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# Monthly automobile sales prediction in Turkey

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**Abstract**

Meeting customer needs in a timely manner has a significant impact on customer satisfaction. For this reason, the planning process has successfully influenced the success of sales activities. The crucial point for the success of the planning process depends on the sales forecasts. Sales forecasting estimates the quantity required by the customer needs. It helps in determining sales targets as campaigns, pricing, brand and product communication, and distribution channels are incorporated in the sales forecast. In this paper, we use regression and artificial neural networks to predict automobile sales in Turkey. The performance of regression is compared with that of an artificial neural network, and it is shown which network is able to predict. Thus, the result of the study, automobile sales in Turkey, was predicted and compared with the actual sales for 2020. The result is that the best prediction method will determine the automobile sales in Turkey.

## 1. Introduction

The ability of companies to forecast sales helps them achieve top rankings in their sectors. Therefore, all companies follow different strategies to stay ahead of the competition. Successfully predicting the future of sales not only helps them to improve sales performance but also to manage the business effectively. In addition, it is important to identify early warning signs and risks in the sales pipeline.

There are two primary methods of demand forecasting: qualitative and quantitative. Qualitative methods are generally used for studies based on subjective thoughts and surveys. However, quantitative methods are very suitable for sales forecasting. One of the quantitative methods is regression analysis. This method was selected in this study to determine the relationship between the relevant independent variables. Artificial neural networks are also used to predict sales volume because they are used in too many different fields.

Depending on the method of calculation, there are many methods of regression analysis that are also evaluated. The best method selected to compare with the results is the artificial neural network. At the same time, the collected data were processed using SPSS to find the best method for regression analysis. In addition, some of the independent variables were eliminated because the regression analysis did not affect the results too much. The study continued with six independent variables. The independent variables used in this study are consumer price index, consumer price index (motor vehicle cost), Brent gasoline futures, dollar exchange rate, unit import index, unit export index, industrial production index, economic confidence index, lending rates, deposit rates, total money supply, and unemployment rate.

The choice of artificial neural network analysis method in MATLAB was related to the studies conducted previously. According to recent studies, there is no particular relationship between the number of hidden networks and the results and recommends a heuristic approach. For this reason, different iterations were created with different sets of neurons and a different ratio of validation to testing. All predictions were compared with the actual results, and the iteration with the best error rate was selected.

The datasets were taken from TUIK (Turkish Statistical Institute) and the EVDS system (Turkish Central Bank). They cover the data between January 2009 and December 2020. For each independent variable, the data are taken as the average of the relevant months. In this way, peaks and troughs are eliminated.

In this paper, the best method is determined using linear regression and artificial neural network results. We have chosen linear regression as one of the forecasting methods because of its popularity in recent studies. Moreover, artificial neural networks are widely used in previous studies. When we compared them in terms of the time taken to achieve prediction, linear regression seems to take a fast path to prediction. However, it was expected that ANN could adapt to the nonlinearities in the dataset to outperform linear regression. Therefore, we decided to compare them to see how the errors change. Moreover, the peaks of the error are interpreted to develop a systematic prediction for automobile sales in Turkey.

## 2. Literature Survey

Herrera (2010) addressed the prediction of water consumption and demand in an urban area of a city in southeastern Spain. Their models were built using time series data of water consumption. All the prediction models such as artificial neural networks (ANN), Projection pursuit regression (PPR), Multivariate adaptive regression splines (MARS), Support vector regression (SVR), Random forecast, and Weighted pattern-based model for predicting water demand were evaluated using an experimental methodology, so this study is very important.

Yücesoy (2011), in addition to the identification of artificial neural networks and demand forecasting, an application was also created for this study. It is used to predict the annual sales volume of cleaning paper in Turkey. The data used for this study are from 1981 to 2010, and independent variables are production volume, import volume, the price index of the paper and printing industry, gross domestic product, population, urban population, and literacy rate. In addition, the performance of simple regression, multiple regression, and artificial neural networks is shown. In conclusion, the compared results show that artificial neural networks are an efficient tool for forecasting.

Wu & Liu (2012) in this study, have worked on a car fuel consumption prediction system using radial basis function network and backpropagation neural network. Mainly five kinds of engineering variables affect the fuel consumption used for the calculations. The result of this study is that the proposed neural network system is effective and satisfactory in predicting fuel consumption.

Kılıç (2015), the researcher has worked on the study of predicting the daily food demand in the dining hall of PAU. This study is different from the others in terms of data preparation. The intelligent identity database system recorded all the data. They were processed using SPSS, and the relationship between the data was tested. According to the relationship, the data is divided into two parts with the help of tests & training. Consequently, the researcher obtained better results by artificial intelligence methods.

Akyurt (2017), this study aimed to predict the automobile production values of Turkey in 2023. The input value of the study is the monthly sales figures between January 2011 and September 2015. A feed-forward neural network model trained with a backpropagation algorithm was used to estimate demand for this time series - the performance of the model was measured using MAPE and MSE.

Santoni (2020) aimed to create a neural network trained to predict the occurrence of kidney cancer in the US. Their method chooses three layers for computation and changes the number of neurons of the hidden layer, starting with five and increasing. Mean square normalized error performance and correlation coefficients for linear regression were used to assign a value to learning performance. The results show that the prevention of hypertension has the greatest impact on reducing the incidence of renal cell carcinoma. In contrast, preventing obesity and smoking would have a smaller effect.

Yazıcıoğlu (2010) has also worked with data from the automotive industry, but the main differences are the data range used and the focused data set. In contrast, the searcher focused on predicting the value of automobile production in Turkey. It can also be very useful in helping industrial companies manage their pre-production phases. Another difference is the scope of data in this study. Most studies on these areas show that the data breadth should be as large as possible.

Wang (2011) has dealt with the prediction of automobile sales in Taiwan. The study used several independent variables, such as the current number of automobile sales, coincidence indicator, leading indicator, wholesale price index, and income. The first step of the study is a stepwise regression analysis to determine the main output variables. Then select the variables, input, and output in adaptive network based fuzzy inference system (ANFIS). The third step of the study is to compare this model with two forecasting models: autoregressive integrated moving average model (ARIMA) and artificial neural network (ANN). Finally, better results were obtained with the ANFIS method.

Loureiro (2018) This study investigates the use of a deep learning approach to predict sales in the fashion industry to predict the sales of new individual products in future seasons. Five types of prediction methods are used: Decision Trees, Random Forest, Support Vector Regression, Artificial Neural Networks, and Deep Neural Networks. Also, work to determine the best method. Distinguish this from the other studies by diversifying the independent variables for each method. The result of the study: if $R^2$ is used as a measure of accuracy, Random Forest can be considered the best technique. When the decision is based on error related metrics, Random Forest shares the lead with the deep neural network as each of these techniques gives the best results for two out of four metrics.

This study differs from others, not only in terms of the subject but also in the elimination method used in the regression analysis. The results of backward elimination of irrelevant independent variables were never used for prediction. In addition, related studies primarily focused on predicting production quantity; however, the main objective of this study is to explain the relationship between quantity-based sales and economic indicators. It aimed to see the overall picture of the market.

## 3. Dataset

The source of the data used in this study is shown in Table 1. The data collected from EVDS and TUIK were created as monthly averages, and the data collected from Investing show the first day of the month. The missing cells were calculated using the simple moving average method and filled in yellow in Table 15.

**Table 1.** Variables

| | Independent Variables | Source |
|---|---|---|
| X1 | Consumer Price Index | EVDS |
| X2 | Consumer Price Index (Automobile expenses) | EVDS |
| X3 | Brent Petrol futures | Investing.com |
| X4 | Rates of US Dollars | EVDS |
| X5 | Unit import index | TUIK |
| X6 | Unit export index | TUIK |
| X7 | Industrial production index | EVDS |
| X8 | Economic confidence index | EVDS |
| X9 | Interest rates of loans | EVDS |
| X10 | Interest rates of deposits | EVDS |
| X11 | Total money supply | EVDS |
| X12 | Unemployment rate | EVDS |
| Y1 | Automobile Sales in Turkey | Otomotivanaliz.com |

# 4. Calculations

## 4.1 Regression Analysis

All independent and dependent variables are used in the first step of the regression analysis, as listed in Table 1.

