

Article

Economic Growth and Sustainable Transition: Investigating Classical and Novel Factors in Developed Countries

Wei Wang ^{1,*}, Kehui Wei ¹, Oleksandr Kubatko ² , Vladyslav Piven ², Yulija Chortok ²
and Oleksandr Derykolenko ²

¹ Collaborative Innovation Research Center of Western Energy Economy and Regional Development, Xi'an University of Finance and Economics, Xi'an 710100, China; weikehui108@xaufe.edu.cn

² Department of Economics, Entrepreneurship and Business Administration, Sumy State University, 40007 Sumy, Ukraine; okubatko@econ.sumdu.edu.ua (O.K.); vladyslav.piven@student.sumdu.edu.ua (V.P.); y.chortok@econ.sumdu.edu.ua (Y.C.); o.derykolenko@biem.sumdu.edu.ua (O.D.)

* Correspondence: wangwei1@xaufe.edu.cn

Abstract: In this study, the factors affecting economic growth in developed countries within the context of their sustainability transition are explored. By analyzing both traditional and novel factors, we aim to expand the scientific knowledge of the drivers behind sustainable economic development. To achieve this purpose, some factors that have demonstrated the potential to positively impact economic growth while simultaneously promoting environmental sustainability are included. Research results demonstrate that a 1% increase in energy consumption is associated with a 0.314% increase in real GDP, indicating a positive relationship between energy usage and economic growth. Additionally, the consumption of renewable energy boosts a positive impact on sustainable economic growth: When it grows by 1%, the real GDP increases by 0.12%. The empirical findings further reveal that scientific progress and economic freedom are significant drivers of economic growth, as a 1% increase in both factors leads to an increase in economic output by 0.349% and 0.323%, respectively. By conducting a comprehensive analysis, we provide valuable insights into the complex interplay between economic growth and sustainability in developed countries. Based on these findings, the study offers specific policy recommendations, which include the diversification of the energy mix, the promotion of education and scientific advancement, and the digitalization of public services.

Keywords: sustainability; economic growth; GDP; factors; drivers; energy; renewable energy; science; economic freedom; Cobb–Douglas production function



Citation: Wang, W.; Wei, K.; Kubatko, O.; Piven, V.; Chortok, Y.; Derykolenko, O. Economic Growth and Sustainable Transition: Investigating Classical and Novel Factors in Developed Countries. *Sustainability* **2023**, *15*, 12346. <https://doi.org/10.3390/su151612346>

Academic Editor: Bruce Morley

Received: 5 July 2023

Revised: 8 August 2023

Accepted: 10 August 2023

Published: 14 August 2023



Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

As the world continues to deal with the challenges of sustainable development, understanding the intricate relationship between economic growth and sustainability transition becomes imperative. Although economic growth is beneficial in many respects (e.g., it creates opportunities for employment, income growth, and poverty reduction), it should not come at the expense of future generations' quality of life and the health of our planet [1]. Fostering a more sustainable and equitable world, where economic progress is achieved in harmony with the environment and society's well-being, is crucial.

This study is about exploring the factors that drive both economic growth and the transition towards a more sustainable future. Our research is dedicated to both classical and novel factors in order to comprehensively analyze their impact on economic growth and sustainability transition. Traditional factors include well-established variables such as labor, capital, and energy consumption, which have long been recognized by the neoclassical theory as critical drivers of economic output [2].

Regarding energy factors, their role in growth is still debatable. Traditionally, increased economic output is considered to be linked with increased energy consumption. Although the global energy intensity produced by the GDP has declined in recent decades (in the

year 2000, it was 6.2 MJ per USD 2017, whereas in 2020, it was 4.5 MJ per USD 2017) [3], it is true that energy still drives growth, according to many research studies [4–6]. The issue of energy–GDP decoupling (both absolute and relative) is of major interest to scientists and policymakers. Moreover, the sustainability transition, which implies the need to harmonize economic, social, and environmental development, requires new approaches to the existing economic and energy paradigm, including the emphasis on increasing energy efficiency and renewable energy promotion [7,8].

In addition to classical factors, we also explore novel variables that have gained prominence in recent years. Renewable energy consumption is one such factor that has demonstrated the potential to positively impact economic growth while simultaneously promoting environmental sustainability. Nevertheless, the relationship between renewable energy and GDP growth is not straightforward. While renewable energy can lead to long-term economic benefits such as energy security, reduced environmental impacts, and job creation, the short-term challenges and uncertainties make the «renewable energy—GDP growth» nexus ambiguous [9]. By examining the influence of renewable energy consumption on real GDP, we aim to assess its significance in driving sustainable economic development. Furthermore, our study acknowledges the importance of scientific progress and economic freedom as key drivers of economic growth. New growth theories (developed by R. Solow, P. Romer, and others) emphasize the role of innovations in economic development. We seek to investigate the role of scientific advancements in fostering economic prosperity, as well as the influence of economic freedom in facilitating sustainable development.

In this research study, our focus is on developed economies. In recent years, the European Union (EU) has been putting much effort to achieve sustainable economic development as it aims to become the first climate-neutral continent by 2050 [10]. Recognizing the need for a balanced approach that integrates environmental preservation, social well-being, and economic prosperity, the EU serves as an ideal context for this study. By examining the factors influencing economic growth and sustainability transition within the EU, we aim to contribute to the existing body of knowledge and provide evidence-based recommendations for decision making.

Accordingly, the core purpose of our research is to empirically investigate the impact of different factors on sustainable economic growth. After this, we will be able to identify strategies and policies that promote sustainable economic development while minimizing negative environmental impacts and ensuring positive social outcomes for present and future generations.

This paper is structured into five main sections. Section 1 is an introductory section with a justification of this research study. Section 2 presents a comprehensive literature review accompanied by bibliometric analysis. This section also contains the tested hypotheses and their explanations. Section 3 outlines the methodology employed in the study, including the model and variables used to test the research hypotheses. Section 4 presents and interprets the empirical results and provides their discussion. In Section 5, the final conclusions are summarized, and policy implications are given.

2. Literature Review

First of all, the bibliometric analysis was conducted with the use of the Scopus database and VOSViewer 1.6.19 software (Netherland). Entering keywords such as «economic growth», «GDP», and «factors» and limiting the time frame from 2007 to 2023 in Scopus Toolkit, 17,460 appropriate scientific publications were found. The number of publications on the topic is vast and growing year-by-year (in 2007, there were 362 papers on this topic, whereas in 2022, there were more than 2000) (Figure 1). Within this period, there were different research trends. Driven by the Great Recession of 2007–2009, many scientists dedicated their research to the role of fiscal and monetary policies in economic recovery, price level stabilization, and overcoming unemployment. In the years 2011–2016, most research concerned the impact of investments, trade, globalization, and other classical economic concepts on economic growth. In 2016–2019, scientists thoroughly analyzed

green economic growth and possible eco-economic decoupling. In recent years, the issue of GDP growth has remained relevant due to COVID-19 and the risks of the world recession in 2023. In addition, current research trends include the nexus between digitalization and economic growth in the transition to Industry 4.0 and 5.0 and the social and energy aspects of economic development.

