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Role of Banking Sector Performance in Renewable Energy Consumption: A Comparative Analysis of OECD Countries and the Western Balkans

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ABSTRACT

The paper explores the impact of banking sector performance on renewable energy consumption and focuses on a panel of 43 countries, including 38 OECD countries and five Western Balkan countries for the period 2010-2022. Recognizing the crucial role of the banking sector in financing renewable energy investments, the study evaluates the influence of five key banking sector performance indicators: the ratio of cost to revenue, asset quality, return on assets, financial stability, and return on equity. The research employs both random and fixed effects models to analyze panel data for the OECD and Western Balkan countries. The Hausman Test results indicated that the Random Effects model was the most suitable for the OECD data, as it efficiently uses within and between country variations without correlation issues. For the Western Balkans, the Fixed Effects model was preferred, as it controls for unobserved heterogeneity that could bias the results. This methodological choice ensures robust and accurate econometric analysis tailored to the specific data characteristics of each region. The key findings of the study reveal that within OECD countries, there is a positive relationship between financial stability, the ratio of cost to revenue, and the return on assets with renewable energy consumption. On the other hand, our analysis shows that in the Western Balkan countries, the quality of banking assets stands out as a key factor influencing renewable energy consumption. These findings emphasize the banking sector's critical role in achieving sustainable energy transitions and show that specific financial policies, such as providing green loans, offering tax incentives for renewable energy investments, and implementing more strict asset quality regulations, could improve the effectiveness of renewable energy investment across different regions.

1. INTRODUCTION

Transition to renewable energy is an important component of addressing global climate change and promoting sustainable development. As demand for cleaner and more sustainable energy increases, so does the need for significant investments in renewable energy technologies. The banking sector plays a crucial role in the financing of development projects and is at the forefront of this transition. The performance of banks, therefore, has a significant impact on renewable energy can be adopted and utilized across different regions. The paper focuses on comparative analyses of the impact of the banking sector on the consumption of renewable energies in two different economic and development contexts: the Organization for Economic Cooperation and Development (OECD) and the Western Balkans. Wu and Broadstock [1] emphasize that a well-functioning financial sector is crucial for the growth of the renewable energy sector. They argue that the financial sector can provide lower-cost funds for investments in energy-efficient technology. This is supported by empirical evidence showing that countries with developed financial sectors tend to have higher levels of investment in renewable energy technologies. For instance, in their study, they found a positive correlation between financial development and renewable energy consumption across multiple countries. Alfaro and Charlton [2] highlight the impact of financial development on the flexibility and efficiency of the banking system. They argue that a more developed financial system can better allocate resources, which is essential for the growth of various sectors, including renewable energy. Their research shows that financial development leads to increased investments in technology and infrastructure, which are critical for the adoption of renewable energy solutions.

The International Energy Agency [3] reports that financial stability is a key determinant of investment in renewable energy technologies. In their analysis, they found that countries with stable financial markets, such as those in the OECD, have been able to mobilize significant capital towards renewable energy projects. This stability reduces investment risks and attracts more private sector funding.

The advanced economies of the OECD and the well-developed financial markets provide a unique environment for studying the interaction between the performance of the

banking sector and the consumption of renewable energies. The OECD countries, with their advanced economies and well-developed financial markets, provide a unique environment for studying the interaction between banking sector performance and renewable energy consumption. According to the OECD [4], these countries have implemented robust financial policies that support green financing, such as green bonds and sustainable investment funds. These financial instruments have been effective in channeling investments towards renewable energy projects The Western Balkans, on the other hand, offer an important contrast background to understand, with its emerging economies and the development of the financial sector. By examining indicators of banking sector performance such as the ratio of cost to revenue, asset quality, return on asset (ROA), financial stability, and return on equity (ROE), this study aims to uncover the dynamics of how financial institutions can either facilitate the adoption of renewable energy solutions. The European Bank for Reconstruction and Development [5] reports that while the financial sectors in these countries are still evolving, there is significant potential for growth in renewable energy investments. The EBRD's Green Economy Transition approach has shown that targeted financial policies, such as improving banking asset quality and providing incentives for green investments, can significantly boost renewable energy consumption in the region.

