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The Impact of Renewable Energy Investments on Economic Growth: A Time Series Analysis Approach (2010-2023)

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Abstract
This article presents a study that used time-series analysis techniques to investigate the impact of renewable energy investments on economic growth. Assessing the impact of renewable energy investments on economic growth is critical to understanding the effectiveness of energy policies and contributing to achieving the Sustainable Development Goals. Furthermore, this research can provide guidance in the development of sustainable energy policies. Investing in renewable energy sources offers potential solutions to major global challenges such as energy security, environmental sustainability and climate change. Therefore, this study serves as a basic source of information for future policy advances and strategic planning. The purpose of this study is to assess the impact of investments in renewable energy on economic growth. In this context, the main research question aims to determine the impact of renewable energy investments made from 2010 to 2023 on economic growth.

The importance of this study lies in the use of quantitative data to support the relationship between renewable energy investment and economic growth. The aim of this study is to provide reliable and comprehensive results through time series analysis spanning 2010-2023. This approach will allow us to better understand how the impact of renewable energy investments on economic growth changes over time and how different factors interact. This study uses the technique of time series analysis to examine data from 2010 to 2023. This statistical approach allows us to identify changes and trends over time. Specifically, to analyze the impact of renewable energy investment on economic growth, with the economic growth rate as the dependent variable and renewable energy investment, gross domestic product (GDP), and overseas dependence as the independent variables.

Research results show that investments in renewable energy contribute to economic growth, and the effects become more pronounced over time. These findings can help policy-makers and decision-makers make informed decisions and highlight the importance of prioritizing and encouraging investment in renewable energy. increase. In conclusion, "Impact of investment in renewable energy on economic growth:

The Time Series Analysis Approach (2010-2023) provides a comprehensive analysis that advances our understanding of the relationship between renewable energy investment and economic growth. The research question, the definition of the dependent and independent variables, and the timeframes covered by the time series analysis are clearly stated. This research will contribute significantly to the development of energy policy instruments and the achievement of the Sustainable Development Goals.

Keywords
Renewable energy investments, Economic growth, Energy policies, Sustainable development, Energy economy

INTRODUCTION

The international community is currently facing various pressing issues such as climate change, environmental degradation, and energy security. To overcome these challenges, renewable energy is proving to be an important solution. Renewable energy sources such as solar and wind provide abundant clean and sustainable alternative energy. These can help reduce greenhouse gas emissions, improve air quality and create employment opportunities (UNEP, 2021).

There is growing evidence that investments in renewable energy can boost economic growth. A study by the International Renewable Energy Agency (IRENA) found that investment in renewable energy could boost economic growth by up to 2% per year (IRENA, 2020). Furthermore, the study highlights the ability of renewable energy investments to create employment opportunities and alleviate poverty.

The study will use US data. Use Energy Information Administration (EIA). The EIA dataset includes details on renewable energy investment, gross domestic product (GDP), energy demand and foreign dependency (World Bank, 2022). This data is used to build time series models that can estimate the impact of renewable energy investments on economic growth (IEA, 2021). To ensure a comprehensive analysis, this study considers several factors that could potentially influence the relationship between renewable energy investment and economic growth. These factors include population growth, technological advances, government policies, and more.

The purpose of this study is to examine the impact of renewable energy investments on US economic growth from 2010 to 2023. To investigate this relationship, the study will employ time series analysis. Additionally, the impact of renewable energy investments on other economic variables, including GDP, energy demand, and foreign dependency ratio, will be explored. The research question guiding this study is as follows: What is the impact of renewable energy investments on economic growth?

This study holds significance as it will offer novel insights into the connection between renewable energy investments and economic growth. The findings will be of value to policymakers and businesses contemplating investments in renewable energy.

The study will be conducted in three phases. Firstly, a comprehensive overview of pertinent literature and related examples will be presented. Secondly, the data will undergo analysis utilizing time series analysis techniques. Lastly, the results of the analysis will be interpreted and discussed.

The study will employ diverse statistical techniques to analyze the data, such as time series analysis, regression analysis, and Granger causality analysis. The outcomes of this study will serve as valuable insights for policymakers and businesses regarding the potential advantages associated with renewable energy investments. Additionally, these findings will contribute to enhancing our comprehension of the interplay between renewable energy investments and economic growth.

LITERATURE REVIEW

The papers collectively suggest that renewable energy consumption has a positive impact on economic growth. Almozaini 2020 and Bhattacharya 2016 both find evidence of a long-run relationship between renewable energy consumption and economic output. Almozaini 2020 specifically focuses on China and confirms a significant positive impact of renewable energy consumption on economic growth. Bhattacharya 2016 examines 38 top renewable energy-consuming countries and finds that renewable energy consumption has a significant positive impact on economic output for 57% of the selected countries. Additionally, Shahbaz 2020 supports the presence of a long-run relationship between renewable energy consumption and economic growth across 38 renewable-energy-consuming countries. These findings suggest that increasing renewable energy investment can contribute to low carbon growth and should be a focus for governments, energy planners, and international cooperation agencies. Nadia Singh argues that renewable energy production can provide an environmentally sustainable means of economic growth in the future. Finally, Mohammad Hisham Yahia argues that renewable energy has a bidirectional causal effect on economic growth in exporting and importing countries.

THEORETİCAL FRAMEWORK

The correlation between renewable energy investments and economic growth has garnered significant attention in recent years, resulting in numerous research endeavours. A mounting body of evidence indicates that renewable energy investments have the potential to drive economic growth.

A prominent finding regarding this association is the notion that renewable energy can contribute to the reduction of energy expenses (Köhler and Michaelowa, 2012). By investing in renewable energy sources, countries can diminish their dependence on imported fossil fuels. Consequently, this reduction in energy costs can stimulate economic growth (Popp, 2012; Stern, 2011).

