African Journal of Business Management Vol. 4(6), pp. 925-929, June 2010
Available online at http://www.academicjournals.org/AJBM
ISSN 1993-8233 ©2010 Academic Journals

Full Length Research Paper

Fuzzy-logic and Neural network Fuzzy forecasting of Iran GDP growth

Mirnaser Mirbagheri

Islamic Azad University, Ardebil branch, Ardebil, Iran. E-mail: Mirbagheri_hir@yahoo.com.

Accepted 1 April, 2010

Investigating the effective factors which effect economic growth is important for most economists. Although lots of studies have been done on economic growth in the world, it gets little attentions in Iran. In this article, by estimating GDP growth, we try to investigate the supply side economic growth of Iran. Then we compare the predictive results of Fuzzy-logic and Neural-Fuzzy methods. And also by comparing the predictive results of methods for the average annual growth, it is predicted that (5.92%) in Neural-Fuzzy and (6.46%) in Fuzzy-logic in the related periods that is 2002 - 2006. And by comparing criteria it has been determined that, method Neural-Fuzzy predicts better than Fuzzy-logic method. In other words, forecasting by the method Neural-Fuzzy is recommended.

Key words: Fuzzy neural network (FNN), Fuzzy-logic, forecasting, government, business, effective decisions, planning.

INTRODUCTION

Eeconomic growth is the most important index among the macroeconomic variables. This variable has been considered as an economical index of government, and its increasing rate shows the welfare condition of the society.

This article tries at first to recognize the effective variables which effect economic growth in Iran (Mirnaser, 2008), then it will apply appropriate means for modeling and forecasting the main macroeconomic variables, that is economic growth. In this article, we also try to estimation, on the main and important effective factors in economic growth. This estimation can be led to applying appropriate, suitable and effective decisions. For this estimation, we designed Fuzzy-logic and Neural-Fuzzy to compare the results and the data is based on the information of informative centers such as central bank, planning budgeting organization and statistical centers.

MATERIALS AND METHODS

On the bases of previous experiences and theories, we can divide the effective variables of economic growth in Iran into 8 parts: 1) investment and physical capital, 2) labor power, 3) human capital, 4) Business, 5) credit and money variable, 6) inflation, 7) government, 8) political situation. For studying the effect of mentioned factors on economic growth, it is better to choose, and test a variable which match with the economic structure of Iran (Mirnaser and Tagiev, 2009).

The literature of prediction has been done by researchers such as: Zhang et al. (1998), and recent applications also have been done by Swanson and White (1997a), Darbellay and Slama (2000), Qi (2001) and Tkacz (2001), but despite of the power and of these models, the function of neural network models in Predictive experiment is combinatory (Zhang et al., 1998) In the field of economic data, Swanson and White (1997b), studied performance of neural network models in predicting macroeconomic time series. In the U.S. Moody et al. (1993), by focusing on integration of production in industry, understood that the neural network model, in the horizon of 6 months and more, is preferred to the linear model.

Tkacz (2001) showed that during a year, production of Gross domestic of Canada, by neural network, is predicted well than linear models. In other different applications, Qi (2001) showed that the neural network models are helpful in predicting binary variable of economic crisis.

In terms of combination, Fuzzy logic of Fuzzy neural networks, lots of researches have been done. Kuo et al. (2001), ANN have offered an appropriate Fuzzy inferences system by a Fuzzy modeling "Takagi-Sugeno".

Buckley and Hayashi (1994), has analyzed new findings, in the learning algorithm and its applications for FNN. FNN emphasized in the above, only am suitable for numerical data. But knowledge of experts is usually Fuzzy type. Therefore, researchers have done some efforts to solve this problem. Ishibuchi et al. (1995) have also offered other learning methods for Neural networks. This methods

methods are used not only for numerical data, but also are often used by expert for "if - then", Fuzzy rules. Le (1985) and Lee (1990), have presented a FNN, which is able to control input and the output of the Fuzzy. Kuo et al. (1998) also offered an intelligent decision support system based on Fuzzy neural networks for prediction.

