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How investments into renewable sources affect economic development: A case of the EU countries

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Abstract. Energy consumption trends reflect an increasing demand for energy. Waste sorting, energy stewardship, and investing in renewable energy sources can help mitigate the consequences of climate change. Sustainability is increasingly dependent on renewable energy sources, as they help ensure long-term economic growth and social stability without dependence on fossil fuels. Scientists, politicians, and investors are interested in the development of alternative energy sources. It is assumed that greater investments in renewable energy not only help reduce environmental pollution but also stimulate innovation and economic development. This article aims to assess the impact of investments in renewable energy sources on the economy and to identify the relationships between the scale of investments and changes in economic indicators. An eclectic specification of the economic growth model, based on the neoclassical conditional beta convergence model supplemented with various economic growth factors (using panel analysis), allowed for the testing of hypotheses and sub-hypotheses raised. The results revealed that investments in renewable sources do not directly impact economic development; however, they do affect other economic indicators that play a crucial role in the economic development process.

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1. INTRODUCTION

Energy consumption trends have recently become increasingly problematic in everyday life. Waste sorting, energy stewardship, and investment in renewable sources can help alleviate the situation with climate change and mitigate negative impacts on our planet. Therefore, sustainability increasingly depends on renewable energy sources, including solar, wind, hydro, geothermal energy and biomass, as they help ensure long-term economic and social stability and reduced dependence on fossil fuels.

Scientists, politicians and investors are increasingly interested in the development of alternative energy sources because greater investments in renewable energy not only help reduce environmental pollution but also stimulate innovation and economic development. The importance of renewable energy has already grown to one of the most hotly debated issues in global discussions on sustainable development (Oliveira et al., 2022; Rezk et al., 2023; Gayen, Chatterjee & Roy, 2024; Johri et al., 2024; Redouani et al., 2024; Pata, 2025; Dirma et al., 2024; Okunevičiūtė & Neverauskienė, 2025a; Alturif et al., 2024; Bazienė et al., 2024; Zemlickienė, Amraoui & El Amrani El Idrissi, 2024; Sebbaghi et al., 2025; Taib et al., 2025; Smaliukienė & Katina, 2025). From a macroeconomic perspective, climate change can be valued through sectoral economic activities and their contribution to emissions, providing an explicit link between decarbonisation pathways and national economic performance (Stankevičienė & Borisova, 2022).

However, about 80% of the world's population lives in countries that are fossil fuel importers, comprising approximately 6 billion people, who are dependent on foreign energy and vulnerable to geopolitical shocks. In contrast, renewable energy, which is accessible to all countries and, according to IRENA forecasts, is expected to provide 90% of electricity by 2050, ensures independence, economic diversification, job creation, and poverty reduction (Okunevičiūtė Neverauskienė et al., 2025b).

To address the problem of climate change, it is necessary to decarbonise both energy supply and demand by 2050. The United States, Europe and China have committed to achieving zero or neutral carbon dioxide emissions by mid-century. Other countries are following their example, which will have a significant impact on the global energy transition, as electricity will become the primary vector in decarbonising the entire energy sector. Therefore, this article aims to assess the impact of investments in renewable energy sources on the economy and to identify the relationships between the scale of investment and changes in key economic indicators.

2. LITERATURE REVIEW

The role of efforts in supporting and promoting green projects is becoming increasingly important as the world grapples with environmental challenges such as climate change and resource depletion. As a result, considerable attention is being paid to green investments, including green projects and programs. To achieve sustainable development in the face of climate change and environmental degradation, there has been a shift towards renewable energy sources (Igielski, 2023; Uen & Rodríguez, 2023; Jafarizadeh et al., 2024; Masárová & Kordoš, 2025; Šateikienė & Šerputis, 2025; Kozáková, Hudáková & Grimberger, 2025). Recent sustainability assessments of European energy generation systems demonstrate that economic, environmental, and social dimensions jointly determine the overall performance and resilience of national power mixes, revealing substantial cross-country heterogeneity in their ability to withstand price and policy shocks (Drożdż et al., 2023). Sector-specific evidence from the hospitality industry shows that targeted investments in waste reduction and plastic recycling can deliver both environmental and economic benefits, illustrating how green projects operate at the micro level of service firms (Ramirez & George, 2019).

