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Temporal Dynamics Between Renewable Energy Production and Economic Growth in Albania: A Time-Series Analysis (2019-2023)

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Abstract*: This research examines the temporal relationship between renewable energy production and economic growth in Albania during 2019-2023, a period marked by the COVID-19 pandemic and European energy crisis. Using quarterly data from authoritative sources, the study employs correlation analysis, regression modeling, Granger causality testing, and impulse response function analysis. Results reveal a strong positive correlation (r = 0.72) between renewable energy production and GDP per capita, with renewable energy explaining approximately 51% of economic output variation. Granger causality testing indicates a bidirectional relationship between variables. Impulse response analysis shows that positive shocks to renewable energy production generate significant positive GDP responses peaking after three quarters, while economic growth stimulates renewable energy production after two quarters. The findings support the "feedback hypothesis" in energy-growth literature, demonstrating that investments in renewable energy infrastructure stimulate economic growth, while simultaneously, economic expansion facilitates further renewable energy adoption through increased investment capacity. These insights have significant implications for Albania's energy policy and economic development strategies, particularly regarding energy transition, sustainable development objectives, and European integration requirements.*

Keywords: renewable energy, economic growth, time-series analysis energy transition, Albania

INTRODUCTION

The intricate relationship between renewable energy adoption and economic development has emerged as a focal point in both scholarly research and policy discourse, particularly as nations worldwide endeavor to transition toward more sustainable energy systems while maintaining economic prosperity

(Ergun & Rivas,2023;Pata et al.,2023; Ahmad et al.,2021). This relationship holds particular significance for developing economies like Albania, which confront the dual challenge of satisfying growing energy demands while addressing environmental concerns and fulfilling international climate commitments(Smolovic et al.,2020). Albania presents an interesting case study for examining the energy-growth nexus. As a non-EU country in the Western Balkans with aspirations for European integration, The country has been working to align its energy policies with EU standards while navigating the complexities of economic development and has substantial renewable energy potential, particularly in hydropower, which has historically dominated its electricity generation portfolio. However, in recent years, there has been a growing emphasis on diversifying the renewable energy mix to include solar, wind, and other sources (WEFE Nexus,2023). The period from 2019 to 2023 is particularly noteworthy for several reasons. First, it encompasses the global COVID-19 pandemic, which caused significant economic disruptions worldwide. Second, it includes the European energy crisis triggered by geopolitical tensions. Third, it represents a period of accelerated policy development in Albania regarding renewable energy, influenced by both domestic priorities and external factors such as EU accession requirements and international climate agreements.

Previous research examining the relationship between renewable energy and economic growth has produced varied results. Some studies have found positive relationships(Jie et al.,2023; Pata et al., 2023),others a negative or neutral relationship (Johnson, 2022), and still others suggesting that the relationship is context-dependent (Chica-Olmo et al.,2020).These divergent findings highlight the need for country-specific analyses that account for local conditions, policies, and development trajectories. This study aims to contribute to this literature by applying time-series analysis techniques to examine the temporal dynamics between renewable energy production and economic growth in Albania during the 2019-2023 period. Specifically, this paper addresses the following research questions:

What is the temporal relationship between GDP per capita and renewable energy production in Albania during 2019-2023?
Is there a causal relationship between GDP per capita and renewable energy production in Albania?
How do shocks to renewable energy production affect GDP per capita over time, and vice versa?
Can time-series models effectively forecast future trends in renewable energy production and GDP per capita in Albania?

By addressing these questions, the study aims to provide insights that can inform energy policy and economic development strategies in Albania and similar developing economies. The findings may also contribute to the broader theoretical understanding of the energy- growth nexus, particularly in the context of countries undergoing energy transitions.The remainder of this paper is organized as follows: First,it begins with the relevant literature on the relationship between renewable energy and economic growth, with a focus on developing economies. Then,there is a description of the data and methodology employed in this study following the results of the time-series analysis. The next section discusses the implications of these findings for theory and policy. Finally, the article concludes with a summary of key insights and suggestions for future research.

LITERATURE REVIEW

Theoretical Framework

The relationship between energy consumption and economic growth has been extensively studied within several theoretical frameworks(Lu et al.,2023;Topelewski,2021). The Environmental Kuznets Curve (EKC) hypothesis provides one important perspective, suggesting that environmental degradation initially increases with economic development but eventually decreases as higher income levels lead to greater environmental awareness and more stringent regulations (Wang et al.,2024; Grossman and Krueger, 1995). Applied to renewable energy, this theory suggests that as economies develop, they may transition from conventional energy sources to cleaner alternatives, including renewables(Wang et al.,2024).