Fuzzy logic

Fuzzy logic provides a practicable way to understand and manually influence the mapping behave our. In general, Fuzzy logic uses simple rules to describe the system of interest, rather than analytical equations, making it easy to implement. It is obvious that forecasting activities play an important role in our daily life. We usually forecast many things concerned with our daily life, such as the economy, stock market, population growth, weather, etc. Forecasting with 100% accuracy may be impossible, but we can do our best to reduce forecasting errors. To solve forecasting problems, many researchers have proposed many different methods or models (Cheng, 2004). Fuzzy systems have supplanted conventional technologies in some scientific applications and engineering systems in the past decade (Cheng, 2004).

Fuzzy logic has the ability to express the ambiguity of human thinking and translate expert knowledge into computable numerical data. A Fuzzy system consists of a set of Fuzzy if–then rules. Conventionally, the selection of Fuzzy if–then rules often relies on a substantial amount of heuristic observation to express the knowledge of proper strategies. Obviously, it is difficult for human experts to examine all the input–output data from a complex system to find proper rules for the Fuzzy system. To cope with this difficulty, several approaches to generating Fuzzy if–then rules from numerical data have been proposed (Cheng, 2004). An FIS (Fuzzy Inference Systems) contains three main components, the; Fuzzification stage, the rule base and the defuzzification stage. The fuzzification stage issued to transform the so-called crisp values of the input variables into Fuzzy membership values. Then, these membership values are processed within the rule-base, using conditional ‘if-then’ statements. The outputs of the rules are summed and defuzzified into a crisp analogue output value. The effects of variations in the parameters of a FIS can be readily understood and this facilitates calibration of the model.

In Fuzzy-logic implemented system, six inputs and one output are used on the base on Principles or rules, of triangular with mathematical formulas.

That real numbers of variables is converted to Fuzzy values. And then these Fuzzy values have been inserted to the basic process ("if-then" rules), and then are based on linguistic values levels: low, middle, high, very high and are graded by membership functions. And then the output values (results) of rules, with no-Fuzzy building (defuzzification) of type gravity center, have been converted to the real numbers and these have been shown in Table 1 and Figure 1.

Neuro-Fuzzy

Fuzzy neural network

Artificial neural networks (ANN) appear to be particularly suitable to forecast the growth of time series, as they can learn highly nonlinear models, hold effective learning algorithms, handle noisy data, and use inputs of different kinds (Armano et al., 2005). ANNs have been designed to mimic the characteristics of the biological neurons in the human brain and nervous system (Zurada, 1992). An ANN creates a model of neurons and the connections between them, and trains it to associate output neurons with input neurons. The network ‘‘learns’’ by adjusting the interconnections (called weights) between layers. When the network is adequately trained, it is able to generate relevant output for a set of input data. One of the valuable properties of neural networks is that of generalization where by a trained neural network becomes able to provide a correct matching in the form of output data for a set of previously unseen input data.

Back Propagation (BP) is one of the most famous training algorithms for multilayer perceptions (Abraham and Baikunth, 2001; Kasabov, 1998). Basically, BP is a gradient descent technique to minimize the error for a particular training pattern. FNNs are a class of hybrid intelligent algorithms that integrate Fuzzy logic with ANNs. A Fuzzy neural network System is defined as a combination of ANN and Fuzzy inference system (FIS) in such a way that neural network learning algorithms are used to determine the parameters of FIS. An even more important aspect is that the system should always be interpretable in terms of Fuzzy if-then rules, because it is based on the Fuzzy system reflecting vague knowledge (Sadeghi, 2008).

A neural network - Fuzzy consists which of five levels, are as follow (Abrahim and Baikunth, 2001): 1) Input Layer, 2) Fuzzification Layer, 3) Rule Base Layer, 4) Fuzzy Outputs, 5) Output Layer.

In designing neural networks – Fuzzy model, multi-layer feed forward neural network (MFNN) with learning algorithm, the propagation error and Fuzzy inference system "Sugeno" input function "difference between of Sigmoid functions" and the output function linear has been used in this system , on the other hand for to non-Fuzzy also moving average function has been used too. For designing the optimum system, neural network Fuzzy. Through continuing changes number of layers and number of hidden neurons layer, and appropriate neural network topology, were evaluated. Through continuous changes of membership functions, and number of membership functions, the suitable Fuzzy inference system was designed.