Nevertheless, many countries still rely on fossil fuels (Okunevičiūtė, Neverauskienė et al., 2025c). It is crucial to find economically viable solutions and develop attitudes (Piccinetti et al., 2025; Cojocaru (Bărbieru) et al., 2025; Miszczak et al., 2025; Sedliačiková et al., 2025) that enable the reduction of energy sources that lead to environmental degradation. Renewable energy sources such as solar, wind, hydro, waste and geothermal energy are naturally renewable, and therefore emit the least pollutants and harmful substances, consequently broad range of society worldwide strongly advocate their adoption as an effective solution to combat climate change (Hoang & Nguyen et al., 2021; Deshmukh et al., 2023; Sharmin et al., 2023; Mutascu, 2023; Liang & Pirouzi, 2024; Figaj, 2024; Herrera-Franco et al., 2024; Rezk et al., 2024; Anya et al., 2024; Nguyen & Uong, 2025; Nguyen et al., 2025; Raihan, 2025; Manal, 2025).

Anyway, transition towards requires additional costs (Maka & Alabid, 2022; McClean & Pedersen, 2022; Pouras et al., 2023; Kwok & Hu, 2023; Sayed et al., 2023; Shahzad et al., 2023; Omidvarnia & Sarhadi, 2024; Jafarinejad & Beckingham, 2024; Zakariazadeh et al., 2024).

Many countries are transitioning to renewable and more sustainable energy systems. These efforts span a variety of trajectories and across multiple industry sectors. One of the main economic challenges associated with deploying hybrid renewable energy systems (HRES) in any combination is the high upfront capital costs. The costs include not only the initial investment in hardware, such as solar panels, wind turbines and batteries, but also the costs of installation, grid connection and possibly land acquisition. These costs are further compounded by any backup generators and storage systems, such as batteries or pumped-storage systems, that may be required to maintain a stable supply. There is no unanimous agreement on how much transition towards renewable energy affects the economic development of countries. This paper aims to contribute to the discussion on answering this complicated question.

The following research problem is tackled: how to evaluate the impact of investments in renewable energy sources on economic growth. The objective of this study is to examine the effects of renewable energy investments on the economy. The study aims to evaluate the economic impact of investments in renewable energy sources.

The following tasks are set in the article to achieve the aim:

1. After analysing the scientific literature on investments in renewable energy sources, determine the importance of renewable energy sources for the economy.

2. After developing a research methodology that includes data collection, systematisation, correlation analysis, panel analysis, and comparison of results, assess the impact of investments in renewable energy sources on economic indicators.

Research methods used: literature review; comparative analysis; generalisation of systematised information; eclectic specification of the economic growth model based on the neoclassical conditional beta convergence model supplemented with various economic growth factors (panel analysis); testing of hypotheses and subhypotheses.

3. METHODOLOGY

Research methods used: literature review; comparative analysis; generalisation of systematised information; eclectic specification of the economic growth model based on the neoclassical conditional beta convergence model supplemented with various economic growth factors (panel analysis); testing of hypotheses and subhypotheses.

The assessment of the impact of the transition to renewable energy sources on economic growth is carried out using an eclectic specification of the economic growth model. The basis of this model is the neoclassical conditional beta convergence model, which, depending on the study's purpose, is supplemented with various economic growth factors. The following equations can describe the most general expression of this model for panel data:

$$\frac{1}{T} ln\left(\frac{Y_{i,t+T}}{Y_{i,t}}\right) = \alpha_i + \beta lnY_{i,t} + \gamma X + \theta_t + \varepsilon_{i,t} \quad (1)$$