**Table 2.** Variables Entered / Removed

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | X12, X7, X2, X9, X6, X10, X8, X3, X11, X5, X4, X1[b] | . | Enter |

a. Dependent Variable: Y1

b. All requested variables entered.

**Table 3.** Anova

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 19675786590,607 | 12 | 1639648882,551 | 9,360 | ,000[b] |
| | Residual | 22949300526,973 | 131 | 175185500,206 | | |
| | Total | 42625087117,580 | 143 | | | |

a. Dependent Variable: Y1

b. Predictors: (Constant), X12, X7, X2, X9, X6, X10, X8, X3, X11, X5, X4, X1

The regression model with automobile sales as the dependent variable and X1...X12 as the independent variables is shown in Table 2 and the sig. level found below 0.01 ($p < 0.01$) was significant.

**Table 4.** Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | -89880,006 | 67459,432 | | -1,332 | ,185 |
| | X1 | 408,285 | 9501,614 | ,042 | ,043 | ,966 |
| | X2 | -1036,168 | 1138,106 | -,291 | -,910 | ,364 |
| | X3 | 584,649 | 1461,084 | ,130 | ,400 | ,690 |
| | X4 | -131,866 | 118,371 | -,722 | -1,114 | ,267 |
| | X5 | -76,567 | 109,360 | -,425 | -,700 | ,485 |
| | X6 | 158,578 | 1168,062 | ,017 | ,136 | ,892 |
| | X7 | 644,198 | 130,512 | ,736 | 4,936 | ,000 |
| | X8 | -244,332 | 158,726 | -,373 | -1,539 | ,126 |
| | X9 | 471,667 | 260,917 | ,194 | 1,808 | ,073 |
| | X10 | 1,594E-5 | ,000 | ,714 | ,651 | ,516 |
| | X11 | -665,305 | 567,664 | -,437 | -1,172 | ,243 |
| | X12 | 1562,385 | 906,837 | ,686 | 1,723 | ,087 |

a. Dependent Variable: Y1

The coefficients on Table 4 shows that the positive effect of X7 on the dependent variable is significant (B=644.198, $p < 0.01$). In his way, the hypothesis is supported, and the main argument explaining the dependent variable is X7.

**Table 5.** Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | ,679[a] | ,462 | ,412 | 9223,372036854777000 |

a. Predictors: (Constant), X12, X7, X2, X9, X6, X10, X8, X3, X11, X5, X4, X1

Found that the independent variables included in the model explained 41% of the variance in automobile sales. Using the backward elimination method, a reanalysis was performed, eliminating variables that frequently affect the dependent variable. The end of the seven steps shows that the most influential independent variables in the model are X2, X4, X7, X8, X9, and X12.

**Table 6.** Variables Entered / Removed (Backward Elimination)

| Model | Variables Entered | Variables Removed | Method |
|---|---|---|---|
| 1 | X12, X7, X2, X9, X6, X10, X8, X3, X11, X5, X4, X1[b] | . | Enter |
| 2 | . | X1 | Backward (criterion: Probability of F-to-remove >= ,100). |
| 3 | . | X6 | Backward (criterion: Probability of F-to-remove >= ,100). |
| 4 | . | X3 | Backward (criterion: Probability of F-to-remove >= ,100). |
| 5 | . | X5 | Backward (criterion: Probability of F-to-remove >= ,100). |
| 6 | . | X10 | Backward (criterion: Probability of F-to-remove >= ,100). |
| 7 | . | X11 | Backward (criterion: Probability of F-to-remove >= ,100). |

a. Dependent Variable: Y1

b. All requested variables entered.

**Table 7.** Model Summary (Backward Elimination)

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Char |
| 1 | ,679[a] | ,462 | ,412 | 9223,37 | ,462 | 9,360 | 12 | 131 | |
| 2 | ,679[b] | ,462 | ,417 | 9223,37 | ,000 | ,002 | 1 | 131 | |
| 3 | ,679[c] | ,462 | ,421 | 9223,37 | ,000 | ,020 | 1 | 132 | |
| 4 | ,679[d] | ,461 | ,425 | 9223,37 | -,001 | ,164 | 1 | 133 | |
| 5 | ,677[e] | ,459 | ,427 | 9223,37 | -,002 | ,490 | 1 | 134 | |
| 6 | ,676[f] | ,457 | ,429 | 9223,37 | -,001 | ,371 | 1 | 135 | |
| 7 | ,672[g] | ,452 | ,428 | 9223,37 | -,006 | 1,449 | 1 | 136 | |

a. Predictors: (Constant), X12, X7, X2, X9, X6, X10, X8, X3, X11, X5, X4, X1

b. Predictors: (Constant), X12, X7, X2, X9, X6, X10, X8, X3, X11, X5, X4

c. Predictors: (Constant), X12, X7, X2, X9, X10, X8, X3, X11, X5, X4

d. Predictors: (Constant), X12, X7, X2, X9, X10, X8, X11, X5, X4

e. Predictors: (Constant), X12, X7, X2, X9, X10, X8, X11, X4

f. Predictors: (Constant), X12, X7, X2, X9, X8, X11, X4

g. Predictors: (Constant), X12, X7, X2, X9, X8, X4

**Table 8.** ANOVA (Backward Elimination)

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 19675786590,607 | 12 | 1639648882,551 | 9,360 | ,00 |
| | Residual | 22949300526,973 | 131 | 175185500,206 | | |
| | Total | 42625087117,580 | 143 | | | |
| 2 | Regression | 19675463123,871 | 11 | 1788678465,806 | 10,288 | ,00 |
| | Residual | 22949623993,709 | 132 | 173860787,831 | | |
| | Total | 42625087117,580 | 143 | | | |
| 3 | Regression | 19672046376,856 | 10 | 1967204637,686 | 11,399 | ,00 |
| | Residual | 22953040740,724 | 133 | 172579253,690 | | |
| | Total | 42625087117,580 | 143 | | | |
| 4 | Regression | 19643726600,779 | 9 | 2182636288,975 | 12,727 | ,00 |
| | Residual | 22981360516,801 | 134 | 171502690,424 | | |
| | Total | 42625087117,580 | 143 | | | |
| 5 | Regression | 19559618579,500 | 8 | 2444952322,438 | 14,310 | ,00 |
| | Residual | 23065468538,080 | 135 | 170855322,504 | | |
| | Total | 42625087117,580 | 143 | | | |
| 6 | Regression | 19496187574,949 | 7 | 2785169653,564 | 16,377 | ,00 |
| | Residual | 23128899542,631 | 136 | 170065437,813 | | |
| | Total | 42625087117,580 | 143 | | | |
| 7 | Regression | 19249758236,546 | 6 | 3208293039,424 | 18,803 | ,00 |
| | Residual | 23375328881,033 | 137 | 170622838,548 | | |
| | Total | 42625087117,580 | 143 | | | |