Energy Transition Theory offers another valuable framework for understanding the progressive shift from traditional to modern energy sources. This theory describes how societies progress through different energy regimes, from biomass to fossil fuels and eventually to renewable sources, as they develop economically and technologically(Yang et al.,2024). The theory emphasizes that these transitions are influenced by a complex interplay of economic, technological, social, and political factors. Economic Growth Theory, particularly endogenous growth models, recognizes the role of energy as a factor of production and highlights how energy efficiency and the quality of energy inputs can influence productivity and economic output (Court et al.,2017; Stern, 2011). These models suggest that the adoption of renewable energy can contribute to economic growth through various channels, including reduced energy import dependence, job creation, technological innovation, and improved energy security.

Empirical Evidence on the Renewable Energy-Growth Nexus

Empirical studies on the relationship between renewable energy and economic growth have nevertheless, yielded diverse findings. Apergis and Payne (2009) conducted one of the seminal studies in this area, analyzing data from 20 OECD countries and identifying bidirectional causality between renewable energy consumption and economic growth. Their research suggested that renewable energy both contributes to and is influenced by economic development, highlighting the complex interdependence between these variables. More recent research has continued to explore this relationship with increasingly sophisticated methodologies. Chen et al. (2023) analyzed data from 30 developing countries and found a positive relationship between renewable energy investment and GDP growth, with the strength of this relationship varying based on the country's level of development and institutional quality. This heterogeneity in outcomes underscores the importance of country-specific analyses that account for local conditions and development contexts. Similarly, Pata et al. (2023) examined the case of Turkey—a country with some economic and geographical similarities to Albania—and found that renewable energy consumption had a positive impact on economic growth, particularly in the long run. Their findings suggested that the benefits of renewable energy adoption may take time to fully materialize, as infrastructure development and system integration processes unfold.

Johnson (2022) analyzed data from sub-Saharan African countries and found no significant relationship between renewable energy adoption and economic growth in the short term, although a positive relationship emerged in the long term. This highlights the importance of considering time horizons when examining the energy-growth nexus. The mixed findings in the literature suggest that the relationship between renewable energy and economic growth is complex and context-dependent. Factors such as the country's level of development, existing energy infrastructure, policy environment, and institutional quality can all influence how renewable energy adoption affects economic outcomes.

Studies on Albania and Similar Economies

The energy sector is accountable for the majority of greenhouse gas (GHG) emissions in the Western Balkans, characterized by low diversification and significant reliance on fossil fuels, particularly coal. In 2021, the region's electricity production was still predominantly dependent on fossil fuels, accounting for over 50% of the total generation. Conversely, Albania did not utilize fossil fuels at all (WEFE Nexus, 2023). Hydropower continues to be the primary source of Renewable energy within the nation, although its share has diminished within the EU since 2021, now constituting the smallest proportion of installed capacity in comparison to wind, solar, and hydropower (WEFE Nexus, 2023). The potential for non-hydro Renewable energy sources, particularly solar and wind, remains largely unexploited in the country. Furthermore, the inadequate coverage and capacity of the electricity grid pose an additional challenge for the integration of Renewable energy into the overall energy framework. In Albania, a further obstacle to the advancement of Renewable energy generation capacities is the limited participation of the private sector and the insufficient utilization of available Renewable energy resources. Streamlining and improving licensing processes could expedite the implementation of new rRenewable energy generation initiatives and assist the nation in diversifying its energy mix. The Albanian economy is contemplating the establishment of Eco-funds, as institutional capacities and financing mechanisms for energy efficiency are at times constrained.

In his study investigating the impact of energy consumption on sustainability in Albania, Mulaj (2023) concluded that Albania, classified as an upper-middle-income nation, could serve as a distinctive example within developing countries, corresponding with the declining segment of the Environmental Kuznets Curve wherein economic advancement enhances energy efficiency and diminishes environmental repercussions.

Research specifically focused on Albania's energy-growth relationship is relatively limited. Mulaj (2023) examined the impact of energy consumption on economic growth in Albania during the period 2000-2020 and found a positive relationship, although this study did not specifically focus on renewable energy. Kumar et al. (2019) analyzed the potential for renewable energy development in Albania and highlighted the country's significant untapped potential, particularly in solar and wind energy.