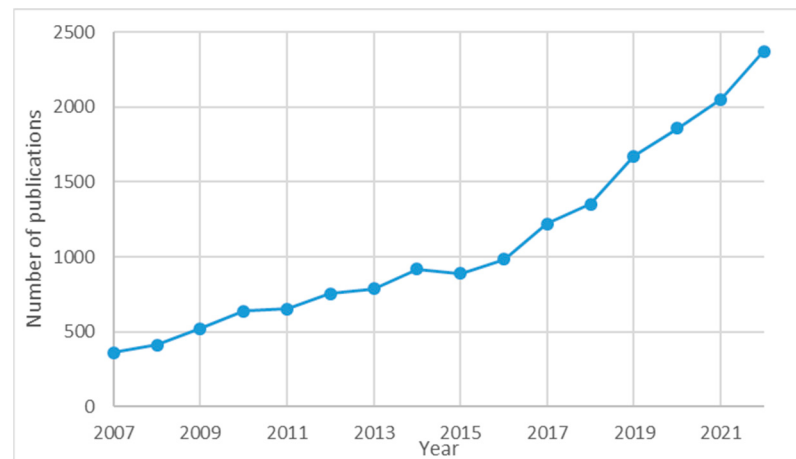


Figure 1. Number of publications on the topic in 2007–2022 (developed by authors, using Scopus database).

Using VOSViewer software, all keywords were automatically united in four clusters (Figure 2). The first (red) cluster involves papers on the classical drivers of economic growth (capital and labor) and related issues (the law of diminishing marginal productivity, total factor productivity, and producer equilibrium). The second (green) cluster includes publications about environmental aspects of economic growth (sustainability, carbon emission, and decoupling). The third (blue) cluster covers the issues of energy factors that affect GDP growth (renewable energy consumption, Kuznets curve, energy efficiency, and intensity). The fourth (yellow) cluster concerns the issues of urbanization and regional development and their effects on economic growth.

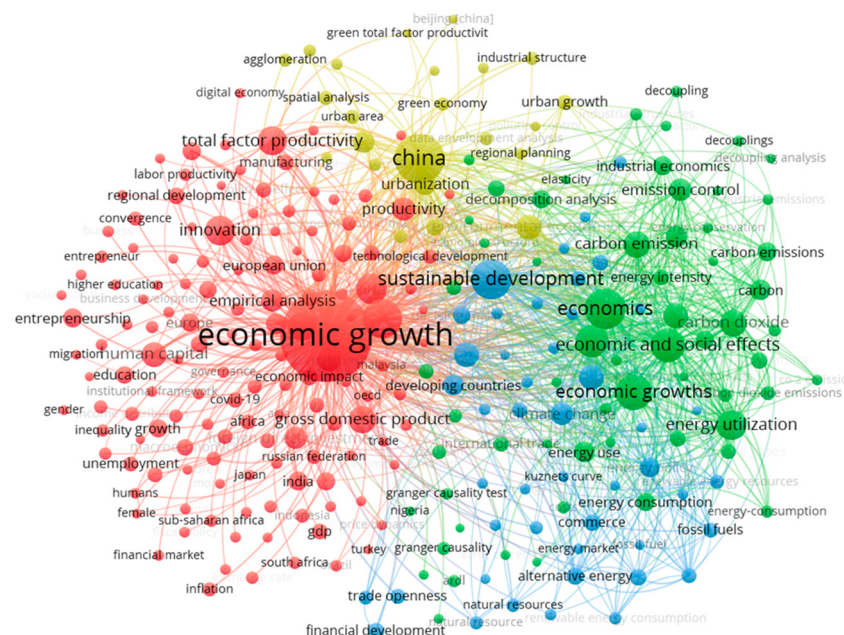


Figure 2. The network map of the keywords (in clusters) to the topic (developed by authors, using VOSViewer).

The second stage of the literature review is the in-depth analysis of specific publications. Various studies researched the relationship between energy use and GDP growth. However, their results are somewhat different depending on many factors (time frame, group of income, and energy exporters/importers). For example, L. Dai confirmed the existence of the energy Kuznets curve [11]. At the same time, the authors stated that most countries are still far from achieving the turning point, after which energy–GDP decoupling is possible. Using a sample of one country with many federal states (the USA), Mahalingam and Orman found a bi-directional nexus: «energy consumption—GDP growth» [4]. However, the authors emphasized that regional disparities play a significant role in these relationships even within one country. Analyzing some EU member states, G. Szustak and colleagues found no bi-directional relationship between energy consumption and economic growth in general; however, in some European countries, this nexus exists [12]. Applying advanced econometric approaches, the researchers found a long-term causality between energy consumption and GDP growth in the Visegrad group of countries [13]. Some research used a Cobb–Douglas production function (modified one with an energy component) to investigate the impact of energy consumption on output growth. This issue was discussed by Wulf from the perspective of the firm theory: The author proved that energy had a significant role in production activities (especially in energy-intensive economic sectors) [14]. The macroeconomic aspects of energy use were described by [15]. The scientist analyzed a group of middle-income economies and concluded that energy consumption (together with capital and labor) has a statistically significant positive impact on GDP. Another research study tested two models (the impact of energy use on GDP and vice versa). The authors obtained positive results in both models; however, a higher GDP affects energy use. Some publications [16,17] also described factors (e.g., energy investments and resource prices) influencing both national income and energy consumption. It is worth mentioning that traditional energy consumption is often linked with increased CO₂ emissions. Such a nexus was investigated in [18–20]. Using the example of France, one of the studies revealed that traditional energy consumption is a cause of more CO₂ emissions, while renewable energy is not [21]. As CO₂ emissions are a significant barrier to sustainability transition, policymakers should apply comprehensive decarbonization measures, as suggested in [22]. For example, technological advances have a strong positive impact on CO₂ emissions reduction according to [23].

Hypothesis 1. *Together with labor and capital, energy has a positive impact on economic growth since it is essential for carrying out almost all industrial and economic activities.*

There is some research on the relationship between renewable energy consumption and GDP growth [24,25]. For example, N. Singh and colleagues described the positive long-term impact of the level of renewable energy development on key economic indicators, including real GDP [26]. Analyzing top world economies, the authors proved that an increase in renewable energy consumption leads to a slight increase in economic growth [27]. Apergis and Payne confirmed the existence of bidirectional causality between REC and real GDP growth in selected OECD economies [28]. However, D. Sahlian and others used panel data analysis for a sample of developed economies and found no short- and long-term relationship between REC and economic development [29]. M. Simionescu et al. also indicated that REC has no impact on economic growth, but the share of RE does have an impact [30]. Using cointegration approaches, Y. Bilan and colleagues confirmed another cause-and-effect hypothesis, namely that GDP growth also stimulates REC [31]. From our perspective, RE already affects economic development since its share of gross final energy consumption is constantly growing (e.g., in some EU countries, the share is more than 40%). Analyzing panel data for the sample of the EU member states, Menegaki confirmed the hypothesis that REC has no effect on GDP growth [32]. However, the time frame of the study covered the first decade of this century. From our perspective, the «REC—GDP growth» causal relationship may have already changed. In [33], researchers concluded

that RE is a significant growth driver in both developed and developing economies. Some publications consider investments in RE projects as a strong driver of GDP [34–38].

