

Fuzzy Logic Applied to Inflation Control in the Nigerian Economy

Ibrahim Goni¹, Mohammed Alhaji Maunde Usman², Auwal Nata'ala³

¹Department Computer Science, Faculty of Science, Adamawa State University, Mubi, Nigeria

²Department of Economics, Faculty of Social and Management Science, Adamawa State University, Mubi, Nigeria

³Department of Computer Science, School of Information Technology Federal Polytechnic, Kaura Namoda, Zamfara State, Nigeria

Email address:

algonis1414@gmail.com (I. Goni)

To cite this article:

Ibrahim Goni, Mohammed Alhaji Maunde Usman, Auwal Nata'ala. Fuzzy Logic Applied to Inflation Control in the Nigerian Economy. *Machine Learning Research*. Vol. 3, No. 4, 2019, pp. 39-72. doi: 10.11648/j.ml.20180304.11

Received: March 9, 2019; **Accepted:** April 22, 2019; **Published:** May 23, 2019

Abstract: In this research work, a fuzzy logic system for inflation control in Nigerian economy is presented. The system consists of four (4) major components which include; the Knowledge base, the Fuzzification, the Inference engine and Defuzzification. Knowledge base were developed based on the discussion with the domain expert and observations of the Nigerian economy. Mamdani's fuzzy inference engine were used to infer data from the rules developed. This resulted in the establishment of some degrees of membership functions of input variables on the output. The methodology allows for High, Low, Yes and No to be applied in order to get the required result. Gaussian membership function was employed to evaluate the degree of participation of each input parameter and the defuzzification technique used in this work is Centroid of Area. Fuzzy logic system has been developed as an alternative to the traditional methods, in order to control inflation in the Nigerian economy.

Keywords: Fuzzy Logic, Inflation, Defuzzification, Fuzzification, Knowledge Base, Mamdani

1. Introduction

Inflation is the persistent increase in price of goods and services to the extent that is detriment to the economic system and citizenry. Inflation is a global concern ranging from developed to developing countries, for this reasons many techniques, models, projections are applied in the literature to inflation control. Laterally, Economics of different taught have contributes to the literature on inflation such as Keynesian, Neo-Keynesian, Post-Keynesian, Classists, Neo-classists, Structuralist, Neo-structuralists and Monetarist [1]. The major factors that causes of inflation in Nigeria are government economic policies, civil unrest, devaluation of currency, reduction in productivity, price of fuel, increased in wages, higher taxes, expectation of inflation, poverty and pre-election and campaign spending [2].

Fuzzy logic is a branch of computational intelligence that provide attempt at modelling the uncertainty of a natural language. The mathematical foundation of fuzzy logic, fuzzy,

rule-based, fuzzy reasoning, fuzzy topology, fuzzy inference system, fuzzy interpolation, fuzzy graph and fuzzy modelling is derived from a fuzzy sets which was first introduced by Zadeh in 1965 and this techniques are applied in many researches in recent years which include control system, medical diagnosis, estimation, decision making, prediction, signal processing, forecasting, robotics, pattern recognition and security systems.

Fuzzy sets A in X can be expressed as a set of ordered pairs;

$$A = \{(x, \mu_A(x)) \mid x \in X\} \quad (1)$$

Where $\mu_A(x)$ is the membership function and X is a collection of objects denoted by x .

Recently, fuzzy sets, fuzzy logic and fuzzy rule-based and other computational intelligence techniques are applied to management decision making and control of economy as in the work of [5-8].

2. Method

This research work derived the concept of expert system which may be forward or backward chaining. In forward chaining the system reason from antecedent truth to consequent truth that is the system would draw a conclusion from the facts in the rule antecedent and establish new facts. The system is structured with six (6) inputs and two outputs of which forty (40) rules were generated by the system with the help of domain expertise and are injected in to the knowledge based where the system would use this rules to make decisions and draw a conclusion. MATLAB 7.0 is used to implement this experiment using fuzzy logic toolbox. The fig. 3 shows the typical structure of fuzzy controller;

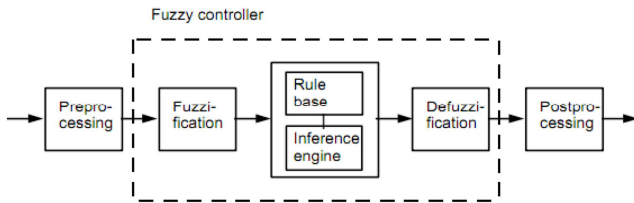


Figure 1. Fuzzy logic controller [3].

