7] Zadeh L. *Toward a perception-based theory of probabilistic reasoning with imprecise probabilities*,Journal of Statistical Planning and Inference 105 , p. 233-264, 2002.

[8] Inuiguchi M., *Tanino T. Portfolio selection under independent possibilistic information*,Fuzzy sets and systems. V. 115. P. 83-92, 2001.

[9] Tardy Yves, *Petrology of Laterites and Tropical Soils*. ISBN 90-5410-678-6, http://www.books.google.com/books. Retrieved April 17, 2010.

[10] Dimova L., Sevastjanov P., Sevastianov D. *Fuzzy Capital Budgeting: Investment Project Valuation and Optimization* , Chenstohova Tech. Univercity Proceedings, 2001.

[11] Shang-Ming Zhou, Robert John, Francisco Chiclana and Jonathan M. Garibaldi. *New Type-2 Rule Ranking Indices for Designing Parsimonious Interval Type-2 Fuzzy Logic Systems*, 2007.

[12] Yazenin I. A. *Minimal risk and efficiency portfolios for fuzzy random data*, XXI Seminar on stability problems of stochastic models. Abstracts, Eger, Hungary, -P. 182, 2001.

[13] Crowther K.G., Haimes Y.Y. *Development of the Multiregional Inoperability Input-Output Model (MRIIM) for Spatial Explicitness in Preparedness of Interdependent Regions*,Systems Engineering Vol. 13, No. 1, 2010.

[14] Dimitras A.I., Slowinski R., Susmaga R., Zopounidis C. *Business Failure Prediction Using Rough Sets* , European Journal of Operational Research 114, 1999.

[15] *Fuzzy Sets in Management, Economy and Marketing* /Ed. By Zopounidis C. and oth. – World Scientific Pub Co, 2002.

[16] *Hua Wang Fuzzy Control Systems Design and Analysis: A Linear Matrix Inequality Approach*., 2011.

[17] Zimmerman H.-J. *Fuzzy Sets Theory -and Its Applications. -Kluwer Academic Publishers*, 2001.

[18] Zobel C.W., L. Khansa *Quantifying Cyberinfrastructure Resilience against Multi-Event Attacks*, Decision Sciences Vol. 43 No. 4, 2012.

[19] Rose P.R. *Risk Analysis and Management of Petroleum Exploration Ventures American Association of Petroleum Geologists, Methods in Exploration Series*, N12,2001.

[20] Uziel Sandler, Lev Tsitolovsky Neural Cell *Behavior and Fuzzy Logic. Springer*, 478 с, 2008.

[21] Takafumi, N., Fminori, T., Kamran, M.N. Bernardino, M.C. and Alessandro P.F., "*Practical Equations for the Elatic Modulus of Concrete*", ACI Structural Journal, September-October, Vol. 106, No. 5, 2009.

[22] *A Novel Algorithm for Tuning of the Type-2 Fuzzy System: Материалыконф* . / First Joint Congress on Fuzzy and Intelligent Systems Ferdowsi University of Mashhad, Iran, 29-31 августа 2007.

[23] Corrado L., Fingleton B. *Where is the economics in spatial econometrics?* Journal of Regional Science, 52 (2), 210–239, 2012.

[24] Chen, Xiaohong and DemianPouzo, *Sieve Wald and QLR inferences on semi*/nonparametric conditional moment models, Econometrica, 83, 1013-1079, 2015.

[25] Edward E. Leamer ,"*Specification problems in econometrics*," The New Palgrave Dictionary of Economics. Abstract. Archived 23 September 2015 at the Wayback Machine, 2008.

[26] Fisher M., LeSage J. *A Bayesian space–time approach to identifying and interpreting regional convergence clubs in Europe*. Paper presented at 53rd ERSA conference, Palermo, August 27–31, 2013.

[27] Gibbons S., Overman H. G. *Mostly pointless spatial econometrics?* Journal of Regional Science, 52 (2), 172–191, 2012.

[28] Hansen, Bruce E. *The Integrated Mean Squared Error of Series Regression and a Rosenthal Hilbert-Space Inequality, Econometric Theory*, 31, 337-361, 2015.

[29] LeSage J., Fischer M. *Spatial growth regressions: Model specification, estimation and interpretation*. Spatial Economic Analysis, 3, 275–304, 2008.

[30] LeSage J. Parent O. *Bayesian model averaging for spatial econometric models*. Geographical Analysis, 39 (3), 241–267, 2007.

[31] Kleibergen, Frank and Richard Paap, *Generalized reduced rank tests using the singular value decomposition*, Journal of Econometrics, 133, 97-126, 2006.

[32] Muhammad K. *The Effects of Electronic Human Resource Management on Financial Institutes*. Journal of Humanities Insights. 02(01):01-5, 2018.

[33] Farzaneh, Dalir Rezagholi Gheshlaghi , Yunes ,Ahmadzadeh , Fahimeh, Faal. *The cash flow statement's component effect on Management Performance in firms enlisted in Tehran Stock Exchange*, UCT Journal of Management and Accounting Studies, Issue1, pp. 14-21, 2014.