Hypothesis 2. *Renewable energy has a positive effect on sustainable economic growth since its share in gross final energy consumption is constantly growing.*

The links between scientific development and economic growth were discussed in [39–41]. Digital and technological advances have a statistically significant impact on GDP per capita according to [42]. Other studies focused on the role of innovations in promoting green economic growth. Basic and applied scientific progress contributes to the introduction of new technologies (for example, in renewable industry or digitalization) and, as a result, boosts the transition to sustainable development. Innovations are proven to be a driver of economic growth according to [43]. C. Tudor and R. Sova investigated the linkages between real GDP, RE consumption, and R&D [44]. RE promotes real GDP in developed economies, whereas R&D contributes to RE in a small group of very high-income countries. The role of innovations on economic growth in the context of sustainability was described by [45]. The authors concluded that technological advances promote economic growth and positively affect natural resource depletion. Similar research was performed by [46,47]. The peculiarities of the circular economy for green growth were revealed by [48]. The scientists proved that the sustainable development of the economy is possible only with the help of science and innovations. From our perspective, the introduction of new technologies, the development of digital industries, and the transition to new economic models allow societies to prosper, inflicting less harm to the environment.

Hypothesis 3. *Scientific and human development, due to its strong impact on innovations and productivity, positively affects sustainable economic growth.*

The relationship between economic freedom and GDP growth is considered to be complex and mixed among scientists. Some scientists [49–51] concentrate on the role of political institutions and governance quality in economic development in general. Ref. [49] emphasized the role of inclusive political and economic institutions for the nation's success. From their perspective, inclusive institutions are best at protecting human rights (including property rights) and entrepreneurship promotion. On the contrary, extractive institutions, which are based on corruption and resource exploitation, hinder economic growth and prosperity. Other scientists focus on the issue of economic freedom in detail. For example, refs. [52–55] observed a unidirectional positive impact of the level of economic freedom on GDP growth. Analyzing the group of the EU member states, other scientists revealed a similar relationship: Even a slight increase in the economic freedom index contributes to a significant increase in GDP per capita. On the contrary, economic freedom may sometimes have negative consequences. For example, in some situations, unlimited freedom stimulates excessive business activity that is undesirable during an inflationary gap. This can lead to serious crises without adequate government interference [56]. Some studies [57] emphasized the role of certain model specifications during the estimation of the results. Another challenge is assessing the level of economic freedom. Economic freedom is a complex concept that cannot be measured using only one indicator. However, the index of economic freedom, calculated by the Heritage Foundation, is widely used due to the advanced methodology (e.g., it consists of many subcomponents that are based on reliable statistical indicators).

Hypothesis 4. *Economic freedom stimulates growth as it is a feature of inclusive socio-economic institutions and a driver of business development.*

The Cobb–Douglas production function is a widely used economic model that shows the relationship between inputs and outputs in production [58]. It assumes that the production function depends only on the levels of labor and capital inputs and their productivity and not on other factors such as the institutional or regulatory environment. However,

economic freedom can significantly affect the levels of labor and capital inputs and their productivity. For example, a country with high levels of economic freedom may have lower taxes and regulations, which can create incentives for firms to invest more in capital and for workers to work more efficiently, thus increasing productivity. We used different modifications of the Cobb–Douglas production function to provide a more accurate representation of the factors that contribute to economic growth (including sustainable ones). To the best of our knowledge, there is very little research that used economic freedom as a variable in a modified Cobb–Douglas production function. Therefore, this research aimed at bringing diversity to the analysis of classical variables (e.g., labor and capital) and filling the gap in existing knowledge by investigating the role of economic freedom using the latest data available. Additionally, the focus on the European Union as a specific context adds to the scientific novelty, as it allows for a deeper understanding of the dynamics within a regional framework.

The results of the research can be used in developing national strategies and specific roadmaps to help policymakers improve economic policies, implement effective stimulus programs, and promote a better future for all.

3. Methods and Data

To test the abovementioned hypotheses, we used three modifications of the Cobb–Douglas production function. To test the first hypothesis, we added the energy component; to test the second hypothesis, we added the renewable energy component; to test the third and fourth hypotheses, we added the scientific development and economic freedom components. Therefore, the modifications are presented below. The modified function can be presented in the other way by converting variables into a natural logarithm form (where α_1 , α_2 , α_3 , and α_4 —the regression-evaluated parameters) (Table 1).

Table 1. The modifications of the Cobb–Douglas production function.

Hypotheses	Function (Analytical Form)	Function (Logarithm Form)
Hypothesis 1	$GDP_t = f(K_t, L_t, E_t)$	$\ln GDP_t = \alpha_1 \ln K_t + \alpha_2 \ln L_t + \alpha_3 \ln E_t$
Hypothesis 2	$GDP_t = f(K_t, L_t, RE_t)$	$\ln GDP_t = \alpha_1 \ln K_t + \alpha_2 \ln L_t + \alpha_3 \ln RE_t$
Hypothesis 3 Hypothesis 4	$GDP_t = f(K_t, L_t, SC_t, EF_t)$	$\ln GDP_t = \alpha_1 \ln K_t + \alpha_2 \ln L_t + \alpha_3 \ln SC_t + \alpha_4 \ln EF_t$

To obtain the appropriate data, the authors used World Bank [59–61], Heritage Foundation [62], and Eurostat [63] datasets. We used real GDP (constant 2015 USD) as a variable for GDP_t ; gross fixed capital formation (constant 2015 USD) as a variable for K_t ; labor force (millions of people) as a variable for L_t ; gross final energy consumption (million tons of oil equivalent) as a variable for E_t ; final renewable energy consumption as a variable for RE_t ; human resources in science and technology (millions of people) as a variable for SC_t ; and economic freedom index (0—no freedom; 100—full freedom) as a variable for EF_t . The time frame of the research covered 2011–2021, which was chosen to include the latest possible data. We used the European Union as an organization of 27 member states. They have overall developed economies and similarly strong social and political institutions. Also, the EU has a sufficient (for this research) level of divergence (national governments have the right to shape their own educational, cultural, and industrial policies). The energy policy of the EU is regulated via a combination of legislative and regulatory measures at both the organizational and national levels. This comprehensive legal framework for energy is designed to ensure secure, affordable, and sustainable energy supplies [64]. Regarding software, we utilized Microsoft Excel for data collection and pre-processing and STATA 16.0 for econometric analysis.

