



Economic Performance Measurement Proposal for Turkish Automotive Sector

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Abstract

Automotive sector is one of the locomotive industries for many developed countries. To take an advantage is crucial for each player in this sector. So, performance measurement gets an important role for competitiveness on this market. Paper presents economic performance measurement proposal by using artificial neural network techniques. The study focuses on a comparison of automotive sector developments in Turkey by using both sale units and economic value data. Proposed analyzes would lead a comparable sectorial economic performance measurements. By the way, getting necessary performance comparisons eliminate problems will provide the automotive industry to expand and improve more than its capabilities.

Keywords: Automotive, Economic Performance Measurement, Forecasting, Neural Networks

Introduction

As it has been seen that automotive sector has an important potential when we compare with other emerging sectors. The sector closely linked with marketing, allowing raw materials, spare parts and final products to reach consumers, dealers, service, fuel, finance, and insurance with achieving most important support in the sector, the fact that automotive industry has an impact on other sectors. Today, there is a serious competition on an international scale in the automotive industry. In the past mainly price competition was concerned but today quality, product variety and competition elements are included to price in terms of future investment. As we consider when all type of motor vehicles is used in defense industry, agriculture, transport, infrastructure and construction sectors need are provided by that sector. Therefore, changes in the sector are related to the whole economy. In this content, R&D expenditures get a significant role and improve production rate in sector. Figure 1 represents the general view of sales numbers in sector. It can be seen that there is a clear increase in world automotive sales trend.

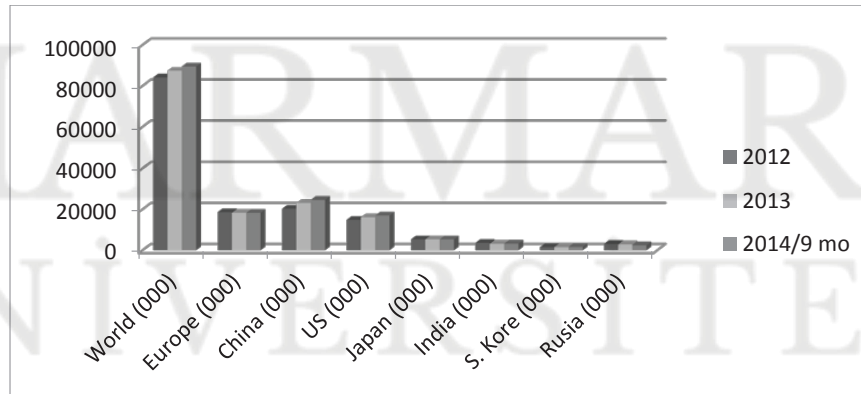


Figure 1. Automotive sector sales numbers

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Growth of export has been realized as a result of including of these facilities in Turkey to the global production plans by the leading manufacturers. In the aim of global and regional sales, a large number of models, which is getting increased day by day, are produced in Turkey while other vehicles which are not manufactured in Turkey are imported. Including of Turkey to the global production planning has been possible with Custom Union agreed with EU and in force since 1996 [1]. To understand the development Turkish automobile industry sales, we can compare sale numbers from 1996 to 2014/10 in Figure 2.

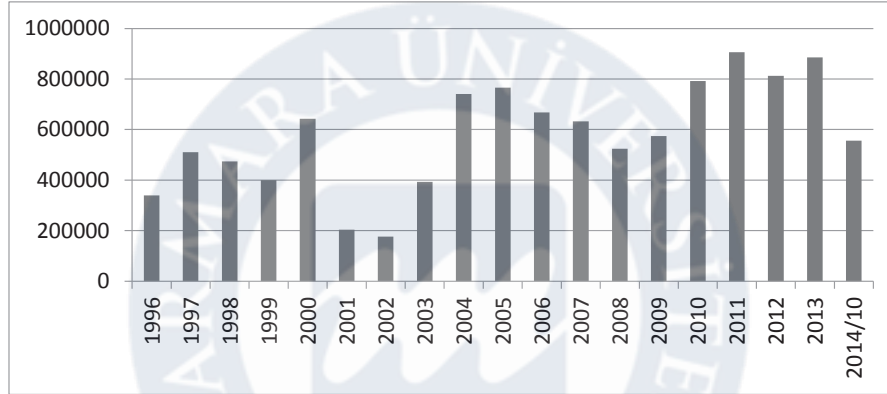


Figure 2. Automotive sector sales numbers, annually

Production index value of Turkish automotive manufacturing sector which had increased steadily until 2008, entered in a downward trend in 2008 and 2009 because of the global crisis, but it has been increasing since the early 2010 to 2014. The projection of the Turkish automotive sector for 2015 is [2];

- 2 Million unit production annually,
- Get a place in top ten in production in the World production,
- Get a place in top three in production in, European Union (EU),
- Get a place in top five in R&D in EU,

For those targets new investments would be needed. To understand reality of this targets this paper applies a comparative forecasting techniques with economic factors for future projections. With a systematic approach paper presents forecasting analysis while considering economic indicators that have effects on economy and automotive sale. A comparison presented base on five European leading automotive countries, sale numbers for last 2 years. (see in, Fig. 3).

