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Forecasting Turkish Stock Market Price With Macroeconomic Variables From The Multivariate Adaptive Regression Splines (Mars) Model

Çok Değişkenli Uyarlanabilir Regresyon Uzanımları (MARS) Modeli Kullanılarak Türkiye'de Borsa Fiyatının Makroekonomik Değişkenler İle Tahmin Edilmesi

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Abstract: This empirical investigation aims at forecasting the macroeconomic determinants of Istanbul Stock Price (XU 100) in Turkey by using the Multivariate Adaptive Regression Splines (MARS) Model over the period spanning from the January 2010 to December 2019. In this study, we used 10 macroeconomic variables for forecasting stock price using the MARS model. Our results indicate that variables such as inflation rate, gold prices, industrial production index, money supply, exchange rate, credit volume, and internal debt stock were found to be important for forecasting XU100 price.

Keywords: Multivariate Adaptive Regression Splines (MARS) Model, XU 100, Macroeconomic Variables

JEL Codes: C14, E44, E47, G17

Öz: Bu çalışma, Türkiye'de Ocak 2010'dan Aralık 2019'a kadar geçen sürede Çok Değişkenli Uyarlanabilir Regresyon Spline (MARS) Modelini kullanarak, Borsa İstanbul kapanış fiyatının (BIST 100) makroekonomik belirleyicilerini tahmin etmeyi amaçlamaktadır. Bu çalışmada, MARS modelini kullanarak hisse senedi fiyatını tahmin etmek için 10 makroekonomik değişken kullanılmıştır. Sonuçlarımız enflasyon oranı, altın fiyatları, sanayi üretim endeksi, para arzı, döviz kuru, kredi hacmi ve iç borç stoku gibi değişkenlerin BIST 100 kapanış fiyatının tahmini için önemli olduğunu göstermektedir.

Anahtar Kelimeler: Çok Değişkenli Uyarlanabilir Regresyon Uzanımları (MARS) Modeli, BIST 100, Makroekonomik Değişkenler

JEL Kodları: C14, E44, E47, G17

1. Introduction

The value of a share on a stock market can be influenced by many macroeconomic factors to realize a loss or a gain of stock returns. Stock and shares benefit come from capital gains and income earned from stock investment. During the daily trading of shares, the price can be subjective to many factors that tends to make the market index fickle. In this regard, 'Smart Investor' critically analyses macroeconomic factors, to gain from informed investment decisions. In this study, benefiting from the related literature, there are a variety of macroeconomic (exogenous) factors have been used to predict the stock prices namely

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inflation rate, interest rate, exchange rate, trade balance, industrial production index, money supply, oil prices, gold prices, internal debt stock, and credit volume.

In recent times, stock price prediction has attracted much attention from investors and academic researchers and has been extensively investigated under different estimation techniques, i.e. Artifical Neural Network (ANN) (Kuo et al., 2001; Chen et al., 2003; Altay and Satman, 2005; Karaatli et al., 2005; Guresen et al., 2011; Moghaddam et al., 2016; Selvamuthu, 2019), Fuzzy Time Series (Kuo et al., 2005; Qiu et al., 2012), Improved C-Fuzzy Decision Trees (Qiu et al., 2012), Machine Learning Techniques (Patel et al., 2015; Weng, 2017; Şahin, 2020), Support Vector Machine (Trafalis and Ince, 2008; Meased and Rasel, 2013; Fenghua et al., 2014; Liu and Duan, 2018; Rustam and Kintandani, 2019; Sedighi et al., 2019), Decision Trees, K-nearest neighbors and Genetic Algorithms (Atsalakis and Valavanis, 2009; Chang, 2011; Alkhatib et al, 2013).

This research makes several important contributions to the existing literature in understanding the forecasting the Istanbul Stock Exchange Market price (XU100). First, to our knowledge, this study is unique, which predicts the XU100 price using a non-parametric technique, Multivariate Adaptive Regression Splines (MARS). Second, this is the first study that used a broad range of macroeconomic factors to estimate the XU100 price.