4. Results and Discussion

First, we examined the stationarity of the data with the use of Levin, Lin, and Chu unit root tests. The empirical results of the panel stationary test are provided in Table 2. We can conclude that the null hypothesis (the panels contain unit roots) was rejected for all analyzed variables; therefore, the data are stationary.

Table 2. Panel unit root test results for the employed variables.

Variables	Adj. t-Statistic	p-Value	Result
lnGDP	−6.4192	0.0000	Stationary
lnK	−10.2894	0.0000	Stationary
lnL	−9.5477	0.0000	Stationary
lnE	−8.2398	0.0000	Stationary
lnRE	−12.3170	0.0000	Stationary
lnSC	−6.8471	0.0000	Stationary
lnEF	−7.3614	0.0000	Stationary

To choose the proper regression model (fixed- or random-effects or OLS regression), two specification tests were applied. Firstly, the Breusch and Pagan Lagrangian multiplier test was utilized to choose between the ordinary least squares (OLS) regression model and the fixed/random effects models. The null hypothesis of the test is that variances across entities are equal to 0; therefore, the OLS model is preferred to the fixed/random-effect models. For our three models, the test probability is less than 5% (therefore, the null hypothesis is rejected, and the appropriate model is not the OLS model) (Appendix A, Table A1). Secondly, the Hausman specification test was used to decide whether the random-effect estimation is better than the fixed-effect estimation. The null hypothesis of the Hausman test is that the individual characteristics are correlated with the regressors, and the RE estimation is more suitable than the FE. Our results demonstrated that for all our models, the probability is less than 5% (therefore, the null hypothesis is rejected, and the FE estimator is more appropriate) (Appendix A, Table A2).

Using STATA 16.0 for the three abovementioned econometric models, we obtained the following results (Table 3).

Table 3. Empirical results estimation for models 1–3 (standard errors fixed-effect estimator).

Dependent Variable—lnGDP _t	(1)	(2)	(3)
	Model 1	Model 2	Model 3
lnK _t	0.393 *** (0.000)	0.376 *** (0.000)	0.323 *** (0.000)
lnL _t	0.383 *** (0.000)	0.0506 (0.573)	0.407 *** (0.000)
lnE _t	0.314 *** (0.000)		
lnRE _t		0.119 *** (0.000)	
lnSC _t			0.349 *** (0.000)

Table 3. Cont.

Dependent Variable—lnGDP _t	(1)	(2)	(3)
	Model 1	Model 2	Model 3
lnEF _t			0.323 *** (0.000)
Constant	9.713 *** (0.000)	15.89 *** (0.000)	9.183 *** (0.000)
Observations	297	297	297
Overall R-squared	0.9561	0.9683	0.9654
Number of countries	27	27	27

p-value in parentheses: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

According to model 1, all factors (capital, labor, and energy) have a statistically significant impact on GDP. When gross fixed capital formation increases or the labor force increases by 1%, GDP grows by 0.393% and 0.383%, respectively. The sum of the shares of all factors of production is about 1, so it exhibits a constant return to the scale. This model confirmed that EU economies are considered to be both labor-intensive and capital-intensive. The energy was revealed to be a powerful factor of economic growth: When gross final energy consumption increases by 1%, GDP increases by 0.314%. This result is in line with studies [65,66]. L. Topolewski found no such relationship, indicating, however, that a 1% increase in GDP contributes to a 0.1% rise in energy consumption in European countries [67]. Another study investigated the impact of non-renewable energy on real GDP, indicating that a 1% increase in fossil fuel consumption reduces the real output by 0.13% [68]. It is important to underline the ambiguous role of energy prices on GDP growth. Higher energy prices can lead to increased costs for businesses and households, potentially offsetting some of the positive effects on GDP growth. Also, some research addresses the «energy price—energy efficiency» link, meaning that higher fossil fuel prices are a driver of energy efficiency.

Having analyzed capital, labor, and renewable energy in model 2, we revealed that capital and renewable energy have a statistically significant impact on GDP. When RE consumption grows by 1%, real GDP increases by 0.11%. This result is consistent with [69–72]. For example, scientists [69] concluded that a 1% increase in RE consumption leads to a 0.09% increase in real GDP. However, Apergis and Payne [28] revealed a stronger impact: When RE consumption increases by 1%, GDP increases by 0.76%. Therefore, according to our results, renewable energy drives economic growth; however, this effect is not so strong compared with capital and labor since it has a relatively small share in gross final energy consumption. Nevertheless, EU member states are actively adopting RE, so its impact on production will grow. Some countries have already experienced powerful economic benefits by investing in RE. For instance, Denmark has been a pioneer in RE adoption and has experienced a substantial boost in its economy due to related industries. According to a report by the Danish Energy Agency, only wind energy contributed approximately USD 16 billion to the country's GDP in 2021 [70]. In addition, RE development is often an indicator of scientific and technological development, and such a nexus should be investigated in further research.

Model 3's estimation demonstrated that scientific development, as well as economic freedom, has a statistically significant impact on GDP. When the number of human resources in science and technology increases by 1%, real GDP increases by 0.349%. When the economic freedom index increases by 1%, GDP increases by 0.323%. Model 3 shows the increasing return to the scale (the sum of elasticity coefficients is more than 1). It emphasizes the role of a reliable institutional environment and advanced scientific progress in economic growth promotion. Some authors used trade openness as a proxy for economic freedom. For instance, Chen et al. [69] found that a 1% increase in trade openness boosts GDP by

0.03%. Similarly, authors [73] proved that such a 1% increase in trade openness contributes to a 0.05% increase in economic output. However, from our perspective, economic freedom is a more complex concept, which includes monetary and investment freedom, political rights compliance, and governmental transparency.

In general, the economies of the EU are both capital- and labor-intensive (the output elasticity coefficients for capital vary from 0.32 in model 3 to 0.39 in model 1, whereas for labor, they vary from 0.38 in model 1 to 0.41 in model 3). From our perspective, industrial companies within the EU are more likely to invest in fixed capital (including the most technological) rather than rely solely on the labor force. It should be underlined that the combination of the abovementioned factors may vary in different EU member states due to different specializations and industry structures [74]. Nevertheless, providing services is a major part of the EU's GDP, so the role of the labor force is significant.

In order to increase the robustness of our estimations, we applied robust standard errors for the FE estimator. Following [75], this approach enhances the robustness of results by addressing issues related to heteroscedasticity and autocorrelation, leading to more reliable and dependable outcomes. They confirmed the previous results that we obtained by applying non-robust standard errors (Appendix A, Table A3).