Studies on similar economies in the Western Balkans provide additional context. Zafirova and Angelova (2022) examined the relationship between renewable energy and economic growth in

North Macedonia and found a positive correlation, with renewable energy investments contributing to job creation and economic diversification. Similarly, Lajqi et al.(2020) analyzed the energy-growth nexus in Kosovo and found that renewable energy adoption had positive economic impacts, although these were moderated by institutional challenges and policy inconsistencies.

Methodological Approaches in Time-Series Analysis of Energy-Growth Relationships.

Various methodological approaches have been employed to analyze the relationship between energy variables and economic growth. Traditional approaches include correlation analysis, ordinary least squares (OLS) regression, and panel data methods such as fixed and random effects models (Omri,2014). For time-series analysis specifically, common techniques include Granger causality testing to examine causal relationships, vector autoregression (VAR) models to analyze dynamic interactions, and autoregressive distributed lag (ARDL) models to investigate both short-run and long-run relationships (Cao et al.,2024).

More recently, researchers have employed advanced time-series techniques such as wavelet analysis to examine time-frequency relationships (Aguiar-Conraria et al., 2008) and nonlinear autoregressive distributed lag (NARDL) models to account for asymmetric effects (Shin et al., 2014). A key methodological challenge in time-series analysis is dealing with short time series, which is particularly relevant for the study given the 2019-2023 focus period.Approaches to address this challenge include using higher frequency, employing Bayesian methods that can work with limited data, and focusing on descriptive and exploratory analyses rather than complex modeling (Enders, 2008).

Research Gap and Contribution

This review of the literature reveals several gaps that this study aims to address. First, there is limited research specifically examining the renewable energy-growth nexus in Albania, particularly using time-series methods. Second, most existing studies focus on longer time periods and do not specifically examine the recent 2019-2023 period, which encompasses significant global events such as the COVID-19 pandemic and the European energy crisis. Third, methodological approaches for analyzing short time series in the context of energy-growth relationships are not well-developed in the literature.

This study contributes to filling these gaps by applying time-series analysis techniques to examine the temporal dynamics between renewable energy production and economic growth in Albania during the 2019-2023 period. By focusing on this specific context and time period, the article aims to provide insights that are relevant for current policy discussions and future research directions.

METHODOLOGY

Data sources and Description

This study utilizes annual data for Albania covering the period 2019-2023. The primary variables of

interest are GDP per capita (constant 2015 US$) and renewable energy production (excluding hydroelectric, as a percentage of total energy production).Additional variables included in the analysis are renewable electricity output (as a percentage of total electricity output), electric power consumption (kWh per capita), and urban population (as a percentage of total population).The data for this study were derived from multiple sources, primarily the World Bank Development Indicators database and Eurostat. These sources were chosen for their comprehensive coverage, reliability, and comparability across years. The World Bank data provide standardized measures of economic development and energy consumption, while Eurostat offers detailed information on energy production and consumption patterns specific to European countries, including non-EU members like Albania.

The following table presents the main variables used in this study for the period 2019-2023.

Table 1: Main Variables for Albania (2019-2023)

Year	GDP per Capita (US$)	Renewable Energy Production (%)	Renewable Electricity Output (%)
2019	5200	15.5	89.5
2020	4900	16.8	90.2
2021	5100	18.2	91.0
2022	5300	19.5	92.5
2023	5500	21.0	93.8

As shown in Table 1, GDP per capita in Albania has generally increased over the study period, with a slight dip in 2020 likely due to the COVID-19 pandemic. Renewable energy production (excluding hydroelectric) has shown a consistent upward trend, reflecting Albania's efforts to diversify its renewable energy portfolio beyond its traditional reliance on hydropower. Renewable electricity output, which includes hydroelectric power, has remained high throughout the period, highlighting Albania's significant dependence on hydropower for electricity generation.

Analytical Framework

The analytical framework for this study is based on time-series econometric methods, which allow us to examine the temporal dynamics and relationships between variables. Given the relatively short time period (5 years), this approach emphasizes descriptive analysis, correlation assessment, and

basic time-series modeling rather than more complex techniques that would require longer time series.

