Journal of Economics and Behavioral Studies
Vol. 3, No. 5, pp. 274-278, Nov 2011 (ISSN: 2220-6140)

Forecasting Government Size in Iran Using Artificial Neural Network

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Abstract: In this study, artificial neural network (ANN) for forecasting government size in Iran is applied. The purpose of the study is comparison various architectures, transfer functions and learning algorithms on the operation of network, for this purpose the annual data from 1971-2007 of selected variable are used. Variables are tax income, oil revenue, population, openness, government expenditure, GDP and GDP per capita; these variables are selected based on economic theories. Result shows that networks with various training algorithms and transfer functions have different results. Best architecture is a network with two hidden layer and twelve (12) neuron in hidden layers with hyperbolic tangent transfer function both in hidden and output layers with Quasi -Newton training algorithm. Base on findings in this study suggested in using neural network must be careful in selecting the architecture, transfer function and training algorithms.

Key words: *government size, forecasting, neural network, training algorithms, transfer functions*

1. Introduction

Presence of the government in economic is one of the argument among the economists. There are two views regarding the role of government in economic activities and its effect on growth and investment.
Since the publication of the article by Barro (1990), growth effects of public spending have been one of the popular topics in economic research. Some argue that increase in government expenditure on socio-economic and physical infrastructures encourages economic growth. For example, government expenditure on health and education raises the productivity of labor and increase the growth of national output. Many economists have theorized that government production is statically less efficient than private sector. They have contended that governmental outputs will be non optimal and produced at higher cost than corresponding private sector outputs. Their explanation for the general non-optimality include the lack of price signal, centralized decision making, lack of competitive pressure and no profit motive(Landau, 1985). Also there are two different views exist on the effects of increased government expenditure on investment. The traditional view argues that government expenditure crowds out private investment. Higher government expenditure, whether financed with taxes or debt, increases the demand for goods and services, raising interest rates, making capital more expensive and, as such, reducing private investment. The non-traditional view sees government expenditure stimulating investment. The crowding in of investment occurs when the economy's resources are un- and under-employed. That may arise in many developing countries where, for example, government expenditure on infrastructure can induce private investment (Ahmed and Miller, 1999). Therefore, government size and its trend is an important element in any economy.

There are many forecasting techniques that can be classified into four main groups: (1) Qualitative methods that are primarily subjective; they rely on human judgment, (2) Time-series methods use historical data to make a forecast, (3) Causal methods involve assuming that the variables forecast are highly correlated with certain factors in the environment, (4) Simulation methods imitate the consumer choices that give rise to demand to arrive at a forecast. Most prior studies that forecast economic variables primarily are based on time-series models, such as moving-average, exponential smoothing, and the Box-Jenkins method, and casual models, such as regression and econometric models (Lee, Padmanabhan, and Whang (1997). Artificial neural networks (ANN) were developed in attempts to simulate the animal brain's cognitive learning process. ANNs are proved to be efficient in modeling complex and poorly understood problems for which sufficient data are collected (Dhar & Stein, 1997). ANN is a technology that has been mainly used for prediction, clustering, classification, and alerting to abnormal patterns (Haykin, 1994). The capability of learning examples is the most important property of neural networks in applications and can be used to train a neural network with the records of past

response of a complex system (Wei, Zhang, & Li, 1997). The purpose of this study is examining the impact of various transfer function and learning algorithms on the operation of a network. In the next section comes empirical study about neural network. In section 3, literature of neural network is discussed, in section 4, data and result of network is defined , and in the last section conclusions and findings of study are articulated.

Empirical studies: There has been a great interest in studying the artificial neural network (ANN) forecasting in economics, financial, business and engineering. ANN models are currently used for forecasting various macroeconomic indicators such as GDP growth, stock returns, and currency in circulation, electricity demand, construction demand, exchange rates, and inflation and so on. Many comparisons have been made between neural networks and traditional methods on time-series forecasting performance. While most researchers find that neural networks can outperform linear methods under a variety of situations, but the conclusions are not consistent (Zhang, Patuwo & Hu, 1998). In table (1) comes some study on neural network and their results.