Comparison analysis is needed because different economic environments and stages of the financial sector's development may influence the efficiency of the performance of the banking sector in supporting renewable energy projects. Furthermore, understanding these dynamics is crucial to ensuring that policy makers, financial institutions and stakeholders in the renewable energy sector develop targeted strategies to improve the role of banks in the global energy transition. This paper employs a methodological approach that includes fixed effect and random effect estimations to provide a comprehensive analysis of the impact of banking sector performance on renewable energy consumption across the OECD countries and the Western Balkans. This comparative view aims to provide valuable insights into global discussions on sustainable energy financing and the crucial role of the banking sector in achieving a greener and more sustainable future. This introduction sets the stage for a detailed study of the various interactions between the performance of the banking sector and the consumption of renewable energies and highlights the importance of financial mechanisms to achieve energy sustainability objectives. The role of the banking sector is increasingly centralized as the role of renewable energy is urgently required to minimize the impacts of climate change and ensure energy security. Investment in renewable energies is essential not only for the sustainability of the environment but also for the development of the economy. However, the degree to which these investments can be mobilized depends on the health, stability, and efficiency of the banking sector.

Comparative analysis between OECD countries and the Western Balkans has two purposes. First, it provides an overview of the financial systems established in OECD countries that support renewable energy projects through various financial performance indicators. These insights are invaluable to understanding best practices and the potential for investment in renewable energy. Secondly, through a study of emerging financial markets in Western Balkan countries, the study reveals the challenges and opportunities that exist in leveraging them. Performance of the banking sector to provide energy for the consumption of renewable energy in different economic and regulatory environments. By identifying key indicators of performance of the banking sector that have a positive impact on renewable energy consumption, policy makers can formulate strategies to strengthen these factors. Furthermore, financial institutions can improve operational and investment strategies to support renewable energy projects and contribute to broader objectives of sustainable development and climate change mitigation. This study is designed to examine the impact of banking sector's performance on renewable energy consumption and to understand how financial institutions can support the transition to renewable energy. The research question that is raised is: How does the performance of the banking sector, as measured by key indicators such as the ratio of cost to revenue, asset quality, return on assets (ROA), financial stability, and return on equity (ROE), impact the consumption of renewable energies? From the results, study will give an answer to this question. The first hypothesis in this paper is that the performance of the banking sector has a positive impact on renewable energy consumption in OECD countries and the second hypothesis is that the performance of the banking sector has a positive impact on renewable energy consumption in the Western Balkans.

Furthermore, this study contributes to literature by filling gaps in comparison analysis of the role of the banking sector in the consumption of renewable energy in different economic regions. It not only emphasizes the important role of financial institutions in the renewable energy sector, but also focuses on adapting and innovative financial solutions to meet the growing demand for renewable energy. As the world moves towards a more sustainable energy future, understanding the complexity of financial support mechanisms becomes essential. The aim of this paper is to provide comprehensive analyses that help formulate effective policies and strategies to exploit the full potential of the banking sector in promoting the consumption of renewable energies around the world.

The manuscript is divided into six different sections. Firstly, the introduction establishes the stage by highlighting the critical aspects and key considerations surrounding the central theme. The literature review section provides an overview of previous studies, summarizing their conclusions and their relevance to our research. Afterward, the methodology section explains the analytical techniques and data processing methods used in the research. The following section presents the empirical results derived from the application of various statistical models to the data collected. The last part focuses on the interpretation of these results and provides detailed analysis and contextual understanding. The final section summarizes the essential views gathered from our research, offers an accurate assessment of its effects, and suggests steps for future research on the influence of the banking sector on the consumption of renewable energy.