In this study, the period from 2011 to 2021 was investigated, so the possibility of structural changes should be taken into account. Such structural breaks may influence interpretations and/or policy implications of the research. There are various statistical methods available for detecting structural breaks in panel data or time series data, such as the Chow test, Quandt–Andrews test, Bai–Perron test, and more. We performed the Ditzen, Karavias, and Westerlund test to investigate structural changes at unknown breakdates. The results are presented in Table 4. The null hypothesis of no break(s) is accepted; therefore, there are no structural breaks in our panel data.

Table 4. Ditzen, Karavias, and Westerlund test for structural breaks.

Bai and Perron Critical Values				
H0: no break(s) vs. H1: up to 2 break(s)				
	Test statistic	1% critical value	5% critical value	10% critical value
UDmax(tau)	4.91	10.95	8.78	7.87

Endogeneity issues may also lead to inconsistent regression estimation. The key causes of endogeneity include measurement error, reverse causality, and an omitted variable [76]. In the Cobb–Douglas production function, labor (L) and capital (K) are usually considered exogenous, meaning that they are determined outside the model and are not influenced by the error term of the production function equation. The inclusion of energy in the production function is supported by strong theoretical reasoning and is based on a solid economic framework, so it is not likely that energy would be endogenous in the model [77–79]. In addition, in our panel data analysis, time-invariant characteristics, which could potentially be correlated with the error term, are captured by fixed effects, mitigating endogeneity concerns.

5. Conclusions and Policy Implications

This research has investigated the impact of different factors on sustainable economic growth and confirmed all tested hypotheses.

Energy has a statistically significant positive impact on GDP. However, it does not mean that governments should thoughtlessly increase energy consumption to provide an increase in GDP. On the contrary, national economic policy should aim at promoting resource efficiency and energy security. Governments can mandate energy-efficient building codes that require new buildings to meet certain energy performance standards. This can encourage the use of more efficient building materials and technologies and reduce the

energy required for heating, cooling, and lighting. Last but not least, governments (together with educational institutions and NGOs) should promote green behavior among all people. Increasing awareness about the negative consequences of energy overconsumption, along with economic incentives to use less energy, is a significant step towards sustainability.

Results demonstrated that renewable energy also affects GDP positively. Given this and the fact that renewable energy is much cleaner than traditional energy, governments should increase the share of RE in the total energy mix. From our perspective, this can be carried out via close cooperation among government, households, and businesses. Governments should set clear and achievable RE targets, create a favorable investment climate, and encourage new technology adoption (with financial and non-financial incentives). Some of the most promising ways to encourage investments in the RE industry include synthetic corporate power purchase agreements (CPPAs) and an energy transition mechanism (ETM). CPPAs are a hedge against RE cost fluctuations when providing demands for such types of energy; ETM provides investors with a chance to purchase high CO₂-emitting assets, use them during their life cycle, and then substitute them with RE equipment.

Scientific progress has proven to be a driver of GDP growth. Investments in education and science and support of basic and applied research should become a priority for national governments. Educational transformations should be aimed at awakening students' interest in scientific research. Therein, an important tool is STEM education, which motivates students to engage in scientific activities, develops hard and soft skills, and promotes academic success. Businesses should also develop R&D strategies to remain competitive in the global markets. It is crucial to encourage international cooperation among scientists and promote the exchange of ideas and knowledge. It is also important to support green innovations and disruptive technologies. This can be implemented by the introduction of green financial markets and the promotion of venture capital investments. In countries with a weakly developed financial system and stock market, innovation support may initially be carried out by the government. The creation of appropriate research funds, start-up incubators, and the provision of preferential loans for risky but promising projects are some of the basic steps that can be implemented in such economies. In developed economies, it is crucial to promote green financial instruments (green bonds, green mutual funds, and green ETFs (exchange-traded funds)) and other sustainable investment options.

Economic freedom was revealed to influence GDP positively. When the country has strong market institutions, favorable investment policy, and property rights compliance, it is more likely to achieve stable growth. Governments should encourage entrepreneurship by removing unnecessary control and groundless restrictive measures, provide understandable and predictable legislative framework, and promote transparent public governance. It is also crucial to implement strong anti-corruption steps to ensure stability for businesses and prevent the misallocation of resources. Many of the abovementioned steps can be implemented via digitalization instruments. The implementation of digital public services has many positive impacts, including the elimination of bureaucratic processes, a reduction in the interaction time between the government and businesses, and higher levels of trust in society.

The key finding of the research is that there are a variety of factors affecting sustainable economic growth, and accordingly, policymakers should use different instruments (including the abovementioned ones) to promote it. The main limitation of the research is its context dependency: We analyzed the group of high-income economies within a limited time period. Nevertheless, the recommendations provided in this study are more universal and can be implemented in different countries, whatever their political or economic situation. Further research should focus on the model's extension by adding new variables and groups of countries (years). Additionally, further scholars may analyze the role of regional disparities in economic growth (e.g., using spatial econometric methods).

Author Contributions: Conceptualization, V.P., O.D. and K.W.; methodology, W.W., Y.C. and O.D.; software, K.W. and O.K.; validation, W.W. and O.D.; formal analysis, Y.C., V.P. and O.K.; investigation, W.W., K.W. and O.D.; resources, O.K. and Y.C.; data curation, O.K. and K.W.; writing—original draft preparation, V.P., O.K. and Y.C.; writing—review and editing, W.W., Y.C. and V.P.; visualization, W.W., K.W. and O.K.; supervision, O.D.; project administration, V.P.; funding acquisition, W.W. and O.K. All authors have read and agreed to the published version of the manuscript.

Funding: The publication contains the results of research conducted within the framework of the research project: “Sustainable development and resource security: from disruptive technologies to digital transformation of Ukrainian economy” (No. 0121U100470) and “Fundamentals of the phase transition to the additive economy: from disruptive technologies to institutional sociologization of decisions” (No. 0121U109557). Wang Wei contribution was funded by the National Social Science Fund of China for funding project “The Endogenous Mechanism and Efficiency Loss of Innovation Factor Mismatch Affecting Industrial Structure Upgrading in China” (grant number: 19CJL040) and Young Talents Development Support Program of Xi’an University of Finance and Economics.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data for this research were taken from open data sources: <https://ec.europa.eu/eurostat/> (accessed on 2 May 2023); <https://data.worldbank.org/> (accessed on 2 May 2023); <https://www.heritage.org/index/> (accessed on 2 May 2023).

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Results of the Breusch and Pagan Lagrangian multiplier test.

	Null Hypothesis	<i>p</i> -Value	Decision (OLS/Other)
Model 1	The OLS estimation is more suitable than the RE/FE	0.041	Other
Model 2		0.000	Other
Model 3		0.002	Other

Table A2. Results of the Hausman specification test.