Explanation of Fuzzy neural networks

Takagi-Sugeno-Kang Fuzzy inference system is used to design the FNN for growth forecasting. The current model has (3) built-in membership functions composed of the difference between two sigmoid membership functions for each input variable with the evolving parameters:

(1) Number of training epochs = 10,
(2) Training error goal = 0,
(3) Step-size for each epoch = 1 and
(4) Learning rates for first and second layer = 0.05.

FNN uses a single pass training approach. And the network parameters were determined using a trial and error approach. The training was repeated 10 times after re initializing the network and the worst errors were reported (Figures 1 and 2). The Error and Structure of FNN are shown). Some performing criteria are usually used to show how to learn data connection in neural network - Fuzzy set. For Prediction, these criteria are often related to the error between the predicted outputs and the real desired outputs.

The Square mean of standard error = MSE,
The square root mean of square error = RMSE,
The normalized mean square of standard error=NMSE,
And the value of one indicates complete adaptation. R2 = 1-NMSE,
The mean of absolute error = MAE,
The average percent of absolute error = MAPE.

RESULTS

Studying different aspects of economic growth of Iran can be important for two reasons. At first, it is important for

Table 1. Criteria results of FNN and F-Logic.

	RMSE	MSE	NMSE	MAPE	MAE	R^2
FNN	$4.5158e^{-005}$	$2.0393e^{-009}$	$1.5947e^{-006}$	$2.4940e^{-004}$	$1.0013e^{-005}$	1.00
F-Logic	0.0081	$6.4808e^{-005}$	0.1032	0.0779	0.0042	0.8968

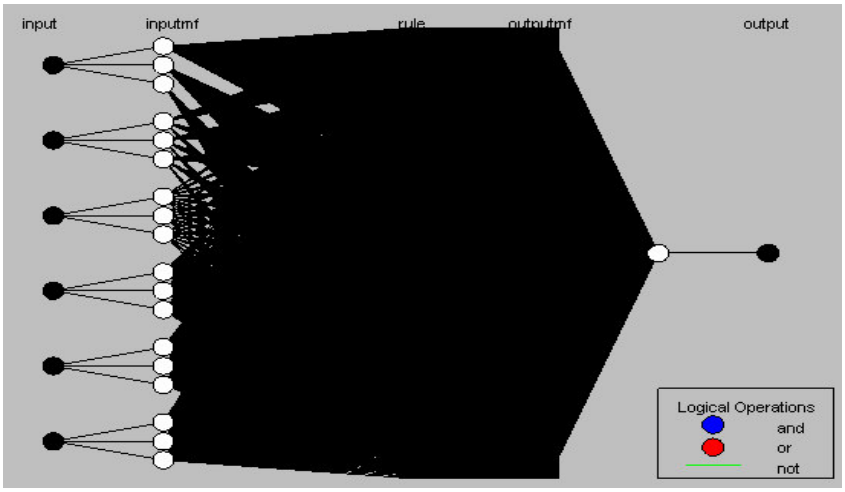

Figure 1. The structure of FNN.

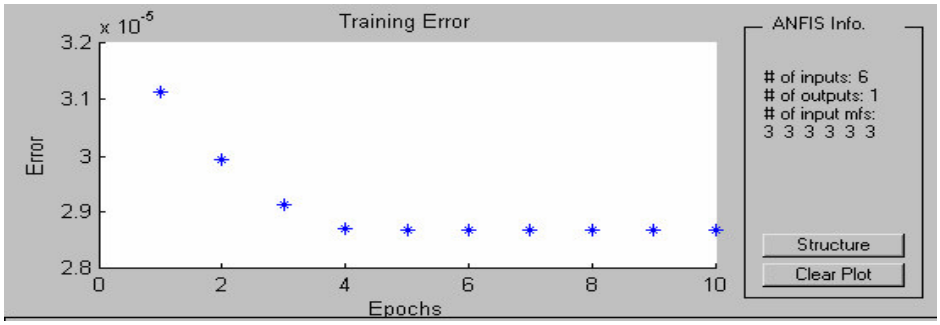

Figure 2. RMSE reduction of GDP growth by using FNN with the normalized data.