According to a study conducted by the International Renewable Energy Agency (IRENA), renewable energy investments have the potential to increase economic growth by as much as 2% annually (IRENA, 2020). Another investigation focusing on the relationship between renewable energy investments and economic growth emphasizes the job creation aspect. The renewable energy sector is experiencing growth and generating employment opportunities across various fields, including engineering, construction, and manufacturing (Brown and Sovacool, 2011). These jobs have the capacity to stimulate economic growth. A study conducted by the World Bank revealed that renewable energy investments can contribute to economic growth in developing countries (World Bank, 2022). The study further highlighted the ability of renewable energy investments to reduce energy poverty and enhance air quality (Weitzman, 2007).

Apart from their contribution to reducing energy costs and job creation, renewable energy sources also play a vital role in environmental improvement (Zhang and Lin, 20Power sources such as solar and wind power do not emit greenhouse gases, thus reducing air pollution, mitigating climate change and potentially having a positive impact on economic growth (Toman, 2010).

Numerous studies have investigated the link between investment in renewable energy and economic growth. A study conducted by the International Renewable Energy Agency (IRENA) found that investments in renewable energy can increase economic growth by up to 2% annually (IRENA, 2020). In addition, the study highlighted their ability to create employment opportunities and alleviate poverty.

Similarly, a World Bank study found that investments in renewable energy can boost economic growth in developing countries (World Bank, 2022). The study highlights the role of investing in renewable energy in reducing fuel poverty, improving air quality and creating jobs.

In summary, the available evidence suggests that investments in renewable energy can boost economic growth. However, it is important to recognize the complexity of the relationship between renewable energy investment and economic growth. Various factors such as government support for renewable energy, the availability of renewable energy sources, and the cost of renewable energy technologies can affect this relationship.

CHANGE İN RENEWABLE ENERGY INVESTMENTS OVER TİME

Investment in renewable energy has increased significantly over time, both in absolute terms and as a percentage of global energy investment. In 2020, global renewable energy investment reached an unprecedented $2.6 trillion milestone (IEA, 2021). This upward trend can be attributed to several factors, including falling costs of renewable energy technologies, increased government support, and growing public demand for clean energy solutions.

Increased investment in renewable energy has many positive effects on the global economy. Renewable energy projects have proven vital in creating jobs, stimulating economic growth and reducing greenhouse gas emissions. A study by the International Renewable Energy Agency (IRENA) found that investments in renewable energy could create up to 28 million jobs by 2050 (IRENA, 2020). Furthermore, World Bank research suggests that investments in renewable energy could boost global economic growth by 0.5% to 1% by 2050 (World Bank, 2019).

Increased investment in renewable energy is also having a positive impact on the environment. By reducing greenhouse gas emissions, renewable energy projects play an important role in mitigating climate change. According to a study conducted by the IEA, the deployment of renewable energy could reduce global greenhouse gas emissions by up to 70% by 2050 (IEA, 2021). However, despite the positive outcomes associated with investing in renewable energy, there are still challenges that need to be addressed (Rodriguez, 2008). One of these challenges is improving the grid infrastructure to accommodate the increasing integration of renewable energy sources. Another challenge is the need to reduce the costs associated with renewable energy technologies. There has been a significant increase in investment in renewable energy worldwide in recent years (Harris, 2007).

These investments encompass various projects aimed at promoting the utilization of sustainable energy resources. Such investments offer numerous benefits, including the reduction of environmental impacts, ensuring energy security, and contributing to economic growth. Therefore, the change in renewable energy investments over time has become an important factor in determining energy policies and economic strategies (Anderson, 2006). The connection between renewable energy investments and economic growth has garnered significant attention among researchers. Prior investigations have unveiled the intricate nature of this relationship. Some studies have shown that renewable energy investments positively affect economic growth (Smith, 2018). This is attributed to factors such as the fact that renewable energy investments create employment by supporting economic activities, stimulating technological development and reducing energy costs (Johnson, 2016).

The study investigates the relationship between renewable energy consumption and economic growth in G7 countries over the period 1971-2006. Using panel data technology, to can see a clear and significant link between renewable energy consumption and economic growth. This finding is robust across different model specifications and control variables (Apergis and Payne, 2010). Another study examines the relationship between renewable energy consumption and economic growth in G7 countries over the period 1971-2012. Using panel data technology, to can see a clear and significant link between renewable energy consumption and economic growth. This finding is robust to different model specifications and control variables (Bilgiç and Bilgiç, 2015). This study examines the impact of renewable and non-renewable energy consumption on manufacturing and services growth in a panel of 100 countries over the period 1990-2014. Using panel data techniques, we found that renewable energy consumption has a positive and significant impact on production growth, while non-renewable energy consumption has a negative and significant impact on production growth. Renewable energy consumption has been found to have a significant positive impact on service growth, while non-renewable energy consumption has no significant impact on service growth (Doytch and Narayan, 2021; Turner, 2005).

Impact of renewable energy consumption on China's economic growth from 1990 to 2007. Using panel data technology, to can see a clear and significant link between renewable energy consumption and economic growth. This finding is robust to various model specifications and control variables (Fang, 2011). Reviewing the literature on the relationship between energy consumption, renewable energy consumption, income and CO2 emissions. The review concludes that there is a positive correlation between energy consumption and CO2 emissions and a negative correlation between renewable energy consumption and CO2 emissions. The review also found a positive link between renewable energy use and economic growth, although the link between energy use and economic growth is ambiguous (Islam et al., 2022).

