

Can We Forecast Stock Movements During Uncertain Times? An Application of Markov Chain Method on Turkish Energy Sector¹

Belirsiz Zamanlarda Hisse Hareketlerini Tahmin Edebilir miyiz? Markov Zinciri Metodunun Türkiye Enerji Sektörü Üzerine Bir Uygulaması

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ABSTRACT

Stock market forecasting has always been difficult for investors, academics, and businesses. The uncertainty created by the COVID-19 epidemic has further added to the difficulty. The goal of this study is to see if using the transition matrix in the Markov chain, the stock return percentages of the energy sectors, which are becoming increasingly important in all aspects of our lives, can be used to estimate the risky situation on the stock markets in the COVID-19 period compared to the previous day. The daily stock movement fluctuations of 18 Turkish energy businesses trading in the BIST100 index over one year (2020/04-2021/04) are examined in this study. The transitions between the states, as well as their numbers, were determined in the study, and then the transition probability matrix was produced. Finally, based on previous data, the price movement for the following day was forecasted with a high degree of certainty. By comparing real and synthetic data, the accuracy of Markov chain predictions can be proved. The results demonstrate that utilizing Markov chains to anticipate stock market movements has a 77.77 percent success rate in the COVID-19 timeframe. The study's findings are intended to be beneficial to businesses and investors.

Keywords: Markov Chain; Energy Sector; Stock; Transition Probability Matrix; Covid-19.

ÖZ

Yatırımcılar, araştırmacılar ve şirketler için borsa tahminleri yapmak her zaman zorlu olmuştur. COVID-19 salgınının yarattığı belirsizlik, zorluğu daha da artırmıştır. Bu çalışmanın amacı, hayatımızın her alanında giderek daha önemli hale gelen enerji işletmelerinin borsa hareketlerinin, COVID-19 sürecinin yarattığı riskli dönemde de, doğru bir şekilde öngörülüp öngörülemeyeceğini Markov zincirindeki geçiş matrisi kullanılarak görmektir. Bu çalışmada BİST100 endeksinde işlem gören 18 Türk enerji işletmesinin bir yıllık dönemde (2020/04-2021/04) günlük hisse senedi hareketlerinin dalgalanmaları incelenmiştir. Çalışmada durumlar arasındaki geçişler ve sayıları belirlenmiş ve daha sonra geçiş olasılık matrisi üretilmiştir. Son olarak, önceki verilere dayanarak, bir sonraki gün için fiyat hareketi yüksek bir kesinlikle tahmin edilmiştir. Markov zinciri tahminlerinin doğruluğu, gerçek ve sentetik veriler karşılaştırılarak gösterilebilmektedir. Sonuçlar, borsa hareketlerini tahmin etmek için Markov zincirlerini kullanmanın COVID-19 zaman diliminde yüzde 77,77 başarı oranına sahip olduğunu gösteriyor. Çalışmanın bulgularının işletmelere ve yatırımcılara faydalı olması amaçlanmıştır.

Anahtar Kelimeler: Markov Zinciri, Enerji Sektörü, Hisse Senedi, Geçiş Olasılık Matrisi, Covid-19.

Tür: Araştırma makalesi

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INTRODUCTION

The COVID-19 outbreak has created a large-scale threat to all businesses due to its rapid spread. As a result, many scholars and businesses have concentrated their efforts on identifying and preventing its consequences, as well as forecasting future catastrophes. The globe stock market indices are one of the most major places affected by the COVID-19 epidemic. According to studies, the pandemic had a significant negative impact on worldwide stock market indexes (Ashraf, 2020; Zhang et al., 2020). As a result, many stakeholders place a premium on the capacity to predict future price movements of publicly traded companies in the face of a macro-scale threat.

Energy is a fundamental component of social and economic progress and one of the economy's most basic inputs (Karatepe, 2011). The energy sector is a critical strategic issue for governments' development policies. Because of the rise in energy demand, the pace of resource consumption is increasing day by day. Because resource depletion will raise energy prices, the energy industry is becoming increasingly important (Iskenderoglu et al., 2015). Forecasting is valued by many firms and investors because it allows them to develop information-based business and data-centric strategies. Many company decisions are influenced by present market conditions as well as estimates for the future. The quantitative forecasting method is based on using existing statistics from the past to anticipate future sales (Dura, 2006). Historical data is gathered and examined to uncover patterns that can be utilized to forecast future trends and divergences. As a result, forecasting allows organizations and investors to take action based on predicted patterns.