a. Dependent Variable: Y1

b. Predictors: (Constant), X12, X7, X2, X9, X6, X10, X8, X3, X11, X5, X4, X1

c. Predictors: (Constant), X12, X7, X2, X9, X6, X10, X8, X3, X11, X5, X4

d. Predictors: (Constant), X12, X7, X2, X9, X10, X8, X3, X11, X5, X4

e. Predictors: (Constant), X12, X7, X2, X9, X10, X8, X11, X5, X4

f. Predictors: (Constant), X12, X7, X2, X9, X10, X8, X11, X4

g. Predictors: (Constant), X12, X7, X2, X9, X8, X11, X4

h. Predictors: (Constant), X12, X7, X2, X9, X8, X4

**Table 9.** Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -89880,006 | 67459,432 | | -1,332 | 0,185 |
| | X1 | 408,285 | 9501,614 | 0,042 | 0,043 | 0,966 |
| | X2 | -1036,168 | 1138,106 | -0,291 | -0,91 | 0,364 |
| | X3 | 584,649 | 1461,084 | 0,13 | 0,4 | 0,69 |
| | X4 | -131,866 | 118,371 | -0,722 | -1,114 | 0,267 |
| | X5 | -76,567 | 109,36 | -0,425 | -0,7 | 0,485 |
| | X6 | 158,578 | 1168,062 | 0,017 | 0,136 | 0,892 |
| | X7 | 644,198 | 130,512 | 0,736 | 4,936 | 0 |
| | X8 | -244,332 | 158,726 | -0,373 | -1,539 | 0,126 |
| | X9 | 471,667 | 260,917 | 0,194 | 1,808 | 0,073 |
| | X10 | 1,59E-05 | 0 | 0,714 | 0,651 | 0,516 |
| | X11 | -665,305 | 567,664 | -0,437 | -1,172 | 0,243 |
| | X12 | 1562,385 | 906,837 | 0,686 | 1,723 | 0,087 |
| 2 | (Constant) | -89000,202 | 64033,698 | | -1,39 | 0,167 |
| | X2 | -1020,691 | 1075,519 | -0,287 | -0,949 | 0,344 |
| | X3 | 584,896 | 1455,538 | 0,13 | 0,402 | 0,688 |
| | X4 | -132,196 | 117,674 | -0,724 | -1,123 | 0,263 |
| | X5 | -75,301 | 104,921 | -0,418 | -0,718 | 0,474 |
| | X6 | 162,601 | 1159,892 | 0,017 | 0,14 | 0,889 |
| | X7 | 642,998 | 127,006 | 0,735 | 5,063 | 0 |
| | X8 | -242,991 | 155,038 | -0,371 | -1,567 | 0,119 |
| | X9 | 471,74 | 259,923 | 0,194 | 1,815 | 0,072 |
| | X10 | 1,67E-05 | 0 | 0,748 | 1,003 | 0,318 |
| | X11 | -656,879 | 530,702 | -0,431 | -1,238 | 0,218 |
| | X12 | 1543,544 | 790,787 | 0,677 | 1,952 | 0,053 |
| 3 | (Constant) | -83801,257 | 52008,267 | | -1,611 | 0,109 |
| | X2 | -1022,514 | 1071,47 | -0,287 | -0,954 | 0,342 |
| | X3 | 587,401 | 1450,055 | 0,131 | 0,405 | 0,686 |
| | X4 | -130,727 | 116,774 | -0,716 | -1,119 | 0,265 |
| | X5 | -74,508 | 104,381 | -0,413 | -0,714 | 0,477 |
| | X7 | 634,704 | 111,967 | 0,725 | 5,669 | 0 |
| | X8 | -243,041 | 154,465 | -0,371 | -1,573 | 0,118 |
| | X9 | 461,703 | 248,944 | 0,19 | 1,855 | 0,066 |
| | X10 | 1,66E-05 | 0 | 0,744 | 1,002 | 0,318 |
| | X11 | -654,294 | 528,424 | -0,43 | -1,238 | 0,218 |
| | X12 | 1519,143 | 768,544 | 0,667 | 1,977 | 0,05 |
| 4 | (Constant) | -86116,972 | 51531,655 | | -1,671 | 0,097 |
| | X2 | -629,39 | 452,73 | -0,177 | -1,39 | 0,167 |
| | X4 | -111,47 | 106,326 | -0,61 | -1,048 | 0,296 |
| | X5 | -72,811 | 103,971 | -0,404 | -0,7 | 0,485 |
| | X7 | 641,377 | 110,403 | 0,733 | 5,809 | 0 |
| | X8 | -248,814 | 153,325 | -0,38 | -1,623 | 0,107 |
| | X9 | 470,168 | 247,29 | 0,194 | 1,901 | 0,059 |
| | X10 | 1,43E-05 | 0 | 0,64 | 0,921 | 0,359 |
| | X11 | -584,799 | 498,239 | -0,384 | -1,174 | 0,243 |
| | X12 | 1441,544 | 741,963 | 0,633 | 1,943 | 0,054 |
| 5 | (Constant) | -86850,487 | 51423,679 | | -1,689 | 0,094 |
| | X2 | -816,815 | 364,461 | -0,23 | -2,241 | 0,027 |
| | X4 | -120,674 | 105,312 | -0,661 | -1,146 | 0,254 |
| | X7 | 634,462 | 109,753 | 0,725 | 5,781 | 0 |
| | X8 | -268,289 | 150,497 | -0,409 | -1,783 | 0,077 |
| | X9 | 441,72 | 243,47 | 0,182 | 1,814 | 0,072 |
| | X10 | 6,97E-06 | 0 | 0,312 | 0,609 | 0,543 |
| | X11 | -593,785 | 497,133 | -0,39 | -1,194 | 0,234 |
| | X12 | 1506,341 | 734,78 | 0,661 | 2,05 | 0,042 |
| 6 | (Constant) | -94422,174 | 49784,137 | | -1,897 | 0,06 |
| | X2 | -915,508 | 325,734 | -0,257 | -2,811 | 0,006 |
| | X4 | -58,504 | 26,004 | -0,32 | -2,25 | 0,026 |
| | X7 | 612,097 | 103,194 | 0,699 | 5,932 | 0 |
| | X8 | -286,055 | 147,304 | -0,437 | -1,942 | 0,054 |
| | X9 | 438,03 | 242,832 | 0,181 | 1,804 | 0,073 |
| | X11 | -597,007 | 495,954 | -0,392 | -1,204 | 0,231 |
| | X12 | 1558,288 | 728,128 | 0,684 | 2,14 | 0,034 |
| 7 | (Constant) | -87892,362 | 49568,756 | | -1,773 | 0,078 |
| | X2 | -975,386 | 322,441 | -0,274 | -3,025 | 0,003 |
| | X4 | -60,376 | 25,999 | -0,331 | -2,322 | 0,022 |
| | X7 | 625,64 | 102,747 | 0,715 | 6,089 | 0 |
| | X8 | -376,042 | 127,134 | -0,574 | -2,958 | 0,004 |
| | X9 | 487,937 | 239,658 | 0,201 | 2,036 | 0,044 |
| | X12 | 935,725 | 513,373 | 0,411 | 1,823 | 0,071 |

. Dependent Variable: Y1

The equation indicating the number of vehicle sales according to the results of the regression analysis using the backward elimination method;
-87893.392 + (X2)*(-975.386) + (X4)*(- 60.376) + (X7)*(625.64) + (X8)*(-376.042) + (X9)*(487.937) + (X12)*(935.725).

## 4.2 Artificial Neural Network

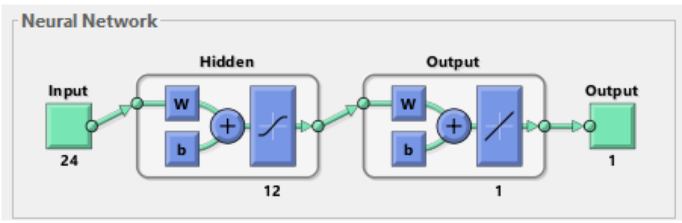
Artificial neural networks are flexible and nonparametric modeling tools. Artificial neural networks are known as a method developed by simulating the brain's cognitive learning process. It is very effective in complex problems. It can find solutions to many problems such as estimation, classification, clustering. The most important property of neural networks is that they can solve the problem by learning based on the past knowledge of complex systems by example.

Artificial neural networks consist of simple elements connected in parallel. These elements have a similar structure to the biological nervous system. The large-scale connections between these elements make up the function of the network. By adjusting the weighting values with which the elements are connected, the network is trained to perform a particular function. In this way, a net output is produced in response to a given input.

With the help of artificial neural networks, many problems can be solved. Different network structures are used to solve each problem. Which network is more suitable for which decision maker is determined by the nature of the problem. In this study, the Multilayer Perceptron Model (MPM) was used because this network structure is commonly used, especially in problems such as classification and estimation.

The MPM was developed by Rumelhart et al. in 1986. This model is also known as the error propagation model or backpropagation network. The backpropagation algorithm is used in the MPM. This algorithm is a robust learning algorithm used in artificial neural networks with middleware. This algorithm allows artificial neural networks to be used to learn the relationship between complex, nonlinear, and process parameters. Artificial neurons, created by mimicking the biological neuron, assemble to form the artificial neural network in Figure 1. These layers are input, output, and intermediate layers. The input layer receives the external information and passes it to the intermediate layer - the information processed in the intermediate layer is sent to the output layer.

**Figure 1.** Neural Network




The output layer receives the output generated for the pattern set presented by the input layer. It facilitates the learning process by classifying the data into itself. The weights of the network should be adjusted to get the correct output in the learning process. The learning rule of the MPM network is a generalization of the delta learning rule based on the least squares method. Therefore, the learning rule is also called as "generalized delta rule". The "delta rule" used in the backpropagation algorithm is a rule based on the idea of constantly adjusting and improving the input connections, i.e., weights, to reduce the difference between the actual output value of a neuron and the desired output value.