The outline of the paper is organized as follows. The following Section describes the data and macroeconomic factors used in the study. Section 3 provides a brief summary of MARS model. Regression analysis findings are then reported in Section 4. Finally, Section 5 addresses the conclusions and lessons learned**.**

2. Data and Variable Selection and Macroeconomic Factors

2.1. Data

The purpose of this study is to forecast the XU100 with the selected macroeconomic variables by applying the MARS model. As far as data sources are concerned, this paper uses secondary monthly frequency time series data covering the period January 2010 to December 2019 with respect to data availability. Consistent with earlier studies, we consider the following macroeconomic variables including gold price per ounce, inflation rate, interest rate, exchange rate, M1 money supply, internal debt stock, credit volume, trade balance, industrial production index, and oil prices. All data are obtained from the Central Bank of the Republic of Turkey (CBRT) and Turkish Statistical Institute (TURKSTAT).

2.2. Variable Selection and Macroeconomic Factors

The selection of macroeconomic variables in prediction of the XU100 market can be explained and hypothesized as follows:

2.2.1. Interest Rate and Stock Price

Interest rates can have both a positive and negative impact on the stock market. The interest rate is a set of the price one pays to borrow money or payment you receive when you lend out money. A gradual increase between low and medium the interests can cause a positive ripple on the stock prices. Federal Reserve Board announced that it possible to raise interest rates, which would play in favor of companies to become profitable in 2018. Rising interest rates affect consumer costs but increase profit realized by companies, and this promotes high stock prices. On the negative side, the companies are overwhelmed by high rates, which hinder companies from borrowing for expenditure, which in turn reduces corporate earnings. The effect dictates lower profits margins and stock prices. According to a conducted study by Alam (2009), interest rates negatively affect the share price for 15 both developing and developed countries while analyzing data from 1988 up to 2003 (Alam et al., 2009). However, interest rates negatively affect the stock prices by increasing the cost of borrowing for companies (Csiszar, 2019).

Hypothesis 1: A lower (higher) interest rates increases (decreases) the stock prices.

2.2.2. Exchange Rate and Stock Price

The ultimate upward or downward shift in exchange rates profoundly affects the stock prices in all economic markets. The strength of a currency against the dollar in any market determines the movements of the exchange rates. The influence of the exchange rate on stock prices depends on a few instruments, and arguably these depend on the size of the equity market, the degree of capital control, exchange rate regime, and finally, the trade size (Pan et al., 2007). Studies show that the reaction of stock market to exchange rates is not clear. One group of resecarhes suggest that exchange rate is negatively affect the stock prices (Soenen and Hennigar, 1988; Kim, 2003; Bautista, 2006; Najafzadeh et al., 2016; etc.). On the other hand, some studies indicate that exchange rate and stock price are positively related (Ma and Kao, 1990; Phylaktis and Ravazzolo, 2005; Diamandis and Drakos, 2011; Sensoy and Cihat, 2014; etc.). Lastly, contrary to these studies, other studies find that there is no relationship between exchange rate and stock prices (see, e.g., Bahmani-Oskooee and Sohrabian,1992; Smyth and Nandha, 2003; Moore, 2007; Rahman and Uddin, 2009; Tudor and Popescu-Dutaa, 2012; etc.).

Hypothesis 2: The relationship between exchange rates and stock prices inconclusive.