where $\frac{1}{T} ln\left(\frac{Y_{i,t+T}}{Y_{i,t}}\right)$ - average annual growth rates of real GDP per capita (Y) from t to T in country i. These growth rates will be further denoted by *gri,t* and will be used to approximate the economic growth rates described in the second equation. The values of the coefficients of the first equation: α_i - include unobservable and time-invariant (or very slowly changing) country-specific effects (Bonhomme, Lamadon & Manresa, 2022), i.e. unobservable heterogeneity of countries (e.g.: average number of sunny and cloudy days and average daylight hours, wind strength and directions, river network suitable for hydroelectric power plants, forest cover of countries, abundance of fossil fuel resources and their exploitation volumes, etc.), which determined and determine the different potential of renewable energy resources of countries and the need to replace imported fossil fuels with them; $lnY_{i,t}$ - the logarithm of the country's initial GDP per capita, and the β estimate reveals whether convergence is taking place between the economies of the studied countries; X - vector of economic growth factors, γ - vector of estimated coefficients of the impact of economic growth factors on economic growth; θ_t - vector of time pseudovariables, with the help of which the study models the general economic growth trend characteristic of the analysed group of countries; $\varepsilon_{i,t}$ - idiosyncratic model error/white noise.

The study uses average overlapping five-year (T=5) future economic growth rates (overlapping forward-looking 5-year growth rate), thus eliminating the effect of the business cycle on economic growth rates and taking into account factors affecting economic growth in the long term. In the context of this study, we can instead expect that it is not investments in and the transition to renewable energy sources in year t that affect economic growth in year t, but economic growth in year t or its forecast made in year t-1 that encourages one or another state investment in the infrastructure of renewable energy resources or the development of their use in year t.

Data for measuring all variables are collected in the Eurostat database. The unbalanced panel data sample comprises 27 EU countries (N = 27), covering the period from 2000 to 2021 (T = 22). The model includes the most commonly used economic growth factors in empirical studies, with the additional inclusion of variables of interest. Therefore, in detailing the first equation, the economic growth factors included in the vector X are described using panel data by equation 2:

$$gr_{i,t} = \alpha_i + \beta lnY_{i,t} + \gamma_1 RnD_{i,t} + \gamma_2 HC_{i,t} + \gamma_3 \Delta lnHICP_{i,t} + \gamma_4 G_{i,t} + \gamma_5 GCF_{i,t} + \gamma_6 GCF^2_{i,t} + \gamma_7 TR_{i,t} + \gamma_8 CC_{i,t} + \gamma_9 \Delta lnEMPL_{i,t} + \theta_t + \varepsilon_{i,t} \quad (2)$$

where gri,t – average overlapping five-year future economic growth rates are calculated as $\frac{1}{5} ln\left(\frac{Y_{i,t+T}}{Y_{i,t}}\right)$, where Y is real GDP per capita, i.e. average overlapping five-year future economic growth rates (index); Yi,t - real (in 2010 prices) GDP per capita (EUR); RnDi,t - gross investment in R&D (% of GDP), which measures the country's innovation potential; HCi,t - share of the population aged 15-64 with tertiary (ISCED 5-8) education (%); ΔlnHICPi,t - inflation (calculated as the average annual change in the Harmonized Consumer Price Index); Gi,t - central government final consumption expenditure (% of GDP); GCFi,t - gross capital formation expenditure (% GDP), in which a second-degree polynomial raised to the square is used to approximate the nonlinear relationship, since according to neoclassical growth theory, the positive impact of investment on economic growth is characterised by a diminishing marginal effect, i.e. as investment grows, its additional amount contributes less and less to promoting economic growth; TRi,t - the ratio of the amount of imports and exports of goods and services to GDP (% of GDP); CCi,t - the level of corruption control (index), the estimates of which are provided by the World Bank in its Worldwide Governance Indicators (WGI) database; ΔlnEMPLi,t - the dynamics of the amount of labor force activated in the economy, i.e. the change in the number of employed (index); $\varepsilon_{i,t}$ - all other factors.

