The Effect of Fossil Fuels and Macroeconomic Indicators on the Electricity Sector in Turkey: Quantile Regression Analysis

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Abstract

Climate change has turned to be a security problem for all nations in the world. The reason of climate change is the cumulation of carbon dioxide. The major reason of carbon emission is the electricity producers depending on fossil fuels especially natural gas and coal. Therefore, the countries are trying to phase out the fossil fuel-based energy production and switch to renewable energy production. Despite all the efforts natural gas and coal are still the major resources in electricity production. Turkey is no different and natural gas and coal-based electricity production is an important source of energy. Besides climate change, the war between Russia and Ukraine also showed that natural gas dependence can be a serious security issue. This study aims to explore the impact of natural gas and coal prices together with major macro-economic factors on the electricity firms enlisted in Borsa İstanbul. Quantile regression model is used to determine the impact of factors in different market conditions. Statistically significant impact of BIST 100, exchange rate and coal on BIST Electricity index is observed.

Keywords: Electricity firms, natural gas, coal, quantile regression

Türkiye'de Fosil Yakıtların ve Makroekonomik Göstergelerin Elektrik Sektörüne Etkisi: Dilim Regresyon Analizi

Öz

İklim değişikliği, dünya genelinde tüm uluslar için bir güvenlik sorunu haline gelmiştir. İklim değişikliğinin nedeni karbondioksit birikimidir. Karbon emisyonunun başlıca nedeni, özellikle doğal gaz ve kömür olmak üzere fosil yakıtlara dayalı elektrik üreticileridir. Bu nedenle ülkeler, fosil yakıtlara dayalı enerji üretimini azaltmaya ve yenilenebilir enerji üretimine geçmeye çalışmaktadır. Tüm çabalara rağmen, doğal gaz ve kömür hala elektrik üretiminde önemli bir kaynaktır. Türkiye de farklı değildir ve doğal gaz ve kömüre dayalı elektrik üretimi önemli bir enerji kaynağıdır. İklim değişikliğinin yanı sıra, Rusya ve Ukrayna arasındaki savaş, doğal gaz bağımlılığının ciddi bir güvenlik sorunu olabileceğini göstermiştir. Bu çalışma, Borsa İstanbul'da işlem gören elektrik firmalarının üstünde doğal gaz ve kömür fiyatları ile birlikte temel makro ekonomik faktörlerin etkisini araştırmayı amaçlamaktadır. Farklı piyasa koşullarında faktörlerin etkisini belirlemek için dilim regresyon modeli kullanılmaktadır. BIST 100 endeksinin, döviz kurunun ve kömürün BIST Elektrik endeksi üstünde istatistiksel olarak bir etkisi gözlemlenmiştir.

Anahtar Kelimeler: Elektrik firmaları, doğalgaz, kömür, dilim regresyon

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1.Introduction

The contemporary global energy sector has assumed unprecedented significance due to multifaceted factors. Primarily, the escalating impact of climate change, once confined to scientific realms a decade ago, has now manifested itself at a pervasive level, influencing individuals worldwide. Scientists and climate activists are fervently advocating for the cessation of energy production reliant on fossil fuels. Moreover, international agreements like the Paris Agreement compel nations to curtail their consumption of fossil fuels to mitigate carbon emissions. Signatories to the Paris Agreement have collectively pledged concerted efforts to limit global warming. However, achieving this ambitious goal poses substantial challenges, necessitating a comprehensive restructuring of the economic system established since the industrial revolution, particularly the energy systems sustaining it. According to statistics from the Center for Climate and Energy Solutions (C2ES) (2023), a considerable 72% of global emissions stem from problematic energy production. Turkey, having committed to carbon emission reduction under the Paris Agreement since October 7, 2021, underscores the imperative to scrutinize the entire energy sector, with a particular focus on electricity producers.

The geopolitical backdrop, notably the Ukraine-Russia war, has underscored the critical nature of the electricity production sector in Turkey. Putin's militarization of energy resources since the conflict's outset serves as a stark lesson for Turkey, prompting heightened scrutiny of electricity production. The electricity sector's foreign dependency on natural resources for production poses a substantial economic burden. According to the Central Bank of Turkey (2023) report, the share of energy import in national income was 5% between 2013 and 2021, while this share increased to 11% in 2022. Despite this, the dependence on fossil fuels in electricity generation persists and shows no signs of immediate transformation.
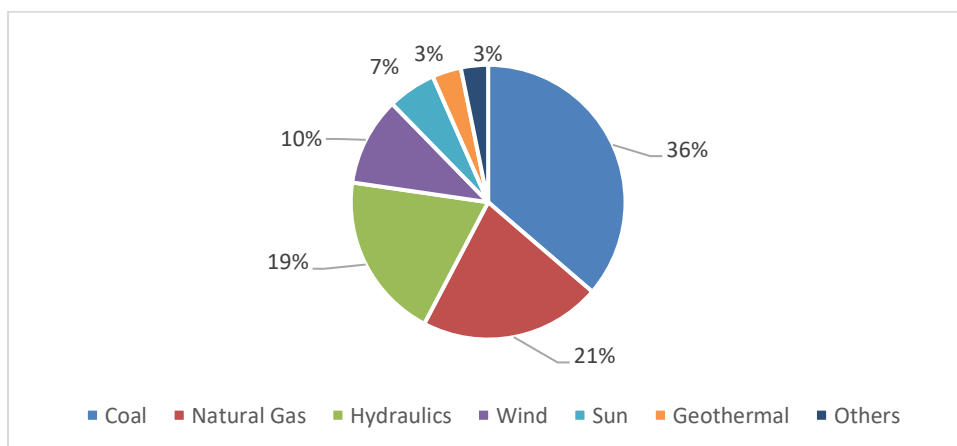