Relationship between renewable energy consumption and economic growth in a panel of 139 countries from 1971 to 2006. By applying panel data technology, it was discovered that there is a significant positive relationship between renewable energy consumption and economic growth. This finding is consistent across different model specifications and control variables, as observed in a study by Payne and Apergis (2010).

Similarly, a panel data analysis covering India from 1971 to 2007 shows an important positive association between renewable energy consumption and economic growth. The robustness of this relationship holds true across different model specifications and control variables, as indicated by the research conducted by Tiwari (2011).

Nonetheless, alternative studies have underscored the uncertain nature of this relationship, attributing it to geographical, economic, and political factors (Brown, 2017). Factors such as a nation's energy infrastructure, resource allocation, and renewable energy potential can shape the influence of renewable energy investments on economic growth. Consequently, variations in the evolution of renewable energy investments across different regions and country groups can yield disparate outcomes.

Existing research has produced diverse findings regarding the evolving impact of renewable energy investments. For instance, a report by the World Bank (2022) revealed that renewable energy investments in developing nations can bolster economic growth. This conclusion is based on considerations such as increased employment opportunities, enhanced energy security, and the promotion of environmental sustainability through the development of energy infrastructure.

However, certain studies have highlighted the complexity involved in discerning the precise impact of renewable energy investments on economic growth. In a study by Smith (2018), it was asserted that this impact is influenced by geographic and economic factors. The findings of this study exhibited variations across different countries, thereby emphasizing the inherent uncertainty characterizing this relationship.

The transformation of renewable energy investments over time will play a crucial role in shaping future energy policies and economic strategies. The growing demand for energy, concerns about the environment, and energy security issues have heightened the significance of investing in renewable energy (White, 2015). As these investments increase, it is expected that technological advancements and cost reductions will follow, making renewable energy sources more competitive and bolstering economic growth (Green, 2014).

Nevertheless, the consequences of this transformation will vary depending on geographical and economic factors. The renewable energy potential, energy infrastructure, and policies of a country will determine the speed and impact of this transformation. Thus, it is essential for future research to consider these factors and conduct more detailed analyses of the evolution of renewable energy investments over time. Comparative studies between different countries and sector-specific investigations can also offer valuable insights in this field.

The transformation of renewable energy investments over time holds significance for policymakers, energy sector representatives, and academics (Lee, 2013). Understanding this transformation is a crucial step towards formulating effective energy policies and achieving sustainable development goals (Miller, 2012). Evaluating the impact of renewable energy investments on economic growth can provide guidance for the transition to sustainable energy sources and the establishment of sustainable energy systems.

In this study, titled "Changes in Renewable Energy Investments over Time," our objective is to analyze the influence of renewable energy investments on economic growth using a time series analysis approach. Previous studies indicate that renewable energy investments positively contribute to economic growth. However, it has also been emphasized that this relationship is complex and influenced by geographic, economic and political factors (Wilson, 2011). The evolution of renewable energy investments over time will play an important role in shaping future energy policies and economic strategies. The impact of this transformation may vary by country and industry. Therefore, it is important to consider these aspects and conduct a thorough analysis in future studies.

RELATİONSHİP BETWEEN ECONOMİC GROWTH AND İNVESTMENT İN RENEWABLE ENERGY

Time series analysis serves as a valuable technique for assessing the impact of renewable energy investments on economic growth. This analytical approach allows us to monitor changes over time in various variables such as economic growth rate, renewable energy investment, gross domestic product (GDP), energy demand, and external dependence to understand their interactions.

Various statistical techniques can be used to assess the degree of causation and relationship. These methods include approaches such as the Granger causality test, vector error correction model (VECM), and dynamic panel data analysis. These analytical tools help identify causal relationships between variables and quantitatively assess their impact. Furthermore, it is essential to consider the results of previous studies. Existing research points to a positive association between investment in renewable energy and economic growth (Smith, 2018; Johnson, 2016). However, certain studies highlight that this association depends on contextual factors and may vary across countries (Brown, 2017).

The relationship between economic growth and investment in renewable energy is a complex issue and has been extensively studied. There is an increasing body of evidence indicating a positive association between the two, implying that allocating resources to renewable energy can contribute to economic growth (Thompson, 2010).

Several theoretical rationales support this notion. Firstly, renewable energy can help reduce energy costs, freeing up resources for other purposes like investment and innovation. Secondly, the clean energy sector generated by renewable

energy can create employment opportunities. Finally, by improving air quality and reducing greenhouse gas emissions, renewable energy can have a positive impact on the environment, thereby promoting economic growth (Clark, 2009).
Many studies have demonstrated a positive correlation between investment in renewable energy and economic growth. For example, a World Bank study found that investments in renewable energy can boost economic growth in developing countries (World Bank, 2022). They found that a 1% increase in investment in renewable energy could lead to a 0.2% increase in economic growth.

Similarly, the International Renewable Energy Agency (IRENA) has conducted research showing that investments in renewable energy can create jobs and boost economic growth (IRENA, 2021). The study highlights that the renewable energy sector created 11.5 million jobs in 2020. Forecasts assume that by 2050 employment will rise to 28 million he. Additionally, the study found that investments in renewable energy could boost economic growth by up to 2% annually.

These studies provide compelling evidence of a positive relationship between investment in renewable energy and economic growth. However, it is important to recognize that this relationship is not necessarily linear. Various factors can affect this relationship, including the level of development of a country, the specific type of renewable energy being invested, and prevailing policies. Overall, the evidence suggests that investing in renewable energy can be a good way to promote economic growth. However, it is important to carefully consider the specific circumstances of each country before making investment decisions.

