ASERC Journal of Socio-Economic Studies

Journal homepage: www.ajses.az Volume1, Number 1, (2018) Pages 73-81

EVALUATION OF THE IMPACT OF THE LOSS CARRY- FORWARD TO THE TAX INCLUSION BY THE FUZZY INFERENCE SYSTEM

Akif Musayev[1], Aygun Musayeva[2], Mirvari Gazanfarli[1]

[1]Azerbaijan National Academy of Sciences

[2]The University of Azerbaijan

ABSTRACT

In this article explores, the loss in the tax inclusion, transferring to the next years depends on condition of the taxpayer (enterprise or physical person) under uncertainty. For the purpose, the position of the taxpayer has been evaluated by Sugeno Fuzzy inference system based on Fuzzy Logic theory and investigated the term of loss carry-forward, based on the confirmed article by legislation. Findings show that indicators of enterprise allow to pay the loss within 2.5-3 years. Findings are useful for tax policy purposes in decision making process.

Key words: tax policy, taxpayer, Sugeno fuzzy inference system, fuzzy rules, membership function

Introduction

Fuzzy inference system is an input-output reflection process that consists of numerous fuzzy rules as If-Then and using expert's knowledge and experience. First applications of this method coincide to 70th and based on "Fuzzy logic" theory was proposed by Zadeh (1965) in 1965. In 1975 Mamdani and Assilian (1975) proposed their own fuzzy inference system based on Zade's (1973) fuzzy inference system and algorithm idea and created a new fuzzy controller for a steam engine and boiler combination using special rules that obtained from experienced operators of the system. In following years Tsukamoto, Larsen, Sugeno and other scientists also had worked on this method and prepared their own fuzzy inference system.

Takagi - Sugeno Fuzzy Model is improved version of Mamdani method and developed by Takagi, Sugeno, and Kang (1985). Fuzzy inference system is applied to numerous problem solving. Cavallaro (2015) proposed the implementation of Takagi-Sugeno fuzzy inference system to create new synthetic index for evaluating the sustainability of production of the biomass for energy purposes. Another application of this is reflected in Musayev, Rustamov, and Madatova (2016, 2018). In this article, authors assess the impact to tax potential of changes and additions of tax administration and legislation by Mamdani method (Musayev et al., 2016, 2018). Yulianto, Komariyah and Ulfaniyah (2017) have used Sugeno model for evaluating salt production under wind speed, radiation, rainfall and other affected factors.

Hodashinsky, Sarin and Cherepanov (2016) have developed new approach for initializing Sugeno method and proposed obtaining initial value of fuzzy antecedent via dinamic decomposition of input space. According to this approach, the subsequent values are found by the recursive least squares method (Hodashinsky et al.,2016). Tikk et al. (2001) investigate the Sugeno's and Yasukawa's qualitative fuzzy modeling. They have proposed a new approach for reduction of rule base if some easily implementable solution for the unclear details applied successfully.

1. Statement of the problem.

Tax policy directed providing economic growth, realizing social and economic obligations of country, is one of the most important factors for forming state budget and economic development of each country (Shome, 1995; Musayev, 2004). For tax policy and its efficient organization considerable experience has been accumulated in international taxation and incentive forms of tax liability have been compiled (A.F. Musayev, Y.A. Kəlbiyev and A.A. Hüseynov, 2002). The Tax legislation of Azerbaijan Republic is also widely used by stimulants. According to called "**Loss Carry-Forward**" article 121 of The Tax Code of Azerbaijan Republic as following:

- 121.1. Part of expenses exceeding the profit, which is allowed to exclude from the profits of the enterprise, shall be switched to the next period continuing for up to five years, and shall be compensated at the expense of the profits of these years with no limitation on years.
- 121.2. With respect to physical persons, expenses deductible from gross income generated from the non-entrepreneurial economic activity, which exceed said gross income may not be deducted from salaries and wages, but shall be carried forward for a period of up to three years and shall be covered at the expense of the gross income generated from entrepreneurial economic activity of future periods.