2.2.3. Inflation Rate and Stock Price

The constant increase in the price of goods and services is known as inflation and a decline in the purchasing value of money (Baumann, 2015). Fluctuations in the stock prices affect supply and demand of stock exchange as fewer investors will be willing to invest, which affects the returns of the stocks negatively. Further, it is observed that existing studies documented mixed results on the impact of inflation on stock prices. Some studies, i.e., Ahmed, Gregoriou and Kontonikas, (2006); Bekaert and Engstrom, (2009); Islam and Khan (2016) find that inflation leads to increase the stock prices. In contrast, there are also studies, such as those by El-Nader and Alraimony (2012); Al Mukit (2013); Adusel (2014) find that inflation rate have a negative impact on the stock prices. Moreover, there are several researchers such as Pearce and Ripley (1988); Anari and Kolari (2001); Crosby (2002). As seen from the previous litereture, there is no well – defined relationship between exist between inflation rate and stock prices.

Hypothesis 3: The relationship between inflation rate and stock price inconclusive.

2.2.4. Industrial Production Index and Stock Price

The industrial production index is used to measure the real production output. Modification in the industrial production index is used as an indicator that drives changes in economic activities. Studies, for example Ratanapakorn and Sharma (2007), Ahmed (2008), Rahman et al. (2009), show that the upward amplification in the IPI affects the profitability of firms and expected cash flow positively (Kandir, 2008). Therefore, in general, the industrial production index and stock prices positively related.

Hypothesis 4: An increase (decrease) in industrial production increases (decreases) the stock prices.

2.2.5. Money Supply and Stock Price

An increase in the money supply means that an increase in the money demand, which is a sign of proactive economic activity. Money supply affects the cost of borrowing when the interest rates to shift downwards due to surplus money circulation in the economy. Previous studies related to the influence of money supply on stock prices have found different results. Based on the review of literature resources, studies conducted by Hanousek and Filler (2000), Brahmasrene and Jiranyakul (2007), Ratanapakorn and Sharma (2007), Shiblee (2009), Sohail and Hussain (2009), advocate positive money supply – stock price relationship. However, there have been a few studies done by Gan et al. (2006); Asmy et al. (2009) and Humpe and Macmillan (2009) documented that money supply has a negative effect on the stock prices.

Lastly, other authors (see, Kimura and Koruzomi (2003), Cagli et al. (2010)), however, found that no relationship between the money supply and stock prices.

Hypothesis 5: The relationship between money supply and stock prices are inconclusive.

2.2.6. Oil Prices and Stock Price

Oil prices are one of the important macroeconomic indicators that impact the companies' expected future cash flows. There are two approaches to explaning the impact of oil prices on stock prices. First, the upward change in oil prices increases the production cost of enterprises, which ultimately leads to a reduced cash flow that result in lower stock prices. Second, the continous increase in oil prices may cause inflation in the economy, which would also result in an increase in interest rates. As a result, high interest rate may push investors to alternative instrument opportunities with higher income than the stock market. In the existing litereature, there is a wide discussion about the oil prices and stock prices move together, or not. There are studies (Papapetrou 2001; Hammoudeh and Eleisa 2004; Basher and Sadorsky 2006; Park and Ratti 2008; Driesprong et al. 2008; Miller and Ronald 2009; Chen 2010; Ciner 2013; Al-Hajj et al. 2017) that have reported negative impact of oil price shocks on stock prices. In addition, some studies including Arouri and Rault (2011); Filis et al. (2011); Diaz and De Gracia (2017); Dutta et al. (2017) confirmed the existence of positive relationship between oil prices and stock prices. Furthermore, there have been fewer number of studies, for instance, Wei, (2003); Lee and Chiou (2011); Filis et al., (2011); Narayan and Sharma, (2011); Anyalechi et al., (2019) suggested oil price changes do not impact stock returns.

Hypothesis 6: The relationship between money supply and stock prices are inconclusive.

2.2.7. Gold Prices and Stock Price

Gold is perceived as an alternative investment tool to the stock markets. Investors, especially in environments with risky and uncertain, escape from different investment tools in order to minimize their risk, which leads to increase the demand for safe-haven assets such as gold. This results in a decrease stock prices. There are intensive discussions on the relationship between gold prices and stock market, including Smith (2001), Baur and Lucey (2010), Patel (2013), Ray (2013), Srinivasan (2014), Doğru and Uysal (2015), Afsal and Haque (2016), Al-Ameer et al. (2018), Başarır (2019).