Figure 1: Electricity generation in Turkey in 2022 based on the resources used

Source: Ministry of Energy and Natural Resources (2023)

In Figure 1, data illustrating electricity generation based on utilized resources in Turkey is presented. Coal-based electricity generation holds the foremost position at 36%, followed by natural gas-based electricity generation at 21%. Nevertheless, electricity generation from renewable sources falls below expectations, with hydro power contributing almost 20%. Although the establishment of nuclear facilities are anticipated to alter this landscape, a substantial shift in consumption rates is not realistic in the near term. Presently, power plants prioritize the use of low-cost coal, followed by natural gas-based production. Regrettably, Turkey lacks abundant natural gas resources and relies on imports from Iran and Russia, rendering the electricity sector susceptible to international market dynamics. The natural gas market, particularly impacted by the Russia-Ukraine war, experienced abrupt spikes and heightened volatility, holding significant implications for Turkey. This study aims to elucidate the dependence of electricity companies in Turkey on natural gas and coal. Notably, the dearth of studies specifically focusing on the electricity sector is observed in our review. While the energy sector, predominantly encompassing oil and natural gas companies, has been extensively studied, electricity producers of strategic importance have been overlooked in the literature. This paper uses the quantile regression for analyzing scrutinize the dependency of electricity company stocks in Turkey on natural gas and coal, along with its correlation with other macroeconomic indicators. The quantile regression method offers several advantages over the Ordinary Least Squares (OLS) method. It conducts regression analysis across different distributions of the dependent variable, without relying on the conditional mean. Additionally, this method facilitates analysis without the necessity for homoscedasticity and normal distribution assumptions, prerequisites in the OLS method. This study stands as the inaugural attempt to examine electricity companies using the quantile regression method. The subsequent sections unfold as follows: a comprehensive literature review, followed by the exposition of data, methodology, and empirical results. The final section encompasses the conclusion and discussion.

2. Literature Review

One investigations into how oil price affect the stock markets was conducted by Sadorsky (1999). This study unveiled a robust negative relation between oil prices and the stock market return of companies. A parallel study by Boyer & Filion (2007) focused on oil and gas companies in Canada, echoing the findings of Sadorsky (1999) by indicating a positive influence of ascending oil and gas prices on Canadian counterparts. Subsequent research delved into scrutinizing the relationship between oil prices and stock markets across diverse regions, including Gulf countries and Europe (Park & Ratti, 2008; Faff & Brailsford, 1999; Filis et al., 2011; Nusair, 2016). Broadly, these inquiries established that oil and natural gas companies tend to thrive in the wake of oil price shocks and escalating oil prices.

However, investigations into the factors shaping stock prices, particularly for companies within the electricity sector, remain scarce. Existing studies predominantly concentrate on the correlation between the energy sector at large and oil prices. Such a blanket approach, equating oil and natural gas companies with electricity firms, can yield misleading outcomes. While a surge in coal prices and natural gas prices is expected to bolster companies engaged in their production and sale, the same trend signifies increased costs for electricity companies—primarily reliant on natural gas and coal. Acknowledging the interdependence of natural gas prices and coal prices, it is evident that electricity producers face susceptibility to fluctuations in both natural gas and coal prices. Nevertheless, the literature's limited efforts to delineate the energy sector into subsectors hinder a nuanced exploration of distinct responses. Consequently, very few studies have specifically analyzed the electricity sector, leaving an important gap in the existing research landscape. Narayan & Sharma (2011) conducted a comprehensive analysis of the effect of oil prices on distinct sectors, encompassing 560 American companies between January, 2000, and December, 2008. Distinguishing themselves by analyzing the energy and electricity sectors separately, they unveiled a higher dependency of both sectors on oil compared to others. While the energy sector demonstrated a positive relation with oil, the electricity sector exhibited a discernible negative relationship. Broadstock et al. (2012) extended this line of inquiry by scrutinizing the effects of oil price shocks on energy companies in China from January 7, 2000, to May 27, 2011, utilizing the time-varying conditional correlation method. Their findings indicated a strengthened relationship between the energy sector and oil prices, particularly accentuated after the 2008 Financial Crisis. This underscored the heightened sensitivity of energy-related sectors to oil shocks in international markets. Degiannakis et al. (2013) employed a time-varying multivariate model to analyze the impact of oil prices on various sectors, including oil and gas energy companies, from January 1992 to December 2010. The study revealed a positive effect of oil shocks on oil and gas companies. In a similar vein, Yang et al. (2016) explored the cross-correlation (MF-DCCA) between sectors in China (CSI300) and WTI oil prices from January 4, 2005, to November 2, 2015. Notably, they observed the strongest multi-fractality between the energy sector in China and oil prices. Tiwari et al. (2018) delved into the impact of oil price shocks on the energy sector, alongside various other sectors in India, utilizing the quantile regression method. Within the bull market (90% quantile), the energy sector responded positively to a decrease in oil prices, experiencing value appreciation. Conversely, in the bear market (10% quantile), they uncovered that the energy sector was adversely affected by negative oil price changes. Consequently, they asserted that the energy sector in India exhibits a notable dependence on oil.