In this rule, the optimal value for the weights is found by constantly changing the connection weights during learning. In this network structure, the method of "instructive learning" is used. Each vector associated with the target output values is presented to the network for learning in instructive learning. The weights are corrected based on the established learning rule.

According to previous studies, we preferred to iterate because there is no linear relationship between the number of hidden neurons and the error. The iteration table is as follows Table 10.

**Table 10.** Iterations

| | Hidden neurons | Training | Validations | Testing |
|---|---|---|---|---|
| 1 | 4 | 60 | 20 | 20 |
| 2 | 8 | 60 | 20 | 20 |
| 3 | 12 | 60 | 20 | 20 |
| 4 | 16 | 60 | 20 | 20 |
| 5 | 4 | 70 | 15 | 15 |
| 6 | 8 | 70 | 15 | 15 |
| 7 | 12 | 70 | 15 | 15 |
| 8 | 16 | 70 | 15 | 15 |
| 9 | 4 | 80 | 10 | 10 |
| 10 | 8 | 80 | 10 | 10 |
| 11 | 12 | 80 | 10 | 10 |
| 12 | 16 | 80 | 10 | 10 |
| 13 | 12 | 65 | 15 | 20 |
| 14 | 12 | 65 | 20 | 15 |

## 5. Results and comparison

When the linear regression analysis was estimated using the backward elimination method with the coefficients from Table 9, the error rate was 16.41%. Then, the error rate was recalculated with all iteration results, and the improvements in the estimates were examined using the linear regression method. In the 13th iteration, 12 hidden neurons were used. The distributions of the training, validation and test data were 65-15-20, respectively. Compared with the linear regression method, the lowest error rate and the most significant improvement were obtained.

Moreover, the success rates in the 13th iteration with 11 internal iterations with the best results can be seen in Table 11-12-13-14.

**Table 11.** Results of Iterations

| | Hidden neurons | Training | Validations | Testing | Error | Improvement |
|---|---|---|---|---|---|---|
| 1 | 4 | 60 | 20 | 20 | 17,89% | -1,48% |
| 2 | 8 | 60 | 20 | 20 | 15,75% | 0,66% |
| 3 | 12 | 60 | 20 | 20 | 19,15% | -2,74% |
| 4 | 16 | 60 | 20 | 20 | 23,60% | -7,19% |
| 5 | 4 | 70 | 15 | 15 | 28,35% | -11,94% |
| 6 | 8 | 70 | 15 | 15 | 24,04% | -7,63% |
| 7 | 12 | 70 | 15 | 15 | 12,58% | 3,83% |
| 8 | 16 | 70 | 15 | 15 | 38,65% | -22,24% |
| 9 | 4 | 80 | 10 | 10 | 25,66% | -9,25% |
| 10 | 8 | 80 | 10 | 10 | 25,87% | -9,46% |
| 11 | 12 | 80 | 10 | 10 | 20,62% | -4,21% |
| 12 | 16 | 80 | 10 | 10 | 12,95% | 3,46% |
| 13 | 12 | 65 | 15 | 20 | 12,05% | 4,36% |
| 14 | 12 | 65 | 20 | 15 | 14,64% | 1,77% |
| Lineer Regression | - | - | - | - | 16,41% | |

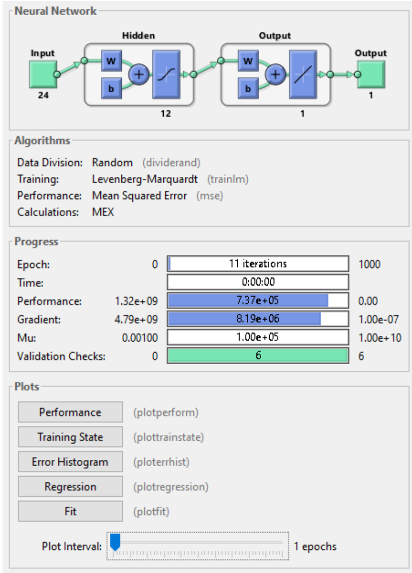



**Figure 2.** Calculation parameters

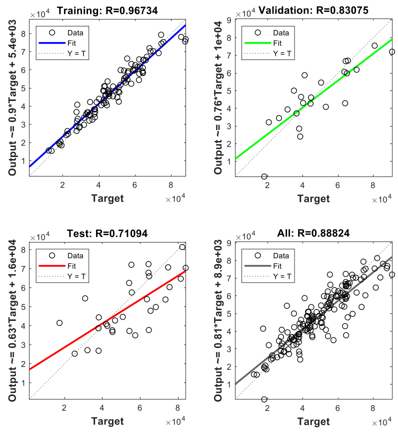



**Figure 3.** Distiribution of improved result

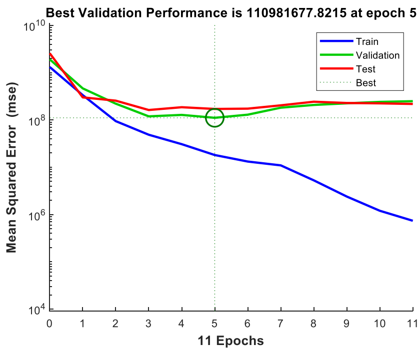



**Figure 4.** Best Validation Performance

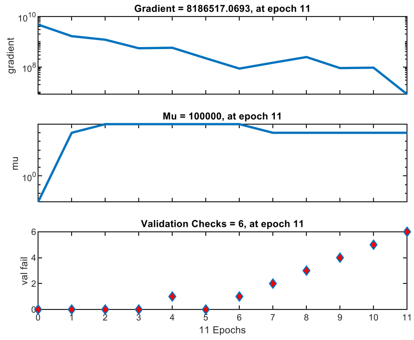



**Figure 5.** Gradient/Mu/Validation Checks

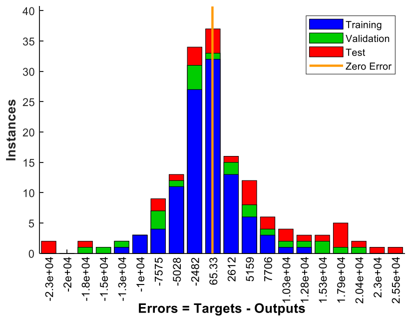



**Figure 6.** Error Histogram with 20 Bins

## 6. Discussion

The first estimate of ODD for 2021, which conducts the most detailed research on the automotive industry in Turkey, was published in September 2020. With the data announced after this estimate, the estimate made with the September 2020 data using the Ann method is shown in Table 12 below. As shown in the table, the absolute error rate of ODD in the first eight months estimate was 28.28%, while the absolute error rate in the Ann method used in this study was 5.4%.
For both estimates, the highest error rate was found in March. As the source of this error, the volatility of the dollar exchange rate, the dependent variable that has the most significant effect on the independent variable, was further examined in the regression analysis. It was found that March was the month with the highest USD/TRY volatility at 17.63%. Moreover, in 2012, when the error rate was the lowest, it was found that the volatility was the lowest among the 20-year data, and the relationship between the two factors was confirmed.
Therefore, it is expected that the success of this study will increase in future studies when the estimation of USD/TRY rate is also investigated, and the estimation is improved in this direction.