Table (1): Summary of Literatures on Neural Networks Applications in Economics

Date	Researcher	Used method	period	Goal	Results
2000	Moshiri & Cameron	ANN & ARIMA, VAR & BVAR	1970-1994	compare the performance	ANN is better than traditional economic method in some case.
2001	Tkacz	ANN & TIME SERIES METHOD	1968-1999	Improve the accuracy of financial and monetary forecasts of Canadian output growth.	networks statistically has lower forecast errors
2002	Ho, Xie & Goh	ARIMA & ANN		Investigate suitable time series model	ANN has better result
2005	Ghiassi, Saidane& Zimbra	ANN,ARIMA & DAN2		To compare the method	DAN2, is an alternative of ANN, and has better result
2005	Nakamura	ANN & AR	1960-2003	Forecasting inflation	ANN training algorithm plays a significant role in the success of the NN model.
2007	Roh	ANN, EWMA, GARCH, EGARCH	930 trade days	To compare methods	NN-EGARCH & NN-GARCH; for periods shorter than a month 100 % direction prediction and periods shorter than 160 days min 50 % direction prediction
2007	Kumar & Ravi	ANN, Fuzzy Logic, Cased-Based Reasoning, Decision Trees, Rough set		Review Bankruptcy prediction(128 paper)	RS based models outperform logistic regression & decision tree. Logistic regression, LDA,QDA, FA clearly outperformed by ANN. Hybrid methods can combine the advantages of methods
2009	Bildirici & Ersin	ARCH, GARCH, EGARCH, TGARCH, PGARCH, APGHARCH, ANN	1987-2008	To improve forecast with ANN	ANN models provide significant improvement
2009	Haider & Nadeem Hanif	ANN, AR(1), ARIMA	1993-2007	Forecast inflation	ANN s Forecasts are more precise.
2010	Liao & Wang	Stochastic Time Effective Neural Network Model	1990-2008	To shows some predictive results on the global stock indices	Stochastic time effective neural network model shows some predictive results on the global stock indices.

Source: Authors Research and (Guresen, Kayakutlu, & Diam, 2011)

Artificial Neural Network: An Artificial Neural Network is making of Artificial Neurons. Neuron is the smallest processing unit and is the base of neural network operation. (Wu, 1995).The greatest advantage of a neural network is its ability to modeling complex nonlinear relationship without a priori assumptions of the nature of the relationship Neural networks have three layers; input layer, hidden layer and output layer. Input layer just take the data and behave like an independent variable therefore amount of neuron in input layer depend to the variable. Output layer behave like a depended variable and amount of neuron in this layer depend on the dependent variables (forecasting variables). For the amount of neurons in hidden layers researcher suggest some relations like; *2n+1, 2n, n*, *n/2* ; that *n* is the number of neuron in input layer but the best rule for choice the number of neuron in this layer is based on trial and error (Jafari-Samimi & Shirazi& Fazlollahtabar, 2007).

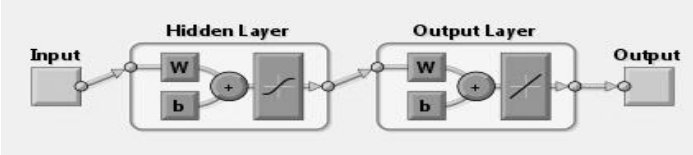
Data divided in two set; training and test set. Network take the training set an according them estimate the behavior of series, then examine the estimation of network according to compare output of network with actual data using test set,. Often use one of the following ratio for allocation data between two set,10%-90%, 20%-80% or 30%-70% (Zhang, Patuwo & Hu, 1998). In some study researcher divide the data in three set; train, validation and test set (Yao & Tan, 2000). If the networks output shows with $\hat{y}_j$ and actual value with y, the purpose of network training is to find the networks weight to minimize the network error. If the error of forecasting determined with Sum of Squared Errors (SSE), purpose is to minimize the Eq.1.

$$SSE = \sum_{j=1}^{n-1} (y_j - \hat{y}_j)^2 \qquad (1)$$

Layers in a network adjoin each other using activity (transfer) function. Proceeding units that are in the hidden and output layers using activity (transfer) functions process the data and transfer to next layer. Important activity (transfer) functions are Sigmoid Function and Hyperbolic Tangent function (Kohzadi & et al, 1995). Learning process in neural network is based on estimation the weights and models parameter. Learning performs with two method; Hetro- association learning and Auto-association learning.