Ma et al. (2019) conducted a comprehensive analysis of stocks from oil, gas, electricity, coal, and alternative energy companies in the USA, exploring the influence of oil prices on the energy sector

between June 8, 2007, and May 10, 2018. Notably, they discovered that WTI oil prices exert an impact on the energy sector, including oil and gas companies. The researchers attribute this result to the financialization of oil market. Huang & Liu (2021) delved into the dynamics of the energy sector in China during the pandemic period. Their findings indicated a reduction in the risk of stock market crashes for companies in the energy sector in the post-pandemic period. Furthermore, they highlighted that among the companies operating in the energy sector in China, those with more effective corporate governance faced lower risks during the crisis. In summary, while there exists a body of research focused on energy companies, studies specifically examining the electricity sector are notably scarce. Koçoğlu & Tanrıöven (2019) scrutinized the factors influencing the stock returns of energy companies listed on Borsa Istanbul. However, with only five energy companies considered at the time of the study, utilization of panel data analysis, the research did not adequately measure sector reactions in diverse financial market conditions. This study makes two contributions to the literature. Firstly, it serves as the inaugural examination of the impact of macroeconomic factors, particularly natural gas and coal, on the BIST Electric index. Secondly, it systematically explores the varied effects of factors under different economic conditions, specifically in bearish or bullish market scenarios. The ensuing section details the methodology employed and presents the empirical results. The theory in the literature is that the energy and electricity firms' stock market performance in affected by the input they use in the production. Based on this argument we chose natural gas and coal as the major factors in our study.

3. Data and Methodology

3.1. Data

In the study, daily data between January 4, 2021 and August 22, 2023 were used. The reason for starting the analysis with the year 2021 is primarily to exempt the analysis from the impact of the pandemic. In addition, as of this date, Türkiye has started to implement an economic model of its own. The most common situation in the analysis made with daily financial data is that the data has a unit root, that is, it is not stationary. If there is a unit root in the data, the regression analysis to be established between the data will give false results. For this reason, daily percentage changes of all data were taken, and the data turned to be stationary. Since it represents the electricity companies in Turkey, the BIST Electric index is used. The index consists of companies that generate electricity from different sources such as natural gas, coal, thermal and solar energy, using both renewable and fossil fuels and there are also energy distributers. BIST 100 factor was taken as the first among the factors that can affect the electricity companies. This is because, as stated by Sharpe (1964), it is the index itself that has the greatest effect on sub-indices and has the strongest explanatory feature. To measure the impact of the exchange rate on companies, the exchange rate between USD/TL

(USDTRY=Z) has been chosen. New Castle Coal futures used as proxy to measure the impact of coal. As the natural gas data, Dutch TTF natural gas future prices have been chosen because they both reflect instantaneous changes in natural gas and are one of the largest natural gas markets. The reason why natural gas and coal prices are chosen as factors affecting the electricity sector is that many power plants in Turkey are natural gas or coal power plants and the profitability of electricity companies is based on natural gas and coal which are main inputs in the production. Finally, the Turkish Lira overnight reference interest rate data was used as the interest data. All data were compiled from investing.com website.

3.2. Methodology

3.2.1. Unit Root Test

Since the financial data are not stationary in the long run, the daily percentage changes is used in the study. The Augmented Dickey-Fuller (Dickey & Fuller, 1979) test and Phillips and Perron (1988) tests with trend and trend, intercept was applied and if there is a unit root over the percent change were tested at the level.

3.2.2. Quantile Regression Analysis

The regression analysis formula to be created for the OLS method is shared below.

$$R_t = a_t + \beta_{bist100}Bist100_t + \beta_{exchangerate}Exchangerate_t + \beta_{coal}Coal_t +$$
$$\beta_{naturalgas}Naturalgas_t + \beta_{interestrate}Interestrate_t +$$
$$\epsilon_t \hspace{8cm} (1)$$

In the above equation, time t represents the daily returns of R_t BIST Electricity Index, and β represents the coefficient of each independent variable in the regression analysis. $BIST100_t$ is the daily return of Borsa İstanbul 100 index; $Exchangerate_t$ daily change of exchange rate between US Dollar and Turkish Lira; $coal_t$ daily change in coal, $Naturalgas_t$ daily change in natural gas prices; $Interestrate_t$ symbolizes the daily interest rate change. However, the OLS method has very tight assumptions such as normal distribution and homoscedasticity. The quantile regression model developed by Koenker & Bassett (1978) is a method to produce accurate results without relying on these assumptions. Linear regression estimates the conditional mean of the dependent variable, providing the average expected value of the dependent variable for a given value of the independent variable. In contrast, quantile regression focuses on estimating the conditional quantiles of the dependent variable, allowing for the analysis of how different points in the distribution of the dependent variable vary with changes in the independent variable. This approach provides a more comprehensive understanding of the relationship between variables by capturing variations across different segments of the distribution. The estimated model is shared below.

$$Q_y\big((\tau|x)\big) = inf\{\partial|F_y(\partial|x) \ge \tau\} = \sum_h \beta_h(\tau)x_h$$

$$= x\beta(\tau) \tag{2}$$

In the above equation, each x value is described by the conditional distribution function $F_y(\partial|x)$. $\beta(\tau)$ is the quantile regression coefficient and shows the dependence of the variable x in different quantiles. (Mensi et al., 2014).

4. Empirical Findings

The descriptive statistics are shared in Table 1.