Hypothesis 7: The relationship between gold price and stock prices are inconclusive.

2.2.8. Internal Debt Stock and Stock Price

Internal debt stock is the government's debt within the country through tools such as treasury bills and government bonds, which are known to investors as risk-free investment tools. In such a case, investors expect to earn at least this amount of income. An increase or decrease in the internal debt stock will affect the price of money by changing money demand and the stock price, consequently, will move on go down or up.

Hypothesis 8: The relationship between internal debt stock and stock prices are inconclusive.

2.2.9. Credit Volume and Stock Price

Credit is a way to transfer purchasing power to another person, provided that it is paid within a certain period of time. On the other hand, credit volume, which refers to all the loans that can be given from banks, has experienced a contraction or expansion in different periods. In such cases, the stock markets may be influenced by this situation.

Hypothesis 9: A higher (lower) credit colume increases (decreases) the stock prices.

2.2.10. Trade Balance and Stock Price

Changes in a country's trade balance used to assess the international competitiveness of the products used by that country in trade. Trade balance, in terms of macroeconomics, reflects the country's net asset status, and changes in this data will affect the markets. As a result, the stock prices will respond to changes in the foreign trade balance.

Hypothesis 10: A deficit in trade balance impacts the stock prices negatively.

3. Empirical Methodology

Methodologically, the present study has applied the Multivariate Adaptive Regression Splines (MARS) model to predict the XU100 price with the selected macroeconomic indicators. The MARS model is a nonlinear and nonparametric estimation technique first introduced by Jerome H. Friedman in 1991. The MARS model can be written as:

$$f(x) = \beta_0 + \sum_{j=1}^{J} \beta_j B_j(x) \tag{1}$$

where $f(x)$ is the response variable, $B_j(x)$ represents the product of Basis Function (BF) included in the final model, β_s are the estimated unknown paramaters obtained using the least-squares method, x is the number of predictor variables, J is the number of BFs, and j is the number of knots. Further, the BF for the j^{th} predictor of the q^{th} product can be represented by the following equation:

$$B_j^q(x) = \prod_{k=1}^{K_m} \left[s(k,m) \left(x_{v(k,m)} - t^*(k,m) \right) \right]_+^q \tag{2}$$

where, "+" denotes a truncated power function, K_m denotes the degree of interaction in the m^{th} basis expansion, $x_{v(k,m)}$ is the variable to split where $1 \leq x_{v(k,m)} \leq n.t_{k,m}$, and $t^*(k,m)$

is the split (knot) point. Finally, collecting equation (1) and (2), the general form of the MARS model can be defined as,

$$f(x) = \beta_0 + \sum_{j=1}^{J} \beta_j B_j^q(x) = \prod_{k=1}^{K_m} \left[s(k,m) \left(x_{v(k,m)} - t^*(k,m) \right) \right]_+^q \tag{3}$$

The MARS algorithm offers several advantages over other nonparametric regression techniques: (i) it allows to optimally split every data point into distinct intervals by identifying the knot locations. (Bolder, 2007); (ii) it allows to automatically determine and transform predictors, which exhibit a nonlinear relationship with the dependent variable; (iii) it does not require any specific assumption between the independent variables and dependent variable in the model (Goh et al., 2017); (iv) it searches over all possible knot locations and interactions between variables to find optimal variable (Goh et al., 2017); and (v) the results of the MARS algorithm can be easily interpreted (Lee and Chen, 2005).