**Table12.** Comparision of Estimations

| | | | | Error (Monthly) | |
|---|---|---|---|---|---|
| | ODD Pred. By Sep '20 | Ann Pred. By Sep '20 | TUIK - 2021 | ODD | Ann |
| Jan | 27702 | 105186 | 97198 | -71,5% | 8,2% |
| Feb | 37217 | 54211 | 54574 | -31,8% | -0,7% |
| Mar | 57283 | 60517 | 98306 | -41,7% | -38,4% |
| Apr | 62065 | 63938 | 70182 | -11,6% | -8,9% |
| May | 55228 | 65476 | 48166 | 14,7% | 35,9% |
| Jun | 65139 | 52304 | 63703 | 2,3% | -17,9% |
| Jul | 58312 | 74718 | 81399 | -28,4% | -8,2% |
| Aug | 48513 | 66384 | 60201 | -19,4% | 10,3% |
| Sep | 58890 | 56046 | | | |
| Oct | 64651 | 58353 | | | |
| Nov | 76574 | 65370 | | | |
| Dec | 119926 | 56447 | | | |
| Aug YTD | 411459 | 542734 | 573729 | | |
| Error (Aug YTD) | -28,28% | -5,40% | | | |

ODD: Automotive Distributors Association
TUIK: Statistical Institute of Turkey


**Figure 7.** USD/TRY Exchange Rate

## 7. Conclusion

It was observed that the estimation ability increased with the increase in the number of hidden neurons. However, beyond a certain point, the increase in this number began to affect the prediction. In particular, as can be seen in the 13th and 14th iterations, the test rate was slightly higher than the validation rate, which had a significant impact on the prediction success. Since the error rate increases rapidly as the training rate increases, diversifying the iterations with the information obtained from this study will allow the system to make more accurate estimates.
As a continuation of this study, by automating the flow of data and transferring all results into the system BI, creating dashboards, and controlling the data, management decision making is greatly facilitated.
Moreover, the success of the system is enhanced by periodically re-questioning the independent variables identified and working with new independent variables according to the changing trend.

## Contribution of researchers

Authors have equal contribution in all the sections.

## Conflicts of interest

The authors declared that there is no conflict of interest.

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**Table 13.** Data Set (2009-01/2012-12)

| Tarih | X1 | X2 | X3 | X4 | X5 | X6 | X7 | X8 | X9 | X10 | X11 | X12 | Y1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2009-01 | 1,59 | 21,65 | 15,67 | 160,90 | 109,32 | 14,10 | 52,52 | 45,88 | 65,57 | 460587164,80 | 92,42 | 95,13 | 27391 |
| 2009-02 | 1,65 | 20,88 | 13,03 | 160,35 | 111,74 | 14,80 | 50,45 | 46,35 | 69,00 | 470279207,50 | 90,63 | 90,94 | 12126 |
| 2009-03 | 1,70 | 20,07 | 12,00 | 162,12 | 104,82 | 14,70 | 56,90 | 49,23 | 71,44 | 473549882,20 | 90,17 | 89,84 | 31679 |
| 2009-04 | 1,60 | 18,63 | 11,74 | 162,15 | 99,75 | 13,80 | 57,79 | 50,80 | 85,54 | 467303012,95 | 89,61 | 91,67 | 34884 |
| 2009-05 | 1,55 | 18,33 | 11,33 | 163,19 | 100,90 | 12,70 | 61,00 | 65,52 | 84,97 | 471327888,90 | 86,36 | 93,78 | 38006 |
| 2009-06 | 1,54 | 18,24 | 11,34 | 163,37 | 104,82 | 12,20 | 65,20 | 69,30 | 86,67 | 475738436,00 | 89,46 | 96,38 | 41216 |
| 2009-07 | 1,51 | 18,22 | 11,03 | 163,78 | 107,37 | 12,10 | 65,79 | 71,70 | 87,45 | 477200014,20 | 90,15 | 97,12 | 13728 |
| 2009-08 | 1,48 | 16,89 | 9,97 | 163,29 | 107,99 | 12,60 | 61,84 | 69,65 | 86,46 | 482703790,70 | 92,27 | 98,64 | 25362 |
| 2009-09 | 1,49 | 15,67 | 9,17 | 163,93 | 108,13 | 12,50 | 61,49 | 69,07 | 85,61 | 493154743,40 | 93,34 | 100,20 | 31699 |
| 2009-10 | 1,46 | 15,02 | 8,46 | 167,88 | 113,70 | 12,20 | 69,97 | 75,20 | 85,21 | 498127945,60 | 96,94 | 101,48 | 29043 |
| 2009-11 | 1,48 | 14,07 | 8,08 | 170,01 | 115,19 | 12,20 | 63,65 | 78,47 | 84,48 | 510997266,80 | 98,68 | 103,32 | 17363 |
| 2009-12 | 1,50 | 13,13 | 8,39 | 170,91 | 113,19 | 12,60 | 69,58 | 77,93 | 85,68 | 519002519,78 | 97,39 | 102,19 | 22842 |
| 2010-01 | 1,47 | 13,18 | 8,18 | 174,07 | 115,11 | 13,60 | 56,84 | 71,46 | 90,22 | 518304595,80 | 97,83 | 100,93 | 44988 |
| 2010-02 | 1,51 | 13,27 | 7,95 | 176,59 | 115,06 | 13,50 | 57,51 | 77,59 | 89,80 | 527424195,80 | 97,83 | 98,62 | 21887 |
| 2010-03 | 1,53 | 12,73 | 8,17 | 177,62 | 115,63 | 12,80 | 68,08 | 82,70 | 94,07 | 534197571,10 | 98,53 | 98,69 | 27523 |