Further detailing the equations and including variables that measure the transition to renewable energy sources (Hydro, geothermal, wind, solar, tidal/wave), they are not analysed separately, but as a common vector X.

$$X = \{REN\_U_{i,t}, REN\_P_{i,t}, REN\_U\_T_{i,t}, REN\_U\_E_{i,t}, REN\_U\_HC_{i,t}, REN\_P\_H_{i,t}, REN\_P\_GWSO_{i,t}\} \quad (3)$$

where REN_Ui,t - share of energy consumed from renewable energy sources in the energy balance; REN_Pi,t- share of energy generation capacities from renewable energy sources in energy generation capacities; REN_U_Ti,t - share of energy consumed from renewable energy sources in the energy balance in the transport sector (%); REN_U_Ei,t - share of electricity consumed from renewable energy sources in the electricity energy balance (%); REN_U_HCi,t - share of energy consumed for heating and cooling from renewable energy sources in the energy balance for heating and cooling (%); REN_P_Hi,t - share of energy generation capacities from hydropower sources in total capacities (%); REN_P_GWSOi,t - share of energy generation capacities from geothermal, wind, solar, tidal/wave energy sources in total capacities (%).

The stages of model development are as follows:

The coefficient estimates of the regression models are calculated using the ordinary least squares (OLS) method.

The α_i estimates of these models are further tested to determine their behaviour and select the appropriate method for calculating the estimates. For this, the practical part applies: Fisher (F) test, which checks whether α_i are specific and invariant in time. Breusch-Pagan (BP1) test, which checks whether α_i are specific and vary randomly in time. Hausman test, which checks whether the AMKM estimates are consistent and decides whether the AMKM method or the FE method is more appropriate. These three tests are based on the analysis of the behaviour of α_i, allowing one to choose one of three methods for calculating estimates - MKM (generalised least squares, GLS), FE (fixed effects, FE) or AE (random effects, RE). Since the choice of the method for calculating estimates according to the behavior of α_i does not guarantee that the model will not be characterised by endogeneity, certain assumptions about the suitability of the residual errors of the models, i.e. $\varepsilon_{i,t}$, are checked by applying: Ramsey RESET test for determining a linear relationship; Wooldridge autocorrelation test; Breusch-Pagan (BP2) test (if the dispersion of model errors does not significantly differ from the normal distribution) or Koenker test (if the dispersion of model errors significantly differs from the normal distribution) to check the heteroscedasticity of the dispersion of model errors; Pesaran CD test to check whether the model errors are characterised by intergroup correlation; Beck-Katz test, which stabilises standard errors; variance inflation factor (VIF) to identify multicollinearity problems; Durbin-Wu-Hausman test, which examines the endogeneity of an independent factor.

To address the endogeneity problem, the two-stage least squares (2SLS) or three-stage least squares (3SLS) method, or another method using instrumental variables (IV), is employed.

Formulas 1 and 2 are applied.

The hypothesis and subhypothesis put forward by the authors are tested:

H1 hypothesis that the transition to renewable energy sources slows down economic growth. The first hypothesis is empirically tested using the following regression equation specification:

$$gr_{i,t} = \alpha_i + \beta lnY_{i,t} + \gamma X + \varphi REN_{i,t} + \theta_t + \varepsilon_{i,t} \quad (4)$$

If the φ estimate is negative and statistically significant, this indicates a negative impact of the development of renewable energy sources on economic growth and H1 is not rejected.

Since in the H1 hypothesis, the growth-slowing effect of the transition to renewable energy sources is based on the cost effect, an additional sub-hypothesis is tested.

H1a: As the prices of renewable energy sources decrease over time and new energy generation capacities from renewable energy sources become more expensive, the negative impact of the transition to renewable energy sources on economic growth decreases. This subhypothesis is empirically tested using the following regression equation specification:

$$gr_{i,t} = \alpha_i + \beta lnY_{i,t} + \gamma X + \varphi REN_{i,t} + \delta_{2001} REN_{i,t} \times td_{2001} + \cdots + \delta_{2021} REN_{i,t} \times td_{2021} + \theta_t + \varepsilon_{i,t} \quad (5)$$

where td2001,…,td2021 are time pseudovariables, $REN_{i,t} \times td_{2001}$, ..., $\delta_{2021} REN_{i,t} \times td_{2021}$ are interaction variables between the transition to renewable energy sources and the time pseudovariables. δ2001,…,δ2021 are coefficients that show the difference in the impact of the transition to renewable energy sources on economic growth in the corresponding year compared to 2000. H1a is not rejected if δ2001,…,δ2021 are positive and statistically significant, and the inequality is satisfied: δ2001,…,δ2021 . This shows that the negative effect of 2000 φ becomes smaller over time.