Table 1: Descriptive Statistics

	BİST Electric	BİST 100	USD/TL	Coal	Natural Gas	Interest Rate
Average	0.002822	0.00259	0.002006	0.001554	0.003542	0.001037
Median	0.002516	0.002315	0.000728	0.000668	0	0
Maximum	0.08676	0.098801	0.123864	0.405751	0.511025	0.757511
Minimum	-0.09932	-0.09793	-0.18864	-0.351085	-0.29701	-0.247563
Std Deviation	0.020155	0.019155	0.014894	0.035926	0.070411	0.045513
Skewness	-0.41093	-0.55634	-1.61799	0.296421	0.807846	6.542800
Kurtosis	6.222536	7.967222	56.41033	46.95149	9.128662	115.7074
Jarque-Bera	316.1366	740.6328	81837.95	55225.43	1148.22	367987.5
Total	1.935735	1.776412	1.376226	1.065708	2.429911	0.711074
Observations	686	686	686	686	686	686

Before regression analysis, the stationarity feature of the data is tested, and Table 2 provides the results. First of all, for the return data of the series Augmented Dickey-Fuller tests (Dickey & Fuller, 1979) were performed at the level. The results suggest that all series are stationary at the level for both the trend and the trend, intercept models. Then, Phillips-Perron (Phillips and Perron, 1988) unit root test results are calculated for both the trend model and the trend, intercept model. Analysis shows that all series are stationary at level.

Table 2: Unit root tests

	Augmented Dickey-Fuller Trend	Augmented Dickey-Fuller Trend and Intercept	Phillips-Perron Trend	Phillips-Perron Trend and Intercept
BİST Elektrik	-23.44088	-23.54234	-23.91681	-23.86186
	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
BİST 100	-25.97254	-26.09214	-26.02442	-26.11114
	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
USD/TL	-23.18661	-23.17059	-23.05657	-23.03920
	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
Coal	-25.01546	-25.18492	-25.20769	-25.29057
	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
Natural Gas	-25.26613	-25.31514	-25.26193	-25.30833
	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***
Interest Rate	-18.18801	-18.26232	-29.60085	-30.05953
	(0.0000)***	(0.0000)***	(0.0000)***	(0.0000)***

*.**.*** significance at 10%. 5%. 1%

Table 3 presents the results of quantile regression. Bull (bear) market is defined as electricity sector gaining (losing) value. In quantile 1, that is, in the lowest 10% of the distribution table of the BIST Electricity Index, the BIST100 index has a positive effect on electricity stocks, and the stock market gaining value has a positive effect on electricity stocks by almost 0.80, as expected. In the 20% quantile, while the BIST has a statistically significant positive effect, natural gas prices have a negative effect while the level of significance is only 10%. In periods when BIST electricity index stocks perform poorly, natural gas prices have a negative impact. The reason for this is that the costs of companies producing electricity rise when natural gas price increases. In the 30% quantile, only BIST100 has a significant effect. BIST100 again had a positive effect in the 40% quantile alone. In the 50% and 60% quantiles, the BIST100 index had a statistically significant effect and interest rate have positive impact on electricity firms but again only at 10% significance. In the case where the electricity index stocks in the 70% quantile which means in bull market, the positive statistical effect of the BIST100 index was observed. Moreover, negative impact of coal prices is observed in this quantile. In the 80% quantile, there was a statistically strong positive effect of the BIST100 index and also the interest rate have a positive impact at only 10% significance. In addition, as expected, the increasing dollar value in this quantile had a negative impact on electricity stocks. Statistically

significant positive effect of BIST100 was observed in the 90% quantile. It is quite surprising that the BIST electricity index shares were positively affected while the interest rate was increasing, but the reason might be the Turkish Economic Model being implemented. The interest rate seems to be increasing, but it has a positive effect on stocks as Central Bank of Turkey raised the interest rates much lower than anticipated. Graphics are shared in Figure 1 to show the results visually.

Table 3. Quantile Regression Analysis Results

	$Q_1(0.10)$	$Q_2(0.20)$	$Q_3(0.30)$	$Q_4(0.40)$	$Q_5(0.50)$	$Q_6(0.60)$	$Q_7(0.70)$	$Q_8(0.80)$	$Q_9(0.90)$
$\beta_{Bist100}$	0.790856***	0.720857***	0.706973***	0.690236***	0.724358***	0.753259***	0.718271***	0.731014***	0.707212***
	[0.028076]	[0.038077]	[0.035861]	[0.040646]	[0.044020]	[0.048346]	[0.069575]	[0.062806]	[0.066900]
	(28.16833)	(18.93160)	(19.71408)	(16.98180)	(16.45536)	(15.58070)	(10.32371)	(11.63918)	(10.57125)
$\beta_{Exchangerate}$	-0.049768	-0.056143	-0.007727	-0.005889	-0.025864	-0.045200	-0.037242	-0.071755**	-0.024914
	[0.058888]	[0.077358]	[0.089721]	[0.054845]	[0.048275]	[0.043836]	[0.044365]	[0.031825]	[0.052566]
	(-0.845132)	(-0.725756)	(-0.086124)	(-0.107377)	(-0.535768)	(-1.031100)	(-0.839444)	(-2.254635)	(-0.473954)
β_{coal}	-0.002858	-0.017691	-0.004750	-0.007629	-0.001560	-0.006476	-0.030069**	-0.004899	-0.008293
	[0.044836]	[0.014627]	[0.010774]	[0.009712]	[0.011193]	[0.015812]	[0.014572]	[0.070377]	[0.029623]
	(-0.063740)	(-1.209444)	(-0.440867)	(-0.785524)	(-0.139390)	(-0.409570)	(-2.063460)	(-0.069610)	(-0.279935)
$\beta_{naturalgas}$	-0.009164	-0.019215*	-0.013526	-0.013225	-0.011491	-0.012412	-0.011806	-0.015404	-0.016078
	[0.007465]	[0.011378]	[0.009929]	[0.009749]	[0.009568]	[0.009569]	[0.009884]	[0.016615]	[0.026166]
	(-1.227605)	(-1.688723)	(-1.362254)	(-1.356534)	(-1.201042)	(-1.297123)	(-1.194452)	(-0.927107)	(-0.614469)
$\beta_{interestrate}$	-0.024591	-0.004362	0.002461	0.010659	0.013536*	0.012025*	0.018017	0.042028*	0.029048
	[0.026437]	[0.033296	[0.023857]	[0.010130]	[0.007113]	[0.006897]	[0.027936]	[0.024249]	[0.036901
	(-0.930147)	(-0.131022)	(0.103175)	(1.052267)	(1.903132)	(1.743531)	(0.644942)	(1.733188)	(0.787196)
c	-0.016002***	-0.009599***	-0.005104***	-0.002020***	0.000389	0.002625***	0.006280***	0.011243***	0.018227***
	[0.000874]	[0.000820]	[0.000637]	[0.000547]	[0.000537]	[0.000542]	[0.000749]	[0.000856]	[0.001226]
	(-18.30749)	(-11.70370)	(-8.008950)	(-3.692612)	(0.724566)	(4.840244)	(8.386832)	(13.14094)	(14.86265)
Pseudo R^2	0.38	0.32	0.29	0.27	0.27	0.26	0.24	0.23	0.22
Adjusted R^2	0.37	0.31	0.29	0.27	0.27	0.25	0.23	0.22	0.22
Probability(Quasi-LR)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