| 2010-04 | 1,49 | 12,01 | 8,15 | 178,68 | 115,92 | 11,30 | 66,12 | 87,44 | 98,02 | 532706354,60 | 100,66 | 99,68 | 38114 |
| 2010-05 | 1,53 | 11,74 | 8,42 | 178,04 | 116,20 | 10,30 | 69,05 | 74,65 | 95,02 | 541863016,50 | 98,98 | 97,91 | 34581 |
| 2010-06 | 1,57 | 11,75 | 8,62 | 177,04 | 115,53 | 9,90 | 72,17 | 75,01 | 95,38 | 557691010,30 | 96,66 | 96,14 | 32789 |
| 2010-07 | 1,54 | 11,38 | 8,38 | 176,19 | 115,86 | 9,90 | 72,69 | 78,18 | 95,41 | 558998046,80 | 97,03 | 98,79 | 34895 |
| 2010-08 | 1,50 | 10,87 | 8,19 | 176,90 | 115,50 | 10,60 | 70,04 | 74,64 | 96,60 | 562595448,50 | 98,41 | 98,15 | 57371 |
| 2010-09 | 1,49 | 10,79 | 8,13 | 179,07 | 114,82 | 10,60 | 67,70 | 82,31 | 99,04 | 571710763,60 | 99,51 | 99,45 | 38459 |
| 2010-10 | 1,42 | 10,60 | 7,98 | 182,35 | 115,23 | 10,50 | 77,30 | 83,15 | 98,15 | 578725018,70 | 104,43 | 103,66 | 45242 |
| 2010-11 | 1,43 | 10,26 | 8,07 | 182,40 | 114,34 | 10,20 | 70,03 | 85,92 | 100,17 | 586342271,50 | 105,19 | 104,11 | 49096 |
| 2010-12 | 1,51 | 9,67 | 7,93 | 181,85 | 112,91 | 10,60 | 85,12 | 94,75 | 101,14 | 615442813,06 | 104,94 | 103,89 | 50103 |
| 2011-01 | 1,55 | 10,28 | 7,30 | 182,60 | 114,60 | 11,10 | 70,72 | 101,01 | 104,80 | 615214329,63 | 107,67 | 106,98 | 90685 |
| 2011-02 | 1,58 | 10,44 | 7,41 | 183,93 | 118,84 | 10,70 | 68,54 | 111,80 | 103,09 | 630657604,98 | 110,71 | 109,46 | 34627 |
| 2011-03 | 1,57 | 10,51 | 7,60 | 184,70 | 119,99 | 10,10 | 79,03 | 117,36 | 102,54 | 643048030,00 | 113,52 | 111,74 | 50775 |
| 2011-04 | 1,52 | 10,69 | 7,84 | 186,30 | 121,66 | 9,30 | 76,03 | 125,89 | 102,23 | 648847488,80 | 117,49 | 114,58 | 50361 |
| 2011-05 | 1,56 | 10,95 | 8,09 | 190,81 | 121,96 | 8,90 | 79,55 | 116,73 | 102,42 | 663763929,92 | 116,83 | 114,02 | 55731 |
| 2011-06 | 1,59 | 11,37 | 8,34 | 188,08 | 122,75 | 8,70 | 82,98 | 112,48 | 103,33 | 673338087,56 | 116,68 | 114,66 | 42620 |
| 2011-07 | 1,65 | 12,48 | 8,69 | 187,31 | 122,77 | 8,60 | 81,88 | 116,74 | 101,96 | 682778896,31 | 116,88 | 114,72 | 59196 |
| 2011-08 | 1,74 | 12,82 | 8,49 | 188,67 | 125,79 | 8,50 | 78,88 | 114,85 | 99,07 | 696129835,29 | 118,70 | 113,52 | 42724 |
| 2011-09 | 1,79 | 12,98 | 8,17 | 190,09 | 129,67 | 8,20 | 80,91 | 102,76 | 101,94 | 698058557,57 | 116,29 | 110,71 | 37919 |
| 2011-10 | 1,83 | 12,97 | 8,17 | 196,31 | 130,95 | 8,40 | 89,86 | 109,56 | 97,47 | 691402320,37 | 116,30 | 109,28 | 43639 |
| 2011-11 | 1,80 | 13,42 | 8,70 | 199,70 | 130,49 | 8,40 | 80,14 | 110,52 | 98,68 | 695623224,03 | 114,74 | 109,51 | 45550 |
| 2011-12 | 1,86 | 12,02 | 9,71 | 200,85 | 130,35 | 9,00 | 92,09 | 107,38 | 98,60 | 708766659,76 | 112,86 | 108,25 | 38958 |
| 2012-01 | 1,84 | 15,04 | 10,03 | 201,98 | 132,71 | 9,30 | 74,98 | 110,98 | 92,50 | 695782874,10 | 110,98 | 108,24 | 74749 |
| 2012-02 | 1,75 | 14,82 | 10,00 | 203,12 | 132,40 | 9,60 | 73,39 | 122,66 | 93,80 | 699951645,01 | 112,66 | 109,75 | 27576 |
| 2012-03 | 1,78 | 13,39 | 9,72 | 203,96 | 131,80 | 9,10 | 83,77 | 122,88 | 93,19 | 709526905,63 | 114,57 | 109,34 | 44347 |
| 2012-04 | 1,78 | 13,17 | 9,73 | 207,05 | 132,34 | 8,20 | 80,30 | 119,47 | 88,71 | 714190305,85 | 115,21 | 109,24 | 42372 |
| 2012-05 | 1,80 | 12,99 | 9,98 | 206,61 | 132,32 | 7,60 | 86,81 | 101,87 | 91,93 | 723723921,82 | 112,56 | 107,60 | 50904 |
| 2012-06 | 1,82 | 12,99 | 10,27 | 204,76 | 132,39 | 7,30 | 86,15 | 97,80 | 91,42 | 735844371,18 | 110,31 | 106,47 | 37848 |
| 2012-07 | 1,80 | 13,38 | 9,81 | 204,29 | 132,32 | 7,60 | 85,43 | 104,92 | 92,50 | 737187297,51 | 108,78 | 106,86 | 56119 |
| 2012-08 | 1,79 | 13,38 | 9,21 | 205,43 | 132,23 | 8,00 | 76,45 | 114,57 | 90,28 | 746358754,20 | 109,72 | 107,73 | 44626 |
| 2012-09 | 1,80 | 13,00 | 8,52 | 207,55 | 131,31 | 8,30 | 87,10 | 112,39 | 89,02 | 759423992,30 | 111,85 | 108,75 | 40021 |
| 2012-10 | 1,79 | 12,77 | 7,94 | 211,62 | 131,36 | 8,30 | 84,84 | 108,70 | 84,87 | 766222192,64 | 111,88 | 108,92 | 46708 |
| 2012-11 | 1,79 | 12,07 | 7,64 | 212,42 | 130,25 | 8,60 | 91,38 | 111,23 | 89,88 | 764900065,75 | 111,70 | 108,20 | 51959 |
| 2012-12 | 1,78 | 11,01 | 7,51 | 213,23 | 129,92 | 9,30 | 91,67 | 111,11 | 89,07 | 783455076,71 | 112,69 | 109,83 | 42015 |