2. LITERATURE REVIEW

The. interplay between banking sector performance and. renewable energy consumption has garnered significant attention, particularly within the context of OECD countries and the Western Balkans. This literature review synthesizes current research findings on various economic and environmental indicators, including renewable energy consumption, banking performance metrics (RCR, AQ, ROA,

ZC, ROE), and other influential factors such as FDI, trade, urban population, industry, CO_2 emissions, GDP growth, and institutional quality. Financial stability, as indicated by banking system z-scores (ZC), plays a crucial role in renewable energy investments. Banks with higher stability are more able to finance renewable energy projects, given their long-term viability and potential for sustainable returns. A study by Bourke [6] suggests that banks with a high degree of market power and stability are more likely to engage in financing activities that support sustainable development, including renewable energy projects. The Return on Equity (ROE) and Asset Quality (AQ) directly impact banks' willingness and capacity to invest in renewable energy sectors. High ROE and strong AQ indicate a bank's profitability and financial health, making it more capable of allocating resources to renewable energy initiatives. A study from Beka and Alili-Abazi [7] shows that economic growth has a positive impact on non-performing loans and from this paper it can concluded that this relationship between economic growth and non-performing loans underscores the importance of considering environmental factors, particularly those related to sustainability and the transition to a green economy, in assessing bank performance. According to Staikouras and Wood [8] a positive correlation exists between bank profitability and investment in sectors that contribute to economic sustainability, including renewable energy, FDI is a significant catalyst for renewable energy sector growth.

The banking sector's performance, particularly in terms of facilitating cross-border transactions and providing financial services to foreign investors, is pivotal. Nejat et al. [9] highlight the role of FDI in transferring technology and capital necessary for renewable energy projects, underscoring the banking sector's role in attracting and managing these investments. Urban population growth increases energy demand, presenting opportunities and challenges for renewable energy consumption. Banks play a critical role in financing urban infrastructure projects that incorporate renewable energy solutions. The work by Golušin et al. [10] points out the importance of the banking sector's involvement in financing energy efficiency and renewable energy projects to meet the growing urban energy demands sustainably. CO_2 emissions reduction is directly linked to renewable energy financing. Banks that prioritize investments in renewable energy contribute to lowering CO_2 emissions by supporting cleaner energy sources. Lamb et al. [11] discuss the importance of sectoral shifts towards renewable energy in reducing greenhouse gas emissions, emphasizing the banking sector's role in financing these transitions. Renewable energy consumption can drive GDP growth by fostering energy independence and creating jobs in the renewable energy sector. Moreover, the banking sector has an essential role to play in achieving this potential, as the banking sector aids renewable energy initiatives. A study by Mensah and Näsström [12] highlights the positive effects of bank size, improved asset quality, and managerial efficiency in high-income countries, and highlights the importance of return on assets and financial stability in middle and low-income countries for enhancing renewable energy consumption.

Brunnschweiler [13] confirms the positive influence of financial sector development, especially commercial banking, on renewable energy production in non-OECD countries. The study underscores the crucial role of financing in overcoming the barriers to renewable energy implementation. Other authors Aslan et al. [14] find a long-run relationship between energy consumption, income, energy prices, and banking sector development indicators, suggesting that banking sector indicators positively affect energy demand in the long run.

Zafar et al. [15] investigate the role of disaggregated financial development and renewable energy in carbon emissions, incorporating gross fixed capital formation and economic growth into the carbon emission function, they find that renewable energy improves environmental quality by lowering carbon emissions intensity, while banking development has varying effects on carbon emissions across country groups. Another study that examines the effect of financial development on renewable energy consumption using a panel of 28 countries in the European Union (EU), finds that all three dimensions of financial development (banking sector, bond market, and capital market) have a positive effect on the share of renewable energy consumption, providing insights into how to best deploy capital in the renewable sector for cost-competitive options [16]. According to Islam et al. [17] economic growth raises energy demand, and financial development leads to higher energy consumption in the future.