For years, academics, businesses, and the financial community have been interested in forecasting stock fluctuations. Many people have wondered how accurate historical stock pricing may be in predicting future stock prices. As a result, several scholars have devised various models and ways to forecast stock price fluctuations. To predict stock price, many researchers employ the Auto-Regressive Conditional Heteroskedasticity (ARCH) method (Hamadu & Ibiwoye, 2010; Onwukwe et al., 2014), the Generalized AutoRegressive Conditional Heteroskedasticity (GARCH) method (Hamadu & Ibiwoye, 2010; Kaiser, 2005; Onwukwe et al., 2014), the Auto-Regression Moving Average (ARMA) method (Erfani & Samimi, 2009; Rounaghi & Nassir Zadeh, 2016), the Autoregressive Integrated Moving Average (ARIMA) method (Mondal et al., 2014; Skehin et al., 2018), Artificial Neural Networks (Affonso et al., 2021; Bebart et al., 2012; Lee et al., 2020; Tjung et al., 2012; F. Zhou et al., 2019; H. R. Zhou & Wei, 2010), the Ordinary Least Square Model (OLSM) (Tjung et al., 2012), and even social media-driven sentiment analysis (Attigeri et al., 2016; Coyne et al., 2018; He et al., 2016). The Markov Model is another estimation approach that can be employed.

Brownian motion is the movement of gas molecules in a closed box. The Markov chain model is an analysis that is used to base past occurrences independently and utilize current probabilities to forecast future probabilities (Alp & Oz, 2009). Many academics from various areas have used the Markov model to generate predictions. To explain, it's employed in a variety of fields ranging from wind energy (Yang et al., 2015) to diabetes

prevalence (Honeycutt et al., 2003), from calculating voter preferences (Gunduz & Kiral, 2020) to predicting basketball game outcomes (Štrumbelj & Vračar, 2012), and from forecasting car sales (Ildırar & Kiral, 2018) to seasonal Antarctic Sea ice forecasting (Chen & Yuan, 2004).

MARKOV CHAINS AND APPLICATION

The Markov chain method was developed by A.A. Markov in 1907. In this method, the events that can happen are expressed by situations. Situations that are likely to occur are collected in a set of states, and the process, starting from one state, transition to other states is provided. (Grinstead & Snell, 2012). In other words, the movement of the system from one state to another is expressed as a transition. (Winston & Wayne, 2004). Markov chains are defined as stochastic processes that are independent of how the process reaches its current state, in other words, its past properties. (Collins, 1970). When the system is in period i . and goes to period j . in the next case, there is a transition from i to j , and this transition is called transition probabilities (P) in the Markov chain. While s is used to express the states, the transition probabilities matrix (P) is represented by the $s \times s$ square matrix. (Winston & Wayne, 2004). The transition probabilities matrix is expressed by the notation in Equation 1.

$$P = [p_{11} \ p_{12} \ \dots \ p_{1s} \ p_{21} \ p_{22} \ \dots \ p_{2s} \ \vdots \ \vdots \ \vdots \ p_{s1} \ p_{s2} \ \dots \ p_{ss}] \quad (1)$$

Properties of the transition probabilities matrix (P) (Karatepe,2011);

1. Square matrix
2. $\forall i, j \quad \text{for} \quad p_{ij} \geq 0$
3. $\forall i, j \quad \text{for} \quad \sum_{j=1}^{j=n} p_{ij} = 1$

Due to the stationarity property of Markov chains, the probability of n -step transition from state i to state j will be independent of time t . In other words, the transition between states does not depend on the previous states of the system, but only on the previous state. It is called the "Markovian property" (Öz & Erpolat,2010). The conditional probability distribution function expressing this transition can be represented as in Equation 2. (Winston & Wayne, 2004).

$$P(X_t = i) = P(X_0 = i) = P_{ij}(n) \quad (2)$$

The probability of the process going from state i to state j after n periods represents the n -stage transition probabilities.