4. Empirical Results

Before processing data, we normalized each variable between 0 and 1 to eliminate differences between measurement units by using following simple formula:

$$x_{normalized} = \frac{x - x_{min}}{x_{max} - x_{min}} \tag{4}$$

The optimal MARS model were generated based on two – stage procedure: forward selection and backward elimination (see Friedman (1991) for more details the selection of the optimal MARS model). To determine the ‘optimal’ MARS model, we use the lowest the Generalized Cross –Validation (GCV) value*. Since we search for interactions between variables, the lowest speed factor (1) and the maximum number of BFs (20) has been selected to consider all possible pair of BFs during the interactions search and to obtain the most accurate model. In addition, to select the number of maximum interactions, both the theoretical framework among the variables and the highest R^2 value has been considered. As a result, the number of optimal interaction determined as 3.

Table 1 reports the variable selection results estimated for the final MARS model. Based on the GCV criterion, the MARS model suggests 7 most important predictors, $\{\boldsymbol{x_1}, \boldsymbol{x_2}, \boldsymbol{x_3}, \boldsymbol{x_4}, \boldsymbol{x_5}, \boldsymbol{x_6}, \boldsymbol{x_7}\}$, as the best subset model. As can be seen, of 10 the predictor variables, the following variables were identified as significant in forecasting the XU100 price: internal debt stock, credit volume, exchange rate, gold prices, money supply, interest rate, and

* $Generalize\ Cross\ Validation\ (GCV) = \frac{RSS}{N\left(\frac{1 - effective\ number\ of\ parameters}{N}\right)^2}$

industrial production index. However, XU100 price are insensitive to the macroeconomics variables, such as inflation rate, trade balance, and oil prices, therefore, these variables will not included in the BFs functions. As it can be seen on Table 1, internal debt stock, credit volume, exchange rate, money supply, gold price, interest rate, and industrial production index were the most important variables with 100.00, 59.70, 58.20, 49.95, 26.88, 24.55, and 11.32 percent importance, respectively. In addition, the percents of inflation rate, oil prices, and trade balance are null.

Table 1. Variable selection results for the MARS stock market forecasting model

Variable	**Variable Name**	**Relative importance (%)**
x_1	Internal Debt Stock	100.00
x_2	Credit Volume	59.70
x_3	Exchange Rate	58.20
x_4	Gold Prices	45.95
x_5	Money Supply	26.88
x_6	Interest Rate	24.55
x_7	Industrial Production Index	11.32

After obtained the variables included in the final model, we construct the BFs of the MARS model. The coefficients and knot points in the BFs and model are normalized coefficients and knot points. By trail and error method, the maximum number of knots were observed as follows: two knots for variable internal debt stock (IDS), at values of IDS=0.285 (AV*=455.308.859,00 TL) and 0.487 (AV*=539.824.000,00 TL); one knot for variable credit volume (CV), at value of CV=0.156 (AV*= 662.053.683,00 TL); one knot for variable exchange rate (ER), at value of ER=0.277 (AV*=3.144); three knots for variable gold prices (GP), at values of GP=0.240, 0.375, and 0.400 (AV*= $1237.43, $1331.32, and $1348.93, respectively); one knot for variable M1 money supply (MS), at value of MS=0.074 (AV*=148.059.813,00 TL); one knot for variable interest rate (IR), at value of IR=0.106 (AV*=7.12), and one knot for variable industrial production index (IPI), at value of IPI=0.411 (AV*=86.9).

Table 2 reports the BFs and their corresponding equation for the optimal MARS model. As can be inferred from the BFs, the MARS model suggests 16 BFs, but only 15 of them are included in the model directly. It is seen that while some functions have a direct contribution to the model by affecting some basic functions besides the direct contribution as well. This effect is known as 'parent effect' in the MARS algorithm. As can be seen, the BFs, such as BF_2, BF_3, BF_5, and BF_7 exhibit a parent effect in the model. Interestingly, although the BF_3

appears in the BFs list but it does not contribute directly to the final model. Besides, it used to explain the BF_{11} and BF_{12}. Table 2 displays the results obtained from the MARS model.

