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Artificial Neuro Network (ANN) Applications in Economics: A Survey of Emprical Literature and Its Using on Economic Studies

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Abstract:

Neural networks are increasingly being used in real-world business applications and, in some cases, such as fraud detection, they have already become the method of choice. Their use for risk assessment is also growing and they have been employed to visualize complex databases for marketing segmentation. This boom in applications covers a wide range of business interests from finance management, through forecasting, to production. Neural networks can be utilized in both macro- and microeconomic analysis, with clear potential to improve the timeliness and quality of economic forecasting. A form of artificial intelligence, neural networks provides significant potential in economic applications by increasing the flexibility of the process of economic forecasting. In this paper, by surveying empirical literature and its using on economics studies artificial neuro network applications have been analyzed. This is a new and developing approach in economics studies. It can be useful to apply on relative areas of economics like labor economics and the other economical problems. Economists can make a forecasting using by ANN on economics studies in the near future.

Key words: *ANN, economics, labor economics, unemployment, Turkey.*

INTRODUCTION

Neural networks are increasingly being used in real-world business applications and, in some cases, such as fraud detection, they have already become the method of choice. Their use for risk assessment is also growing and they have been employed to visualize complex databases for marketing segmentation. This boom in applications covers a wide range of business interests from finance management, through forecasting, to production.

Business is a diverted field with several general areas of specialization such as accounting or financial analysis. Almost any neural network application would fit into one business area or financial analysis. In the financial sector, neural networks are mainly used for stock selection, stock ranking, credit analysis, risk assessment and asset allocation. There is some potential for using neural networks for business purposes, including resource allocation and scheduling (Lendasse *et al.*, 2000). Neural networks can be utilized in both macro- and microeconomic analysis, with clear potential to improve the timeliness and quality of economic forecasting. A form of artificial intelligence, neural networks provides significant potential in economic applications by increasing the flexibility of the process of economic forecasting (Tall and Nazareth, 1995; Gaubert and Cottrell, 1999). In this study a novel approach on dynamics of unemployment in Turkey between 2000 and 2004 years is presented by using Artificial Neural Network (ANN).

THE DATA

The data source for the analysis in this paper is Household Labor Force Surveys (HLFS) conducted nationwide by the Turkish Statistical Institution (TURKSTAT). HLFS data were collected biannually (in April and October) from 1988 to 1999 and quarterly since 2000. Major improvements in the quarterly HLFS include the use of a moving reference week, a larger sample, an expanded sample frame that allows regional representation, and a rotating panel design. So in this paper we use the data of HLFS on unemployed people after 2000. (Detailed information on the HLFS is available on the SIS web page, http://www.die.gov.tr).

In accordance with the standard of International Labor Organization in Turkish labor market the unemployed people comprise all persons 15 years of age and over who were not employed (either worked for profit, payment in kind or family gain at any job even for one hour, or with any job attachment) during the reference period, who have taken at least a specific step to obtain a job during the last six months and were available to start work within 15 days.

The reference population is the non-institutional civilian population, ages 15 and over. To get classified as unemployed, an individual has to satisfy three criteria: (i) did not work during the reference week; (ii) searched actively for a job during the past six (1988-99) or three (2000-2002) months; and (iii) is ready to start work in 15 days. According to this definition those who have found a job and are about to start working are classified as unemployed.

THE METHOD OF ARTIFICIAL NEURAL NETWORKS

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurones) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurones. This is true of ANNs as well. The commonest type of artificial neural network consists of three groups, or layers, of units: a layer of input units is connected to a layer of hidden units, which is connected to a layer of output units as shown Figure 1 (Karlık *et al*., 2002).

- The activity of the input units represents the raw information that is fed into the network.
- The activity of each hidden unit is determined by the activities of the input units and the weights on the connections between the input and the hidden units.
- The behaviour of the output units depends on the activity of the hidden units and the weights between the hidden and output units.