Markov chain assumptions;

1. It has a finite set of states.
2. The number of states is fixed.
3. The change of future situations does not change over time.

The probability of future events depends on the previous state. (Timor, 2001). In the method of the research, the transitions between states were determined by using the daily stock returns of 18 companies traded in the BIST100 index and doing business in the field of energy between 01.04.2020 and 01.04.2021, the number of transitions between states was determined, and a transition probability matrix was created. Using the data from the previous days, the price return for the next day was forecasted with certain probabilities. The data of daily stock returns of 18 companies in the energy sector between 01 April 2020 and 01 April 2021 are 4,572 in total. Forecasts are made with Markov chains. There can be three situations in which the movements of the stock according to the previous day's return can take place. There can be three situations in which the movements of the stock according to the previous day's return can take place. The set of possible states is $D = \{+, -, 0\}$. "+" indicates that the return has increased compared to the previous day, "-" indicates that the return has decreased compared to the previous day, and 0 indicates that the return will remain constant compared to the previous day.

Table 1: Descriptive characteristics of energy companies in Borsa Istanbul

Company ID	Sector	Energy Interest	Activity
C1	Energy	Both	Generation*
C2	Energy	Fossil	Generation
C3	Energy	Renewable	Generation
C4	Energy	Renewable	Generation
C5	Energy	Fossil	Marketing**
C6	Energy	Both	Marketing
C7	Energy, Packaging, Textile, Construction, Foundry	Renewable	Generation
C8	Energy	Fossil	Generation
C9	Energy, Tourism, Construction, Technology	Renewable	Generation
C10	Energy	Renewable	Generation
C11	Energy, Mining	Both	BOTH
C12	Energy, Construction	Both	Marketing
C13	Energy	Renewable	Generation
C14	Energy, Mining	Fossil	Generation
C15	Energy	Fossil	Generation
C16	Energy, Tourism	Renewable	Generation
C17	Energy, Tourism, Construction	Renewable	Generation
C18	Energy	Both	BOTH

* Generation, covers the production of electricity, natural gas, and chemical products.

** Marketing is the companies that ensure the delivery of the product to the final customer. For example, electricity distribution companies

Table 1 shows the detailed information of the 18 companies examined in the study. Transition matrices are created for each energy company based on the percentage increase-decrease-invariance of the stocks.

Table 2: Transition number matrix for stock returns states for C1

	+	-	0
+	53	59	10
-	11	5	2
0	57	45	7

Table 3: Transition probabilities matrix for stock return states for firm C1

	+	-	0
+	43,44%	48,36%	8,20%
-	61,11%	27,78%	11,11%
0	52,29%	41,28%	6,42%

It has been concluded that while the C1 firm is decreasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 61.11% probability, decrease with 27.78% probability, and there will be no increase-decrease with 11.11% probability. With a probability of 61.11%, we can say that the stock percentage return on April 01, 2021, for the C1 company will increase compared to the return of March 31. When we look at the actual situation, we saw that the percentage return of the stock increased compared to the previous day. Our forecast for the C1 firm gave the correct result.

Table 4: The share increase-decrease-invariance percentage rate of energy companies traded in BIST100