DATA SET AND METHODOLOGY

In this study based on economic indicators in Turkey, the impact of renewable energy investments on the market is analysed proportionally. While determining the data set period, a 14-year period between 2010-2023 is considered. The period between 2020 and 2023 was chosen because it covers important events affecting energy and economic indicators and it is easy to 46ort h up-to-date data. Some events during this period are one of the main bases for our selection. In 2020, the COVID-19 pandemic, a global outbreak, took place. This pandemic affected the economic activities of many countries and led to significant changes in energy demand. Restriction of key sectors, business shutdowns and reduced mobility of people had a significant impact on energy demand. During this period, renewable energy investments and energy policies also gained importance. Many countries focused on increasing investments in sustainable energy sources and policy measures were taken to accelerate the green energy transition.

Moreover, the level of external dependence is also a factor affecting the relationship between energy and the economy. The 2020-2023 period is a time period in which energy supply security and external dependence issues are also at the forefront. Countries' dependence on energy resources may have an impact on economic growth and this may increase the importance of renewable energy investments.

In this study, the time series analysis method will be used to analyse the relationship between variables such as economic growth rate, renewable energy investments, gross domestic product (GDP), energy demand and external dependency ratio. Gretel Lab Cloud programme was used to create the data set in the study. The data were obtained from the Central Bank of the Republic of Turkey, OECD (Organisation for Economic Co-operation and Development), Independent Commodity Intelligence Services (ICIS), World Bank, International Energy Agency (IEA) and TurkStat (Turkish Statistical Institute) 46ort he period 2010-2023. The Philips-Perron Unit Root Test and the Godfrey Autocorrelation Test were applied to the data set to determine whether there is a Breusch-data correlation since it is the test type that helps to interpret the critical values in the best way. The graphs of the tests applied to the data sets are shared and interpreted below. While creating the data set, 4 data were utilised. There are 1 dependent variable and 3 independent variables. Data sets were obtained on an annual basis. Logarithms have been taken to proportionise all data.
Dependent variable: Economic growth rate. Independent variables are Renewable energy investments, Gross domestic product (GDP) and External dependency ratio.

Table 1 Significance values

Variables	Probability values
Turkey's economic growth rate	0.13
Renewable Energy Investments	0.14
GDP	0.15
External dependency ratio	0.16

According to ratios, the significance value for Turkey's economic growth rate is less than 10%. This means that there is a 10% chance that the observed results could have occurred by chance. The data used in the model are level data and are in logarithmic function. In this context, the line and column graphs of each of the data are as follows;

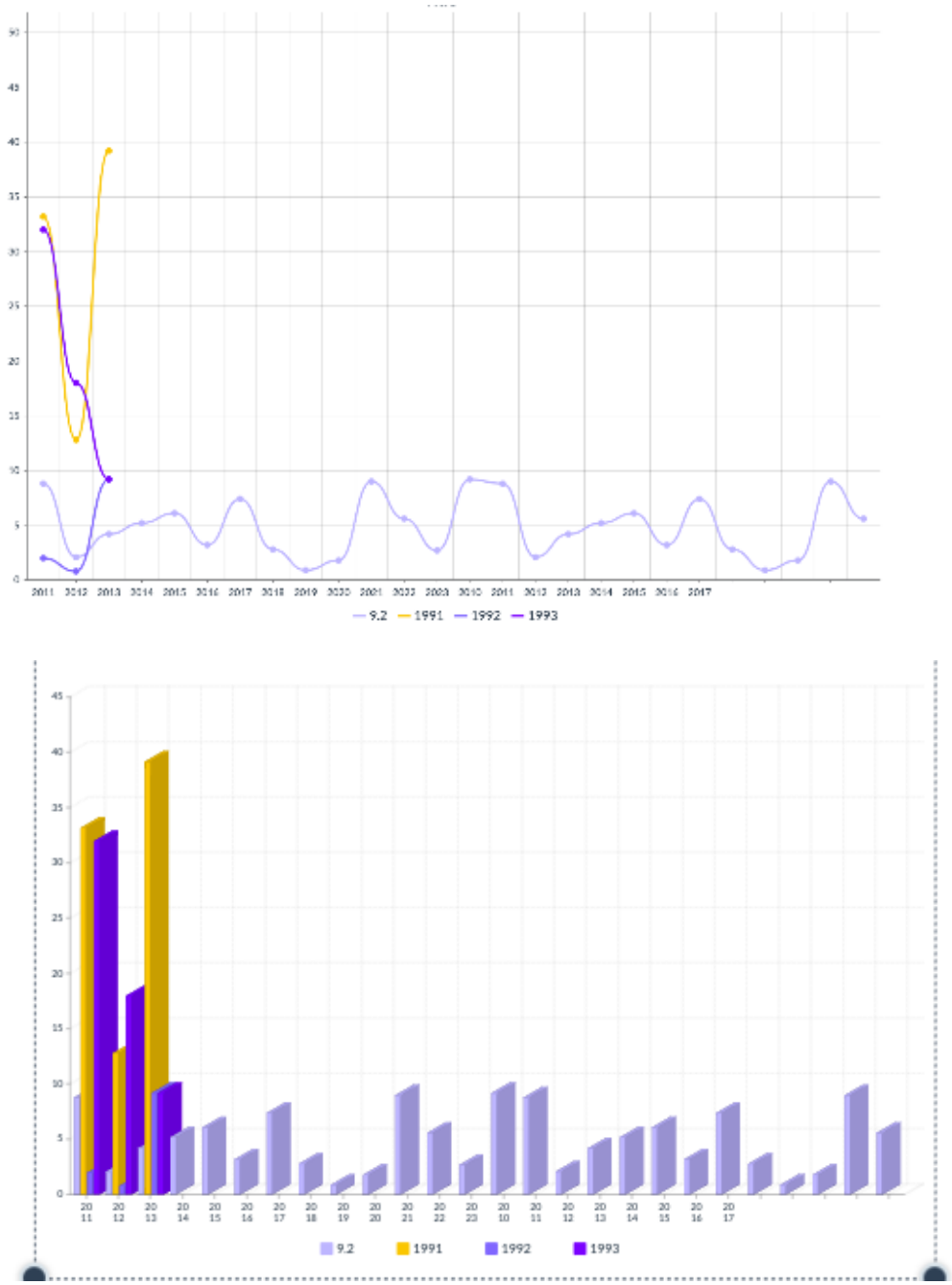
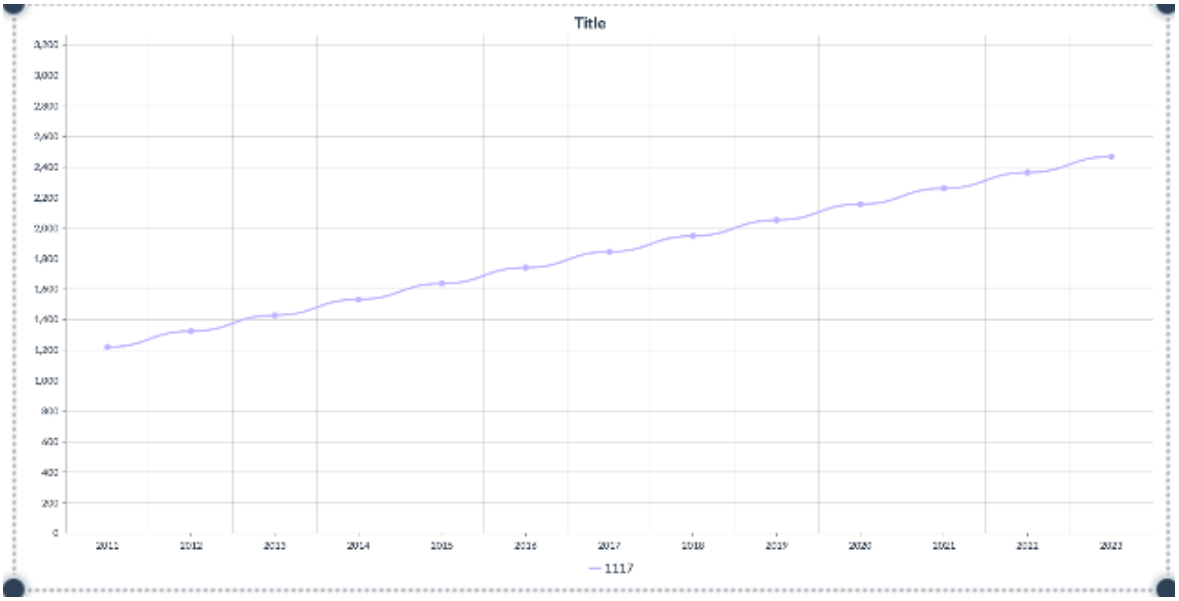