	Null Hypothesis	<i>p</i> -Value	Decision (RE/FE)
Model 1	The RE estimation is more suitable than the FE	0.002	FE
Model 2		0.000	FE
Model 3		0.000	FE

Table A3. Empirical results estimation for models 1–3 (using the robust standard error fixed-effect estimator).

Dependent Variable—lnGDP	(1)	(2)	(3)
	Model 1	Model 2	Model 3
lnK	0.393 *** (0.000)	0.376 *** (0.000)	0.323 *** (0.000)
lnL	0.383 *** (0.000)	0.0506 (0.790)	0.407 *** (0.003)
lnE	0.314 *** (0.002)		

Table A3. Cont.

Dependent Variable—lnGDP	(1)	(2)	(3)
	Model 1	Model 2	Model 3
lnRE		0.119 *** (0.001)	
lnSC			0.349 *** (0.005)
lnEF			0.323 *** (0.000)
Constant	9.713 *** (0.000)	15.89 *** (0.000)	9.183 *** (0.000)
Observations	297	297	297
Overall R-squared	0.9561	0.9683	0.9654
Number of countries	27	27	27

p-value in parentheses: *** *p* < 0.01; ** *p* < 0.05; * *p* < 0.1.

References

- Santos, M.E.; Dabus, C.; Delbianco, F. Growth and Poverty Revisited from a Multidimensional Perspective. *J. Dev. Stud.* **2019**, *55*, 260–277. [\[CrossRef\]](#)
- Acs, Z.J.; Estrin, S.; Mickiewicz, T.; Szerb, L. Entrepreneurship, Institutional Economics, and Economic Growth: An Ecosystem Perspective. *Small Bus. Econ.* **2018**, *51*, 501–514. [\[CrossRef\]](#)
- Energy Intensity–SDG7: Data and Projections–Analysis. Available online: <https://www.iea.org/reports/sdg7-data-and-projections/energy-intensity> (accessed on 3 May 2023).
- Mahalingam, B.; Orman, W.H. GDP and Energy Consumption: A Panel Analysis of the US. *Appl. Energy* **2018**, *213*, 208–218. [\[CrossRef\]](#)
- Le, T.-H.; Nguyen, C.P. Is Energy Security a Driver for Economic Growth? Evidence from a Global Sample. *Energy Policy* **2019**, *129*, 436–451. [\[CrossRef\]](#)
- Khan, I.; Hou, F.; Irfan, M.; Zakari, A.; Le, H.P. Does Energy Trilemma a Driver of Economic Growth? The Roles of Energy Use, Population Growth, and Financial Development. *Renew. Sustain. Energy Rev.* **2021**, *146*, 111157. [\[CrossRef\]](#)
- Matvieieva, Y. Modelling and Forecasting Energy Efficiency Impact on the Human Health. *Health Econ. Manag. Rev.* **2022**, *3*, 78–85. [\[CrossRef\]](#)
- Oe, H.; Yamaoka, Y.; Duda, K. How to Sustain Businesses in the Post-COVID-19 Era: A Focus on Innovation, Sustainability and Leadership. *Bus. Ethics Leadersh.* **2022**, *6*, 1–9. [\[CrossRef\]](#)
- Burke, P.J.; Csereklyei, Z. Understanding the Energy-GDP Elasticity: A Sectoral Approach. *Energy Econ.* **2016**, *58*, 199–210. [\[CrossRef\]](#)
- Grzebyk, M.; Stec, M. Sustainable Development in EU Countries: Concept and Rating of Levels of Development: Measures of Sustainability. *Sustain. Dev.* **2015**, *23*, 150–162. [\[CrossRef\]](#)
- Dai, L.; Jia, R.; Wang, X. Relationship between Economic Growth and Energy Consumption from the Perspective of Sustainable Development. *J. Environ. Public Health* **2022**, *2022*, 6884273. [\[CrossRef\]](#)
- Szustak, G.; Dąbrowski, P.; Gradoń, W.; Szewczyk, Ł. The Relationship between Energy Production and GDP: Evidence from Selected European Economies. *Energies* **2021**, *15*, 50. [\[CrossRef\]](#)
- Myszczyński, J.; Suproń, B. Relationship among Economic Growth (GDP), Energy Consumption and Carbon Dioxide Emission: Evidence from V4 Countries. *Energies* **2021**, *14*, 7734. [\[CrossRef\]](#)
- Wulf Betancourt, E. Energy, Growth and Environment: Analysis from the Microeconomics Perspective. *Rev. Mex. Econ. Finanz.* **2020**, *15*, 621–645. [\[CrossRef\]](#)
- Bağcıoğlu, H. A Study in Estimation of Cobb-Douglas Production Function for Developing Countries. *J. Res. Bus.* **2021**, *6*, 54–68. [\[CrossRef\]](#)
- Hang, L.; Tu, M. The Impacts of Energy Prices on Energy Intensity: Evidence from China. *Energy Policy* **2007**, *35*, 2978–2988. [\[CrossRef\]](#)
- Verbič, M.; Filipović, S.; Radovanović, M. Electricity Prices and Energy Intensity in Europe. *Util. Policy* **2017**, *47*, 58–68. [\[CrossRef\]](#)
- Mitić, P.; Munitlak Ivanović, O.; Zdravković, A. A Cointegration Analysis of Real GDP and CO₂ Emissions in Transitional Countries. *Sustainability* **2017**, *9*, 568. [\[CrossRef\]](#)
- Magazzino, C.; Mele, M.; Schneider, N. A Machine Learning Approach on the Relationship among Solar and Wind Energy Production, Coal Consumption, GDP, and CO₂ Emissions. *Renew. Energy* **2021**, *167*, 99–115. [\[CrossRef\]](#)