Table 2. Model selection in MARS using information complexity

$$y = 0.134 - 5.129 * \boldsymbol{BF_1} - 1.969 * \boldsymbol{BF_2} + 3.912 * \boldsymbol{BF_4} + 8.664 * \boldsymbol{BF_5} + 6.379 * \boldsymbol{BF_7} + 38.411 * \boldsymbol{BF_9} - 4.153 * \boldsymbol{BF_{10}} - 7.247 * \boldsymbol{BF_{11}} + 8.092 * \boldsymbol{BF_{12}} - 0.639 * \boldsymbol{BF_{13}} - 2.238 * \boldsymbol{BF_{14}} + 16.74 * \boldsymbol{BF_{15}} + 5.971 * \boldsymbol{BF_{17}} - 12.91 * \boldsymbol{BF_{18}} - 30.57 * \boldsymbol{BF_{20}}$$

where,

$\boldsymbol{BF_1} = \max(0,\ x_1 - 0.486)$

$\boldsymbol{BF_2} = \max(0,\ 0.486 - x_1)$

$\boldsymbol{BF_3} = \max(0,\ x_3 - 0.276)$

$\boldsymbol{BF_4} = \max(0,\ 0.276 - x_3)$

$\boldsymbol{BF_5} = \max(0,\ x_2 - 0.155) * \max(0,\ 0.486 - x_1)$

$\boldsymbol{BF_7} = \max(0,\ x_1 - 0.284)$

$\boldsymbol{BF_9} = \max(0,\ x_4 - 0.400) * \max(0,\ x_2 - 0.155) * \max(0,\ 0.486 - x_1)$

$\boldsymbol{BF_{10}} = \max(0,\ 0.400 - x_4) * \max(0,\ x_2 - 0.155) * \max(0,\ 0.486 - x_1)$

$\boldsymbol{BF_{11}} = \max(0,\ x_4 - 0.239) * \max(0,\ x_3 - 0.276)$

$\boldsymbol{BF_{12}} = \max(0,\ 0.239 - x_4) * \max(0,\ x_3 - 0.276)$

$\boldsymbol{BF_{13}} = \max(0,\ x_5 - 0.074)$

$\boldsymbol{BF_{14}} = \max(0,\ 0.074 - x_5)$

$\boldsymbol{BF_{15}} = \max(0,\ x_6 - 0.105) * \max(0,\ x_2 - 0.155) * \max(0,\ 0.486 - x_1)$

$\boldsymbol{BF_{17}} = \max(0,\ x_4 - 0.374) * \max(0,\ x_1 - 0.284)$

$\boldsymbol{BF_{18}} = \max(0,\ 0.374 - x_4) * \max(0,\ x_1 - 0.284)$

$\boldsymbol{BF_{20}} = \max(0,\ 0.410 - x_7) * \max(0,\ x_2 - 0.155) * \max(0,\ 0.486 - x_1)$

$\boldsymbol{R^2}$ =0.9680, $\boldsymbol{Adj-R^2}$ =0.9633, $\boldsymbol{F-stat}$ =209.78 (0.000)

The analyses were repeated using the original and normalized data but same results were achieved. In other words, the knot points were obtained by original and normalized data correspond to the same observation value. Therefore, our findings were interpreted based on the actual values but reported normalized values.

Internal debt stock (x_1) is represented by three BFs (BF_1, BF_2, and BF_7) in the final MARS model. BF_1 is zero for values of internal debt stock less than or equal to 539.824.000,00 TL, while BF_2 is zero for values of internal debt stock greater or equal to 539.824.000,00 TL. Also, BF_7 is zero for values internal debt stock is less than or equal to 455.308.809,00 TL. In other words, when internal debt stock is less than 455.308.809,00 TL, then the stock price is not affected by internal debt stock. When internal debt stock takes the value between 455.308.809,00 TL and 539.824.000,00 TL, and greater than 539.824.000,00 TL, then the response variable depends on the coefficients of the variables. Lastly, BF_1 and BF_2 are the mirror functions of each other.