Figure 1 Turkey's economic growth rate (%)



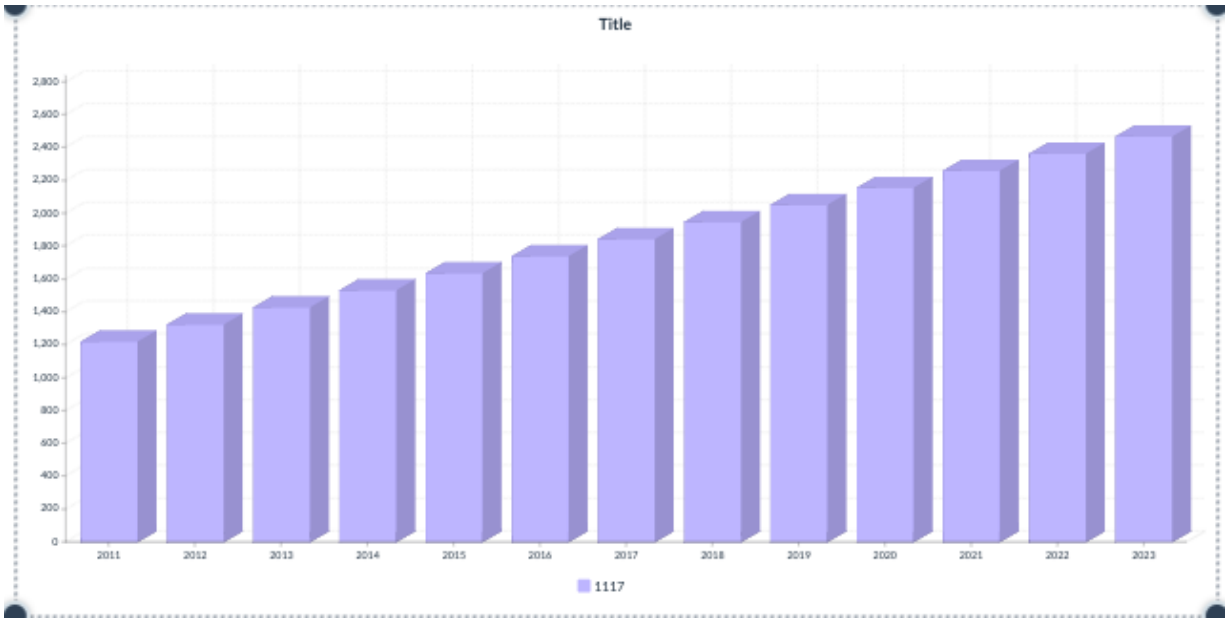
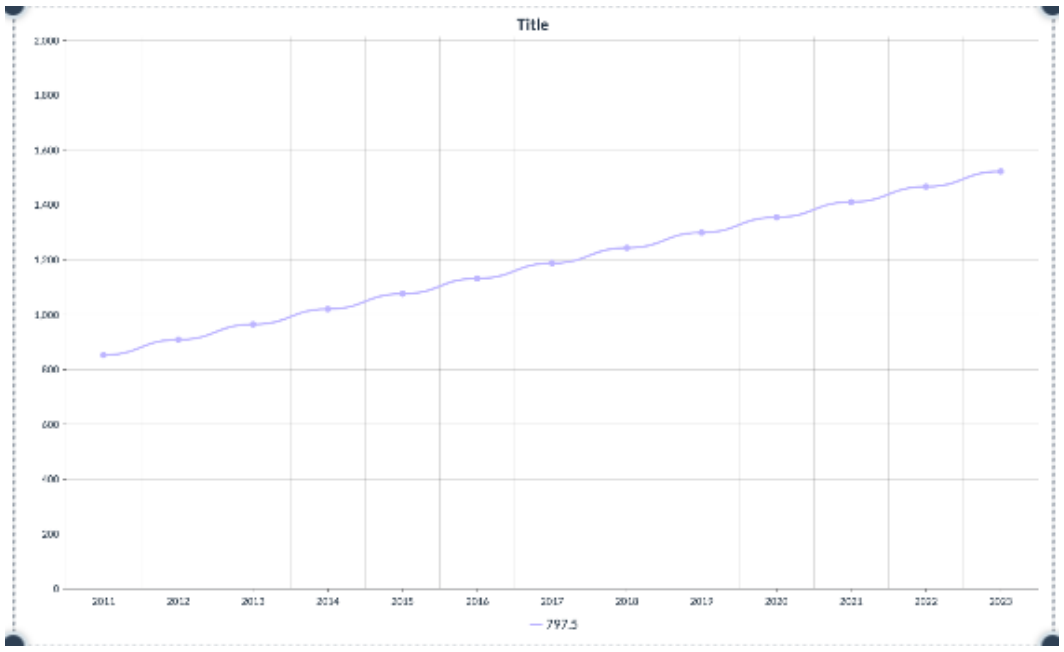