3. System Architecture

The determinant of inflation were analyzed and used as inputs parameters to the system. The following are the inputs used in the system; Interest rate, Exchange rate, Tax, Importation, Lending rate and Government participation. Linguistic variables are assigned to the various inputs parameters Interest rate parameter is define based on two (2) linguistic variables High and Low, Exchange rate parameter is define based on two (2) linguistic variables which are High and Low, Tax parameter are define based on two (2) linguistic variables which are Yes and No, Importation are define based on two (2) linguistic variables which are Yes and No, Lending rate parameter are define based on two (2) linguistic variables which are High and Low and Government participation parameter are define based on two (2) linguistic variables which are High and Low, while the outputs parameters are defined based on two linguistic variables which are single digit and double digits.

3.1. Fuzzification

This process is mainly used to transform a crisp set to a fuzzy set, and can also be used to increase the fuzziness of a fuzzy set. For mapping the crisp values to fuzzy ones, you have to evaluate their membership degree using membership functions. With this you get one fuzzy value for each crisp input [4].

3.2. Defuzzification

To defuzzify the outputs we use the center of sums method. In this method we take the output from each contributing rule, and then we add them. The center of sums is one of the most popular methods for defuzzification because it is very easy to implement and gives good results

[4]. The defuzzification is define using the equation;

$$u = \frac{\sum_{i=1}^N u_i \sum_{k=1}^n \mu_k(u_i)}{\sum_{i=1}^N \sum_{k=1}^n \mu_k(u_i)} \quad (2)$$

Where N represents the number of sample points and n represents the number of rules.

4. Membership Functions for the Experiment

In this work Gaussian Membership function were used which can be express using the equation;

$$f(x; \sigma, c) = e^{-\frac{(x-c)^2}{2\sigma^2}} \quad (3)$$

Where c represents the membership function center and σ is the width

Figure 2 below illustrate a Gaussian membership function of interest rate which is define using two linguistic variables high and low. Which can be used by the knowledge base to make decision and draw conclusion.

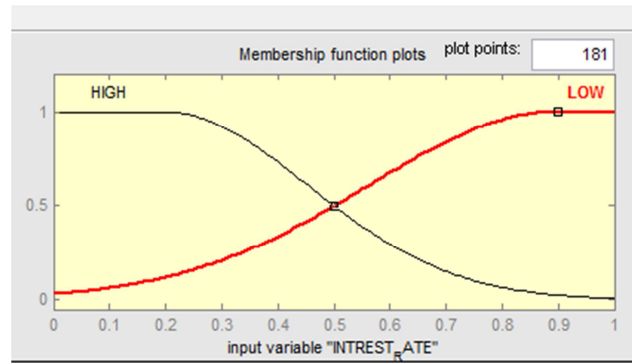


Figure 2. Membership Function Plot for Interest rate.

From the figure 3 below exchange rate is define using two major linguistic variables high or low in which rules would be generated using them to enable the knowledge base make a decision and draw conclusion.

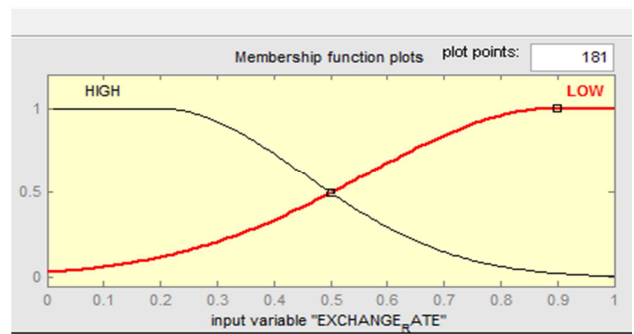


Figure 3. Membership Function Plot for Exchange rate.

Tax membership function is illustrated in figure 4 below, it is define using two linguistic variables that is yes and No which would enable the system to make decision.

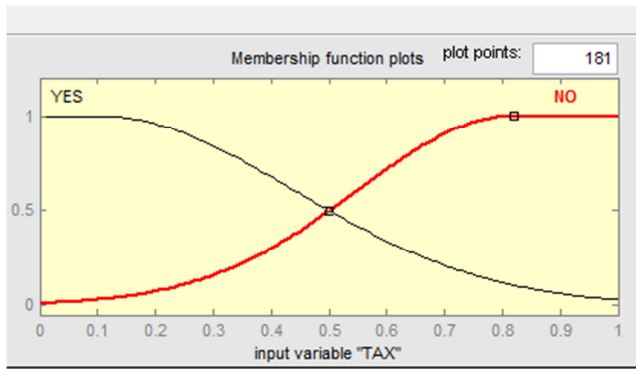


Figure 4. Membership Function Plot for Tax.