	+> +	+> -	+> 0	-> +	-> -	-> 0	0> +	0> -	0> 0
C1	43,44%	48,36%	8,20%	61,11%	27,78%	11,11%	52,29%	41,28%	6,42%
C2	45,97%	50,81%	3,23%	54,70%	42,74%	2,56%	42,86%	57,14%	0,00%
C3	53,44%	46,56%	0,00%	52,17%	45,22%	2,61%	33,33%	66,67%	0,00%
C4	51,22%	48,78%	0,00%	49,18%	49,18%	1,64%	33,33%	33,33%	33,33%
C5	46,77%	51,61%	1,61%	52,89%	46,28%	0,83%	66,67%	33,33%	0,00%
C6	49,23%	47,69%	3,08%	55,14%	39,25%	5,61%	63,64%	27,27%	9,09%
C7	40,37%	48,62%	11,01%	47,00%	37,00%	26,00%	46,15%	28,21%	25,64%
C8	44,92%	52,54%	2,54%	51,61%	46,77%	1,61%	33,33%	66,67%	0,00%
C9	59,33%	36,00%	4,67%	61,63%	32,56%	5,81%	61,54%	30,77%	7,69%
C10	50,43%	49,57%	0,00%	45,04%	54,96%	0,00%	0,00%	0,00%	0,00%
C11	46,97%	46,97%	6,06%	59,22%	35,92%	4,85%	71,43%	28,57%	0,00%
C12	44,63%	49,59%	5,79%	53,10%	40,71%	6,19%	42,86%	57,14%	0,00%
C13	59,72%	34,72%	5,56%	56,67%	37,78%	5,56%	53,85%	46,15%	0,00%
C14	45,53%	51,22%	3,25%	53,85%	43,59%	2,56%	62,50%	25,00%	12,50%
C15	52,38%	45,24%	2,38%	48,70%	47,83%	3,48%	42,86%	57,14%	0,00%
C16	56,20%	42,34%	1,46%	54,81%	41,35%	3,85%	50,00%	50,00%	0,00%
C17	49,59%	47,11%	3,31%	49,11%	41,96%	8,93%	40,00%	53,33%	6,67%
C18	48,72%	38,46%	12,82%	45,19%	46,15%	8,65%	51,85%	37,04%	11,11%

It has been concluded that while the stock return of C2 company was decreasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with a probability of 54,70%, decrease with a probability of 42.74%, and there will be no increase or decrease with a probability of 2.56%. With a probability of 54.70%, we can say that the stock percentage return on April 01, 2021, for the C2 company will increase compared to the return of March 31. When we look at the actual situation, we saw that the percentage return of the stock increased compared to the previous day. Our forecast for the C2 firm gave the correct result.

It has been concluded that while the stock return of C3 company was decreasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 52.17% probability, decrease with 45.22% probability, and will not increase-decrease with 2.61% probability. With a probability of 52.17%, we can say that the stock percentage return on April 01, 2021, for the C3 company will increase compared to the return of March 31. When we look at the actual situation, we saw that the percentage return of the stock increased compared to the previous day. Our forecast for the C3 company gave the correct result.

It has been concluded that the stock return of the C4 company on March 31, 2021, when it is increasing compared to March 29, 2021, will increase with 51.22% probability, decrease with 48.78% probability, and 0% probability that there will be no change in the return of the stock while increasing. With a probability of 51.22%, we can say that the stock percentage return on April 01, 2021, for the C4 company will increase compared to the return of March 31. When we look at the actual situation, we saw that the percentage return of the stock increased compared to the previous day. Our forecast for the C4 company was correct.

It has been concluded that while the stock return of C5 company was decreasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 52.89% probability, decrease with 46.28% probability, and there will be no increase-decrease with 0.83 probability. With a probability of 52.89%, we can say that the stock percentage return on April 01, 2021, for the C5 company will increase compared to the return of March 31. When we look at the actual situation, we saw that the percentage return of the stock increased compared to the previous day. Our forecast for the C5 company was correct.

It has been concluded that while the stock return of C6 company was increasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 49.23% probability, decrease with 47.69% probability, and there will be no increase-decrease with 3.08% probability. With a 49.23% probability, we can say that the stock percentage return for the C6 company will increase on 01 April 2021 compared to the 31 March return. When we look at the actual situation, it is seen that the percentage return of the stock has increased compared to the previous day. Our forecast for the C6 company was correct.

It was concluded that while the C7 company was decreasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 47% probability, decrease with 37% probability, and will not increase-decrease with 16% probability. With a probability of 47%, we can say that the stock percentage return on April 01, 2021, for the C7 company will increase compared to the return of March 31. However, when we look at the actual situation, it is seen that the percentage return of the stock does not differ in the rate of change of the price compared to the previous day. Our forecast with Markov analysis for C7 company gave wrong results.