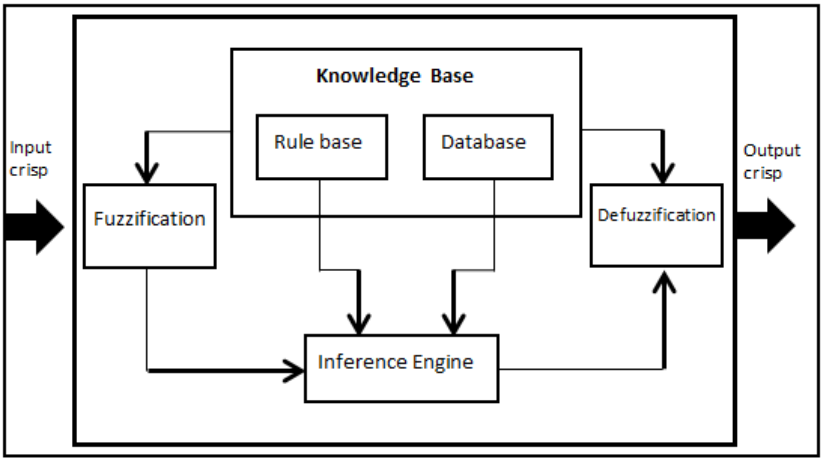
The process of transferring loss to the next years depends on financial and economic activity and evaluated within by defined term of Tax Code of Azerbaijan Republic. In this problem,

the condition of the taxpayer estimated by Sugeno fuzzy inference system under uncertainty and transferring years of loss is defined by the approved term. In the explored problem, the taxpayer is enterprise, so the loss may be paying within 5 years.

2. Sugeno fuzzy inference method

Generally, fuzzy inference system consists of 3 blocks: fuzzification, inference engine and defuzzification. The fuzzification of input variables is membership degree that appropriate to fuzzy set via membership function each of them. By the purpose, initially, rule base is defined by using expert's knowledge and experience and each of inputs are expressed with linguistic variables. Superposition of the modified phase clusters is performed in the inference block. Finally, the obtained fuzzy result turn to price in the defuzzification block. The general scheme of the system as follows:

Fig.1 Fuzzy inference system



The most commonly used and necessary Fuzzy inference methods are Mamdani and Sugeno (Sugeno-Takagi). Effectiveness, good working with linear and optimization methods, ensuring sustainability of the output surface increases the implementations of Sugeno method. 2 steps of both of methods are the same, however the most essential difference is being linear or constant of output function in Sugeno fuzzy system. Typical forms of rules in Sugeno as follows:

If x_1 is A and x_2 is B then y= f (x_1, x_2)

Where, A and B fuzzy sets, f (x_1, x_2) is a crisp function. In many cases f function expressed as a polynomial, for instance: $y=ax_1+bx_2+c$. In case, is called first-order Sugeno fuzzy model. If the f function is constant (a=b=0), then it called zero-order Sugeno fuzzy inference system and this is a particular case of Mamdani method. Each rule weights its output level, y_i , by the firing strength of the rule, w_i. For an AND rule with Input 1 = x_1 and Input 2 = x_2, the firing strength is:

w_i = AndMethod ($F_1(x_1)$, $F_2(x_2)$)

Where $F_1(x_1)$, $F_2(x_2)$ are the membership functions for input variables. And the final output is expressed as below:

$$\text{Final output} = \frac{\sum_{i=1}^{N} w_i y_i}{\sum_{i=1}^{N} w_i}$$

Where, *N* is the number of rules (Mehran, 2008).