The assessment model developed in the article applies several methods for assessing the impact of RES development on economic growth. The assessment model highlights the parts that are combined into an assessment of the impact of RES development on the economy, based on the study of economic growth factors, using econometric modelling (Jabiyev et al., 2022; Azizov et al., 2023).

RESULTS

The estimates of all regression models were calculated using the least squares method (LSM). After that, the α_i estimates of these models were tested to determine their behaviour and select an appropriate method for calculating the estimates. The dependent variable is the average of the five-year future economic growth rates. The Fisher (F) test determined that α_i is specific, $p<0.0001$, allowing us to conclude that the

MSM, which does not eliminate and model country-specific effects of ⍺_i, is not appropriate. In this case, calculating fixed effects (FE) estimates would be a more suitable alternative. The Breusch-Pagan test, with a p-value of <0.0001, allows us to conclude that ⍺_i are specific and vary randomly over time; therefore, MKM may result in biased parameter estimates. A more suitable alternative for calculating random effects (AE) estimates, which uses the generalised least squares method (GLS), would be the one. The Hausman test p<0.0001 allows us to conclude that GLS is not appropriate, and the FE method should be preferred. Based on the results obtained, the estimates of all models were calculated using FE. The Durbin-Wu-Hausman test p>0.05 indicates that the independent variables of the model are exogenous and the FE estimates are not biased, so all the main factors of economic growth are included in the models, and no variables that would affect economic growth and correlate with other independent variables included in the model, thus causing endogeneity, were omitted. In the last stage, the FE models were tested for errors due to compliance with the typically required assumptions. The Ramsey RESET test indicated that the model specifications and data transformations applied are sufficient to render the analysed relationships linear. The Wooldridge autocorrelation test showed that the model errors are characterised by a small, but positive and statistically significant autocorrelation. The Breusch-Pagan test showed that the dispersion of the model errors is heteroskedastic, which is why the calculated conventional standard model errors may be ineffective and inappropriate for determining the statistical significance of the estimates. The Pesaran CD test found that the errors are characterised by intergroup correlation. Such a situation is very likely, since the analysed EU countries are interconnected by trade, investment and labor migration flows, and changes in economic growth in one country are related to changes in economic growth in other countries, i.e. the economic growth factor of a particular EU country is weighted by the economic growth rate vector of the remaining EU countries, where the weight depends on the strength of economic ties. Beck-Katz stabilised standard errors, which take into account the intergroup correlation inherent in the usual model errors, as well as heteroscedasticity and autocorrelation, eliminate ineffective and likely smaller than the true standard errors of the model estimates. The obtained results (VIF<4) allow us to state that the models are not characterised by multicollinearity.

Finally, time pseudovariables are included in all models, since the Wald test p<0.0001, which allows us to state that the hypothesis H0: $td_{2000} = td_{2001} = \cdots = td_{2021} = 0$ is rejected. Individual country effects are included in all models, i.e. the two-way fixed effects method (2-way FE) i.e., least squares dummy variable regression (LSDV) was applied. After testing the α_i estimates of the models, their behaviour was determined, and an appropriate method for calculating the estimates was selected. In the next stage, using formula 1, economic growth factors are studied, which were included in the models as control variables. These variables are repeated in all models. The negative and statistically significant (at the 1% level) correlation between the initial GDP per capita and its average five-year growth rates indicates that beta convergence of approximately 3% occurred among the analysed EU countries during the period under study. This suggests that countries with lower GDP per capita experienced faster growth than those with higher GDP (a one per cent difference in GDP per capita is associated with a 0.03% difference in economic growth rates). Faster economic growth rates were characterised by countries that invested more in R&D. A one percentage point (p.p.) increase in R&D investment was associated with a 0.37% faster economic growth rate.