It was concluded that while the C8 company was increasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 44.92% probability, decrease with 52.54% probability, and there will be no increase-decrease with 2.54% probability. With a probability of 52.54%, we can say that the stock percentage return for the C8 company will decrease on 01 April 2021 compared to the 31 March return. However, looking at the actual situation, it is seen that the rate of change in the price of the stock's percentage return has increased compared to the previous day. Our forecast with Markov analysis for C8 company gave wrong results.

It has been concluded that while the C9 company is increasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 59.33% probability, decrease with 36% probability, and not increase-decrease with 4.67% probability. With a probability of 59,33%, we can say that the stock percentage return on April 01, 2021, for the C9 company will increase compared to the return of March 31. Looking at the actual situation, it is seen that the percentage return of the stock has increased compared to the previous day. Our forecast for the C9 company was correct.

It has been concluded that on March 31, 2021, when the stock return of C10 is increasing compared to March 29, 2021, the stock return on April 01, 2021, will increase with 50.43% probability, decrease with 49.57% probability, and there is a 0% probability that there will be no change in the return of the stock while increasing. With a probability of 50.43%, we can say that the stock percentage return on April 01, 2021, for the C10 company will increase compared to the return of March 31. Looking at the actual situation, it is seen that the percentage return of the stock has increased compared to the previous day. Our forecast for the C10 company was correct.

It was concluded that while the C11 company was increasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with a probability of 46.97%, decrease with a probability of 46.97% and not increase or decrease with a probability of 6.06%. With a 46.97% probability, we can say that the stock percentage return on April 01, 2021, for the C11 company will increase compared to the return of March 31. Looking at the actual situation, it is seen that the percentage return of the stock has increased compared to the previous day. Our forecast for the C11 company gave the correct result.

It has been concluded that while the stock return of C12 company was decreasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 53.10% probability, decrease with 40.71% probability, and will not increase-decrease with 6.19% probability. With a probability of 50,10%, we can say that the stock percentage return on April 01, 2021, for the C12 company will increase compared to the return of March 31. Looking at the actual situation, it is seen that the percentage return of the stock has increased compared to the previous day. Our forecast for the C12 company gave the correct result.

It has been concluded that while C13 company is increasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 59.72% probability, decrease with 34.72% probability, and not increase-decrease with 5.56% probability. With a probability of 59.72%, we can say that the stock percentage return on April 01, 2021, for the C13 company will increase compared to the return of March 31. Looking at the actual situation, it is seen that the percentage return of the stock has increased compared to the previous day. Our forecast for the C13 company gave the correct result.

It was concluded that while the C14 company was increasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with a probability of 45.53%, decrease with a probability of 51.22%, and not increase or decrease with a probability of 3.25%. With a probability of 45.53%, we can say that the stock percentage return on April 01, 2021, for the C14 company will increase compared to the return of March 31. Looking at the actual situation, it is seen that the percentage return of the stock has decreased compared to the previous day. Our forecast with Markov analysis for C14 company gave wrong results.

It has been concluded that while the stock return of the C15 company was decreasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 48.70% probability, decrease with 47.83% probability, and there will be no increase-decrease with 3.48% probability. With a 48.70% probability, we can say that the stock percentage return for the C15 company will increase on 01 April 2021 compared to the 31 March return. Looking at the actual situation, it is seen that the percentage return of the stock has increased compared to the previous day. Our forecast for the C15 company gave the correct result.

It has been concluded that while C16 company is increasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 56.20% probability, decrease with 42.34% probability, and there will be no increase-decrease with 1.46% probability. With a 56.20% probability, we can say that the stock percentage return for the C16 company will increase on 01 April 2021 compared to the 31 March return. Looking at the actual situation, it is seen that the percentage return of the stock has decreased compared to the previous day. Our forecast with the Markov analysis for the company C15 gave wrong results.

It has been concluded that while the company C17 is increasing on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with 49.59% probability, decrease with 47.11% probability, and not increase-decrease with 3.31% probability. With a probability of 49.59%, we can say that the stock percentage return on April 01, 2021, for the C17 company will increase compared to the return of March 31. Looking at the actual situation, it is seen that the percentage return of the stock has increased compared to the previous day. Our forecast for the C17 company gave the correct result.