3. Problem solving via Sugeno fuzzy inference system

As we have already mentioned, the taxpayer is an entity and its financial activities must be evaluated in order to determine the period of Loss Carry-Forward (within the period of up to five years approved by the legislation). Reflecting indicators of the object's activities are as follows:

Table 1. Factors and sub parameters for evaluating them

Liquidity	Maneuvered skill of objects recources 0.03	General covering coefficient 0.14	Speedy liquidity coefficient 0.46	Absolute liguidity coefficient 0.72	Circulating resources of objects actives 0.93	
Financial durability	Concentration coefficient of objects capital 0.23	Financial depending coefficient 0.25	Maneuvered coefficient of objects capital 0.77	Concentration coefficient of involved capital 4.43		
Business activity	Fund capasity 0.01	Coefficient of the funds in settlements 0.47	Circulating of industrial resources 1.06	Maneuvered skill of objects capital 1.81	Circulating skill of main capital 2.07	Sustainability coefficient of economic growth 3.42
Profitability	Profitability of product 0.02	Profitability of main activity 0.02	Profitability of main capital 1	Profitability of capital of object 1		
Property of object	Active part of main resources 0.17	Etching coefficient of main recources 0.46				

Source: Authors own completion

Using sub parameters of each factors, we can estimate the average value by the following formula:

$$\bar{x}_j = \sqrt[n]{\sum_{i=1}^{n} s_i} \quad (1)$$

For transferring term of loss, fuzzy rules are determined depends on the financial activity of object by expert:

1. If (x_1 is "high") and (x_2 is "high") and (x_3 is "very high") and (x_4 is "high") and (x_5 is "normal") then (y is "short")
2. If (x_1 is "medium") and (x_2 is "low") and (x_3 is "high") and (x_4 is "medium") and (x_5 is "normal") then (y is "average")
3. If (x_1 is "low") and (x_2 is "normal") and (x_3 is "high") and (x_4 is "high") and (x_5 is "normal") then (y is "average")
4. If (x_1 is "low") and (x_2 is "low") and (x_3 is "low") and (x_4 is "low") and (x_5 is "low") then (y is "long")

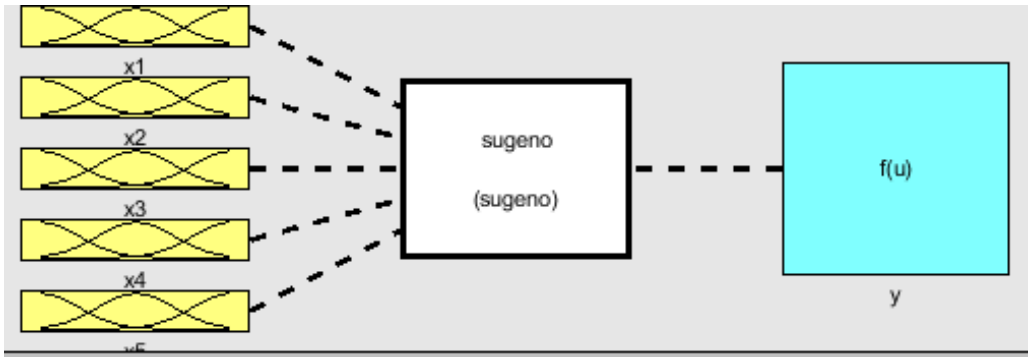
Table 2: Average value of inputs

Signs	Reflecting indicators of the object's activities	Average value
x_1	Liquidity	0.33
x_2	Financial durability	0.67
x_3	Business activity	0.92
x_4	Profitability	0.45
x_5	Property of object	0.28

Source: Authors own completion

The structure of the Sugeno fuzzy inference system consisting of 5 input variables will be as follows:

Figure 2. Sugeno fuzzy inference system



Where, x1, x2, x3, x4, x5 are input variables, that names of them are mentioned in table 2, y is a result, expresses transferring term of loss.

For fuzzification input variables, membership functions are defined by writing them as a set of linguistik variables which are expressed in rules:

- x_1 input variable consists of {High, Medium, Low} linguistic variables and is defined as in figure 3.
- x_2 input consists of {High, Normal, Low} linguistic variables and fuzzificated by triangular and trapezoidal membership functions.
- x_3 input consists of {Very high, High, Low} linguistic variables and fuzzificated by triangular and trapezoidal membership functions.
- x_4 input consists of {High, Medium, Low} linguistic variables and fuzzificated by triangular membership function:
- x_5 input consists of {Normal, Low} linguistic variables and fuzzificated by triangular and trapezoidal membership functions:

Table 3. Appropriate membership functions of each linguistic variables

x_1	High Medium Low	a=0.7 b=1 c=1 a=0.1 b=0.4 c=0.5 d=0.8 a=-0.4 b=0 c=0.3	Triangle MF Trapezoid MF Triangle MF
x_2	High Normal Low	a=3 b=5 c=7 a=1 b=1.3 c=3.2 d=4 a=0 b=0 c=2	Triangle MF Trapezoid MF Triangle MF

x_3	Very high High Low	a=3 b=4.5 c=5 d=8 a=1.5 b=4 c=4 a=-2 b=0 c=1 d=2	Trapezoid MF Triangle MF Trapezoid MF
x_4	High Medium Low	a=0.7 b=1 c=1 a=0.2 b=0.5 c=0.8 a=-0.5 b=0 c=0.4	Triangle
x_5	Normal Low	a=0.45 b=0.95 c=1 d=1 a=0 b=0 c=0.5	Trapezoid MF Triangle

Source: Authors own creation

Figure 3: Graphical description of the linguistic variables

Figure 3(a): linguistic variables appropriate to x_1

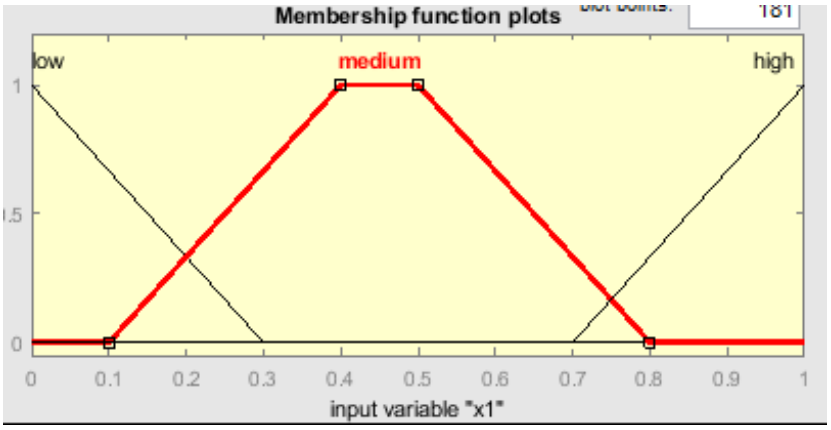


Figure 3(b): linguistic variables appropriate to x_2

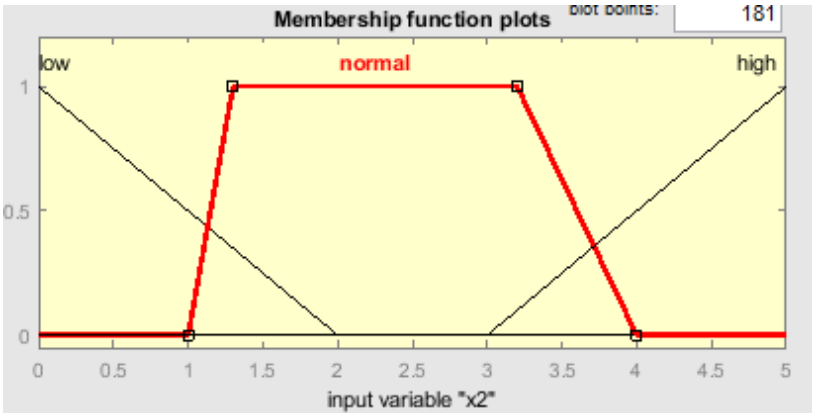


Figure 3(c): linguistic variables appropriate to x3

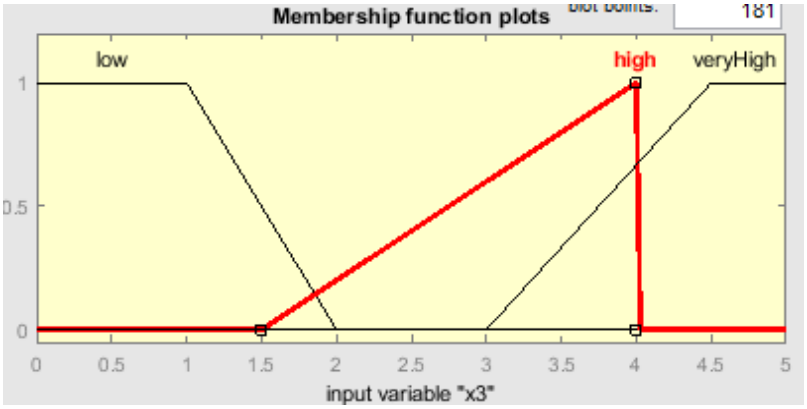


Figure 3(d): linguistic variables appropriate to x4