Sadorsky [18] investigated the impact of CO_2 emissions and discovered it to be an important indicator of renewable energy consumption. On the other hand, Mehrara et al. [19] disclose that CO_2 emissions have a negative significant effect on renewable energy consumption for Middle Eastern countries as part of the Economic Cooperation Organization and that urban population is one of the most powerful driving of renewable energy consumption. Also, another study from Paramati et al. [20] evaluates the influence of foreign direct investment and stock market growth on clean energy and indicates that these variables are drivers of both the development and consumption of clean energy. Also, Beka et al. [21] reveal that the business environment is the main factor in attracting foreign investments, and the environment can draw investors who are interested in utilizing technology that is environmentally friendly. In similar terms, Dogan and Seker [22] argue that trade and financial development can assist countries in adopting and implementing new environmentally friendly technology, hence increasing renewable energy usage. A recent study by Beka et al. [23] reveals that in OECD countries, domestic credit provided by banks negatively impacts green growth. This finding suggests that increased bank credit may not be effectively channeled towards environmentally sustainable projects. Furthermore, it highlights the importance of focusing on renewable energy consumption as a critical factor for achieving green growth. Li and Deng [24] found significant regional disparities in green finance development, highlighting the importance of financial systems in promoting sustainable investments and the need for targeted policies. Fithri et al. [25] identified key success factors for sustainable business incubators, such as regional economic growth and industry cooperation, which are crucial for banks supporting renewable energy projects. These studies emphasize the role of equitable financial systems and targeted support in advancing renewable energy consumption.

3. METHODOLOGY

The study uses panel data from five countries in the Western Balkans and 38 countries of the OECD in 2010-2022. This methodology uses a variety of panel data techniques, including the pooled ordinary least squares (OLS), fixed effects (FE),

random effects (RE). The Hausman test identifies the most accurate model as the random effect and the fixed effect. The use of appropriate estimate techniques is necessary to ensure that the coefficients are accurately, effectively, and objectively estimated. In addition, methodological approaches are used to compare different countries. The results of the Hausman test show that the Random Effect is more appropriate for studying the relationship between bank performance and renewable energy consumption in 38 OECD countries and the Fixed Effects most appropriate model for the Western Balkans. The study was conducted in the long term and included 559 observations and analyzed 43 countries (38 of the OECD and 5 of the Western Balkans) over 13 years (2010-2022). This article uses five variables linked to bank performance to estimate the association between bank performance and renewable energy use. These include the ratio of cost to revenue (Bank cost to income ratio), the return on assets, the ZC, Financial Stability (Banking system z-scores), asset quality (non-performing loans), and the return on equity. Renewable energy consumption is defined as the percentage of renewable energy in the total use of energy. About the control variables used, CO_2 emissions are an important determinant of renewable energy consumption, GDP and trade openness also have an impact on renewable energy. Urbanization and industry have been shown to have a significant impact on energy consumption.

Based on the test performed, is chosen the fixed effects model for our overall results because it is more appropriate based on the results of the Hausman test. Specifically, we used the random effects model for the OECD countries and the fixed effects model for the WBC. This approach lets us understand and explain how banks influence renewable energy use in these different areas. For OECD countries, is used random effects model based on the results of the Hausman test. This model helped us because it can handle data that changes over time and between different countries. On the other hand, for the Western Balkan Countries, we found that a fixed effects model is more appropriate based on the results of the Hausman test.