When applying formula 2, the models are supplemented with the share of consumed energy from renewable energy sources in the energy balance (REN_U) or the share of energy generation capacities from renewable energy sources in total capacities (REN_P)[the size of the R&D impact remains similar but becomes statistically insignificant. This indicates that R&D investments and REN_P are related, i.e., REN_P and REN_P did not occur without R&D activities, and their inclusion in the models approximates the differences in the scale of R&D activities across countries quite well. Greater provision of human capital, which in this research is referred to as the share of the population with higher education, is statistically significantly (at the 1%-5% level) accelerating economic growth rates. A 1% higher share of the population with higher education is associated with a 0.03-0.05% faster economic growth rate. No statistically significant effect of inflation on economic growth was found. During the period under study, inflation rates in the EU were sufficiently low (the average annual price growth rate was 2.2%, and the maximum was 16.8%) and did not have a negative impact on economic growth. The size of the public sector, which measures the degree of government intervention in the economy and is approximated by the share of GDP redistributed through the budget managed by the central government, has a negative impact on economic growth. Neither the size of the effect nor its statistical significance in the models is stable. In the model that includes REN_P, the impact on growth becomes insignificant, indicating that the differences in the share of renewable energy generation capacity in total capacity across countries are related to the share of central government final consumption expenditure as a share of GDP, i.e., the state finances a significant part of the growth of these generation capacities through its budget. A nonlinear but statistically insignificant relationship was found between gross capital formation expenditure and economic growth. The negative coefficient on the square of gross capital formation expenditure indicates that the marginal investment effect on economic growth is decreasing. The turning point is reached when gross capital formation expenditure reaches about 16 per cent of GDP (the study alternatively used (i) gross capital formation expenditure per employee and (ii) gross fixed capital formation expenditure as a share of GDP. Similar results were obtained – a nonlinear statistically insignificant inverted U-shaped relationship was found between capital investment and economic growth). Economic openness to trade, measured as the share of imports and exports in GDP, has a statistically significant (at the 1% level) positive effect on economic growth. A one percentage point higher share of international trade in GDP is associated with an average of 0.003-0.007 per cent faster economic growth. A better institutional environment, measured by a lower level of corruption, is associated with faster economic growth. A one-point lower level of corruption (in the 5-point range) is statistically significantly (at the 1% level) associated with 0.7-0.1 per cent faster economic growth. The growth in the number of employed persons, as one of the main factors of production, has a statistically significant (at the 1% level) positive effect on economic growth. The calculated elasticity coefficient fluctuates around 0.4-0.5, i.e., a one per cent increase in the number of employed persons is associated with a 0.4-0.5 per cent increase in GDP.

After applying formula 4, the results of the calculation of the H1 hypothesis were obtained. Due to the abundance of data in the results table, only the conclusions are presented. We can state that the share of renewable energy sources in the energy balance does not have a statistically significant effect on economic growth, i.e. the transition to renewable energy sources does not slow down economic growth in countries, because the Wald test, which tests H0: $td_{2000} = td_{2001} = \cdots = td_{2021} = 0$, is rejected, because $p<0.0001$. However, when evaluating renewable energy sources by the share of energy generation, a positive statistically significant effect on the economy is determined - a one percentage point higher share of energy generation capacities from renewable energy sources in total capacities is associated with 0.00763% faster economic growth in the country. This is associated with investments, respectively, increasing generation capacities. Therefore, we can reject the H1 hypothesis, and conclude that the transition to renewable energy sources does not slow down economic growth.