20. Ajmi, A.N.; Hammoudeh, S.; Nguyen, D.K.; Sato, J.R. On the Relationships between CO₂ Emissions, Energy Consumption and Income: The Importance of Time Variation. *Energy Econ.* **2015**, *49*, 629–638. [\[CrossRef\]](#)
21. Kartal, M.T.; Pata, U.K.; Kılıç Depren, S.; Depren, Ö. Effects of Possible Changes in Natural Gas, Nuclear, and Coal Energy Consumption on CO₂ Emissions: Evidence from France under Russia's Gas Supply Cuts by Dynamic ARDL Simulations Approach. *Appl. Energy* **2023**, *339*, 120983. [\[CrossRef\]](#)
22. Tu, Y.X.; Kubatko, O.; Karintseva, O.; Piven, V. Decarbonisation Drivers and Climate Change Concerns of Developed Economies. *Int. J. Environ. Pollut.* **2021**, *69*, 112. [\[CrossRef\]](#)
23. Adebayo, T.S.; Ullah, S.; Kartal, M.T.; Ali, K.; Pata, U.K.; Ağa, M. Endorsing Sustainable Development in BRICS: The Role of Technological Innovation, Renewable Energy Consumption, and Natural Resources in Limiting Carbon Emission. *Sci. Total Environ.* **2023**, *859*, 160181. [\[CrossRef\]](#) [\[PubMed\]](#)
24. Kolosok, S.; Bilan, Y.; Vasylieva, T.; Wojciechowski, A.; Morawski, M. A Scoping Review of Renewable Energy, Sustainability and the Environment. *Energies* **2021**, *14*, 4490. [\[CrossRef\]](#)
25. Samusevych, Y.; Vysochyna, A.; Vasylieva, T.; Lyeonov, S.; Pokhylko, S. Environmental, Energy and Economic Security: Assessment and Interaction. *E3S Web Conf.* **2021**, *234*, 00012. [\[CrossRef\]](#)
26. Singh, N.; Nyuur, R.; Richmond, B. Renewable Energy Development as a Driver of Economic Growth: Evidence from Multivariate Panel Data Analysis. *Sustainability* **2019**, *11*, 2418. [\[CrossRef\]](#)
27. Bhattacharya, M.; Paramati, S.R.; Ozturk, I.; Bhattacharya, S. The Effect of Renewable Energy Consumption on Economic Growth: Evidence from Top 38 Countries. *Appl. Energy* **2016**, *162*, 733–741. [\[CrossRef\]](#)
28. Apergis, N.; Payne, J.E. Renewable Energy Consumption and Economic Growth: Evidence from a Panel of OECD Countries. *Energy Policy* **2010**, *38*, 656–660. [\[CrossRef\]](#)
29. Sahlian, D.N.; Popa, A.F.; Crețu, R.F. Does the Increase in Renewable Energy Influence GDP Growth? An EU-28 Analysis. *Energies* **2021**, *14*, 4762. [\[CrossRef\]](#)
30. Simionescu, M.; Bilan, Y.; Krajňáková, E.; Streimikiene, D.; Gędek, S. Renewable Energy in the Electricity Sector and GDP per Capita in the European Union. *Energies* **2019**, *12*, 2520. [\[CrossRef\]](#)
31. Bilan, Y.; Streimikiene, D.; Vasylieva, T.; Lyulyov, O.; Pimonenko, T.; Pavlyk, A. Linking between Renewable Energy, CO₂ Emissions, and Economic Growth: Challenges for Candidates and Potential Candidates for the EU Membership. *Sustainability* **2019**, *11*, 1528. [\[CrossRef\]](#)
32. Menegaki, A.N.; Marques, A.C.; Fuinhas, J.A. Redefining the Energy-Growth Nexus with an Index for Sustainable Economic Welfare in Europe. *Energy* **2017**, *141*, 1254–1268. [\[CrossRef\]](#)
33. Cho, S.; Heo, E.; Kim, J. Causal Relationship between Renewable Energy Consumption and Economic Growth: Comparison between Developed and Less-Developed Countries. *Geosystem Eng.* **2015**, *18*, 284–291. [\[CrossRef\]](#)
34. Bardy, R.; Rubens, A. Weighing Externalities of Economic Recovery Projects: An Alternative to Green Taxonomies that is Fairer and more Realistic. *Bus. Ethics Leadersh.* **2022**, *6*, 23–34. [\[CrossRef\]](#)
35. Dave, H. The Constitution of Value. *Financ. Mark. Inst. Risks* **2022**, *6*, 75–90. [\[CrossRef\]](#)
36. Habib, A.M. Does the Efficiency of Working Capital Management and Environmental, Social, and Governance Performance Affect a Firm's Value? Evidence from the United States. *Financ. Mark. Inst. Risks* **2022**, *6*, 18–25. [\[CrossRef\]](#)
37. Lahouirich, M.W.; Oulfarsi, S.; Eddine, A.S.; Sakalli, H.E.B.; Boutti, R. From Financial Performance to Sustainable Development: A Great Evolution and an Endless Debate. *Financ. Mark. Inst. Risks* **2022**, *6*, 68–79. [\[CrossRef\]](#)
38. Khalatur, S.; Dubovych, O. Financial Engineering of Green Finance as an Element of Environmental Innovation Management. *Mark. Menedžment Inovacij* **2022**, *1*, 232–246. [\[CrossRef\]](#)
39. Chygryn, O.; Bektas, C.; Havrylenko, O. Innovation and Management of Smart Transformation Global Energy Sector: Systematic Literature Review. *Bus. Ethics Leadersh.* **2023**, *7*, 105–112. [\[CrossRef\]](#)
40. Aliyeva, A. Post-Oil Period in Azerbaijan: Economic Transformations, Anti-Inflation Policy and Innovations Management. *Mark. Menedžment Inovacij* **2022**, *2*, 268–283.
41. Kolosok, S.; Saher, L.; Kovalenko, Y.; Delibasic, M. Renewable Energy and Energy Innovations: Examining Relationships Using Markov Switching Regression Model. *Mark. Menedžment Inovacij* **2022**, *2*, 151–160.
42. Melnyk, L.; Kubatko, O.; Piven, V.; Klymenko, K.; Rybina, L. Digital and Economic Transformations for Sustainable Development Promotion: A Case of OECD Countries. *Environ. Econ.* **2022**, *12*, 140–148. [\[CrossRef\]](#)
43. Galindo, M.-Á.; Méndez, M.T. Entrepreneurship, Economic Growth, and Innovation: Are Feedback Effects at Work? *J. Bus. Res.* **2014**, *67*, 825–829. [\[CrossRef\]](#)
44. Tudor, C.; Sova, R. On the Impact of GDP per Capita, Carbon Intensity and Innovation for Renewable Energy Consumption: Worldwide Evidence. *Energies* **2021**, *14*, 6254. [\[CrossRef\]](#)
45. Ahmad, M.; Jiang, P.; Majeed, A.; Umar, M.; Khan, Z.; Muhammad, S. The Dynamic Impact of Natural Resources, Technological Innovations and Economic Growth on Ecological Footprint: An Advanced Panel Data Estimation. *Resour. Policy* **2020**, *69*, 101817. [\[CrossRef\]](#)
46. Dauda, L.; Long, X.; Mensah, C.N.; Salman, M. The Effects of Economic Growth and Innovation on CO₂ Emissions in Different Regions. *Environ. Sci. Pollut. Res.* **2019**, *26*, 15028–15038. [\[CrossRef\]](#) [\[PubMed\]](#)