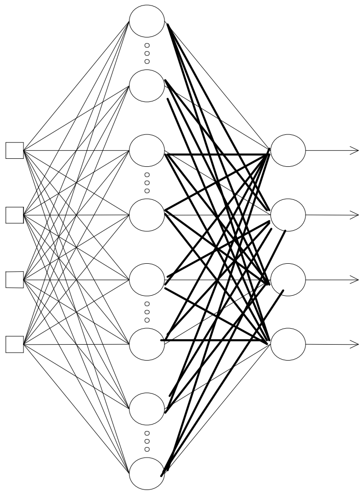


Figure-1: General structure of MLP neural network

This simple type of network is interesting because the hidden units are free to construct their own representations of the input. The weights between the input and hidden units determine when each hidden unit is active, and so by modifying these weights, a hidden unit can choose what it represents. We also distinguish single-layer and multi-layer architectures. The single-layer organization, in which all units are connected to one another, constitutes the most general case and is of more potential computational power than hierarchically structured multi-layer organizations (Pao , 1989). In multi-layer perceptron (MLP) networks, units are often numbered by layer, instead of following a global numbering. Figure 1 shows a general structure of a neural network.

In order to train a neural network to perform some task, we must adjust the weights of each unit in such a way that the error between the desired output and the actual output is reduced. This process requires that the neural network compute the error derivative of the weights. In other words, it must calculate how the error changes as each weight is increased or decreased slightly. The generalized form of the delta rule, developed by D.E. Rumelhart, G.E. Hinton, and R.J. Williams, is needed for networks with hidden layers. They showed that this method works for the class of semi linear activation functions, which is non-decreasing and differentiable (Rumelhart *et al*., 1986). Generalizing the ideas of the delta rule, consider a hierarchical network with an input layer, an output layer and a number of hidden layers. We will consider only the case where there is one hidden layer. The network is presented with input signals which produce output signals that act as input to the middle layer. Output signals from the middle layer in turn act as input to the output layer to produce the final output vector. This vector is compared to the desired output vector. Since both the output and the desired output vectors are known, the delta rule can be used to adjust the weights in the output layer. Both the input signal to each unit of the middle layer and the output signal are known. What is not known is the error generated from the output of the middle layer since we do not know the desired output. To get this error, back propagate through the middle layer to the units that are responsible for generating that output. The error generated from the middle layer could be used with the delta rule to adjust the weights (Ozbay et al., 2002).

Each layer is fully connected to the previous layer, and has no other connection. The output O_j of each unit j is defined by

$$O_j = f(net_j),\ net_j = \sum_i w_{ji} O_i + \theta_j \qquad (1)$$

where O_i is the output of unit i, w_{ji} is the weight of the connection from unit i to unit j, θ_j is the bias of unit j, Σ_i is a summation over every unit i whose output flows into unit j, and $f(x)$ is a monotonously increasing function. In practice, a logistic activation function (sigmoid function) $f(x) = 1/(1+\exp(-x))$ is used. When the set of m-dimensional input patterns $\{i_p = (i_{p1}, i_{p2}, \ldots, i_{pm}) ; p \in P\}$ where P denotes set of presented patterns, and their corresponding desired n-dimensional output patterns $\{t_p = (t_{p1}, t_{p2}, \ldots, t_{pm}) ; p \in P\}$ are provided, the neural network is trained to output ideal patterns as follows. The squared error function E_p for a pattern, p is defined by

$$E_p = \frac{1}{2}\left[\sum_{j \in output} (t_{pj} - o_{pj})^2\right] \qquad (2)$$

Where, t_{pj}: target (desired) value, o_{pj}: actual network output value. The purpose is to make $E = \sum_p E_p$ small enough by choosing appropriate w_{ji} and θ_j. To realize this purpose, a pattern $p \in P$ is chosen successively and randomly, and then w_{ji} and θ_j are changed by

$$\Delta_p w_{ji} = -\varepsilon\,(\partial E_p / \partial w_{ji}) \qquad (3)$$

$$\Delta_p \theta_j = -\varepsilon\,(\partial E_p / \partial \theta_j) \qquad (4)$$

where, ε is a small positive constant. By calculating the right hand side of (3-4), it follows that;

$$\Delta_p w_{ji} = \varepsilon\, \delta_{pj} O_{pi} \qquad (5)$$

$$\Delta_p \theta_j = \varepsilon\, \delta_{pj} \qquad (6)$$

where

$$\delta_p = \begin{cases} f'(net_j)(t_{pj} - O_{pj}) \\ f'(net_j) \sum_k w_{kj} \delta_{pk} \end{cases} \qquad (7)$$