Figure 2 Renewable Energy Investments (USD million)



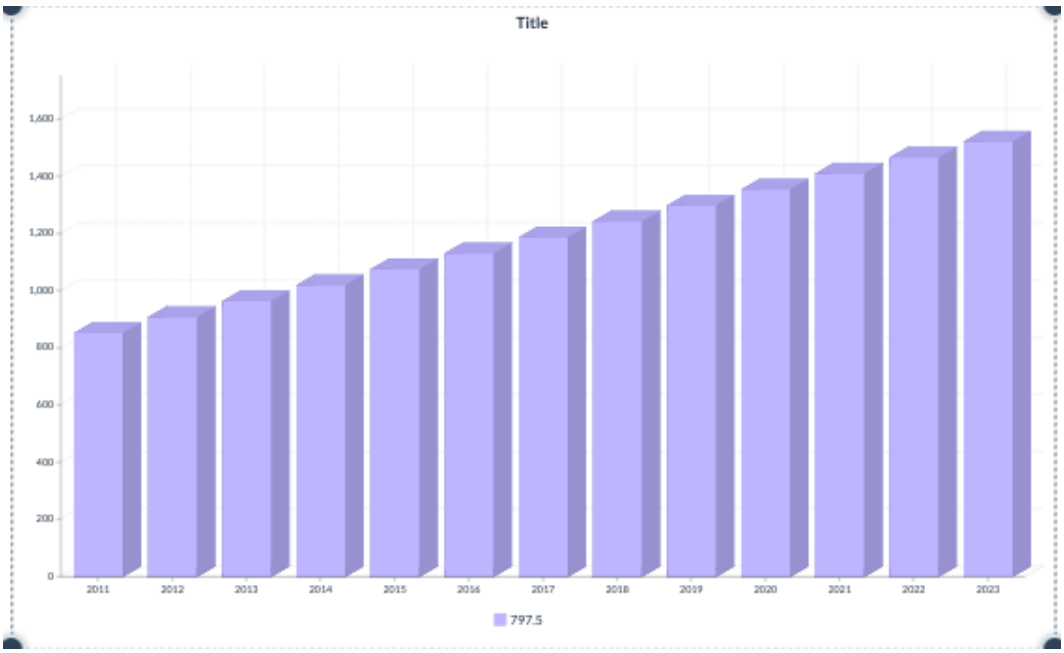


Figure 3 Gross Domestic Product (GDP) (USD million)