*.**.*** significance at 10%. 5%. 1%
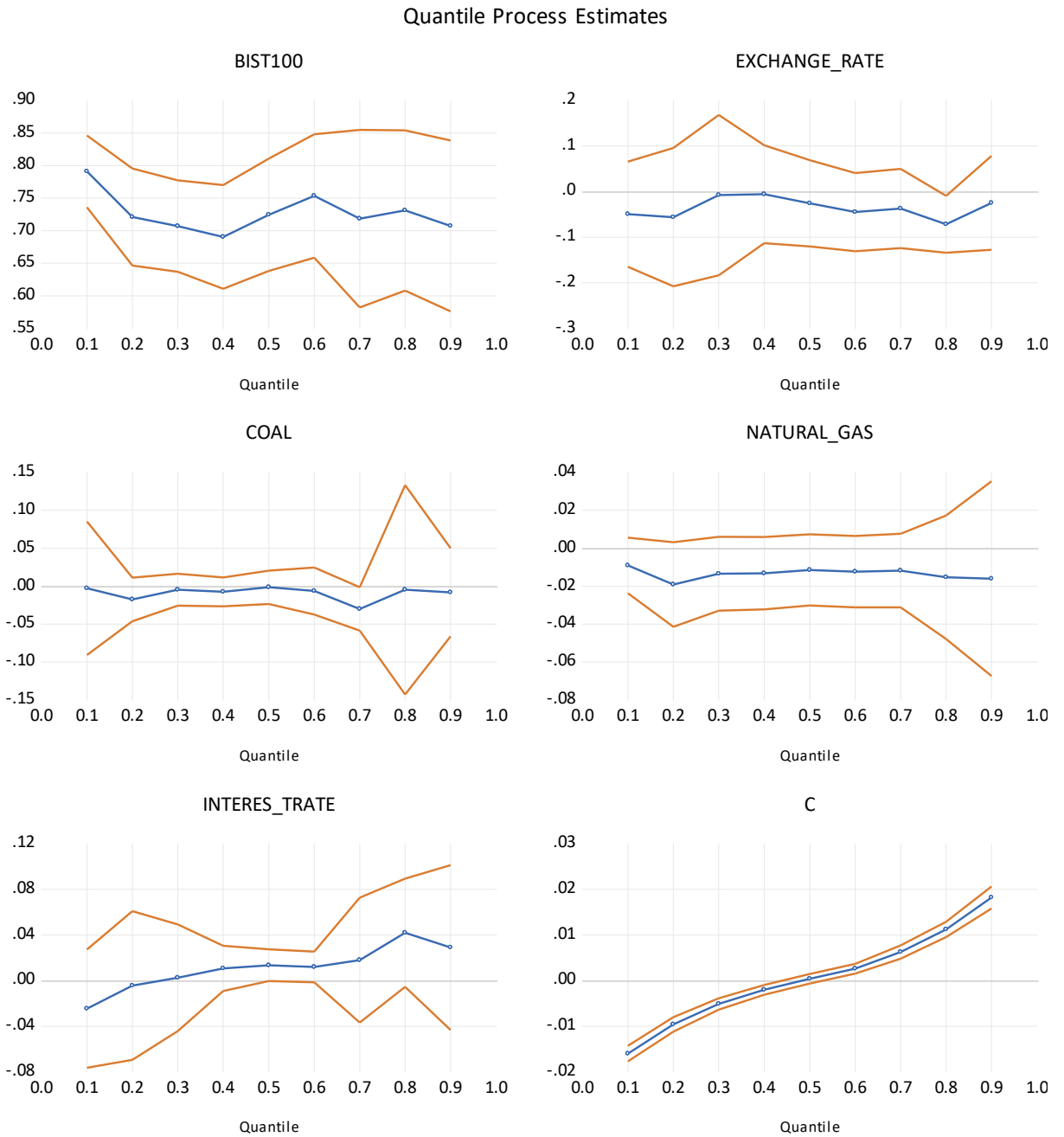
Figure 2: Graphical Representation of Quantile Regression Results

In Table 4, firstly, the result of the quantile slope equality test is shared. As a result of the test, Chi-Square was found to be 53.11 and it is not statistically significant at 5% significance. The slope equality is not different across quantile levels. The result of the symmetrical quantiles test was shared and the Chi-Square statistic was found to be 13.46. Chi-square is not statistically significant and as a result, there is symmetry.