$$Yit = \beta_0 + \beta_1(\mathrm{RCR}) + \beta_3(\mathrm{AQ}) + \beta_4(\mathrm{ROA}) + \beta_5(\mathrm{ZC}) + \beta_6(\mathrm{ROE}) + \beta_7(\mathrm{FDI}) + \beta_8(T) + \beta_9(U) + \beta_{10}(I) + \beta_{11}(\mathrm{CO2}) + \beta_{12}(\mathrm{IQ}) + \beta_{13}(\mathrm{GDP}) + U_{\mathrm{it}}$$

where, yit is the dependable variable, in our paper REC is the dependent variable, i=1….43 (countries), t=2010…2022 (years); c is constant; the explanatory variables include Yit, RCR (Ratio of cost to revenue); AQ (Asset quality); ROA (Return on Asset); ZC (Banking system z-scores, financial stability); ROE (Return on Equity); FDI (Foreign direct investment); T (Trade); U (Urban population); I (Industry); CO_2 (CO_2 emissions); GDP (GDP growth); IQ (Institutional Quality) and u_{it} is error term. Table 1 presents the definitions of variables, units, and sources.

3.1 Data

We use the World Bank (WBD) database, Global Economy, Heritage and International Energy Agency database to create a comprehensive panel data set from four primary sources. This data set covers the period 2010-2022 and includes a range of countries, including five of the Western Balkan Countries-Albania, North Macedonia, Bosnia and Herzegovina, Montenegro, and Serbia-and 38 members of the Organization for Economic Cooperation and Development (OECD). OECD data include countries. from around the world such as Colombia, Turkey, Mexico, Costa Rica, Chile, Poland, Hungary, Greece, Latvia, Slovenia, Czech Republic, Estonia, Slovenia., Spain., South Korea, Italy, Japan, France, Britain, New Zealand, Germany, Israel, Belgium, Canada, Austria, Finland, the Netherlands, Australia, Sweden, Denmark, Iceland, the United States, Norway, Switzerland, Ireland and Luxembourg. Our comprehensive data sets allow for a detailed comparison of how banks' performances affect the use of renewable energy in different countries. We pay particular attention to the development paths of the Western Balkan Countries compared to the economically advanced OECD countries. Our aim is to identify patterns, contrast different countries' experiences and understand how the performance of the banking sector influences the consumption of renewable energy in different regions.

Table 1. Definition of variables

Variable	Definition	Unit	Source
REC	Renewable energy consumption	% of total final energy consumption	WDB, IEA
RCR	Ratio of cost to revenue	%	GE
AQ	Asset quality (non-performing loans as percent of all bank loans)	(% of all banks loans)	GE
ROA	Return on Asset	%	GE
ZC	Banking system z-scores financial stability	Index	Global Economy
ROE	Return on Equity	%	Global. Economy
FDI	Foreign direct investment	(% of GDP)	Global. Economy
T	Trade	(% of GDP)	WDB
U	Urban population	(% of total population)	WDB
I	Industry	(% of GDP)	WDB
CO_2	CO_2 emissions	Metric tons per capita	WDB
IQ	Institutional Quality	(0-100)	Heritage
GDP	GDP growth	(annual %)	WDB

3.2 Descriptive statistics

Table 2. Descriptive statistics for all sampled countries

Variable	Obs	Mean	Std. Dev.	Min	Max
REC_ln	473	2.88	0.75	0.27	4.41
ROE	511	7.65	13.48	-112.19	33.26
RCR	507	58.94	12.25	5.03	118.19
AQ	419	5.23	6.40	.15	45.57
ROA	509	.83	2.14	-10.88	38.88
ZC	512	15.85	9.96	-.33	57.44
FDI	559	3.80	22.71	-391.43	234.46
T	558	101.38	57.87	23.38	388.51
U	559	75.40	12.53	45.56	98.15
CO_2	559	6.82	3.71	1.31	21.75
I	547	23.87	5.57	10.39	48.69
IQ	559	70.70	6.42	53.2	84.4
GDP	559	2.33	3.30	-15.30	24.37

Source: Author's Calculation

Table 2 presents the descriptive statistics for all sampled countries REC (Renewable Energy Consumption), defined as the percentage of total final energy consumption that comes from renewable sources. The mean value of REC stands at 2.88% of total final energy consumption. This value represents

the energy consumption that comes from renewable sources as compared to the total energy.