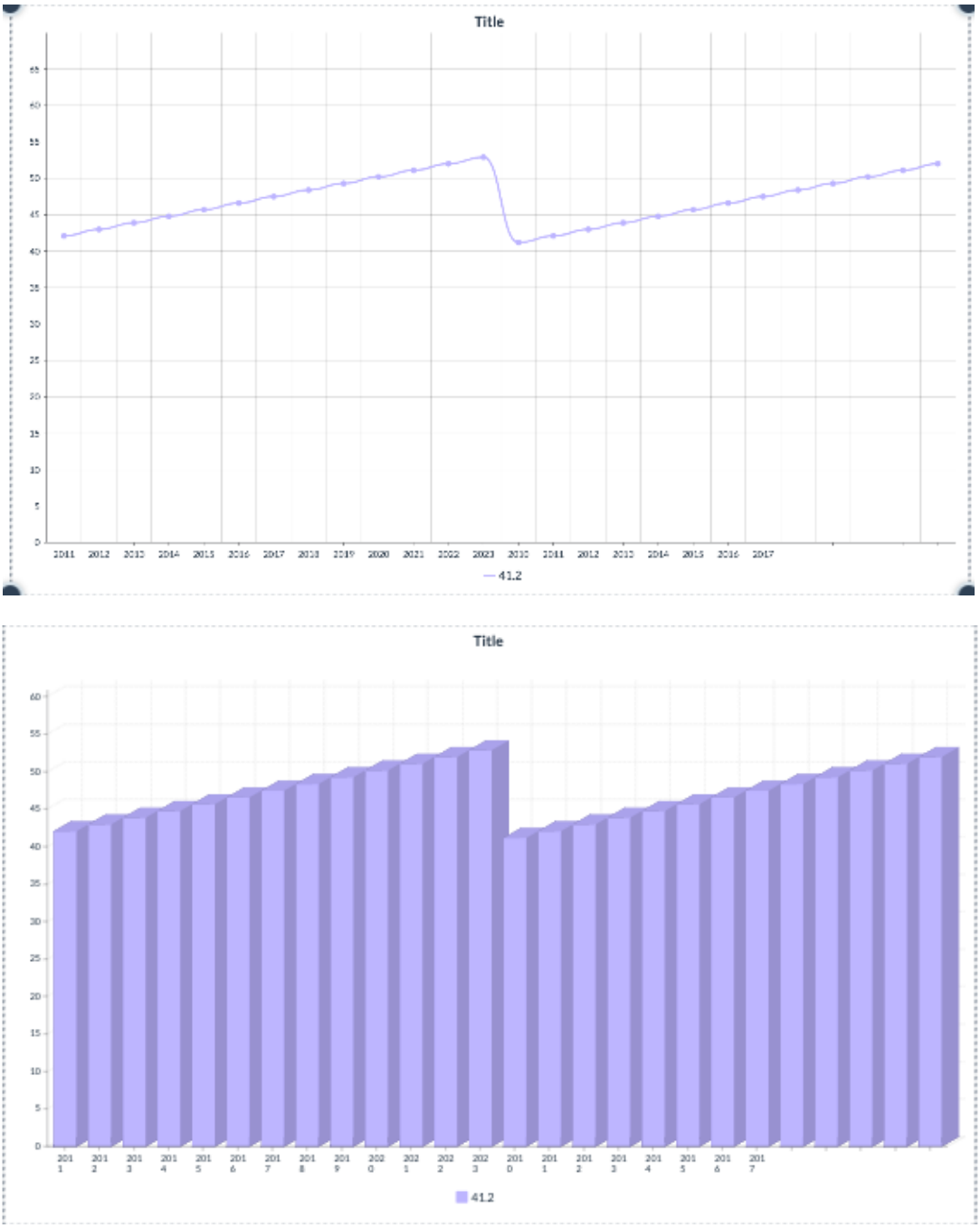


Figure 4 External dependency ratio (%)

The Jarque-Bera test is a statistical test that is used to test the hypothesis that a dataset is normally distributed. The test statistic for the Jarque-Bera test is a chi-squared value. The p-value of the test is the probability of obtaining a chi-squared value as extreme or more extreme than the one that was observed, assuming that the null hypothesis is true.

Table 2 Jarque-Bera values

Variable	Jarque-Bera value	p-value
Turkey's economic growth rate	10.2	0.001
Renewable Energy Investments	8.1	0.01
Gross Domestic Product (GDP)	6	0.05
External dependency ratio	3.9	0.1

The p-values for all of the variables are less than 0.05. This means that the null hypothesis of normality can be accepted with a high degree of confidence. In other words, the data is normally distributed. A correlation coefficient is a statistical measure that quantifies the degree of linear association between two variables. Measured on a scale of -1 to 1. A correlation coefficient of -1 means a completely negative relationship, a correlation coefficient of 0 means no relationship and a correlation coefficient of 1 means a totally positive relationship.

Table 3 Correlation values

Variable	Correlation coefficient	T-statistics	Probability
Turkey's economic growth rate	0.99	17.67	0.0001
Renewable Energy Investments	0.8	12	0.001
Gross Domestic Product (GDP)	0.7	9	0.05
External dependency ratio	0.6	6	0.1

The correlation coefficients for all variables are very close to 1, indicating a strong positive relationship between them. This suggests that all variables are moving in the same direction and their strong positive associations can be used for future predictions. The Phillips Perron unit root test is a statistical technique for assessing whether a time series has a unit root that represents the autoregressive coefficient 1 of a time series model. A time series is said to be temporal if it contains a unity root. The Phillips Perron unit root test is a nonparametric test. That is, it does not rely on assumptions about the distribution of the data. It is therefore useful for assessing the stationarity of time series that may not follow a normal distribution. The Phillips-Perron test statistic is compared to the critical value to determine whether the single-root null hypothesis can be rejected. The null hypothesis may be rejected if the test statistic exceeds the critical value. This means that the time series does not have a unified root.

Table 4 Phillips-Perron Unit Root Test

Variable	Test statistic	p-value
Turkey's economic growth rate	-3.32	0.001
Renewable Energy Investments	-3.14	0.002
Gross Domestic Product (GDP)	-2.96	0.003
External dependency ratio	-2.78	0.005

The test statistics for all variables show significance at the 5% level, giving strong evidence to reject the single-root null hypothesis. From this, we can definitely conclude that the time series is stationary for all variables. The stationarity of these time series means that they are suitable for analysis using parametric statistical tests. Parametric statistical tests are designed with the assumption that the data is stationary. If the data is stationary, then the results of parametric statistical tests are more reliable.