Table 4: Quantile Slope Equality Test and Symmetrical Quantiles Test

Quantile Slope Equality Test	Chi-Square	Number of Quantiles
Wald Test	53.10659*	10
Symmetrical Quantiles Test		
Wald Test	13.45946	10

*. **.*** significance at 10%. 5%. 1%

5. Conclusion and Discussion

Carbon is the reason why the earth is a habitable planet and enough heat is trapped in the atmosphere for living things to exist. Carbon stabilizes the earth's temperature by preventing the heat from the sun from returning to space. However, with the industrial revolution, mankind has switched to fossil fuel based economic growth and has been burning the fossil fuels that hide the carbon they have trapped under the ground. Therefore, the atmosphere started to retain more heat and the world entered the process of warming rapidly. Climate change is now the top security problem of all countries in the world. Electricity companies, which are responsible for the huge amount of carbon emissions and produce based on fossil fuels, must be understood and analyzed very well. In this study, macroeconomic factors, especially natural gas prices and coal, which affect the stock returns of electricity companies in Turkey, are explored. In the study, which examines the period after 2021, the effect of the Turkish Economic Model was also observed. In the paper, the effect of the selected factors in different financial market conditions, namely bear and bull market situations, was examined by the quantile regression method. First of all, by confirming Sharpe's (1964) argument, positive effect of BIST 100 on the electricity index in every quantile is observed, that is in every market condition. The rise (fall) in the stock market index causes the rise (fall) in the electricity firms' stock prices. As the second factor, the effect of the exchange rate between the dollar and lira on electricity stock returns was examined. In the 80% segment the increase in the exchange rate, that is, the Turkish lira depreciates, negatively affected the return of electricity stocks. Coal is chosen as the third factor. Negative impact of coal on electricity firms under bullish market is observed. As the fourth factor, the effect of natural gas prices was examined, and the natural gas is only significant at 10%. The negative effect of natural gas prices was observed in the bear market situation where electricity stocks lost value. They describe the rising natural prices as a risk factor when the electricity market loses value. Finally, the effect of interest rates was examined.

Interest rate factor is also only significant at 10%. In normal and bull market conditions the rising interest rate have positive impact over the stock of electricity firms. Although this result seems contrary to expectations, it is the result of the new economic model implemented in Turkey recently. Although the Central Bank increased interest rates in the period that the stock market gained value, the market interpreted these interest rate increases positively, since there were limited increases well below the current inflation rate. Within the scope of the Turkish economic model, Borsa İstanbul broke records and the electricity sector seems to have been positively affected by this situation. This study contributed in two ways. First of all, it was the first study to examine the effect of natural gas and coal prices on the electricity sector. In addition, with the quantile regression analysis used, the different effects of the factors used in different market conditions were analyzed. In future studies, the companies in the BIST Electricity index which invest in natural gas and coal power plants should be distinguished and how their stocks are dependent on natural gas and coal prices should be analyzed. The relationship between the energy sector, which is a security issue for Turkey, and natural gas and coal should be explored with a more detailed study.

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Genişletilmiş Özet

Dünya genelinde enerji sektörü, şu anki kadar hiç önemli olmamıştır ve bunun birçok nedeni bulunmaktadır. İlk olarak, yalnızca 10 yıl önce bilim insanlarının ilgi alanı olan iklim değişikliği, şu anda her bireyi etkileyen bir düzeyde kendini hissettirmeye başlamıştır. Dünya genelinde bilim insanları ve iklim aktivistleri, fosil yakıt tabanlı enerji üretimini sona erdirmek için güçlü bir lobi oluşturmaktadırlar. Ayrıca, Paris Anlaşması gibi uluslararası anlaşmalar, ülkeleri karbon emisyonlarını azaltmak amacıyla fosil yakıt tüketimlerini düşürmeye zorlamaktadır. Paris Anlaşması'na taraf olan tüm ülkeler, küresel ısınmayı belli bir seviyenin altında tutmak için ortaklaşa bir şekilde çalışma sözü vermişlerdir. Ancak bu söz, tutulması çok zor bir hedef olan bir sözdür, çünkü bu iddialı hedef, sanayi devriminden bu yana oluşan ekonomik sistemin ve bu ekonomik sistemi besleyen enerji sistemlerinin yeniden yapılandırılmasını gerektirmektedir. C2ES (2023) tarafından verilen verilere göre, enerji üretimi dünya genelinde toplam emisyonların büyük bir bölümünü oluşturan %72'lik bir orandan sorumludur. 7 Ekim 2021'de Türkiye Paris Anlaşması tarafı olarak karbon emisyonlarını azaltma taahhüdünde bulunmuştur. Karbon emisyonlarının çoğu enerji üretimi sonucunda ortaya çıktığından, özellikle elektrik üreticileri olmak üzere enerji sektörünü tümüyle anlamak ve analiz etmek gereklidir. Ayrıca, Ukrayna-Rusya savaşı, Türkiye'de elektrik üreticilerinin neden bu kadar dramatik bir öneme sahip olduğuna dair adeta ders niteliğindedir. Enerji, savaşın ilk günlerinden itibaren Putin tarafından silahlaştırılmıştır. Türkiye da aynen Avrupa ülkeleri gibi enerjide dışa bağımlıdır ve enerji şirketleri ithal enerji hammaddesi ile üretim yapmaktadır. TCMB (2023) raporuna göre, enerji ithalatının milli gelire oranı 2013 ve 2021 yılları arasında ortalama oranla %5 iken, bu oran 2022'de %11'e yükselmiştir. Fosil yakıtlara elektrik üretiminde bağımlılık devam etmekte ve bu durumun kısa vadede değişmeyecektir. Kömür temelli elektrik üretimi %36 ile ilk sırada yer alırken, doğal gaz temelli elektrik üretimi %21 ile ikinci sıradadır. Ancak, yenilenebilir enerji kaynaklı üretim beklentinin çok altında kalmıştır. Hidroelektrik enerji üretimi yaklaşık %20 oranında olsa da, rüzgar, güneş ve jeotermal kaynaklara dayalı toplam üretim yaklaşık %10'dur. Akkuyu nükleer santralinin faaliyete geçmesi ve diğer nükleer enerji santrallerinin kurulması ile bu tablo kuşkusuz değişecektir, ancak orta vadede bu tüketim oranlarında ciddi bir değişiklik beklemek gerçekçi olmayacaktır. Şu anda, elektrik santralleri en düşük maliyetli kömürü tercih etmekte, ardından doğal gaz temelli üretimi tercih etmektedir. Ne yazık ki, Türkiye'nin zengin doğal gaz kaynakları yoktur ve doğal gaz ithalatı için İran ve Rusya'ya bağımlıdır. Bu, elektrik sektörünü uluslararası piyasalara bağımlı hale getirmektedir. Rusya-Ukrayna savaşı sırasında ani bir yükseliş yaşayan ve ciddi volatilite gösteren doğal gaz piyasası, Türkiye için kritik bir