politicians to have appropriate decision for government, secondly, for economists to got appropriate economic planning for the country as well as for economical For model estimating, it is better to use variables such as the ratio of labor power to gross domestic product institutions. The purpose of this study is to present the theoretical model, estimating and forecasting economic growth through models: Fuzzy Logic and Neural-Fuzzy. And the statistical data of country have been used from 1959 - 2006. (DLGDD), and the ratio of capital to gross domestic product (DKGDP). But, because the mentioned variables is not completely attached with the economical structure of Iran, we use variables such as the ratio of human being capital that is, consuming expenses of government to GDP, export growth (RX), the ratio of inflation (CPI), and dummy variables such as war, revolution, and crises (DUM). The purpose of this study is to estimate economic growth, and to provide a suitable model for predicting growth in the future. This is also useful for decision makers, to overcome many of these kinds of problems and change conditions from uncertain condition to certain condition. In spite of research carried out in the field of prediction, this study focuses on developing accurate methods for exact and reliable prediction. For this purpose, the spectrum of nonlinear methods, have been investigated. And the methods of Fuzzy-logic and neural-Fuzzy are also used as a non-linear method, in the prediction and it has been compared on the base of six criteria.

Research results indicate that in terms of all performing

Table 2. Comparison of prediction: FNN and F-Logic with real values.

Years	Real	F-Logic	FNN
2002	0.0756	0.0778	0.0755
2003	0.0683	0.0785	0.0682
2004	0.0484	0.0495	0.0484
2005	0.0539	0.05	0.0538
2006	0.05	0.0675	0.0503
Average	0.05924	0.06466	0.05924

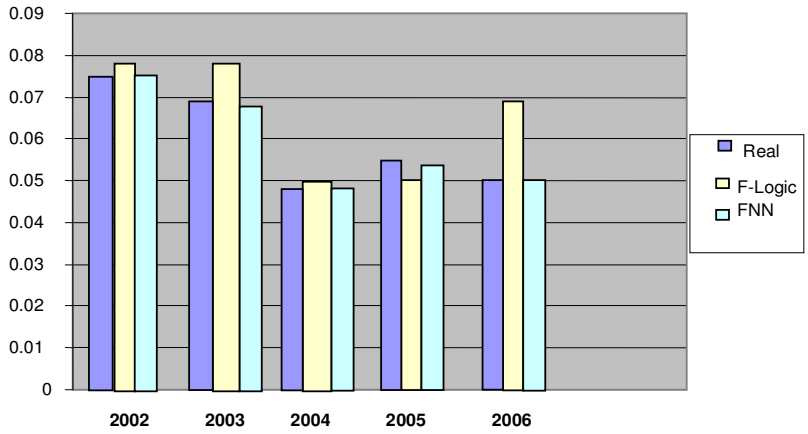

Figure 3. Comparison of the prediction: FNN and F-logic with real values.

criteria, Fuzzy neural networks are better than all Fuzzy logic method. For example, in terms of the criteria of RMSE equal 4.5158e-005 that has been in Table 1, error rate of Fuzzy neural networks, is remarkably less than the Fuzzy logic method. The experimental results of this study and the similar researches have shown that combination of artificial neural networks and Fuzzy logic, neural networks Fuzzy has been successful and predictive errors have been remarkably decreased. And it has significant features in the rapid convergence, high precision and strong ability in the function approximation. Because Fuzzy neural network system doesn't need explicit and definite data, and large samples and the data is not required, it can be a great prediction of economic growth. And make sure that this method is better than predictive other method.

DISCUSSION

Therefore each of the criteria of evaluating performance evaluates special aspects, the six mentioned criteria, is used for evaluating network performance. Results of performing evaluation of criteria which have been mentioned in Table 1 used different methods for testing data.