According to the developed model, the refinement subhypothesis (H1a) was tested using formula 5. Due to the large number of variables, only a few fixed effects estimate of the α_i, β equation and test values are presented in Table 1. *, **, *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Table 1
Results of testing the confirmatory/refining subhypothesis (H1a). Source: compiled by the authors based on own research

Full variable name	Abbreviation	Coefficient	(4)	(5)
Constant		α_i	0,2873***	0,3025***
			(0,02817)	(0,02817)
Logarithm of real (2010 prices) initial GDP per capita (EUR)	$lnY_{i,t}$	β	-0,02867***	-0,03128***
			(0,002253)	(0,002089)
Results of other variables from γ_1 to γ_9; and $REN\_U_{i,t} \times td_{2004}$ to $REN\_U_{i,t} \times td_{2015}$ and φ;$REN\_P_{i,t} \times td_{2002}$ to$REN_P_{i,t} \times td_{2016}$	…	…	…	…
Number of observations	n	42,1	351	417
Adjusted coefficient of determination	$R^2_{kor.}$	0,6942	0,6658	0,7000
Fisher (F) test H0: $\alpha_1 = \alpha_2 \ldots = \alpha_i$ p-value		<0,0001	<0,0001	<0,0001
Breusch-Pagan (BP1) test H0: $\alpha_1 = \alpha_2 \ldots = \alpha_i$ p-value		<0,0001	<0,0001	<0,0001
Hausman test H0: AMKM estimates are consistent p-value		<0,0001	<0,0001	<0,0001
Durbin-Wu-Hausman test H0: the independent variables of the model are exogenous p-value		0,13135	0,11719	0,12658
Ramsey RESET test H0: the relationships between the dependent variable and the independent variables are linear p-value		0,10735	0,14486	0,13986
Wooldridge test H0: no first-order autocorrelation p-value		<0,0001	<0,0001	<0,0001
Breusch-Pagan (BP2) test H0: variance is homoscedastic p-value		<0,0001	<0,0001	<0,0001
Pesaran CD test H0: intergroup variance does not differ from zero p-value		<0,0001	<0,0001	<0,0001

After evaluating the obtained results, we can state that there is no statistically significant change in the effect during the period under study. When evaluating renewable energy sources based on their share of energy generation, a similar positive effect on the economy is observed, and this effect remains relatively stable over time. The statistically insignificant effect of the share of energy consumed from renewable energy sources in the energy balance determined in the previous stage remains so throughout the period under study. Therefore, the determined effects remain relatively constant over time.

5. CONCLUSION

Renewable energy sources are crucial for achieving sustainability and addressing environmental issues. Various solutions are being implemented to effectively implement the green course, promote clean energy production, and reduce dependence on fossil fuels. All this is not only vital in combating climate change but also in protecting the planet from pollution, reducing greenhouse gas emissions, contributing to long-term environmental sustainability and economic stability.

Economic development depends on numerous factors; we found that faster economic growth rates characterised European countries that invested more in R&D. One percentage point (p.p.) higher investment in R&D as a percentage of GDP was associated with a 0.37% faster economic growth rate. Higher human capital provision accelerates economic growth rates, too. A 1 percentage point higher share of the population with higher education is associated with a 0.03-0.05% faster economic growth rate. No statistically significant effect of inflation on economic growth has been identified. The size of the public sector has a negative impact on economic growth. Neither the effect size nor its statistical significance is stable in the models. No relationship has been identified between total capital formation expenditure and economic growth. Statistically significant relationships influencing economic growth were identified with the following factors: the marginal investment effect, the openness of the economy to trade, a better institutional environment, a lower level of corruption, and growth in the number of employed people as one of the main factors of production.

Investments in renewable energy sources do not significantly impact economic development. When evaluating renewable energy sources by their share of energy generation, a statistically significant positive effect on the economy is identified. A one percentage point higher share of energy generation capacities from renewable energy sources in total capacities is associated with 0.00763% faster economic growth in the country. This is associated with investments, respectively, increasing generation capacities. On the other hand, when evaluating renewable energy sources based on their share of energy generation, a positive effect on the economy is identified, and this effect remains relatively stable over time. It was determined that the impact of the share of energy consumed from renewable energy sources in the energy balance is statistically insignificant, and remains so throughout the entire period under consideration, i.e., the identified effects remain relatively constant over time.

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