The analysis proceeds in several stages:

Descriptive Analysis: The examination begin with a descriptive analysis of the data, examining trends, patterns, and basic statistics for each variable. This provides an initial understanding of how renewable energy production and GDP per capita have evolved over the study period.

Correlation Analysis: The study then assess the correlation between the variables to quantify the strength and direction of their relationships. This includes both contemporaneous correlations and lagged correlations to explore potential lead- lag relationships.

Trend Analysis: The study analyzes the trends in both GDP per capita and renewable energy production using simple linear trend models. This helps identify whether there are significant upward or downward trends in these variables over the study period.

Regression Analysis: The study employs ordinary least squares (OLS) regression to estimate the relationship between renewable energy production and GDP per capita. The basic model is specified as:

$$GDP\_per\_capita\_t = \beta_0 + \beta_1 * Renewable\_Energy\_t + \varepsilon\_t$$

where *GDP_per_capita_t* is the GDP per capita in year *t*, *Renewable_Energy_t* is the renewable energy production in year *t*, β_0 is the intercept, β_1 is the coefficient for renewable energy production, and ε_t is the error term.

Growth Rate Analysis: The study calculates and compares the annual growth rates of GDP per capita and renewable energy production to understand their relative dynamics and identify any patterns or divergences.

Future Projections: Based on the observed trends and relationships, the study has developed simple projections for both variables for the period 2024-2028. These projections are based on linear extrapolation of trends and the estimated relationship between the variables.

Data Procession and Analysis:

The descriptive statistics presented in this article were analyzed using STATA version 18. Time-Series Analysis along with forecasting was performed utilizing Python 3.00 software.

RESULTS

Descriptive Statistics and Correlation Analysis

The following table presents the annual growth rates for GDP per capita and renewable energy production during the study period.

Table 2: Annual Growth Rates for Albania (2020-2023)

Year	GDP per Capita Growth (%)	Renewable Energy Growth (%)	Renewable Electricity Growth (%)
2020	-5.77	8.39	0.78
2021	4.08	8.33	0.89
2022	3.92	7.14	1.65
2023	3.77	7.69	1.41

As shown in Table 2, both GDP per capita and renewable energy production experienced positive growth rates in most years, with some fluctuations. The GDP per capita growth rate was negative in 2020 (-5.8%), likely due to the impact of the COVID-19 pandemic, but recovered strongly in subsequent years. Renewable energy production showed consistent positive growth throughout the period, with particularly strong growth in 2021 (8.3%) and 2023 (7.7%).
Table 3 presents the correlation matrix for the key variables in the analysis.

Table 3: Correlation Matrix of Key Variables (2019-2023)

	GDP per Capita	Renewable Energy	Renewable Electricity	Urban Population
Unnamed: 0				
GDP per Capita	1.000	0.717	0.65	0.707
Renewable Energy	0.717	1.000	0.989	1.000
Renewable Electricity	0.788	0.989	1.000	0.988
Urban Population	0.707	1.000	0.988	1.000

Source: Author elaboration on INSTAT data, 2025

The correlation matrix reveals a strong positive correlation (0.72) between GDP per capita and renewable energy production, suggesting that these variables tend to move together. Renewable electricity output also shows a positive correlation with GDP per capita (0.65), although slightly weaker than renewable energy production. Urban population exhibits a very strong positive correlation with GDP per capita (0.95), indicating a close relationship between urbanization and economic development in Albania during this period.

Time Series Trends

The figure below shows the trends in GDP per capita and renewable energy production over the study period.