RCR (Ratio of Cost to Revenue) is reported at 58.94%. This ratio indicates that the costs associated with producing or consuming renewable energy represent a significant part of the generated revenue.

AQ (Asset Quality) the mean of the quality of a bank's assets is reported at 5.23%. Banks with healthier asset portfolios are more capable of financing renewable energy projects.

ROA (Return on Asset) stands at 0.83%. This means that banks with profitable assets can support renewable energy consumption by financing more renewable energy projects.

ZC (Banking System Z-Scores), the mean of 15.85 indicates that banks are in a position to finance renewable energy projects, with a stable banking system showing that banks have the capacity to support renewable energy projects.

ROE (Return on Equity) is at 7.65%. This reflects the banks are generating profit from their investments, including those in renewable energy projects.

Furthermore, economic variables such as FDI (Foreign Direct Investment) are reported at 3.80%. This level of foreign direct investment shows that international investors are very interested in the renewable energy sector, and investments can provide important capital for the development of renewable energy projects.

T (Trade) the mean of 101.38%. Trade at this level reflects high trade activity including renewable energy technologies or services.

The GDP growth rate is recorded at 2.33%. A positive GDP growth shows the economic development of countries. This indicates that the economy is growing, which indicates more investments in renewable energy projects as part of sustainable development.

U (Urban Population) is expressed as a percentage of the total population, with a mean of 75.40%. There is a significant opportunity to expand renewable energy infrastructure.

I (Industry) stands at 23.87%. There is a need for significant energy, highlighting the importance of turning to renewable energy sources and reducing CO_2 emissions.

CO_2 (Carbon Dioxide Emissions) measured in metric tons per capita, the mean of 6.82%. Higher emissions could be linked to higher industrial activity and lower usage of renewable energy.

IQ (Institutional Quality Index) means that of 70.70 suggests that on average, countries have high institutional quality, which positively influences investment levels, including in renewable energy.

Each mean value gives an average across the sampled countries, and the variation in these means could be due to economic, regulatory, and institutional differences between the countries.

When comparing the variables between the five countries of the Western Balkans and the OECD countries, we observed significant differences, which could be different levels of economic development and the regulatory frameworks described in Table 3. The Western Balkans show a higher average for Renewable Energy Consumption (REC_ln) with a mean of 3.32 compared to the OECD countries' mean of 2.82.

The Return on Equity (ROE) for banks in the Western Balkans averages 5.22, which is lower than the OECD average of 7.97. This could be indicative of varying profitability levels, possibly due to economic conditions, market maturity, or operational efficiencies that differ between the two regions. The Ratio of Cost to Revenue (RCR) is higher in the Western Balkans, with a mean of 62.65 compared to 58.44 in the OECD. This might reflect higher operational costs or lower revenue efficiencies within Western Balkan banks, possibly due to smaller economies or less optimized processes. Asset Quality (AQ) also shows a significant difference, with the Western Balkans averaging 11.62 and the OECD at 4.44. Return on Assets (ROA) is similar between the two regions, though slightly lower in the Western Balkans at 0.722 compared to 0.84 in the OECD.

Banking System Z-Scores (ZC), which expresses financial stability, are lower in the Western Balkans with a mean of 14.08, as opposed to 16.09 in the OECD. A lower Z-Score could imply a higher risk of insolvency or less stable banking environments in the Western Balkans.

