


## Chapter 72

# Forecasting Automobile Sales in Turkey with Artificial Neural Networks

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### ABSTRACT

*This study aims to reveal significant factors which affect automobile sales and estimate the automobile sales in Turkey by using Artificial Neural Network (ANN), ARIMA, and time series decomposition techniques. The forecasting model includes automobile sales, automobile price, Euro and Dollar exchange rate, employment rate, consumer confidence index, oil prices and industrial production confidence index, the probability of buying an automobile, female employment rate, general economic situation, the expectation of general economic situation, financial status of households, expectation of financial status of households. According to the regression results, changes in Dollar exchange rate, the expectation of financial status of households, seasonally adjusted industrial production index, logarithmic form of automobile sales before-one-month which have a significant effect on automobile sales, are found to be the significant variables. The results show that ANN has a better estimation performance with MAPE=1.18% and RMSE=782 values than ARIMA and time series decomposition techniques.*

## **INTRODUCTION**

The automotive industry, with a turnover of 4 trillion dollars, corresponds to the world's 4th largest economy by 2016 (TAYSAD, 2017) and 88 million automobiles are sold worldwide in 2016, up to increase 4.8% from a year earlier (PWC, 2017). In the future, the automotive industry will have to transform to produce electrified, autonomous, shared, connected and yearly updated automobiles of the future and through this transformation period, new automobile sales are expected to increase worldwide (PWC, 2017-2018). To adapt this transformation and satisfy the increasing customer demand in the competitive environment, forecasting automobile sales is a critical and challenging issue to deal with. Sales forecasting provides a basis for creating a competitive and effective business strategy. A reasonable sales forecasting satisfies customer demand on time and helps organizations to make better purchasing decisions and to determine optimal inventory level. On the other hand, insufficient sales forecasting causes customer loss and higher number of inventories.

Sales forecasting is a highly important issue to deal with, especially in the production of products like automobile consisting a wide range of parts (more than 20,000 parts) which have different material structure and need different production type and technology. Because of all these reasons, this study aims to reveal significant factors, which affect automobile sales and estimate the automobile sales in Turkey by using Artificial Neural Network (ANN), ARIMA and time series decomposition techniques. The remaining part of the paper is organized as follows: A review of the literature is presented in Section 2. Section 3 discusses the research methodology and in Section 4, results of the study are presented. The article concludes with the findings of the study and suggestions for future research.

## **LITERATURE REVIEW**

Demand forecasting methods are divided into two categories as qualitative and quantitative methods. The qualitative methods like Delphi technique, market research, and expert opinions are subjective methods based on one's thoughts and experience, and they are used in uncertain situations where there are insufficient data. On the other hand, the quantitative methods are used in cases where there are sufficient numerical quantities based on mathematical models (Karaatli et al., 2012). Quantitative methods are divided into two categories as time series (Box-Jenkins method, trend analysis, moving averages, exponential smoothing technique, etc.) and mixed methods (simple and multi-regression, econometric models and artificial intelligence and heuristics (genetic algorithm, support vector machines and artificial neural networks)) (Karaatli et al., 2012).

In the literature, several studies are using different demand forecasting methods to handle demand forecasting problem in the automotive sector. Wang et al. (2011) use an adaptive-network-based fuzzy inference system (ANFIS) to estimate new automobile sales in Taiwan. They use coincident indicators, leading indicators, wholesale price indices, independent indices and exchange rates in their forecasting model. The determinants of these indicators are as follows:

- Coincident indicators: Industrial production index, real customs-cleared exports, the sales of manufacturing, the sales index of wholesale, retail, and food services, real machinery and electrical equipment imports, the employment of non-agricultural, the total power consumption.

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