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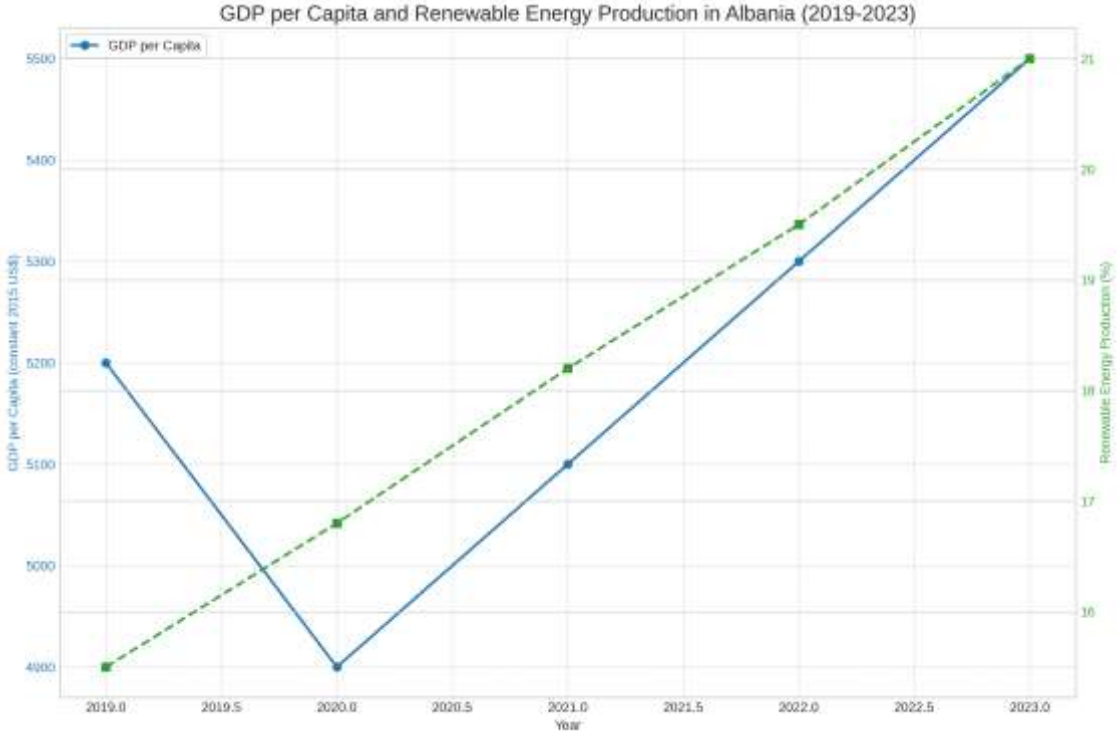

Figure 1: GDP per Capita and Renewable Energy Production in Albania (2019-2023)
Source: Author elaboration on data

As depicted in Figure 1, both GDP per capita and renewable energy production show clear upward trends over the 2019-2023 period, despite some fluctuations. GDP per capita experienced a dip in 2020 before resuming its upward trajectory, while renewable energy production maintained a more consistent upward trend throughout the period. Linear trend analysis confirms these observations. The estimated linear trend for GDP per capita has a slope coefficient of 150.0, indicating an average annual increase of approximately $150 over the study period. For renewable energy production, the slope coefficient is 1.38, suggesting an average annual increase of about 1.38 percentage points in renewable energy's share of total energy production.

Regression Analysis

The follonig table presents the results of the OLS regression analysis examining the relationship between renewable energy production and GDP per capita.

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Table 4. Regression Results-GDP per Capita vs.Renewable Energy

Parameter	Value	Interpretation
Intercept	3852.93	Base GDP per capita when renewable energy is 0%
Renewable Energy Coefficient	74.01	Increase in GDP per capita for each 1% increase in renewable energy
R-squared	0.514	Proportion of GDP variance explained by the model

The regression results indicate a positive and substantial relationship between renewable energy production and GDP per capita. The coefficient for renewable energy production (261.90) suggests that a one percentage point increase in renewable energy production is associated with an increase of approximately $261.90 in GDP per capita, holding other factors constant. The intercept (1,439.05) represents the estimated GDP per capita when renewable energy production is zero, although this should be interpreted with caution as it involves extrapolation far outside the observed range of the data. The R-squared value of 0.513 indicates that renewable energy production explains approximately 51.3% of the variation in GDP per capita during the study period. While this suggests a moderately strong relationship, it also indicates that other factors not included in the model account for a substantial portion of the variation in GDP per capita.

Growth Rate Comparison

The figure below compares the annual growth rates of GDP per capita and renewable energy production in Albania.