Furthermore, analyzing the economic variables such as Foreign Direct Investment (FDI) as a percentage is notably higher in the Western Balkans at 6.47, compared to 3.45 in the OECD. This might be due to the Western Balkans attracting proportionally more investment relative to their economic size, possibly because of investment incentives. Trade (T) as a percentage of GDP is lower in the Western Balkans with a mean of 99.60 compared to 101.61 in the OECD. This small difference suggests that both regions are similarly open to trade relative to their economic output. The Industrial sector's contribution to the economy (I) is lower in the Western Balkans, with a mean of 21.82, compared to the OECD's 24.15. This might suggest a smaller industrial base or different economic structures. Lastly, GDP growth is quite similar between the two regions, with the Western Balkans averaging 2.40 and the OECD at 2.32. This indicates comparable economic growth rates, although these figures do not reflect the absolute size of the economies or the per capita income levels.

Urban Population (U) percentages are lower in the Western Balkans, averaging 57.12, compared to 77.80 in the OECD. This reflects different stages of urbanization or demographic trends, with OECD countries having a larger proportion of their populations living in urban areas. CO_2 emissions per capita are higher in the OECD with a mean of 7.15 metric tons, compared to 4.37 in the Western Balkans. This may be due to higher industrial activity or energy consumption patterns in OECD countries.

The Institutional Quality Index (IQ) is higher in the Western Balkans on average at 63.51 compared to 71.64 in the OECD, indicating potentially stronger governance and institutional frameworks in the OECD.

Table 3. Comparison of results in 5WB countries and OECD countries

Variable	5 Western Balkans			OECD		
	Obs.	Mean	Std.Dev	Obs.	Mean	Std.Dev
REC_ln	55	3.32	0.365	418	2.82	0.771
ROE	60	5.22	8.20	451	7.97	14.01
RCR	60	62.65	10.82	447	58.44	12.35
AQ	46	11.62	5.12	373	4.44	6.10
ROA	60	0.722	0.978	449	.84	2.25
ZC	60	14.08	4.93	452	16.09	10.42
FDI	65	6.47	3.92	494	3.45	24.10
T	65	99.60	20.43	493	101.61	61.13
U	65	57.12	6.25	494	77.80	11.08
CO_2	65	4.37	1.82	494	7.15	3.78
I	65	21.82	3.70	482	24.15	5.73
IQ	65	63.51	3.81	494	71.64	6.09
GDP	65	2.40	3.61	494	2.32	3.26

Source: Author's Calculation

These differences in means could be influenced by a variety of factors, including policy decisions, and economic development.

4. EMPIRICAL FINDINGS

Table 4 presents the results of fixed effects and random effects models for Western Balkan countries and OECD countries, respectively. The regression models aim to identify the impact of various independent variables on a dependent variable, which is not explicitly stated but could be related to economic performance or environmental outcomes.

In the analysis of the Western Balkan countries' banking sector, the variable ZC (Banking system Z-scores financial stability) reached statistical significance with a p-value of 0.055, with a coefficient of -0.06. This indicates a negative relationship with renewable energy consumption, suggesting that higher financial stability might be associated with a decrease in renewable energy consumption, although the result is not statistically significant. The Asset Quality (AQ) variable, on the other hand, shows a statistically significant positive relationship with renewable energy consumption, with a coefficient of 0.02 and a p-value of 0.013. This implies that improvements in the quality of assets within the banking sector may contribute to increased consumption of renewable energy. For OECD Countries, the ZC variable shows a positive and statistically significant relationship with renewable energy consumption, with a coefficient of 0.01 and a highly significant p-value of 0.001. This contrasts with the Western Balkans' results, showing that in OECD countries, better financial stability within the banking sector is associated with higher renewable energy consumption. ROA (Return on Asset) for the OECD countries shows a coefficient of 0.00 with a significant p-value of 0.034, implying a positive and significant relationship.

Additionally, other significant variables in the Western Balkans include Urban Population (U), with a positive coefficient of 0.07 and a p-value of 0.004, indicating that urbanization contributes positively to renewable energy consumption. Similarly, the Industry (I) variable shows a positive impact, with a coefficient of 0.08 and a p-value of 0.003, suggesting that a larger industrial sector correlates with higher renewable energy consumption. In OECD countries, the negative coefficient for Trade (T), though statistically significant with a p-value of 0.036, shows a negative impact on renewable energy consumption. CO_2 Emissions present a strong negative relationship, with a coefficient of -0.08 and a p-value of 0.000, indicating that higher per capita CO_2 emissions are associated with lower renewable energy consumption.