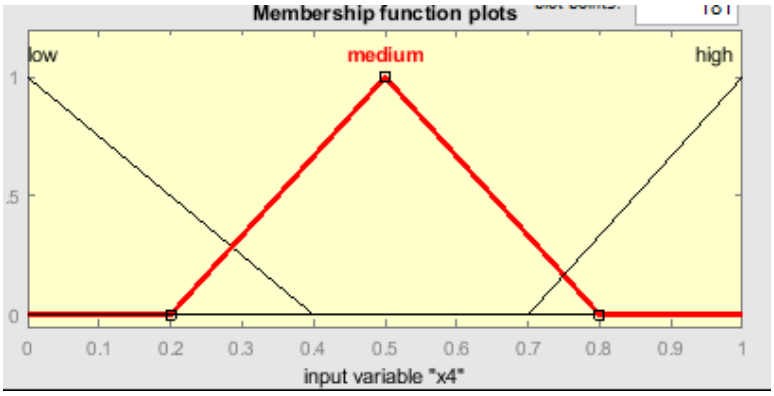


Figure 3(e): linguistic variables appropriate to x5

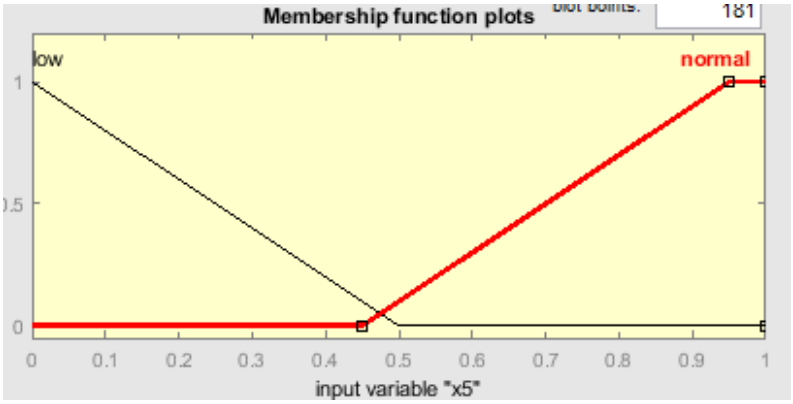


Fig 3(e). Graphical description of the linguistic variables corresponding to x_5. Where, a, b, c are parameters of triangular function, a, b, c, d are parameters of trapezoidal function.

After fuzzification input variables, output levels for each rule are defined. For obtaining these, the system uses AND (prod) and OR (probor) operators. Output level is expressed by 3 linguistic variables (long, average, short) and constant function. Appropriate parameters are: y_1 (short)=0, y_2 (average)=0.5, y_3(long)=1 (see figure 4).

As a result of calculation, the final output is 0.5, it means, is the average level. The surface graphs of the dependence on the input variables of the obtained result can also be determined using the help of Fuzzy Logic Toolbox™ software. Let's look through some of these graphs as follows (see figure 5).