pozisyonda bulunmaktadır. Bu çalışmanın amacı, Türkiye'deki elektrik şirketlerinin doğal gaza ve kömüre olan bağımlılığını ortaya koymaktır. İncelediğimiz kadarıyla, özellikle elektrik sektörünü inceleyen çalışmaların sayısı çok azdır. Genellikle petrol ve doğal gaz şirketlerini içeren enerji sektörü incelenmiş, ancak stratejik öneme sahip olan elektrik üreticileri literatürde ihmal edilmiştir. Bu çalışmada, Türkiye'deki elektrik şirketlerinin hisselerinin doğal gaza ve kömüre olan bağımlılığı ve diğer makroekonomik göstergelerle olan ilişkisi, dilim regresyon yöntemi kullanılarak incelenmektedir. Dilim regresyon yönteminin OLS yöntemine göre birçok avantajı bulunmaktadır. Dilim regresyon yöntemi, bağımlı değişkenin farklı dağılımlarında regresyon analizi yapar ve bunu koşullu ortalamaya dayanmaksızın analiz eder. Ayrıca, OLS yönteminde sağlanması gereken eş varyans ve normal dağılım varsayımlarına ihtiyaç duyulmadan analiz yapılabilir. Bu çalışma bu yöntemle elektrik şirketlerini inceleyen ilk çalışma olacaktır. Enerji şirketleri için yapılan çalışmalar mevcut olsa da, elektrikle ilgili çalışmalar sınırlı sayıdadır. Koçoğlu & Tanrıöven (2019) Borsa İstanbul'a kote olan enerji şirketlerinin hisse senedi getirilerini etkileyen faktörleri incelemişlerdir. Ancak, çalışmanın yapıldığı dönemde sadece beş enerji şirketi bulunmaktadır ve panel veri modeli ile yapılan çalışma, sektörün farklı finansal piyasa koşullarındaki tepkilerini ölçmemektedir. Bu çalışmanın literatüre katkısı temelde 2 tanedir. BIST Elektrik endeksini etkileyen makroekonomik faktörlerin, özellikle doğal gazın ve kömürün etkisini inceleyen ilk çalışmadır. İkinci olarak, faktörlerin farklı ekonomik koşullarda, yani piyasa düşükse veya yükselse, farklı etkileri incelenmiştir.

Tablo 3, dilim regresyon sonuçlarını sunmaktadır. Yükselen piyasa (düşen piyasa) elektrik sektörünün değer kazanması (kaybetmesi) olarak tanımlanmıştır. BIST Elektrik Endeksi'nin dağılım tablosunun en düşük %10'luk diliminde yer alan dilim 1'de, BIST100 endeksi elektrik hisseleri üzerinde pozitif bir etkiye sahiptir ve borsa değer kazandığında elektrik hisseleri üzerinde beklenildiği gibi yaklaşık %0,80'lik pozitif bir etki yaratmaktadır. %20'lik dilimde, BIST100 istatistiksel olarak anlamlı bir pozitif etkiye sahipken, doğal gaz fiyatları %10 anlamlılık düzeyinde negatif bir etki göstermektedir. BIST Elektrik Endeksi hisselerinin zayıf performans gösterdiği dönemlerde, doğal gaz fiyatlarının olumsuz bir etkisi bulunmaktadır. Bunun nedeni, doğal gaza dayalı elektrik üreten şirketlerin maliyetlerinin önemli ölçüde artmış olmasıdır. %30'luk dilimde sadece BIST100 anlamlı bir etkiye sahiptir. %40'lık dilimde ise BIST100 yine yalnızca pozitif bir etki yaratmıştır. %50 ve %60'lık dilimlerde, BIST100 endeksi istatistiksel olarak anlamlı bir etkiye sahip olmuş ve faiz oranları elektrik şirketleri üzerinde pozitif bir etki yaratmıştır, ancak bu etki yine yalnızca %10 anlamlılık düzeyindedir. %70'lik dilimde, yani boğa piyasası anlamına gelen durumda,