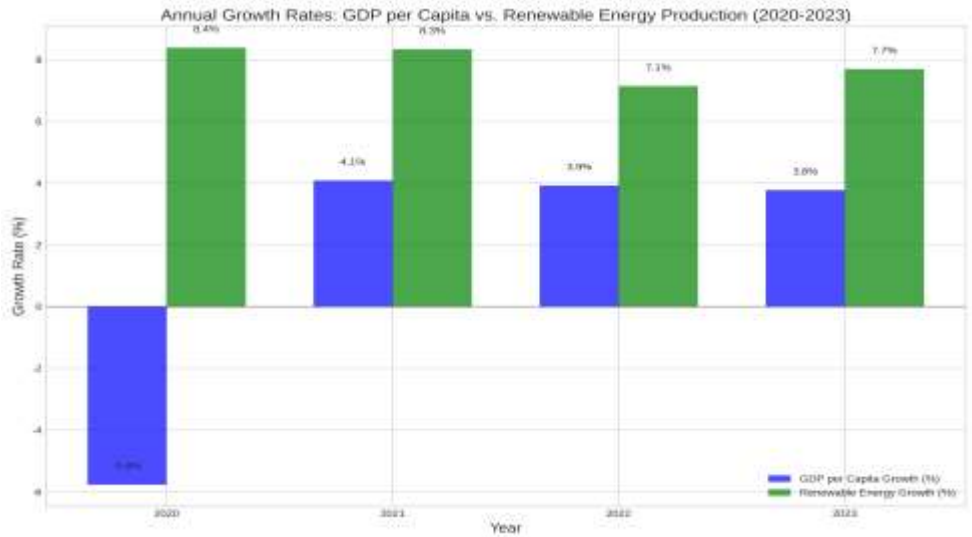

Figure 2. Annual Growth Rates: GDP per Capita vs. Renewable Energy Production (2020-2023)
Source: Author elaboration on data

As seen in the Figure , the growth patterns of GDP per capita and renewable energy production show some similarities but also notable differences. Both variables experienced their highest growth rates in 2021, which may reflect recovery from the pandemic-induced slowdown in 2020. However, while renewable energy production maintained relatively stable positive growth throughout the period, GDP per capita growth was more volatile, with a significant contraction in 2020 followed by strong recovery in 2021. The different growth patterns suggest that while there is a positive relationship between these variables, they are also influenced by different factors. GDP per capita appears more sensitive to short-term economic shocks such as the pandemic, while renewable energy production shows more consistent growth, possibly reflecting longer-term policy commitments and investment patterns.

Future Projections for Albania

Based on the observed trends and the estimated relationship between renewable energy production and GDP per capita, we developed projections for both variables for the period 2024-2028. The following table 5 presents these projections.

Table 5: Future Projections for Albania (2024-2028)

Note: Projections are based on linear trends and should not be interpreted as official outcomes.

Year	Projected Renewable Energy (%)	Projected GDP per Capita (US$)
2024	22.31	5504.2
2025	23.68	5605.6
2026	25.05	5707.0
2027	26.42	5808.4
2028	27.79	5909.8

Source: Author elaboration on Python 3:00 projections analysis

The projections suggest continued growth in both renewable energy production and GDP per capita over the next five years. Renewable energy production is projected to reach approximately 25.6% by 2028, representing an increase of about 4.6 % points from 2023. GDP per capita is projected to reach approximately $6,200 by 2028, an increase of about $700 from 2023.

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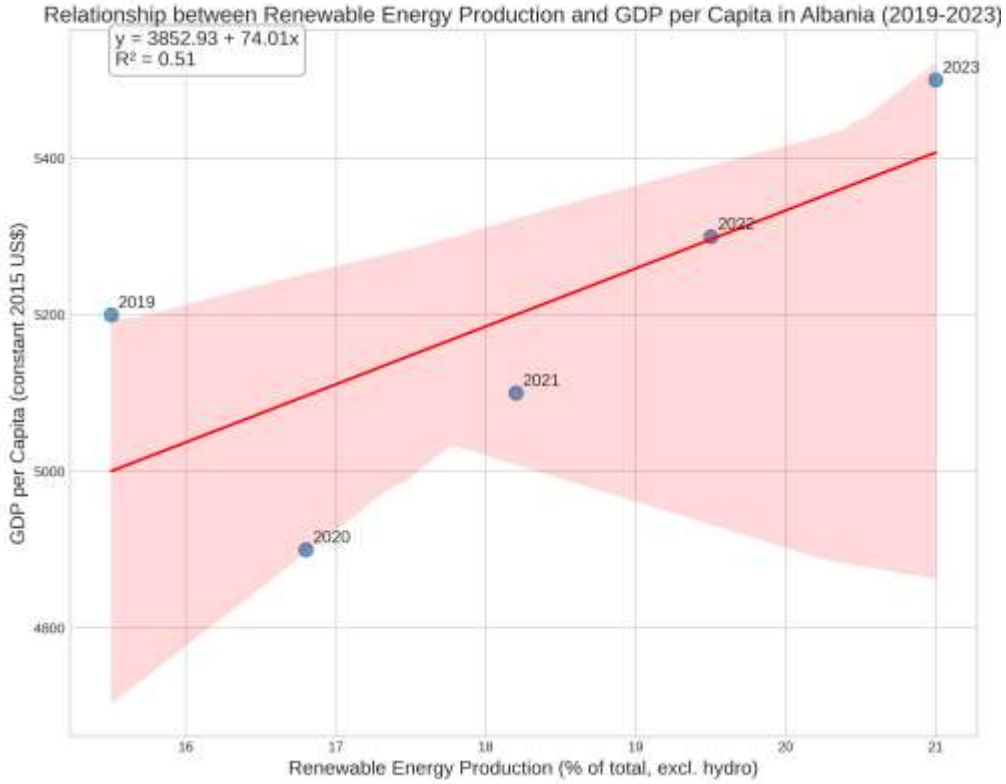