Figure 4. The result of Sugeno fuzzy inference system

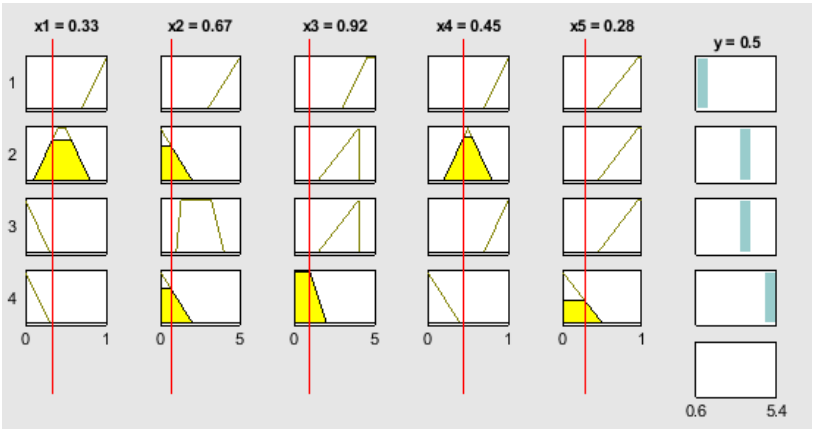


Figure 5: Surface graphs

Figure 5(a): Fig 9. The surface of the term of loss carry - forward depends on liquidity and financial durability

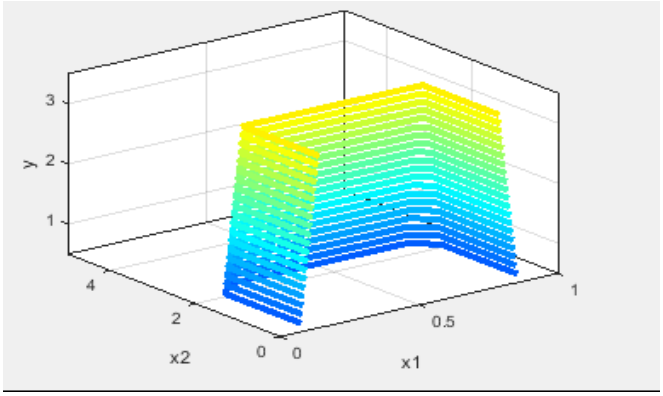


Figure 5(b): The surface of the term of loss carry-forward depends on the business activity and property of object

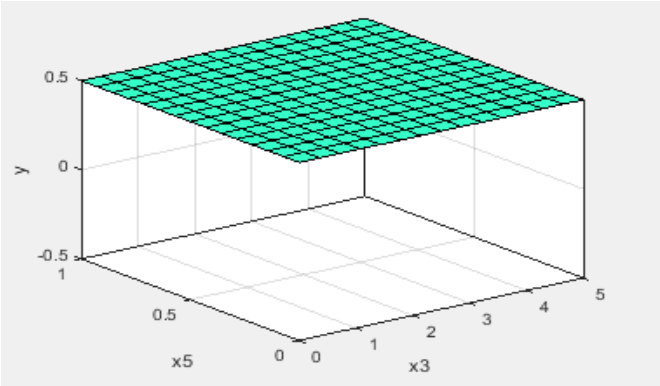


Figure 5(c): The surface of the term of loss carry-forward depends on liquidity and profitability

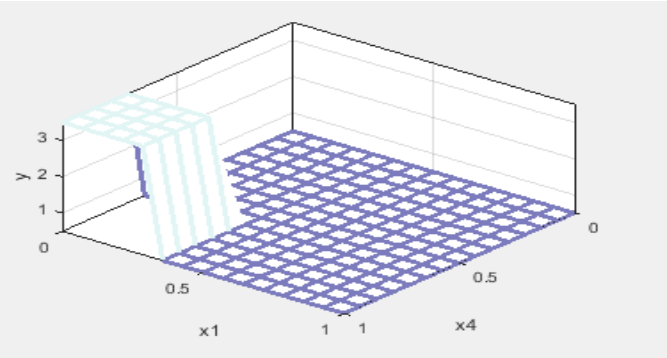
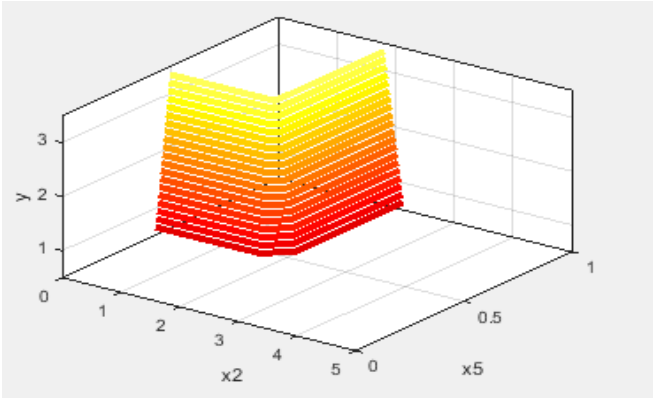