Importation of good and services in to a country is also one of the determinant of inflation in this work it is define using two linguistic variables yes and No that is to say there is importation or not which are illustrated in the figure 5 below to enable the system make decision.

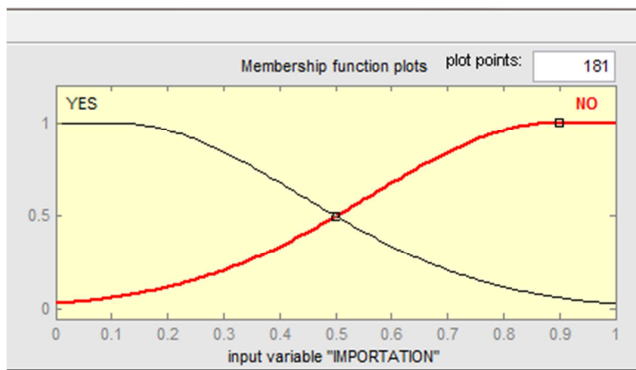


Figure 5. Membership Function Plot for Importation.

Lending rate is also among the determinant of inflation in this work it is define using two linguistic variables that high and low which would enable the system to generate rules and draw conclusion which is illustrated in figure 6 below.

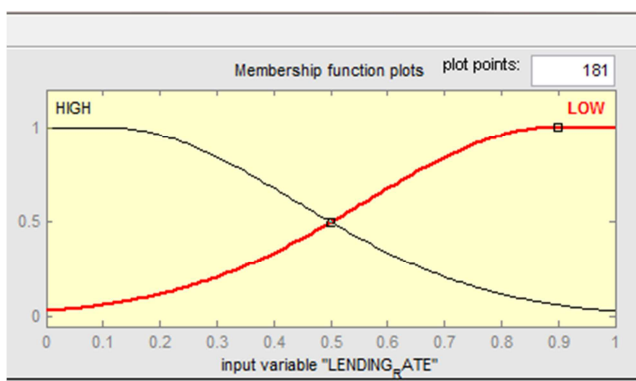


Figure 6. Membership Function Plot for Lending rate.

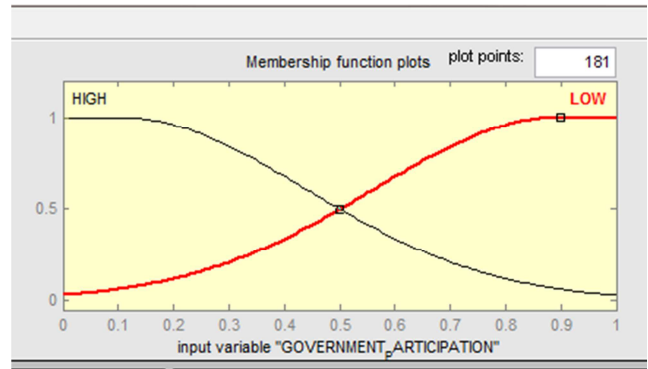


Figure 7. Membership Function Plot for Government participation.

Government participation is also one of the factors of inflation in this research is define using two linguistic variables high and low as show.

4.1. Surface Viewers

The effect of exchange rate is plotted against interest rate in Figure 8 it can be seen that the higher the exchange rate and interest rate, the higher the inflation. The model takes into consideration factors that bring out inflation like tax, importation, government participation among others and plot against each other as in figure 8, 9 and 10 to predict the possibility of inflation in Nigeria. However, in the research of [9] fuzzy logic is applied to valuation of real estate investment. [10] used Mamdani methodology to predict the future price of fuel on the basis of future demand and supply.

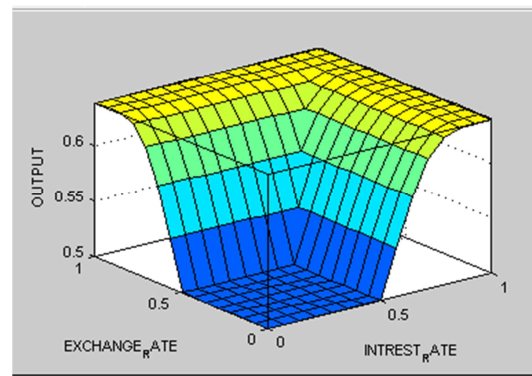


Figure 8. Surface viewer.