As seen in Table 1 in term of all performance, Fuzzy neural network method is better than the Fuzzy-logic method. The comparison of predicted results on the base of Fuzzy logic and neural-Fuzzy, with real values have been in the Table (2) and Figure (3).The predicted values with Fuzzy neural networks, are approximately consistent with real values. Considering that, Fuzzy neural networks in compare to other method in performance evaluation of six criteria are superior; this method is recommended for predicting economic growth. The Predicted values have been shown in Table (2).

REFERENCES

Abraham Ajith, Nath Baikunth (2001). "A neuro-Fuzzy approach for modeling electricity demand in Victoria", Applied Soft Computing, 1: 127-138.

Armano G, Marchesi M, Murru A (2005). A hybrid genetic-neural architecture for stock indexes forecasting, Inform. Sci. 17: 3-33.

Buckley JJ, Hayashi Y (1994). "Fuzzy neural networks: a survey", Fuzzy Sets and Systems, 66: 1-13.

Cheng Jian Lin (2004). Time series prediction using adaptive neuro-Fuzzy Networks, Inter. J. Sci., 35(5): 273-286.

Darbellay GA, Slama M (2000). "Forecasting the short-term demand for electricity: do neural networks stand a better chance", Inter. J. Forecasting, 16: 71-83.

Ishibuchi H, Kwon K, Tanaka H (1995). "A learning algorithm of Fuzzy neural networks with triangular Fuzzy weights", Fuzzy Sets and Systems, 71: 277-293.

Kasabov N (1998). Evolving Fuzzy neural networks: algorithms, applications and biological motivation, in: Yamakawa T, Matsumoto G (Eds.), Methodologies for the Conception, Design and Application of Soft Computing, World Scientific, Singapore. pp. 271–274.

Kuo RJ, Chen CH, Hwang YC (2001). “An intelligent stock trading decision Support system through integration of genetic algorithm based Fuzzy neural network and Artificial neural network", Fuzzy Sets and Systems, 118(1): 21-45.

Kuo RJ, Lee LC, Lee CF (1998). “Intelligent stock decision support system. Through artificial neural networks and Fuzzy Delphi", Comput. Intell. Finance, 6: 24-34.

Qi M (2001). "Predicting US recessions with leading indicators and neural network Models", Inter. J. Forecasting, 17: 383-401.

Le CY (1985). "Une procedure dapprentissage pour reseau a seuil assymetrique", Cognitive, 85: 599-604.

Lee CC (1990). “Fuzzy logic in control systems: Fuzzy logic controller", IEEE Trans. Systems Man Cybernet Part I, 20(2): 404-418.

Mirnaser Mirbagheri (2008). Analysis Factors influencing on the Economical development, Physic –Mathematical. Sci Series, BDU, 4: 90-96.

Mirnaser Mirbagheri, Tagiev N (2009). Reviewing and Analyzing the Economic growth and Economic structure of Iran, Transactions of National Academy of Sciences of Azerbaijan series of Economic, 1: 126-130.

Moody J, Levin U, Rehfuss S (1993). "Predicting the US index of industrial production", Neural Network World, 3: 791-794.

Sadeghi MR, Afsar A, Sohrabi B (2008). Inventory Lot-sizing with supplier. Selection using hybrid intelligent algorithm,Science Direct, Applied Soft Computing, 8: 1523-1529.

Swanson NR, White H (1997a). "A model selection approach to real time. Macroeconomic forecasting using linear models and artificial neural networks", Rev. Econ. Stat., 39: 540-550.

Swanson NR, White H (1997b). "Forecasting economic time series using adaptive versus non adaptive and linear versus nonlinear econometric models", Inter. J. Forecasting, 13: 439-461.

Tkacz G (2001). "Neural network forecasting of Canadian GDP growth ", Inter. J. Forecasting, 17: 57-69.

Zhang G, Patuwo BE, Hu MY (1998). "Forecasting with artificial neural networks: the state of the art", Inter. J. Forecasting, 14: 35-62.

Zurada JM (1992). Introduction to Artificial Neural Systems, PWS Pub. Co.