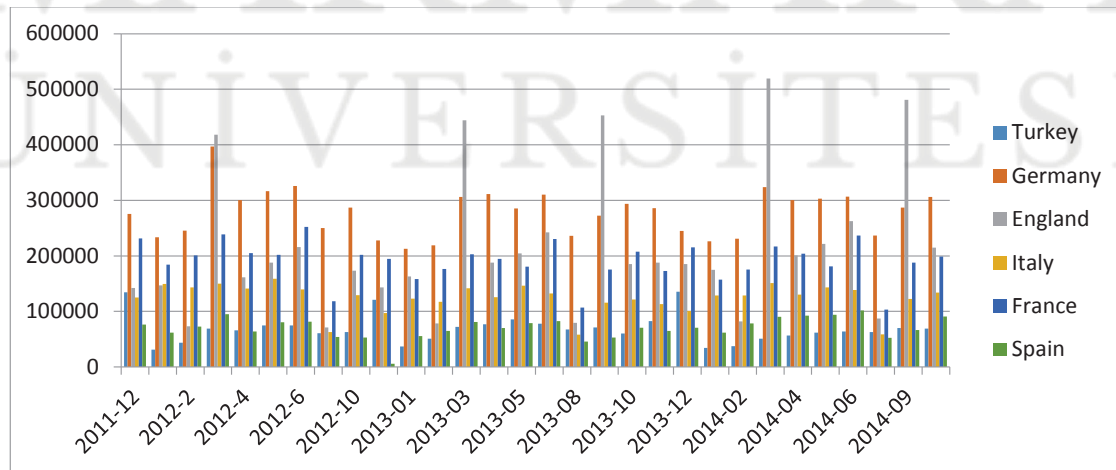


Figure 3. Comparative sale numbers, monthly



To determine future trends the study applies economic performance measurements by using artificial neural networks. Neural networks are a proven, widely used technology for such complex prediction problems. Study continues with literature review about studies on defining economic performance indicators and then next chapter study identifies artificial neural network methodology. At the application chapter we examined collected data to get a conclusion about future trend of Turkey. Finally, comparison and results are discussed in conclusion chapter.

Economic Performance Measurement Criteria

In many industrialized countries, developments in the automotive industry are key significance for overall economic activity. Because of this, there are many studies that have analyzed in depth the dynamics of car sales and make forecasting. In 1994, Jonsson and Agren [3] try to investigate determinates of expected expenditures on automobiles in Sweden. They find that combining car registrations with other economic indicators helps to forecast expenditures on automobile. Pierdzioch, Rulke and Stadtmann [4] accomplish detailed literature review about studies such as relation between automotive sales with economic variables. Those studies concentrate on growth of car ownership as a function of per-capita income and other variables. On the other hand some analyzes have been done about correlation between developments in the automotive industry and macroeconomic variables like exchange rates [4]. Also, Wang et al. [5] used an adaptive network-based fuzzy inference system to estimate new automobile sales in Taiwan with economic indicators.

In literature there are relatively small researches trying to find a link between economic indicators and automotive sales. Bruhl et al. [6] investigated the German automobile market and forecast the sales using economic variables. They used Gross Domestic Product, available personal income, consumer price index, interest rate, unemployment rate, industrial investment demand, petrol prices and private consumption as exogenous parameters. Shahabuddin [7] investigated the USA automotive industry and to forecast automobile sales in the USA, some demographic and economic variables were selected. Data on automobile sales and twelve independent variables such as durable industrial demand, durable personal consumption, population, discount rate, non-durable industrial goods, non-durable personal consumption, GNP, GDP, M1, M2 and M3 were analyzed.

Artificial neural networks

Artificial neural network (ANN) computational modeling technique was inspired by a biological nervous system as in the human brain. It can be employed to model complex physical systems and does not require an explicit mathematical representation. The fundamental processing element of the ANN is a neuron, while weighted connection serves as the synapse. Each neuron receives input through weighted connections (inputs) and these inputs are combined or summed in a specific manner. The formulation for the sum of the weighted inputs is given by

$$n = \sum_{i=1}^R w_i p_i + b \quad (1)$$

where p_i and w_i are the input vector and the connection weight from the input vector p_i , respectively and b is the bias of the neuron [8]. The sum of the weighted inputs with a bias is processed through an activation function, represented by a and the output that it evaluates is

$$a(n) = f(\sum_{i=1}^R w_i p_i + b) \quad (2)$$

The activation function can be defined in many ways such as threshold function, sigmoid function and hyperbolic tangent function [3]. Typically, the architecture of an ANN model is made up of three basic layers namely an input layer, a hidden layer and an output layer.