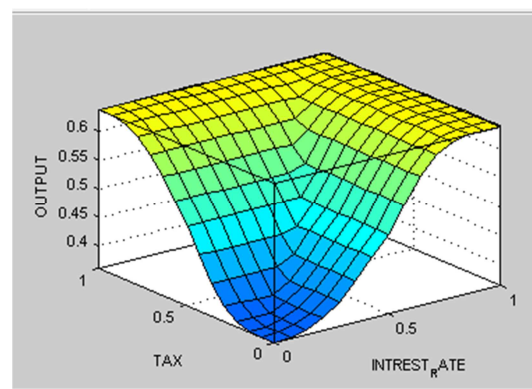


Figure 9. Surface viewer.

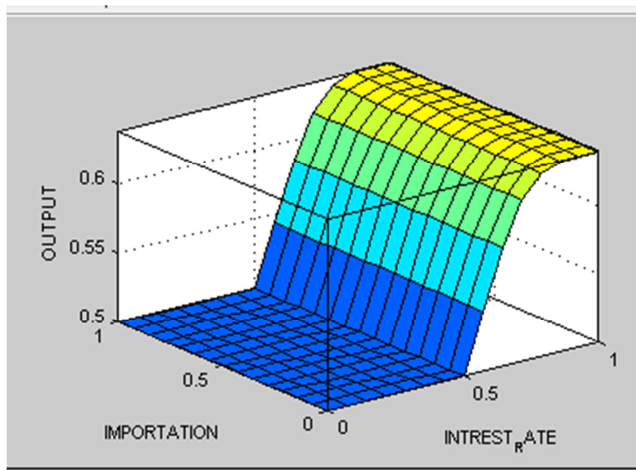


Figure 10. Surface viewer.

5. Conclusion

In conclusion, fuzzy ruled based system has been developed as an alternative to the traditional methods, in order to control inflation in the Nigerian economy. Based on this experiment the system suggested that if the interest rate is high, exchange rate is high, government due participate in the economy, lending rate is high, no importation in an economy with the exception of luxury goods it would resulted to single digit inflation which is significant and good to an economy like Nigeria. However, if the interest rate is set by an authority (CBN) low, exchange rate is low or fixed government do not participate fully in an economy, lending rate is said to be low and the government do import goods and services (both luxuries and food items) this would resulted to double digits or any other higher form of inflation in the economy.

References

- [1] Victor OA. The Causes of Persistent Inflation in Nigeria. CBN Journal of Applied Statistics, 2016; 7 (2).
- [2] Eskey 10 causes of inflation in Nigeria, Information guide in Nigeria, 2018 available online at <https://infoguidenigeria.com/causes-inflation-nigeria/>
- [3] Marcus F. (2011). The Application of Fuzzy Logic in Determining Linguistic Rules and Associative Membership Functions for the Control of a Manufacturing Process, M. Engr. Dissertation Dublin Institute of Technology India.
- [4] Ponce-Cruz, FD. Ramirez-Figueroa. Intelligent Control Systems with LabVIEW™ Springer 2010.
- [5] Kalaichelvi A, Malini, PH, Application of fuzzy soft sets to investment decision making problem, International Journal of Mathematical Sciences and Applications 2011; 1(3), 1583-1586.
- [6] Karaca F. Taş, V. Decision making problem for life and non-life insurances, Journal of BAUN Inst. Sci. Technol. 2018; 20 (1), 572-588.
- [7] Özgür NY., Taş N., A note on "application of fuzzy soft sets to investment decision making problem", Journal of New Theory, 2015; 7 1-10.
- [8] Taş, N., Özgür NY., Demir, P. An application of soft set and fuzzy soft set theories to stock management, Süleyman Demirel University Journal of Natural and Applied Sciences 2017; 21 (2), 791-196.
- [9] Vincenzo D. G., Pierfrancesco D. P. and Giovanni B. C. (2017) Valuation of Real Estate Investments through. Fuzzy Logic. *Buildings MDPI*.
- [10] Jagendra D. and Ramesh T. (2015) Design of Mamdani - Type Model for Predicting the Future Price of Fuel on theBasis of Demand and Supply *International Journal on Recent and Innovation Trends in Computing and Communication* 3 (6). 3667-3671.