**Table 14.** Data Set (2013-01/2018-12)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2013-01 | 1,76 | 11,06 | 7,17 | 216,74 | 130,62 | 9,70 | 78,18 | 115,55 | 91,52 | 786170788,19 | 111,89 | 110,80 | 74538 |
| 2013-02 | 1,77 | 10,91 | 6,87 | 217,39 | 133,56 | 9,70 | 77,04 | 111,38 | 91,76 | 794838821,03 | 114,00 | 111,03 | 33957 |
| 2013-03 | 1,81 | 10,48 | 6,55 | 218,83 | 133,85 | 9,40 | 85,94 | 110,02 | 92,06 | 806033273,52 | 111,99 | 109,29 | 50790 |
| 2013-04 | 1,80 | 10,30 | 6,41 | 219,75 | 134,00 | 8,70 | 87,08 | 102,37 | 92,71 | 814526896,79 | 111,09 | 108,36 | 54717 |
| 2013-05 | 1,82 | 9,88 | 5,95 | 220,07 | 134,70 | 8,20 | 91,88 | 100,39 | 95,53 | 835241603,74 | 109,33 | 108,12 | 75505 |
| 2013-06 | 1,89 | 9,61 | 6,14 | 221,75 | 134,85 | 8,10 | 91,22 | 102,16 | 94,70 | 849475857,57 | 108,80 | 108,60 | 27951 |
| 2013-07 | 1,93 | 10,10 | 6,95 | 222,44 | 138,11 | 8,60 | 93,69 | 107,70 | 96,54 | 870469348,87 | 107,53 | 107,53 | 75620 |
| 2013-08 | 1,95 | 10,60 | 7,56 | 222,21 | 139,20 | 9,00 | 77,59 | 114,01 | 95,29 | 889675766,98 | 108,89 | 108,16 | 47741 |
| 2013-09 | 2,02 | 11,46 | 7,99 | 223,91 | 142,30 | 9,20 | 96,31 | 108,37 | 91,43 | 903561042,43 | 108,83 | 107,44 | 51276 |
| 2013-10 | 1,99 | 11,81 | 7,78 | 227,94 | 144,18 | 9,10 | 87,73 | 108,84 | 93,34 | 909555599,18 | 110,36 | 107,47 | 44319 |
| 2013-11 | 2,02 | 11,28 | 7,58 | 227,96 | 143,45 | 9,30 | 100,39 | 109,69 | 96,78 | 918359122,88 | 108,80 | 107,46 | 60040 |
| 2013-12 | 2,06 | 10,99 | 7,87 | 229,01 | 143,25 | 9,60 | 100,92 | 110,80 | 94,16 | 948561344,63 | 110,16 | 108,16 | 51840 |
| 2014-01 | 2,22 | 12,84 | 8,20 | 233,54 | 151,68 | 10,30 | 87,54 | 106,40 | 91,54 | 965478573,89 | 108,86 | 109,25 | 80785 |
| 2014-02 | 2,21 | 15,09 | 9,98 | 234,54 | 161,10 | 10,20 | 83,36 | 109,07 | 89,21 | 964416666,72 | 109,62 | 108,26 | 27807 |
| 2014-03 | 2,22 | 15,21 | 10,62 | 237,18 | 166,94 | 9,70 | 93,89 | 107,76 | 92,43 | 965242047,59 | 110,24 | 107,58 | 35050 |
| 2014-04 | 2,13 | 14,91 | 10,43 | 240,37 | 167,83 | 9,00 | 92,89 | 108,07 | 97,37 | 970058514,76 | 109,48 | 107,95 | 40128 |
| 2014-05 | 2,09 | 14,29 | 9,96 | 241,32 | 166,66 | 8,80 | 94,26 | 109,41 | 95,11 | 966337733,23 | 107,99 | 108,02 | 42924 |
| 2014-06 | 2,12 | 13,31 | 9,58 | 242,07 | 164,96 | 9,10 | 95,71 | 112,36 | 93,50 | 985377927,18 | 108,48 | 108,71 | 37497 |
| 2014-07 | 2,12 | 12,79 | 8,92 | 243,17 | 164,87 | 9,80 | 90,64 | 106,02 | 93,73 | 1009206293,71 | 108,17 | 109,52 | 62284 |
| 2014-08 | 2,16 | 12,84 | 8,53 | 243,40 | 164,79 | 10,10 | 89,34 | 103,19 | 93,65 | 1014270568,80 | 107,43 | 107,31 | 43463 |
| 2014-09 | 2,20 | 12,72 | 8,60 | 243,74 | 164,83 | 10,50 | 102,30 | 94,67 | 94,02 | 1038568395,68 | 105,69 | 105,50 | 45649 |
| 2014-10 | 2,26 | 12,37 | 8,76 | 248,37 | 164,74 | 10,40 | 92,38 | 85,86 | 91,43 | 1028803573,71 | 103,90 | 104,84 | 50974 |
| 2014-11 | 2,23 | 12,38 | 8,91 | 248,82 | 163,84 | 10,70 | 100,09 | 70,15 | 90,87 | 1032143736,29 | 103,05 | 104,12 | 55343 |
| 2014-12 | 2,29 | 12,60 | 9,15 | 247,72 | 162,89 | 10,90 | 108,50 | 57,33 | 90,15 | 1060136918,03 | 100,78 | 103,13 | 57916 |
| 2015-01 | 2,33 | 12,91 | 9,15 | 250,45 | 166,79 | 11,30 | 86,73 | 52,99 | 89,35 | 1069329669,30 | 96,26 | 101,67 | 87689 |
| 2015-02 | 2,46 | 13,06 | 9,03 | 252,24 | 170,74 | 11,20 | 84,18 | 62,58 | 88,80 | 1095353011,66 | 95,23 | 100,24 | 37327 |
| 2015-03 | 2,58 | 12,58 | 9,26 | 255,23 | 171,23 | 10,60 | 99,67 | 55,11 | 86,49 | 1117361798,61 | 93,96 | 97,91 | 60013 |
| 2015-04 | 2,65 | 12,79 | 9,49 | 259,39 | 171,46 | 9,60 | 99,26 | 66,78 | 87,42 | 1144509086,80 | 92,66 | 97,64 | 68259 |
| 2015-05 | 2,65 | 13,14 | 9,62 | 260,85 | 173,65 | 9,30 | 98,83 | 65,56 | 86,80 | 1155360991,42 | 92,57 | 98,93 | 61335 |
| 2015-06 | 2,70 | 13,44 | 9,78 | 259,51 | 174,15 | 9,60 | 104,51 | 63,59 | 89,63 | 1165738112,40 | 92,23 | 98,44 | 47768 |
| 2015-07 | 2,69 | 13,60 | 9,94 | 259,74 | 176,27 | 9,80 | 95,08 | 52,21 | 88,24 | 1196001711,60 | 90,39 | 97,37 | 85525 |
| 2015-08 | 2,85 | 14,14 | 10,11 | 260,78 | 176,90 | 10,10 | 101,57 | 54,15 | 85,20 | 1219438469,62 | 88,74 | 95,67 | 62114 |
| 2015-09 | 3,00 | 15,20 | 10,34 | 263,11 | 183,80 | 10,30 | 97,06 | 48,37 | 82,15 | 1250247051,98 | 86,68 | 94,95 | 45627 |
| 2015-10 | 2,93 | 15,82 | 10,56 | 267,20 | 187,45 | 10,50 | 108,69 | 49,56 | 86,04 | 1233926306,11 | 86,41 | 93,94 | 44740 |
| 2015-11 | 2,87 | 15,62 | 10,45 | 268,98 | 186,92 | 10,50 | 107,49 | 44,61 | 95,15 | 1223676554,60 | 85,21 | 91,91 | 55596 |
| 2015-12 | 2,92 | 15,18 | 10,70 | 269,54 | 185,87 | 10,80 | 116,93 | 37,28 | 93,34 | 1232282824,94 | 83,58 | 91,90 | 81423 |
| 2016-01 | 3,01 | 15,82 | 10,85 | 274,44 | 188,76 | 11,10 | 91,33 | 34,74 | 91,95 | 1242984422,28 | 79,80 | 90,90 | 67922 |
| 2016-02 | 2,94 | 16,32 | 11,02 | 274,38 | 194,28 | 10,90 | 95,81 | 35,97 | 89,68 | 1251375149,27 | 79,81 | 91,62 | 38656 |
| 2016-03 | 2,89 | 16,33 | 11,01 | 274,27 | 194,79 | 10,10 | 106,41 | 39,60 | 89,87 | 1264541021,41 | 80,53 | 91,67 | 59168 |
| 2016-04 | 2,83 | 15,92 | 10,81 | 276,42 | 194,82 | 9,30 | 102,69 | 48,13 | 91,25 | 1268602052,89 | 80,86 | 92,70 | 63985 |
| 2016-05 | 2,93 | 15,54 | 10,50 | 278,02 | 195,09 | 9,40 | 107,11 | 49,69 | 91,70 | 1294245139,14 | 82,68 | 93,07 | 70521 |
| 2016-06 | 2,92 | 15,30 | 10,25 | 279,33 | 197,42 | 10,20 | 107,37 | 49,68 | 92,01 | 1305663140,39 | 83,57 | 93,36 | 73343 |
| 2016-07 | 2,96 | 15,31 | 9,95 | 282,58 | 197,36 | 10,70 | 86,90 | 42,46 | 89,66 | 1328208050,57 | 82,64 | 93,01 | 54143 |
| 2016-08 | 2,96 | 15,45 | 9,93 | 281,76 | 199,71 | 11,30 | 105,49 | 47,04 | 95,17 | 1327789036,34 | 82,48 | 93,26 | 53937 |
| 2016-09 | 2,96 | 15,01 | 9,88 | 282,27 | 200,23 | 11,30 | 93,47 | 49,06 | 94,78 | 1346519410,42 | 82,52 | 93,03 | 45347 |
| 2016-10 | 3,07 | 14,74 | 9,79 | 286,33 | 202,96 | 11,80 | 113,01 | 48,30 | 95,02 | 1366054775,37 | 83,59 | 92,33 | 58882 |
| 2016-11 | 3,27 | 13,71 | 9,65 | 287,81 | 206,10 | 12,10 | 113,72 | 50,47 | 91,41 | 1411438545,47 | 82,39 | 91,41 | 87999 |
| 2016-12 | 3,49 | 13,86 | 9,57 | 292,54 | 209,43 | 12,70 | 117,58 | 56,82 | 87,01 | 1452354420,01 | 82,99 | 91,47 | 65042 |