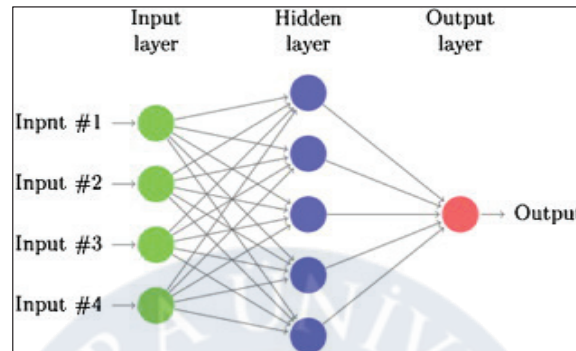


Figure 4. The architecture of the ANN model

The first layer is an input layer with four neurons, the middle layer is a hidden layer consisting of five neurons and the third layer is an output layer with three neurons. The accuracy of the ANN model prediction can be measured using a one-step ahead prediction technique in which the predicted output is compared with the previous input and output data. The one-step ahead prediction is defined as,

$$y_i(t) = f_i(x(t-1), \dots, x(t-n_y), u(t-1), \dots, u(t-n_u)) \quad (3)$$

where $f_i(t)$ is the predicted nonlinear function [3].

The inputs to the ANN model are consumer price index, consumer confidence index, production index, and harmonized unemployment rate. The ANN model is developed through 2 stages: training stage and testing stage. The network is trained to predict an output based on input data during the training stage. To validate the result, the model is tested using difference sets of input. In this study, the computer program was performed NeuroXL Predictor which is a neural network forecasting tool that quickly and accurately solves forecasting, classification and estimation problems in Microsoft Excel.

The ANN approach has applied in many sectors for planning, emulation and management of production processes. For example, Kamar et al., [8] developed ANN system for automotive air-conditioning system for a passenger car with a low error index, Cavalieri et al., [9] studied on estimation of the unitary manufacturing costs of a new type of brake disks produced by an Italian manufacturing firm, Zhang et al. [10] illustrated the use of a neural network-based model for the estimation of the packaging cost, based on the geometrical characteristics of the packaged product.

Economic Performance Measurement with ANN

The Neural model parameters have to be carefully adjusted to improve the accuracy of the predictor. In addition, it is necessary to accomplish a compromise between the accuracy needed and the computing time to suit each specific application. Based on the above parametric study, a suitable ANN model for economic performance measurement system was developed. The properties of the ANN model for the measurement system are tabulated in Table 1. F At the first run of data set gave us Fig. 5 and fourth run program gave us Fig. 6, respectively.

Table 1. Properties of the final ANN model

Structure	Feed forward neural network
Activation Function	Zero-based Log-Sigmoid
Initial weights	0.30
Learning rate	0.30
Momentum	0.60
Epoch	3000
Weight Delta	0.0003884
Minimum weight Delta	0.000001

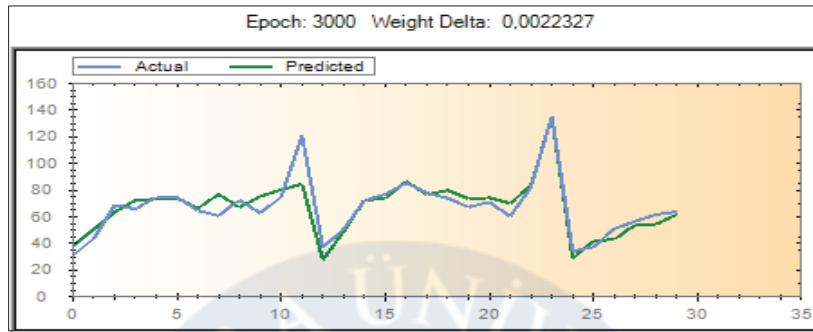


Figure 5. NeuroXL Predictor first learning process

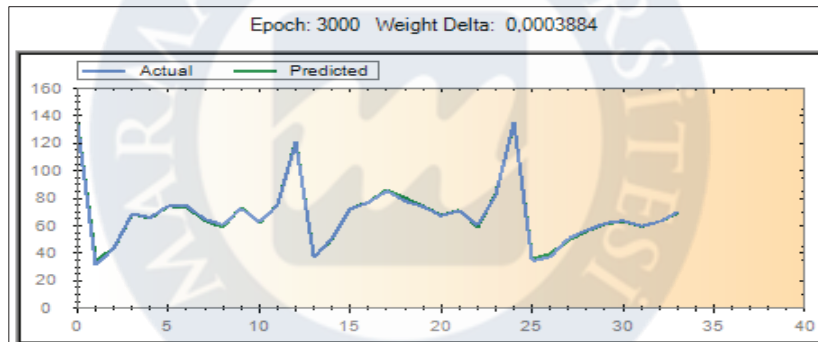


Figure 6. NeuroXL Predictor fourth learning process

Table 1. presents data that used to make a forecast and result of ANN model. As result shows that estimation of economic performance measurement of automotive sector for month November is 69488 automotive units and the real value for October is 69271 units. Model gives as a similar sale values when we compare with actual sale numbers.