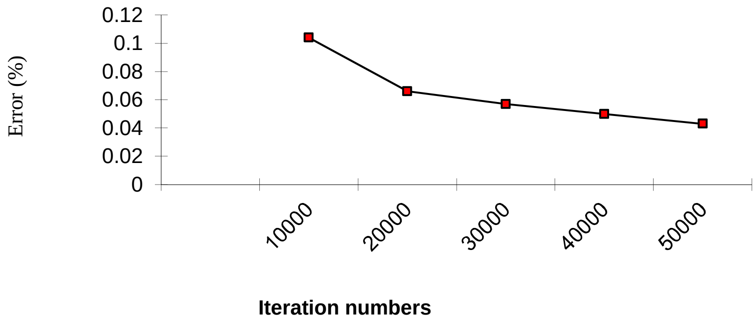
Note that k in the above summation represents every unit k in the layer following the layer of j (unit j). In order to accelerate the computation, the momentum terms are added in (5-6),

$$\Delta_p w_{ji}(n+1) = \varepsilon\, \delta_{pj} O_{pi} + \alpha \Delta_p w_{ji}(n) \qquad (8)$$

$$\Delta_p \theta_j(n+1) = \varepsilon\, \delta_{pj} + \alpha\, \Delta_p \theta_j(n) \qquad (9)$$

Where, n represents the number of learning cycles, and α is a small positive value. The MLP structures of both works are 6:7:5 and 3:6:5. The trial and error the optimum α and ε constant values were determined to be: $\alpha = 0.9$, $\varepsilon = 0.7$ for both of them. Figure 2 shows total Mean Square Error (MSE) belonging to iteration. As it can be seen in Figure, if we increase the iteration number of neural networks, the error is decrement.

Figure-2: Total MSE belonging to iteration



ANN APPLICATION ON DYNAMICS OF UNEMPLOYMENT IN TURKEY

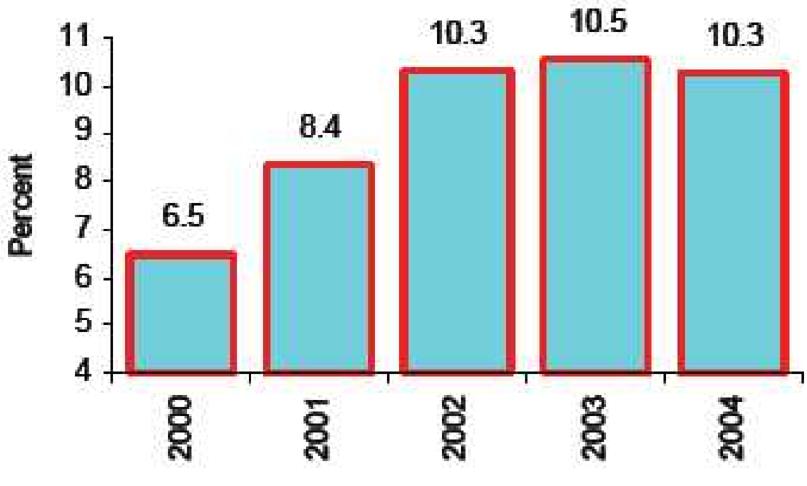
The Turkish economy has remarkably displayed a stable structure since 2002. Following the 2001 crisis, the Turkish economy rebounded very strongly and was one of the fastest growing economies in the world in 2004. Annual growth averaged 8 percent during 2002-2004 and a 7.6 percent growth rate realized in 2005. Inflation has come down to single digits in 2004 (9.3 percent) for the first time in the last 35 years, greatly facilitating the reduction in interest rates. Inflation continued to decelerate in 2005 (7.7 percent) and realized below the year-end target of 8 percent despite soaring oil prices. Rapidly rising labor productivity, amounting to 23 percent for the whole period 2002-2004, has underpinned strong growth. Thanks to improved competitiveness exporters have penetrated into new markets, while the composition of exports has changed towards more high tech products, such as automobile, electrical and electronic equipment and machinery (IMF, 2006).