For the credit volume (x_2), there is only one BF (BF_5). BF_5 is zero in cases where for values of $\boldsymbol{x_2}$ less than or equal to 662.053.683,00 TL and internal debt stock is more than 539.824.000,00 TL, there is no impact on the stock price. When $\boldsymbol{x_2}$ is greater than 662.053.683,00 TL, then it affects the stock price with internal debt stock. In particular, this effect is realized positively on the stock price with both the credit volume being more than 662.053.683,00 TL and the internal debt stock is less than 539.824.000,00 TL.

The variable exchange rate (x_3) was indicated by BF_3 and BF_4 , which are the mirror images of each other. The effect of exchange rate on XU100 can be explained as follows. When exchange rate was less than 3.144 TL, its impact on the stock price is positive. In addition, when exchange rate greater than 3.144 TL, it does not affect directly the stock price, but affects with gold prices.

Gold Prices (x_4) (indicated by BF_9, BF_{10}, BF_{11}, BF_{12}, BF_{17}, and BF_{18}) effects the stock market price with the exchange rate, credit volume and internal debt stock. Accordingly, gold prices affect the stock market prices in all values where when the exchange rate is more than 3.144 TL, the credit volume is more than 662,053,683.00 TL, and the internal debt stock is between 455,308,809.00 TL and TL 539,824,00 TL.

Money Supply (x_5) is represented by BFs (BF_{13} and BF_{14}) in the model. When money supply is less than 148.059.813,00 TL, it is observed that it has a negative effect on the stock price. On the other hand, when money supply is greater than 148.059.813,00 TL, its effect on the stock price is negative but the strength of this effect increases when money supply is more than 148.059.813,00 TL.

Interest Rate (x_6) as indicated by BF_{15}. It was determined that when the interest rate is lower than or equal to 7.12, it did not have any affect on the stock price. However, interest rate is greater than 7.12, it affects the stock price positively with the credit volume and internal debt stock. This effect observes in cases where the credit volume is more than 662.053.683,00 TL and the internal debt stock is less than 539.824.000,00 TL with the interest rate being greater than 7.12.

Industrial Production Index (x_7) is represented by BF_{20}. When industrial production index is lower than (86.9) affect the stock prices not only alone, but affects with credit volume and internal debt stock. In addition to the industrial production index being lower than 86.9, the stock prices were negatively affected in cases where the credit volume is greater than 662.053.683,00 TL and the internal debt stock is less than 539.824.000,00 TL. It is observed that when the industrial production index takes any value above 86.9 has no impact on the stock price.

5. Conclusions And Discussions

This study aims to determine macroeconomic indicators affecting XU100 prices and to reach the final forecast model by calculating the impact levels. Following existing studies, we used 10 different macroeconomic indicators, namely, gold price per ounce, inflation rate, exchange rate, interest rate, M1 money supply, internal debt stock, credit volume, trade balance, industrial production index, and oil prices were used with the response variable of XU100 in an attempt to predict the relationship. Unlike the well-known traditional econometric techniques, this study applied MARS model, which determines knot points and creating different estimation equations and coefficients for each range. In order to increase the accuracy of the model established in the MARS method, the most appropriate model was created by determining the optimum interaction and maximum number of basic functions. From our investigation, it is evident that XU100 price is significantly affected by inflation rate, gold prices, industrial production index, money supply, exchange rate, credit volume, and internal debt stock.

Additionally, because MARS algorithm is a machine learning technique, the system should learn the original data and calculate the refractions. Thus, there is no need for unit root testing in the analysis. However, it cannot be possible to interpret the results when the data set is stationary.

As our study mainly predict XU100 price using different macroeconomic variables, future studies may aim at collecting more macroeconomic variables, i.e. unemployment rate, savings deposit rate, manufacturing industry capacity utilization rate, in forecasting XU100 price.

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