Figure 5(d) The surface of the term of loss carry-forward depends on financial durability and property of object



5. Conclusion

This article has been investigated, issue of the loss carry- forward to next years appropriate condition of the taxpayer by using Sugeno FIS. In implementation problem, the taxpayer is enterprise, so the period that how many years the loss can be paid (lasts up to 5 years), has been evaluated depends on its indicators by the Sugeno method. The factors of Inquired enterprise and parameters that participate for forming them are defined based form determined by legislation. The average values of subparameters have evaluated via (1), for general condition of the enterprise and used for obtaining the final result by Sugeno fuzzy inference method. The final result is equal to average level, it means, indicators of enterprise allow to pay the loss within 2.5- 3 years.

REFERENCES

1. Shome, P. (Ed.). (1995). *Tax policy handbook*. International Monetary Fund.
2. Zadeh, L.A.(1965). Fuzzy sets. *Information and Control*, 8, 338–353.
3. Zadeh, L. A. (1973). Outline of a new approach to the analysis of complex systems and decision processes. *IEEE Transactions on systems, Man, and Cybernetics*, (1), 28-44.
4. Mamdani, E. H., & Assilian, S. (1975). An experiment in linguistic synthesis with a fuzzy logic controller. *International journal of man-machine studies*, *7*(1), 1-13.
5. Takagi, T., & Sugeno, M. (1985). Fuzzy identification of systems and its applications to modeling and control. *IEEE transactions on systems, man, and cybernetics*, (1), 116-132.
6. Musayev, A.F., Kəlbiyev, Y.A. & Hüseynov, A.A. (2002). *The tax system of Azerbaijan Republic: reforms and results*. Baku.
7. Musayev, A.F. (2004). *Vergi siyasətinin iqtisadi problemləri* . CBS "Poliqraphic Production", Bakı.
8. Musayev, A., Madatova, S., & Rustamov, S. (2016a). Evaluation of the impact of the tax legislation reforms on the tax potential by fuzzy inference method. *Procedia Computer Science*, *102*, 507-514.
9. Musayev, A., Madatova, S., & Rustamov, S. (2018). Mamdani-Type Fuzzy Inference System for Evaluation of Tax Potential. In *Recent Developments and the New Direction in Soft-Computing Foundations and Applications* (pp. 511-523). Springer, Cham.
10. Yulianto, T., Komariyah, S., & Ulfaniyah, N. (2017, August). Application of fuzzy inference system by Sugeno method on estimating of salt production. In *AIP Conference Proceedings* (Vol. 1867, No. 1, p. 020039). AIP Publishing.
11. Cavallaro, F. (2015). A Takagi-Sugeno Fuzzy Inference System for developing a sustainability index of biomass. *Sustainability*, *7*(9), 12359-12371.
12. Mehran, K. (2008). Takagi-Sugeno fuzzy modeling for process control. *Industrial Automation, Robotics and Artificial Intelligence (EEE8005)*, *262*.
13. Hodashinsky, I. A., Sarin, K. S., & Cherepanov, S. A. (2016). Initialization method for fuzzy Takagi–Sugeno systems. *Optoelectronics, Instrumentation and Data Processing*, *52*(3), 266-273.
14. Tikk, D., Gedeon, T. D., Kóczy, L. T., & Biró, G. (2001). Implementation details of problems in Sugeno and Yasukawa's qualitative modeling. In *Research Working Paper RWP-IT-02-2001, School of Information Technology*.