**Table 15.** Data Set (2017-01/2020-12)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2017-01 | 3,73 | 15,21 | 9,50 | 299,74 | 213,34 | 13,00 | 97,07 | 55,70 | 88,39 | 1471951172,76 | 84,89 | 91,45 | 84025 |
| 2017-02 | 3,67 | 15,62 | 9,84 | 302,17 | 223,43 | 12,60 | 96,25 | 55,59 | 87,63 | 1452653321,82 | 85,68 | 91,32 | 37702 |
| 2017-03 | 3,67 | 15,38 | 10,04 | 305,24 | 232,01 | 11,70 | 113,22 | 52,83 | 89,89 | 1494420502,19 | 85,92 | 90,91 | 53858 |
| 2017-04 | 3,65 | 15,68 | 10,68 | 309,23 | 236,01 | 10,50 | 110,16 | 51,73 | 91,95 | 1521508812,51 | 86,87 | 91,48 | 53034 |
| 2017-05 | 3,56 | 15,61 | 11,34 | 310,61 | 235,32 | 10,20 | 113,71 | 50,31 | 94,22 | 1536277105,91 | 87,36 | 92,26 | 63602 |
| 2017-06 | 3,52 | 15,37 | 11,84 | 309,78 | 231,73 | 10,20 | 105,11 | 47,92 | 92,67 | 1562194354,17 | 87,27 | 93,47 | 57844 |
| 2017-07 | 3,56 | 15,97 | 11,89 | 310,24 | 234,39 | 10,70 | 112,48 | 52,65 | 93,21 | 1569127150,34 | 87,60 | 93,85 | 74395 |
| 2017-08 | 3,51 | 16,22 | 11,92 | 311,85 | 239,66 | 10,60 | 113,69 | 52,38 | 93,49 | 1594665339,79 | 88,60 | 94,63 | 62557 |
| 2017-09 | 3,47 | 16,36 | 11,88 | 313,88 | 241,58 | 10,60 | 110,57 | 57,54 | 92,00 | 1613206675,90 | 89,88 | 95,83 | 45132 |
| 2017-10 | 3,66 | 15,69 | 11,94 | 320,40 | 250,09 | 10,30 | 125,87 | 61,37 | 89,60 | 1665554306,58 | 90,35 | 95,09 | 64500 |
| 2017-11 | 3,88 | 14,49 | 12,07 | 325,18 | 256,56 | 10,30 | 124,95 | 63,57 | 87,35 | 1684309646,48 | 91,19 | 95,27 | 68489 |
| 2017-12 | 3,85 | 14,64 | 12,36 | 327,41 | 265,56 | 10,40 | 130,17 | 66,87 | 87,81 | 1686379871,93 | 92,02 | 96,42 | 66526 |
| 2018-01 | 3,77 | 17,48 | 12,31 | 330,75 | 268,55 | 10,80 | 109,17 | 69,05 | 92,38 | 1677943312,77 | 94,10 | 97,99 | 73036 |
| 2018-02 | 3,78 | 18,01 | 12,44 | 333,17 | 273,28 | 10,64 | 105,33 | 65,78 | 92,97 | 1696368567,79 | 91,81 | 98,36 | 36356 |
| 2018-03 | 3,88 | 17,39 | 12,55 | 336,48 | 277,24 | 10,12 | 120,66 | 70,27 | 92,28 | 1744515345,08 | 92,61 | 98,01 | 54721 |
| 2018-04 | 4,05 | 18,19 | 12,63 | 342,78 | 289,99 | 9,60 | 114,91 | 75,17 | 91,65 | 1779939106,88 | 93,70 | 98,55 | 54289 |
| 2018-05 | 4,41 | 18,86 | 12,92 | 348,34 | 296,08 | 9,70 | 121,09 | 77,59 | 90,95 | 1854602762,92 | 94,05 | 96,77 | 54914 |
| 2018-06 | 4,63 | 21,74 | 15,09 | 357,44 | 307,72 | 10,16 | 107,16 | 79,44 | 91,05 | 1875337445,42 | 93,27 | 97,06 | 33460 |
| 2018-07 | 4,75 | 24,09 | 16,37 | 359,41 | 312,05 | 10,76 | 120,86 | 74,25 | 92,92 | 1939142195,58 | 92,74 | 95,80 | 55541 |
| 2018-08 | 5,73 | 26,35 | 17,22 | 367,66 | 330,34 | 11,12 | 100,84 | 77,42 | 88,70 | 2166978696,48 | 92,41 | 94,06 | 36349 |
| 2018-09 | 6,37 | 32,44 | 22,63 | 390,84 | 375,35 | 11,40 | 114,80 | 82,72 | 81,15 | 2077795641,62 | 92,18 | 93,69 | 20605 |
| 2018-10 | 5,86 | 32,78 | 24,11 | 401,27 | 364,56 | 11,60 | 119,82 | 75,47 | 78,42 | 2007126254,07 | 93,38 | 92,84 | 18235 |
| 2018-11 | 5,37 | 30,83 | 23,17 | 395,48 | 316,80 | 12,30 | 116,20 | 58,71 | 80,95 | 1951039975,28 | 92,75 | 92,46 | 45660 |
| 2018-12 | 5,31 | 29,49 | 22,25 | 393,88 | 313,82 | 13,50 | 117,22 | 53,80 | 79,66 | 1994691011,65 | 92,07 | 92,37 | 37740 |
| 2019-01 | 5,37 | 29,52 | 21,15 | 398,07 | 311,52 | 14,70 | 100,97 | 61,89 | 80,11 | 2010694312,22 | 91,19 | 92,71 | 43779 |
| 2019-02 | 5,26 | 26,78 | 20,04 | 398,71 | 311,41 | 14,70 | 100,09 | 66,03 | 78,79 | 2059988823,40 | 90,70 | 92,26 | 17988 |
| 2019-03 | 5,44 | 23,58 | 19,65 | 402,81 | 307,04 | 14,10 | 115,12 | 68,39 | 81,10 | 2172575702,83 | 91,03 | 91,91 | 32124 |
| 2019-04 | 5,74 | 25,07 | 20,54 | 409,63 | 310,25 | 13,00 | 113,58 | 72,80 | 83,61 | 2243233092,37 | 91,12 | 91,54 | 29379 |
| 2019-05 | 6,05 | 27,59 | 22,30 | 413,52 | 321,85 | 12,80 | 120,96 | 64,49 | 77,05 | 2262095362,26 | 90,42 | 91,56 | 26393 |
| 2019-06 | 5,81 | 28,68 | 22,62 | 413,63 | 325,18 | 13,00 | 96,97 | 66,55 | 80,09 | 2254588885,64 | 89,80 | 92,44 | 17882 |
| 2019-07 | 5,67 | 27,40 | 21,47 | 419,24 | 358,13 | 13,90 | 120,39 | 65,17 | 78,94 | 2243488855,35 | 89,11 | 92,24 | 37840 |
| 2019-08 | 5,62 | 22,89 | 17,88 | 422,84 | 348,48 | 14,00 | 99,12 | 60,43 | 79,60 | 2347314405,55 | 87,61 | 90,71 | 18615 |
| 2019-09 | 5,71 | 20,18 | 15,39 | 427,04 | 345,80 | 13,80 | 119,55 | 60,78 | 77,64 | 2354207337,02 | 87,33 | 90,52 | 28181 |
| 2019-10 | 5,78 | 16,03 | 13,51 | 435,59 | 348,34 | 13,40 | 123,14 | 60,23 | 78,17 | 2415642858,24 | 87,01 | 90,25 | 42741 |
| 2019-11 | 5,73 | 14,95 | 11,78 | 437,25 | 348,83 | 13,30 | 121,01 | 62,43 | 81,24 | 2453011972,26 | 86,68 | 90,65 | 43204 |
| 2019-12 | 5,84 | 13,75 | 10,57 | 440,50 | 352,18 | 13,70 | 128,88 | 66,00 | 80,49 | 2554042031,75 | 86,39 | 91,38 | 40968 |
| 2020-01 | 5,92 | 14,06 | 9,64 | 446,45 | 354,12 | 13,80 | 108,70 | 58,16 | 81,12 | 2574581601,47 | 86,64 | 92,01 | 64716 |
| 2020-02 | 6,04 | 13,12 | 9,29 | 448,02 | 353,58 | 13,60 | 111,49 | 50,52 | 79,29 | 2669522364,49 | 85,17 | 90,93 | 31279 |
| 2020-03 | 6,31 | 13,35 | 9,36 | 450,58 | 359,25 | 13,20 | 113,93 | 22,74 | 80,98 | 2794985768,35 | 85,21 | 89,65 | 42633 |
| 2020-04 | 6,82 | 13,91 | 9,19 | 454,43 | 371,05 | 12,80 | 78,12 | 25,27 | 78,18 | 3035274638,76 | 79,81 | 88,04 | 19231 |
| 2020-05 | 6,95 | 13,12 | 7,65 | 460,62 | 380,98 | 12,90 | 84,11 | 35,33 | 82,85 | 3062952694,69 | 78,54 | 88,35 | 22509 |
| 2020-06 | 6,81 | 11,64 | 7,38 | 465,84 | 395,43 | 13,40 | 114,03 | 41,15 | 82,98 | 3134025516,58 | 81,73 | 89,86 | 30876 |
| 2020-07 | 6,85 | 11,61 | 7,34 | 468,56 | 404,73 | 13,40 | 119,57 | 43,30 | 82,82 | 3260026111,41 | 80,76 | 90,73 | 82221 |
| 2020-08 | 7,25 | 14,39 | 8,98 | 472,61 | 410,30 | 13,20 | 115,16 | 45,28 | 79,77 | 3307055828,09 | 84,54 | 91,52 | 55879 |
| 2020-09 | 7,51 | 16,85 | 10,29 | 477,21 | 426,84 | 12,70 | 133,22 | 40,95 | 81,91 | 3379105043,23 | 85,50 | 90,63 | 53860 |
| 2020-10 | 7,87 | 17,45 | 11,04 | 487,38 | 439,53 | 12,70 | 134,94 | 37,46 | 81,54 | 3521619805,45 | 84,45 | 90,75 | 70065 |
| 2020-11 | 8,00 | 18,81 | 13,08 | 498,58 | 481,33 | 13,08 | 131,54 | 47,59 | 79,98 | 3419213271,64 | 86,83 | 91,34 | 65882 |
| 2020-12 | 7,72 | 17,15 | 15,10 | 504,81 | 499,86 | 13,02 | 126,88 | 51,80 | 79,80 | 3377404011,96 | 84,42 | 91,00 | 65581 |