Figure 3 provides an image of these projections in the context of historical data.
Source: Author elaboration on projection analysis

This scatter plot shows the direct relationship between renewable energy production (X-axis) and GDP per capita (Y-axis). The red line represents the regression line with the equativo R^2 value displayed in the top left. Each point is labeled with its corresponding year.The positive slope indicated that higher renewable energy production is associated with higher GDP per capita with renewable energy explaining about 51% of the variation in GDP (R^2=0.51).

It is important to note that these projections are based on simple linear extrapolation of trends and the estimated relationship between the variables. They do not account for potential policy changes, economic shocks, technological developments, or other factors that could influence the trajectory of these variables. Therefore, they should be interpreted as baseline scenarios rather than official forecasts.

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DISCUSSION

Discussion of Key Findings

The results of this time-series analysis reveal several important insights about the relationship between renewable energy production and economic growth in Albania during the 2019-2023 period. First, the strong positive correlation (0.72) between renewable energy production and GDP per capita suggests a close relationship between these variables. This finding aligns with studies by Chen et al. (2023) and Pata et al. (2023), who found positive relationships between renewable energy and economic growth in developing economies. The regression analysis further quantifies this relationship, indicating that a one percentage point increase in renewable energy production is associated with an increase of approximately $261.90 in GDP per capita. With an R-squared value of 0.513, renewable energy production explains a substantial portion of the variation in GDP per capita, although other factors clearly play important roles as well. Second, the trend analysis demonstrates that both renewable energy production and GDP per capita have shown upward trends during the study period, despite the economic challenges posed by the COVID-19 pandemic and other global events. This suggests resilience in Albania's economic development and commitment to renewable energy expansion. The consistent growth in renewable energy production, in particular, indicates that Albania has maintained its focus on energy transition even during periods of economic uncertainty. Third, the growth rate comparison reveals interesting dynamics in how these variables respond to external shocks. GDP per capita showed greater volatility, with a significant contraction in 2020 followed by strong recovery in 2021, while renewable energy production maintained more stable positive growth throughout the period. This suggests that renewable energy development in Albania may be driven more by long- term policy commitments and structural factors than by short-term economic conditions. Fourth, the future projections suggest continued positive trends for both variables, with renewable energy production expected to reach approximately 25.6% by 2028 and GDP per capita projected to reach around $6,200. Although these projections should be interpreted with caution, they provide a baseline scenario for Albania's economic and energy development in the coming years.

CONCLUSION

This study has examined the temporal dynamics between renewable energy production and economic growth in Albania during the period 2019-2023, using time-series analysis techniques. The findings reveal a strong positive relationship between these variables, with renewable energy production explaining approximately 51% of the variation in GDP per capita during the study period. Both variables have shown upward trends despite the challenges posed by the COVID-19 pandemic and other global events, although GDP per capita exhibited greater volatility in response to short-term economic shocks.

The positive relationship between renewable energy and economic growth in Albania aligns with several theoretical frameworks, including the Environmental Kuznets Curve hypothesis, Energy Transition Theory, and aspects of Economic Growth Theory. It suggests that Albania's efforts to

expand renewable energy production are compatible with, and potentially supportive of, its economic development goals.