In Hetro-association method that used it in our study, gives the network actual values of targets with input variable and network with estimate the target value compare actual and estimated values and calculate errors, and using algorithms change the weights to minimize the errors. With iteration, this process network has trained and weights and parameters are calculated (Moshiri & Cameron, 2000). There are algorithms to training a network such as Quick Propagation (QP), Quasi -Newton (QN), Levenberg _Marquardt (L-M), Back- Propagation (BP) and Genetic Algorithm (GA). There are several type of neural network; Feed Forward, Cascade Forward, Elman and General Regression Neural Network (GRNN), but researchers unanimously about better performance of Feed Forward neural network in forecasting (Kasstra & Boyd, 1996), (Tkacz, 2001). In the figure no. 1, there is a Feed Forward neural network with a nonlinear transfer function in hidden layer and a linear transfer function in output layer

Figure (1): A Feed Forward Neural Network



Neural networks are powerful in forecasting non-linear variables so in the next section first tested the non-linearity of depended variable, and then to set up the network examined various network components.

2. Data and result

One of the critics to application neural network in economic is about the selections of variables, Critics says that selection is just based on results and do not attention to economic theory (Moshiri & Cameron,

2000). Therefore in this study variable are selected based on economic theory. Selected variables are tax income, oil revenue, GDP per capita, openness and population.

Data of variables are gathered from publications of Central Bank of Iran from 1971-2007, and randomly 5 years selected as test set. Neural network are useful for nonlinear time series data, so in first step for examine the non-linearity use BDS test. Result shows that the series of GS is nonlinear. Results are shown in table no.2.

Table 2: Result of BDS Test on the Residual of AR (2)

Dimension	M=2	M=3	M=4	M=5
$\frac{\varepsilon}{sd} = 0.3$	0.0273	0.0273	0.0169	0.0118
$\frac{\varepsilon}{sd} = 0.5$	0.0433	0.062	0.059	0.058
$\frac{\varepsilon}{sd} = 1$	-0.000*	0.001	0.002	0.003

*Note: Except * , all coefficient are significant in 5 percent level*

For determine the number of neurons and layers in hidden layer has done experiments, According the experiments a Feed Forward neural network with two hidden layers with 12 neurons in hidden layers has been selected. Networks trained based on different transfer functions and training algorithms and compared based on average test error. Results are in table no.3.

Table3: Result of Testing Neural Network

Hidden transfer function	Output transfer function	Training algorithm	Average test error
Logistic	Logistic	Back- Propagation	0.00641
		Levenberg-Marquardt	0.00629
		Quasi _Newton	0.00629
	Hyperbolic Tangent	Back- Propagation	0.01572
		Levenberg-Marquardt	0.010154
		Quasi _Newton	0.010242
	Linear	Back- Propagation	0.008683
		Levenberg-Marquardt	0.01442
		Quasi _Newton	0.01442
Hyperbolic Tangent	Logistic	Back- Propagation	0.008164
		Levenberg-Marquardt	0.01048
		Quasi _Newton	0.00935
	Hyperbolic Tangent	Back- Propagation	0.010732
		Levenberg-Marquardt	0.01548
		Quasi _Newton	0.0054
	Linear	Back- Propagation	0.00863
		Levenberg-Marquardt	0.01466
		Quasi _Newton	0.01442

Results shows that different training algorithm and transfer function have different results based on average test error. Three transfer functions are used in this study, two of them are non-linear and one linear, in hidden layer just used non-linear transfer functions. For training, the network used three training algorithms, and among them in different conditions Quasi -Newton usually has a better performance.

3. Findings and Conclusions

In this study, different training algorithms and transfer function are used. Best architecture is a network with two (2) hidden layers and twelve (12) neuron in hidden layers with hyperbolic tangent transfer function both in hidden and output layers with quasi-Newton training algorithm. The result shows that different training algorithm and transfer function have different results based on average test error. According to the findings of this study several conclusions reported;

First, the number of hidden layer and neurons in this layer strongly affect the results of network, in this study, best results are gets in networks with two (2) hidden layers, and network performance is the best measurement about the number of neurons. Second, among the various transfer functions that used in this study best result gets with hyperbolic tangent function so in applying neural networks various transfer function should be examined. Third, various networks learning algorithms has different results based on the problem quality so different transfer functions should be test in using neural networks.