However, despite strong growth for four consecutive years, high unemployment continues to persist, at reached 10.3 percent in 2004. Turkey has not translated output growth into job creation as well as most other countries. Compared to EU countries and selected emerging market economies (World Bank, 2006)[1]. As it is well-known, Turkish economy could not record any increase in the level of employment in the years 2002 and 2003, despite the substantial economic growth achieved since 2002. In 2004, employment increased by 3 percent firstly as a result of productivity gains reaching its limits; secondly, lagged response of employment to the considerable increases in private fixed investment in 2003 and 2004 and thereby the arising necessity to create more employment so as to grow further; and lastly, rising confidence to the permanence of the economic stability.

Turkey already has a larger working-age population than any current member of the EU and demographic trends will ensure that this segment continues to grow rapidly throughout the accession period (Taymaz and Ozler, 2006). This situation offers Turkey the possibility of benefiting from a population structure that is weighted towards potentially productive age groups. However, this productive potential will only be realized if the economy can generate adequate employment opportunities. Even at the currently low labor force participation rate of about 40 percent for the 15-24 year age group (where the new entrants will largely come from), about 335,000 new jobs would need to be created annually just to address this new labor supply.

The labor force (the part of the working age population that is either working or looking for work) has been rising at a much slower pace than the adult population, reflecting the falling labor force participation rates for women. Not surprisingly, employment rates for women have been falling in parallel. By 2004, only one in four women aged 15–64 was employed in Turkey. As Turkey has urbanized and families have moved out of agriculture, employment rates for women have fallen significantly. A significant number of women who are not working are not looking for employment, a principal reason for the low labor force participation rates. The differences for men are less significant.

Figure -3: Unemployment rate, 2000-2004.



According to the data by TURKSTAT, the amount of unemployed people was 1.5 million in 2000. After crises of 2001 the unemployed people has reached to 2.5 million at the end of 2004. Unemployment rate increased from 6.5 percent in 2000 to 10.3 percent in 2004. The amount of unemployed people for male in 2000 was 1.1 million and 387 thousand for female. At the end of 2004 this numbers have reached to 1.9 million and 620 thousand respectively. After the year of 2003 the high rapid of unemployment rate has decreased but this was not enough to meet the high number of unemployed people especially for males and urban areas. The number of female unemployed people has started to drop from beginning of 2004. The number of unemployed people has decreased for males in urban areas in 2003 but this situation has returned to over 2002 level in 2004 again. In rural areas unemployed people has started to decrease from 2003 for males. For females the number of unemployed has started to drop form 2003 in urban areas and 2004 in rural areas.

By age group (15-24, 25-44, 45-64 and 65+), the risk of unemployment is highest for the new entrants especially after 25 age. Unemployment rates are especially high for educated young people. Both demand and supply factors are likely to matter. The economy may not be generating jobs that can absorb educated young, but also the educated young may not be well suited to the job market. Older workers appear to find jobs more readily than younger workers, independent of education level. Older workers are dropping out of the labor force. By age 55, participation in the labor market drops considerably in Turkey. An important factor in falling labor force participation by older workers was the elimination of the minimum retirement age in 1993.

By using ANN we can get findings on dynamics of unemployment in labor market in Turkey between 2000 and 2004 period. In this period, the unemployed people data has shown similar results in parallel with the dynamics of unemployment given by TURKSTAT data above.

To reach findings two estimation programs using ANN were developed by Karlık. Each ANN algorithms consist of two different MLP structures, which are 6:7:5 and 3:6:5. Outputs of both structures are same, and show unemployed persons. The inputs of first MLP structures are educational status and gender (Female/Male). The second inputs describe gender, location (Urban/Rural), and age groups. The data has classified by using ANN algorithm as shown Table-1 in below using the second MLP structure.