BIST100 endeksinin pozitif istatistiksel etkisi gözlemlenmiştir. Ayrıca, bu dilimde kömür fiyatlarının negatif etkisi gözlemlenmiştir. %80'lik dilimde, BIST100 endeksinin istatistiksel olarak güçlü bir pozitif etkisi bulunmuş ve faiz oranlarının da yalnızca %10 anlamlılık düzeyinde pozitif bir etkisi olmuştur. Ayrıca, bu dilimde doların artan değeri beklendiği gibi elektrik hisseleri üzerinde negatif bir etki yaratmıştır. %90'lık dilimde BIST100'ün istatistiksel olarak anlamlı pozitif etkisi gözlemlenmiştir. Faiz oranları artarken BIST Elektrik Endeksi hisselerinin pozitif etkilenmesi oldukça şaşırtıcıdır, ancak bunun nedeni, uygulanmakta olan Türkiye Ekonomik Modeli olabilir. Faiz oranı artıyor gibi görünse de Türkiye Cumhuriyet Merkez Bankası'nın faiz oranlarını beklenenden çok daha düşük artırması nedeniyle hisseler üzerinde pozitif bir etki yaratmıştır.

Karbon, dünyanın yaşanabilir bir gezegen olmasının sebebidir ve canlıların varlığı için yeterli ısının atmosferde hapsolmasını sağlar. Karbon, güneşten gelen ısıyı uzaya geri dönmesini engelleyerek dünyanın sıcaklığını dengeleyerek stabilize eder. Ancak sanayi devrimi ile birlikte insanlık, fosil yakıtlara dayalı ekonomik büyüme modeline geçmiş ve yer altında tuttukları karbonu içeren fosil yakıtları yakmaya başlamıştır. Bu sonucunda atmosfer daha fazla ısıyı tutmaya başlamış ve dünya hızla ısınma sürecine girmiştir. İklim değişikliği artık dünyadaki tüm ülkelerin en büyük güvenlik sorunudur. Karbon emisyonunun büyük oranından sorumlu olan ve fosil yakıtlara dayalı üretim yapan elektrik şirketleri, çok iyi anlaşılmalı ve analiz edilmelidir. Bu çalışmada, Türkiye'deki elektrik şirketlerinin hisse getirilerini etkileyen makroekonomik faktörler, özellikle doğal gaz ve kömür fiyatları incelenmektedir. Çalışmanın sonuçları şöyle özetlenmektedir:

İlk olarak, Sharpe'ın (1964) tezini doğrulayarak, her dilimde yani her piyasa koşulunda BIST 100 endeksinin elektrik endeksi üzerindeki pozitif etkisi doğrulanmıştır. Borsa endeksindeki yükseliş (düşüş), elektrik şirketlerinin hisse fiyatlarında yükselişe (düşüşe) neden olmaktadır. İkinci faktör olarak, dolar ve lira arasındaki döviz kurunun elektrik hisse getirileri üzerindeki etkisi incelenmiştir. %80'lik segmentte, yani boğa piyasası durumunda, döviz kurundaki artış, yani Türk lirasının değer kaybetmesi, elektrik hisselerinin getirisini olumsuz etkilemiştir. Üçüncü faktör olarak kömür seçilmiştir. Boğa piyasasında kömürün elektrik firmaları üzerindeki olumsuz etkisi gözlemlenmiştir. Dördüncü faktör olarak doğal gaz fiyatlarının etkisi incelenmiş ve doğal gazın yalnızca %10 anlamlılık düzeyinde olduğu tespit edilmiştir. Doğal gaz fiyatlarının negatif etkisi, elektrik hisselerinin değer kaybettiği ayı piyasası durumunda gözlemlenmiştir. Elektrik piyasası değer kaybettiğinde yükselen doğal gaz fiyatlarını bir risk faktörü olarak tanımlamışlardır. Son olarak, faiz oranlarının etkisi incelenmiştir. Faiz oranı faktörü de yalnızca %10 anlamlılık düzeyinde anlamlıdır. Borsa ve

elektrik piyasası değer kazandığında, normal piyasada ve ayı piyasasında faiz oranlarındaki artışın elektrik şirketlerinin hisseleri üzerinde pozitif bir etkisi olmuştur. Bu sonuç, beklentilerin aksine görünse de, son dönemde Türkiye'de uygulanan yeni ekonomik modelin bir sonucudur. Merkez Bankası, borsanın değer kazandığı dönemde faiz oranlarını artırmış olmasına rağmen, bu faiz artışları, mevcut enflasyon oranının oldukça altında sınırlı kaldığı için piyasa bu faiz artışlarını olumlu bir şekilde yorumlamıştır. Türkiye ekonomik modeli kapsamında, Borsa İstanbul rekorlar kırmış ve elektrik sektörü bu durumdan olumlu etkilenmiş görünmektedir.

Bu çalışma iki şekilde katkıda bulunmuştur. İlk olarak, doğal gaz ve kömür fiyatlarının elektrik sektörü üzerindeki etkisini inceleyen ilk çalışma olmuştur. Ayrıca, kullanılan dilim regresyon analizi ile farklı piyasa koşullarında kullanılan faktörlerin farklı etkileri analiz edilmiştir. Gelecekteki çalışmalarda, BIST Elektrik endeksindeki doğal gaz ve kömür santrallerine yatırım yapan şirketler ayrıştırılmalı ve bu şirketlerin hisselerinin doğal gaz ve kömür fiyatlarına nasıl bağımlı olduğu analiz edilmelidir. Türkiye için bir güvenlik sorunu olan enerji sektörü ile doğal gaz ve kömür arasındaki ilişki daha detaylı bir çalışma ile incelenmelidir.