Table 1. Data set

	Turkey				
	Mounty Sale Units	Consumer price index	Consumer confidence index	Production index	Harmonized unemployment rate
2011-12	134281	0,60	78,82	120,10	8,20
2012-1	31192	0,60	79,03	104,50	8,10
2012-2	43778	0,60	79,65	102,90	8,20
2012-3	68831	0,40	79,34	115,80	8,20
2012-4	66014	1,50	75,75	110,00	8,10
2012-5	74773	-0,20	78,11	118,20	8,00
2012-6	74781	-0,90	76,76	116,50	7,80
2012-7	64754	-0,20	77,01	116,10	8,00
2012-8	60871	0,60	74,33	103,40	8,00
2012-9	72620	1,00	72,12	116,40	8,20
2012-10	62699	2,00	69,34	112,30	8,10
2012-11	75039	0,40	72,60	121,40	8,30
2012-12	121113	0,40	73,59	116,70	8,50
2013-01	37139	1,60	75,79	106,80	8,50



2013-02	50885	0,30	76,66	104,40	8,40
2013-03	72380	0,70	74,91	116,00	8,50
2013-04	77038	0,40	75,62	115,30	8,60
2013-05	85421	0,10	77,46	120,50	8,70
2013-6	78105	0,80	76,23	120,00	8,70
2013-07	74007	0,30	78,47	122,90	9,00
2013-08	67412	-0,10	77,18	102,10	9,00
2013-09	71037	0,80	72,11	123,90	9,10
2013-10	60406	1,80	75,54	111,70	8,90
2013-11	82474	0,00	77,50	127,00	8,80
2013-12	135596	0,50	74,97	124,80	8,50
2014-01	34288	2,00	72,40	114,40	9,20
2014-02	37502	0,40	69,20	109,20	9,10
2014-03	51062	1,10	72,70	120,90	9,10
2014-04	56741	1,30	78,50	120,50	9,20
2014-05	61866	0,40	76,00	122,60	9,50
2014-06	63826	0,30	73,70	121,90	10,00
2014-07	59907	0,50	73,90	117,20	10,40
2014-08	62837	0,10	73,20	114,90	10,40
2014-09	70143	0,10	74,00	129,40	10,10
2014-10	69488	Forecast units			
2014-10	69271	Actual units			

Calculated October automotive sale value gives us a feedback about seasonal pattern that is followed by ANN model. Hereby, the result has only 217 unit error that could be easily tolerated. In analyze part we collected those economic performance indicators to show influences on economic performance measurement.

Conclusions

An ANN model has been developed in this study to forecast the October sale units of an economic performance measurement. The ANN model contains four nodes. Training and testing data set for the ANN model were obtained from tests. The performance of the ANN model was assessed using the comparison with actual sale units. The ANN model was found to be capable of accurately predicting the economic performance measurement parameters. ANN model can forecast the performance parameters of the model accurately.

Economic performance indicators which are consumer price index, consumer confidence index, production index, harmonized unemployment rate are capable of forecasting automotive sale units. As so, those performance measurement criteria would be used as a prediction data.

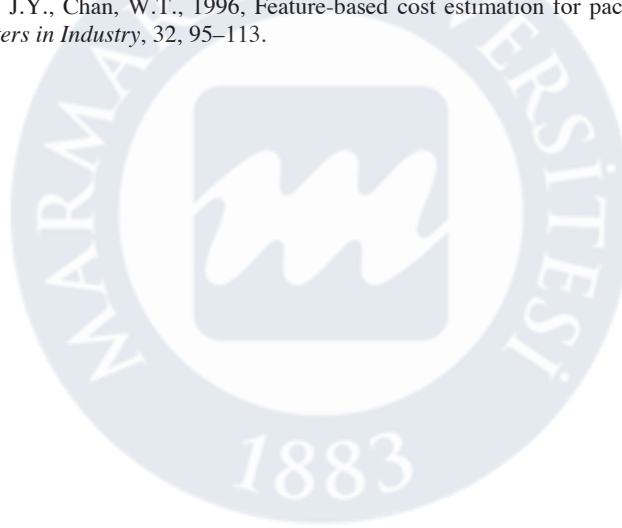
In future studies data set could be used more historical perspective and investigated as more indicators to find any correlation between sale units.

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