It was concluded that while the C18 company was on the rise on March 31, 2021, compared to March 29, 2021, the stock return on April 01, 2021, will increase with a probability of 48.72%, a decrease with a probability of 38.46%, and with a probability of 12.82%, there will be no increase or decrease. With a probability of 48.72%, we can say that the stock percentage return for the C18 company will increase on 01 April 2021 compared to the 31 March return. Looking at the actual situation, it is seen that the percentage return of the stock has increased compared to the previous day. Our forecast for the C18 company gave the correct result.

CONCLUSION

Accurate forecasting of stock market changes allows investors to make better decisions, resulting in increased wealth and luxury. In order to anticipate future stock market movements, various technical, fundamental, and statistical indicators have been offered, and various approaches have been utilized in previous studies. Models designed to forecast future stock market movements can assist investors in reducing investment risk and selecting the most profitable stocks. At the same time, the right estimation may help

organizations prepare for the future adjustments they're making as well as the threats they face in an ever-increasing competitive climate.

Markov chains, one of the stochastic models utilized in the decision-making process under uncertainty, are employed in this study to evaluate the movement of stocks of firms in the energy sector. The percentage growth and reduction in energy sector stock prices over the recorded time period were analyzed in detail in the research, and conclusions were drawn about the structure of price movements. Based on the stock data of the 18 energy businesses studied, it was discovered that 14 of the estimates were right. The accuracy of predictions made with Markov chains can be demonstrated by comparing real and synthetic data.

According to the findings, stock percentage returns in the energy sector have achieved a success rate of 77.77 percent as a result of estimating with Markov chains. Since the time interval in the research is designated the COVID-19, that is, the uncertainty period, it has been observed that estimate using Markov chains produces accurate results with a high probability even in the uncertainty period. There was no discernible difference between the sectors, energy interests, and activity of the corporations. The outcomes of the study are expected to be advantageous to energy company executives and investors.

Contributions, Limitations, and Future Research

One of the most important financial assets for investors is stocks. Especially knowing the future prices of financial assets is the dream of many investors. (Kostadinova et al., 2021) Forecasting future movements based on historical data has been a popular topic for many researchers. When we examine the literature on stock forecasting, it is seen that the studies mostly cover the pre-pandemic period. Although there are some limited studies (Budiharto, 2021; Chandra & He, 2021; Gurav & Kotrappa, 2020; Sharma et al., 2020) with different forecasting methods for stock movements during the pandemic period, when uncertainties were dominant, studies in which the Markov model was applied in this period could not be found as our knowledge. Therefore, this study contributes to the existing literature by showing the success of the Markov Chain Model in forecasting ability and that it is a successful method for stakeholders to forecast firm stock movements even in uncertain times by using the Markov model. In addition, it is thought that the study will guide the energy sector and help investors, financial circles, and companies in terms of stock estimation.

On the other hand, since it is a pioneering study on the subject, this study has some limitations and therefore many research opportunities. Forecasting is important for decision-making for almost all investors, firms, and financial circles. However, as economic activities encounter unpredictable events, uncertainties are experienced. In addition, it is necessary to accept the limits of forecasting accuracy (Makridakis et al., 2009). First, the sample of the research focuses on the energy companies traded in the stock market in Turkey. In this sense, it can be recommended to expand the sample and apply it to different sectors and countries. Then, the 1-year stock market movements of the Covid-19 period (1 April 2020-1 April 2021) were examined in the research. Due to

the prolongation of the pandemic period, the examined time interval can be increased. Another issue that can be suggested for future studies is to determine the most effective factor of the underlying causes of stock activity in the stock market, by means of the hidden Markov method, by considering the variables that affect the stock market activity other than Covid-19 in the examined period. While analyzing with the hidden Markov method, the independent variables such as the policies of governments and central banks, and developments in the energy sector, in the Covid-19 period, can be discussed. As a different study proposal, a comparison between the methods can be made by applying different forecasting methods with the Markov method for estimating stock movements in the Covid-19 period.

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