Base on findings in this study suggested that in using neural network we must be careful in selecting the architecture, transfer function and training algorithms.

Reference

Ahmed, H. & Miller, M. (1999). Crowding-Out and Crowding-In Effects of the Components of Government Expenditure. *Contemporary Economic Policy*, 18, 124-133.

Barro, R. (1990). Government spending in a simple model of endogenous growth, *Journal of Political Economy*, supplement (II), 103–125.

Bildirici, M. & Ersin, Ö. Ö. (2009). Improving Forecasts of GARCH Family Models with the Artificial Neural Networks: An Application to the Daily Returns in Istanbul Stock Exchange. *Expert Systems with Applications , 36 (4),* 7355-7362*.*

Dhar, V. & Stein, R. (1997). Seven methods for transforming corporate data into business intelligence. NJ, Prentice-Hall.

Ghiassi, M., Saidane, H. & Zimbra, D. K. (2005). A Dynamic Artificial Neural Network Model for Forecasting Time Series Events. *International Journal of Forecasting*, 21, 341–362.

Guresen, E., Kayakutlu, G. & Diam, T. U. (2011). Using Artificial Neural Network Models in Stock Market Prediction. *Expert System with Application*, 38(2011), 129–137.

Haider, A. & Nadeem-Hanif, M. (2009). Inflation Forecasting in Pakistan Using Artificial Neural Network. *Pakistan Economic and Social Review*, 47(1), 123-138.

Haykin, S. (1994). Neural networks a comprehensive foundation, New York,MacMillan.

Ho , S.L., Xie, M. & Goh, T. N. (2002). A Comparative Study of Neural Network and Box-Jenkins ARIMA Modeling in Time Series Prediction. *Computers and Industrial Engineering*, 42 (2002), 371–375.

Jafari-Samimi, A., Shirazi, B. & Fazlollahtabar, H. (2007). A Comparison between Time Series, Exponential Smoothing and Neural Network Methods to Forecast GDP of Iran. *Iranian Economic Review*, 12(19),19-35.

Kaastra, I. & Boyd, M. (1996). Designing A Neural Network For Forecasting Financial and Economic Time Series. *Neurocomputing*, 10,215-236.

Kohzadi, N., Boyd, M. S., Kaastra, I., Kermanshahi, B. & Scuse, D. (1995). Neural Networks for Forecasting: An Introduction. *Canadian Journal of Agricultural Economics*, 43, 463-474.

Kumar, P. R. & Ravi, V. (2007). Prediction in Banks and Firms via Statistical and Intelligent Techniques – A Review Therefore, government size and its trend is an important element in any economy. *European Journal of Operational Research*, 180, 1–28.

Landau, D. (1985). Government Expenditure and Economic Growth in the Developed Countries: 1952-76. *Public Choice*, 47, 459-477.

Lee, H. L. Padmanabhan, V. & Whang, S. (1997). The bullwhip effect in supply chains, Sloan Management. Review, 38, 93–102.

Liao, Z. & Wang, J. (2010). Forecasting Model of Global Stock Index by Stochastic Time Effective Neural Network. *Expert Systems with Applications*, 37(1), 834–841.

Moshiri, S. Cameron, N. (2000). Neural Networks versus Econometric Models in Forecasting Inflation. *Journal of Forecasting*, 19, 201-217.

Nakamura, E. (2005). Inflation Forecasting Using a Neural Network. *Economic Letters*, 86, 373-378.

Roh, T. H. (2007). Forecasting the volatility of stock price index. *Expert Systems with Applications*, 33, 916–922.

Tkacz, G. (2001). Neural Network Forecasting of Canadian GDP Growth. *International Journal of Forecasting,* 17, 57-69.

Wei, S., Zhang, J. & Li, Z. (1997). A supplier-selecting system using a neural network. IEEE international conference on intelligent processing systems, 468–471.

Wu, S. I. (1995).Artificial neural networks in forecasting, neural networks world, 2(IDGVSP): 199-220.

Yao, J., Yili, L. & Tan, C. L. (2000). Option price forecasting using neural networks. *Omega*, 28, 445-466.

Zhang, G., Patuwo, B. E. & Hu, M. Y. (1998). Forecasting With Artificial Neural Networks: The State of The Art. *International Journal of Forecasting*, 14, 35-61.