47. Mughal, N.; Arif, A.; Jain, V.; Chupradit, S.; Shabbir, M.S.; Ramos-Meza, C.S.; Zhanbayev, R. The Role of Technological Innovation in Environmental Pollution, Energy Consumption and Sustainable Economic Growth: Evidence from South Asian Economies. *Energy Strategy Rev.* **2022**, *39*, 100745. [CrossRef]
48. Hysa, E.; Kruja, A.; Rehman, N.U.; Laurenti, R. Circular Economy Innovation and Environmental Sustainability Impact on Economic Growth: An Integrated Model for Sustainable Development. *Sustainability* **2020**, *12*, 4831. [CrossRef]
49. Acemoglu, D.; Johnson, S.; Robinson, J.A. Institutions as a fundamental cause of long-run growth. *Handb. Econ. Growth* **2005**, *1*, 385–472.
50. Urbano, D.; Aparicio, S.; Audretsch, D. Twenty-Five Years of Research on Institutions, Entrepreneurship, and Economic Growth: What Has Been Learned? *Small Bus. Econ.* **2019**, *53*, 21–49. [CrossRef]
51. Zallé, O. Natural Resources and Economic Growth in Africa: The Role of Institutional Quality and Human Capital. *Resour. Policy* **2019**, *62*, 616–624. [CrossRef]
52. De Haan, J.; Sturm, J.-E. On the Relationship between Economic Freedom and Economic Growth. *Eur. J. Political Econ.* **2000**, *16*, 215–241. [CrossRef]
53. Mohammadi, H.; Shayanmehr, S.; Borrero, J.D. Does Freedom Matter for Sustainable Economic Development? New Evidence from Spatial Econometric Analysis. *Mathematics* **2022**, *11*, 145. [CrossRef]
54. Cebula, R.J.; Foley, M. A Panel Data Study of the Effects of Economic Freedom, Regulatory Quality, and Taxation on the Growth Rate of Per Capita Real GDP. *J. Public Financ. Public Choice* **2012**, *30*, 103–122. [CrossRef]
55. Tu, Y.-X.; Kubatko, O.; Piven, V.; Kovalov, B.; Kharchenko, M. Promotion of Sustainable Development in the EU: Social and Economic Drivers. *Sustainability* **2023**, *15*, 7503. [CrossRef]
56. Rapsikevicius, J.; Bruneckiene, J.; Lukauskas, M.; Mikalonis, S. The Impact of Economic Freedom on Economic and Environmental Performance: Evidence from European Countries. *Sustainability* **2021**, *13*, 2380. [CrossRef]
57. Doucouliagos, C.; Ulubasoglu, M.A. Economic Freedom and Economic Growth: Does Specification Make a Difference? *Eur. J. Political Econ.* **2006**, *22*, 60–81. [CrossRef]
58. Douglas, P.H. Comments on the Cobb-Douglas production function. In *The Theory and Empirical Analysis of Production*; NBER: Cambridge, MA, USA, 1967; pp. 15–22.
59. Gross Fixed Capital Formation (Constant 2015 USD). Available online: <https://data.worldbank.org/indicator/NE.GDI.FTOT.KD> (accessed on 3 May 2023).
60. Labor Force, Total. Available online: <https://data.worldbank.org/indicator/SL.TLF.TOTL.IN> (accessed on 3 May 2023).
61. GDP (Constant 2015 USD). Available online: <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD> (accessed on 3 May 2023).
62. Index of Economic Freedom: Promoting Economic Opportunity and Prosperity by Country. Available online: <https://www.heritage.org/index/> (accessed on 3 May 2023).
63. Human Resources in Science and Technology. Available online: <https://ec.europa.eu/eurostat/web/products-datasets/-/tsc00025> (accessed on 3 May 2023).
64. European Commission, Official Website. Available online: https://commission.europa.eu/index_en (accessed on 3 May 2023).
65. Mishra, V.; Smyth, R.; Sharma, S. The Energy-GDP Nexus: Evidence from a Panel of Pacific Island Countries. *Resour. Energy Econ.* **2009**, *31*, 210–220. [CrossRef]
66. Baranzini, A.; Bareit, M.; Weber, S.; Mathys, N.A. The Causal Relationship between Energy Use and Economic Growth in Switzerland. *SSRN J.* **2011**, 1–18. [CrossRef]
67. Topolewski, Ł. Relationship between Energy Consumption and Economic Growth in European Countries: Evidence from Dynamic Panel Data Analysis. *Energies* **2021**, *14*, 3565. [CrossRef]
68. Zou, G. The Relationships between Energy Consumption and Key Industrial Sector Growth in China. *Energy Rep.* **2022**, *8*, 924–935. [CrossRef]
69. Chen, J.; Su, F.; Jain, V.; Salman, A.; Tabash, M.I.; Haddad, A.M.; Zabalawi, E.; Abdalla, A.A.; Shabbir, M.S. Does Renewable Energy Matter to Achieve Sustainable Development Goals? The Impact of Renewable Energy Strategies on Sustainable Economic Growth. *Front. Energy Res.* **2022**, *10*, 829252. [CrossRef]
70. Danish Annual and Monthly Energy Statistics. Available online: <https://ens.dk/en/our-services/statistics-data-key-figures-and-energy-maps/annual-and-monthly-statistics> (accessed on 1 August 2023).
71. Javed, A.; Ashraf, J.; Khan, T. The Impact of Renewable Energy on GDP. *Int. J. Manag. Sustain.* **2020**, *9*, 239–250. [CrossRef]
72. Soava, G.; Mehedintu, A. Final Energy Consumption—Growth Nexus in Romania Versus the European Union: A Sectoral Approach Using Neural Network. *Energies* **2023**, *16*, 871. [CrossRef]
73. Sunde, T.; Tafirenyika, B.; Adeyanju, A. Testing the Impact of Exports, Imports, and Trade Openness on Economic Growth in Namibia: Assessment Using the ARDL Cointegration Method. *Economies* **2023**, *11*, 86. [CrossRef]
74. Gregory, T.; Salomons, A.; Zierahn, U. Racing with or Against the Machine? Evidence from Europe. *SSRN J.* **2016**, 1–67. [CrossRef]
75. Wooldridge, J.M. *Econometric Analysis of Cross Section and Panel Data*, 2nd ed.; MIT Press: Cambridge, MA, USA, 2010; ISBN 9780262232586.
76. Hill, A.D.; Johnson, S.G.; Greco, L.M.; O’Boyle, E.H.; Walter, S.L. Endogeneity: A Review and Agenda for the Methodology-Practice Divide Affecting Micro and Macro Research. *J. Manag.* **2021**, *47*, 105–143. [CrossRef]

77. Stiglitz, J. Growth with Exhaustible Natural Resources: Efficient and Optimal Growth Paths. *Rev. Econ. Stud.* **1974**, *41*, 123. [[CrossRef](#)]
78. Solow, R.M. The Economics of Resources or the Resources of Economics. In *Classic Papers in Natural Resource Economics*; Gopalakrishnan, C., Ed.; Palgrave Macmillan UK: London, UK, 1974; pp. 257–276. ISBN 9781349417506.
79. Keen, S.; Ayres, R.U.; Standish, R. A Note on the Role of Energy in Production. *Ecol. Econ.* **2019**, *157*, 40–46. [[CrossRef](#)]

Disclaimer/Publisher’s Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.