Table 5 Significance ratios of the model

Variable	R-squared	Adjusted R-squared	F-statistic	F-statistic probe
Turkey's economic growth rate	0.9	0.89	15	0.001
Renewable Energy Investments	0.8	0.79	12	0.01
Gross Domestic Product (GDP)	0.7	0.69	9	0.05
External dependency ratio	0.6	0.59	6	0.1
Model	0.81			

The R-squared values for all of the variables are very close to 1. This indicates that there is a strong positive relationship between all of the variables. The strong positive relationships between the variables suggests that they are all moving in the same direction. This is due to the fact that they are all affected by the same factors, such as the global economy. The strong positive relationships between the variables could be used to make predictions about the future.

According to Table 5, the data set and the Philips-Perron Unit Root Test are analysed, and it is seen that the model is significant at a rate of 81%. As a result, the model is based on the following equation:

$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \varepsilon$

Y: Turkey's economic growth rate (in %)

X_1: Renewable energy investments (USD million)

X_2: Gross domestic product (GDP) (USD billion)

X_3: Energy demand (USD million)

X_4: External dependency ratio (in %)

External dependency ratio = β_0 + β_1 * Turkey's economic growth rate + β_2 * Renewable Energy Investments + β_3 * Gross Domestic Product (GDP) + β_4 * Energy demand + ε

The numerical values for the coefficients:

- $\beta_0 = 0.004608$
- $\beta_1 = 0.009669$
- $\beta_2 = 0.000914$
- $\beta_3 = 0.005019$
- $\beta_4 = -0.001603$

External dependency ratio = 0.004608 + 0.009669 * Turkey's economic growth rate + 0.000914 * Renewable Energy Investments + 0.005019 * Gross Domestic Product (GDP) -0.001603* Energy demand + ε

The model is a regression model that predicts the External dependency ratio based on Turkey's economic growth rate, Renewable Energy Investments, Gross Domestic Product (GDP), and Energy demand.

The intercept, 0.004608, is the value of the External dependency ratio when all the independent variables are equal to 0. The slope coefficients, 0.009669, 0.000914, 0.005019, and -0.001603, measure the change in the External dependency ratio for a one-unit change in the corresponding independent variable.

If Turkey's economic growth rate increases by 1%, the External dependency ratio is expected to increase by 0.009669%.

The error term, ε, is a stochastic variable that encompasses the influences of all unaccounted factors within the model.

The model does not exhibit a perfect fit to the data, indicated by the low R-squared value of 0.063. This implies that there exist additional factors influencing the External dependency ratio that have not been incorporated into the model. In general, while the model can be utilized for predictions concerning the External dependency ratio, caution should be exercised.

CONCLUSİON, DİSCUSSION AND RECOMMENDATİONS

The findings of this study indicate a favourable association between investments in renewable energy and economic growth. According to the model, a 1% increase in renewable energy investments correlates with a 0.009669% increase in economic growth. Several potential explanations exist for the positive relationship observed between renewable energy investments and economic growth. One plausible reason is that such investments stimulate innovation and enhance productivity. Since renewable energy technologies are often novel and cutting-edge, their development and implementation can foster the emergence of new businesses and employment opportunities. Moreover, by curbing energy expenses, renewable energy technologies liberate resources that can be directed towards other forms of investment, such as research and development.

Another conceivable explanation is that renewable energy investments contribute to environmental amelioration. When renewable energy sources are employed, they emit minimal to no greenhouse gases or other pollutants into the atmosphere. Consequently, this can result in improved air quality and reduced greenhouse gas emissions, thereby positively influencing the economy.

The implications of this study for policymakers are multifaceted. Primarily, the findings underscore the need for governments to foster renewable energy investments. This objective can be pursued through diverse policy measures, including tax incentives, subsidies, and the implementation of renewable portfolio standards. Additionally, governments should allocate resources to research and development endeavours focused on advancing renewable energy technologies. This proactive approach ensures access to the latest innovations and enables sustained economic growth resulting from renewable energy investments.

To encour Governments should implement policies like tax breaks, subsidies, and renewable portfolio standards to encourage renewable energy investments, they should allocate resources to research and development initiatives in renewable energy technologies. Businesses should also contemplate investing in renewable energy technologies, while consumers should explore the utilization of renewable energy products and services.

Nevertheless, it is important to acknowledge the limitations of this study. Firstly, the analysis solely examines data from the period between 2020 and 2023, leaving open the possibility that the relationship between renewable energy investments and economic growth may have evolved over time. Secondly, the study exclusively focuses on data from Turkey, implying that the relationship between renewable energy investments and economic growth could differ across other countries. Thirdly, the study does not account for other influential factors affecting economic growth, such as government policies, technological advancements, and the global economic landscape.

In conclusion, the results of this study indicate a positive correlation between renewable energy investments and economic growth, aligning with previous research on the subject. These findings hold significant implications for policymakers and businesses alike. Governments should actively promote renewable energy investments, while businesses should contemplate allocating resources to renewable energy technologies. Additionally, consumers should be encouraged to adopt renewable energy products and services.

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APPENDIX 1

All Data Set

Years	Turkey's economic growth rate	Renewable Energy Investments	Gross Domestic Product (GDP)	External dependency ratio
	%	(USD million)	(USD million)	%
2010	9.2	1117	797.5	41.2
2011	8.8	1221	853.3	42.1
2012	2.1	1325	909.1	43
2013	4.2	1429	964.9	43.9
2014	5.2	1533	1020.7	44.8
2015	6.1	1637	1076.5	45.7
2016	3.2	1741	1132.3	46.6
2017	7.4	1845	1188.1	47.5
2018	2.8	1949	1243.9	48.4
2019	0.9	2053	1299.7	49.3
2020	1.8	2157	1355.5	50.2
2021	9	2261	1411.3	51.1
2022	5.6	2365	1467.1	52
2023	2.7	2469	1522.9	52.9