Table-1: Comparing ANN Test Results with TURKSTAT Values

Inputs			ANN Results					TURKSTAT Values				
M/F	**Groups**	**U/R**	**2000**	**2001**	**2002**	**2003**	**2004**	**2000**	**2001**	**2002**	**2003**	**2004**
Male	1	Urban	305	391	451	432	439	304	387	451	431	432
Male	2	Urban	364	518	679	674	736	368	515	681	679	745
Male	3	Urban	84	130	189	187	180	88	127	188	186	181
Female	1	Urban	178	216	256	245	238	177	224	256	242	244
Female	2	Urban	121	172	247	245	255	123	177	247	245	246
Female	3	Urban	19	25	29	29	21	9	13	16	19	17
Male	1	Rural	183	205	210	220	199	186	210	211	224	204
Male	2	Rural	146	191	247	268	269	133	198	244	261	266
Male	3	Rural	27	33	39	45	33	28	42	47	46	41
Female	1	Rural	76	68	69	84	67	78	41	62	78	63
Female	2	Rural	24	24	26	35	25	39	23	47	64	44
Female	3	Rural	6	6	7	9	6	8	4	8	15	3

Figure 4: Dynamics of unemployment in Turkey using ANN

Figure 2 shows artificial neural network program application results on dynamics of unemployment in Turkey labor market from 2000 to 2004 using first MLP structures.

CONCLUSION

In this study we have reached important findings and results using by ANN on dynamics of labor market in Turkey. First of all, we have founded similar trends by ANN in parallel with the results of TURKSTAT data in Turkish labor market after 2000 especially unemployed people in urban or rural areas and for males or females by age groups. Second, this similarity between ANN and TURKSTAT shows that we can make a forecasting using by ANN on dynamics of unemployment in Turkish labor market in the future. This is a new and developing approach for labor economics studies on Turkish labor market. This application was the first study of expert system on labor market. It can be useful to apply on relative areas of labor market and the other economical problems.

REFERENCES

[1] Gaubert P., Cottrell M., “Neural Network and Segmented Labor Market”, *European Journal of Economic and Social Systems*, 13, 1999, pp.19-39.

[2] Karlık, B., Tokhi, O., Alcı, M., “A Novel Technique for classification of Myoelectric Signals for Prosthesis”, *CD-ROM Proceeding of IFAC’02*, Barcelona, July, 2002.

[3] Lendasse, A., Bodt, E. De, Wertz, V., Verleysen, M., Non-linear financial time series forecasting –Application to the Bel 20 stock market index, *European Journal of Economic and Social Systems* **14** N° 1 (2000) 81-91.

[4] Ozbay, Y., Karlık, B., “A Fast Training Back-Propagation Algorithm on Windows”, Proceedings of the Third International Symposium on Mathematical & Computational Applications, 4-6 September, 2002, Konya, Turkey, pp. 204-210.

[5] Pao, Y. H., Adaptive pattern recognition and neural network. Addison-Wesley, New York, USA, 1989.

[6] Rumelhart, D. E., Hinton, G. E., Williams, R. J., “Learning representations by back-propagating errors”, *Nature*, 323,1986, pp.533-536.

[7] IMF, Turkey Country Economic Memorandum, February 2006
World Bank, Turkey Labor Market Study Report, 2006.

[8] Tall B., Nazareth L., "Artificial Intelligence and Economic Forecasting", *Canadian Business Economics*, 1995, pp. 69-73.

[9] Taymaz E., Ozler Ş., "Labor Market Policies and EU Accession: Problems and Prospects for Turkey", ERC Working Papers in Economic 04/05, March 2004.

[10] Turan, G., Karlık, B., "An Artificial Neural Networks Application on Dynamics of Unemployment in Turkey", *Selected Proceedings of the Second International Conference on Business, Management and Economics,* 13-21, Yasar University , Izmir (2006).