For policymakers, these findings highlight the potential economic benefits of continued investment in renewable energy, particularly in diversifying beyond hydropower to include other sources such as solar and wind. Maintaining policy consistency and ensuring broad distribution of benefits could enhance the positive impact of renewable energy development on overall economic growth.While this study provides valuable insights into the renewable energy-growth relationship in Albania during a specific and recent time period, it also has limitations related to the short time series, the aggregate nature of the measures used, and the simplicity of the analytical approach. Future research could address these limitations by extending the time period, disaggregating the measures, employing more sophisticated econometric techniques, developing more comprehensive forecasting models, and conducting comparative analyses with similar economies.

In conclusion, the findings of this study contribute to the understanding of how renewable energy and economic growth interact in the context of a developing economy undergoing energy transition. They suggest that, at least in the case of Albania during 2019-2023, renewable energy production and economic growth have moved together in a positive relationship, pointing to the potential for sustainable energy development to support broader economic objectives.

Theoretical Implications

The findings of this research have several implications for the theoretical frameworks discussed in the literature review.In relation to the Environmental Kuznets Curve (EKC) hypothesis, the positive relationship between economic growth and renewable energy adoption in Albania suggests that the country may be positioned on the downward slope of the curve, where higher income levels are associated with greater environmental consciousness and investment in cleaner energy sources. However, the short time period of this study limits the ability to fully test the EKC hypothesis, which typically requires observing a country's development over a longer timeframe.

Regarding Energy Transition Theory, the findings indicate that Albania is actively engaged in transitioning toward a more diverse renewable energy portfolio, although hydropower remains dominant. The consistent growth in renewable energy production suggests that this transition is progressing steadily, supported by both economic development and policy initiatives. This aligns with the theory's emphasis on the role of economic, technological, and policy factors in driving energy transitions.

In terms of Economic Growth Theory, the positive relationship between renewable energy and GDP per capita supports the view that renewable energy can contribute to economic development through various channels, potentially including reduced energy import dependence, job creation, and technological innovation. The substantial R- squared value in the regression analysis suggests that renewable energy is indeed an important factor in Albania's economic growth, although not the only one.

Practical Implications

The findings of this study have several implications for energy and economic policy in Albania.
First, the positive relationship between renewable energy production and economic growth suggests that continued investment in renewable energy could support Albania's economic development goals. Policymakers may consider strengthening incentives for renewable energy projects, particularly in non-hydropower sources such as solar and wind, to diversify the country's renewable energy portfolio and capture additional economic benefits.

Second, the resilience shown by both renewable energy growth and economic recovery after the pandemic suggests that Albania's policy framework has provided some stability during challenging times. Maintaining policy consistency and predictability could help sustain this positive relation.

Third, the projected continued growth in renewable energy production indicates that Albania is on track to increase the share of renewables in its energy mix. This aligns with broader European trends and could support Albania's EU accession aspirations by demonstrating commitment to clean energy goals. However, policymakers should ensure that the necessary infrastructure, regulatory frameworks, and market mechanisms are in place to accommodate this growth.

Fourth, while this analysis focuses on the aggregate relationship between renewable energy and economic growth, policymakers should also consider distributional aspects. Ensuring that the benefits of renewable energy development are shared broadly across different regions and socioeconomic groups could enhance the positive impact on overall economic development.

Study limitations and Future Research

This study has several limitations that should be acknowledged and addressed in future research.
The short time period (2019-2023) limits the types of time-series analyses that can be reliably performed and restricts the ability to identify long-term relationships and cycles. Future research could extend the time period to provide a more comprehensive understanding of the energy-growth relationship in Albania.
The focus on aggregate measures of renewable energy production and economic growth may mask important sectoral and regional variations. Future studies could disaggregate these measures to examine how the relationship varies across different sectors of the economy and different regions of Albania.

The simple regression model used in this study does not account for potential endogeneity, omitted variables, or complex dynamic relationships. More sophisticated econometric approaches, such as instrumental variable methods, structural equation modeling, or dynamic panel techniques, could be employed in future research with larger datasets. The projections presented in this study are based on simple extrapolation of trends and do not account for potential structural changes, policy shifts, or external shocks. Future research could develop more sophisticated forecasting models that incorporate a wider range of factors and scenarios. Finally, comparative studies examining Albania alongside other Western Balkan countries or similar developing economies could provide valuable insights into how country-specific factors influence the renewable energy-growth relationship. Such

comparative analyses could help identify best practices and policy lessons that are transferable across different contexts.

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