The empirical analysis revealed that the various indicators perform differently in the Western Balkans and OECD countries due to differences in economic development, financial market maturity, regulatory environment and socio-economic structures. In the Western Balkans, less mature and stable financial markets may give priority to traditional and less risky investments, resulting in a negative but statistically not significant relationship between financial stability (ZC) and renewable energy consumption. On the other hand, the countries of the OECD have developed more sophisticated financial markets and demonstrate positive relationships, with stronger financial stability strengthening investor confidence and supporting innovative renewable energy projects.

The positive impact of asset quality (AQ) on renewable energy consumption in the Western Balkans indicates that better financial health will enable banks to better support these investments. On the contrary, in OECD countries, the significant positive relationship between the return on investment (ROA) and the consumption of renewable energy reflects banks' more financial resources and investment capacity. Economic structures also play a role: urbanization and industrial growth in the Western Balkans drive energy demand, including renewable energy, as part of modernization efforts. At the same time, in OECD countries, the negative impact of trade on the consumption of renewable energy indicates that high trade volumes can be linked to traditional energy use patterns. In addition, the strong negative relationship between CO_2 emissions and renewable energy consumption in OECD countries underlines the influence of stringent environmental regulations that encourage the adoption of renewable energies. These regional differences highlight the need for a personalized policy approach that takes into account the unique economic, financial and regulatory contexts of each region in order to effectively promote investment in renewable energy.

Table 4. Results of the fixed effect and random effect model for Western Balkan countries and OECD countries

Variable	5 Western Balkans			OECD		
	Coef	Std. Err	P-value	Coef	Std. Err	P-value
ROE	0.03	0.03	0.238	0.00	0.001	0.705
RCR	-0.00	0.00	0.973	0.00*	0.001	0.057
AQ	0.02**	0.01	0.013	0.00	0.002	0.516
ROA	-0.28	0.29	0.350	0.00*	0.003	0.078
ZC	-0.06*	0.03	0.055	0.01***	0.003	0.000
FDI	-0.00	0.01	0.732	0.00	0.00	0.447
T	-0.00	0.00	0.359	0.00***	0.001	0.002
U	0.07***	0.02	0.004	0.00	0.006	0.965
CO_2	-0.00	0.08	0.905	-0.12***	0.008	0.000
I	0.08***	0.02	0.003	0.00	0.005	0.715
IQ	0.03*	0.01	0.054	0.01***	0.005	0.000
GDP	0.00	0.00	0.525	-0.00*	0.003	0.053
Mean dependent var			3.395	Mean dependent var		2.797
R-squared			0.609	Overall r-squared		0.148
F-test			3.636	Chi-square		603.778
Akaike crit. (AIC)			-42.806	R-squared within		0.674
SD dependent var			0.374	SD dependent var		0.756
Number of obs			44	Number of obs		348
Prob>F			0.002	Prob>chi2		0.000
Bayesian crit. (BIC)			-19.611	R-squared between		0.121

Source: Author's Calculation
Notes: * p<0.1, ** p<0.05, *** p<0.01

5. DISCUSSION

Hypothesis 1: The performance of the banking sector has a positive impact on renewable energy consumption in OECD countries.

The positive and statistically significant coefficient for the ZC (B=0.01 and P-value=0.000) variable in OECD countries shows a supportive role of financial stability in renewable energy consumption. Additionally, the Ratio of cost to revenue (RCR) with coefficient (B=0.00 and P=0.057) and the Return on Assets (ROA) with coefficient (B=0.00 and P=0.078), indicate a positive relationship with renewable energy

consumption. These findings, together with the literature that highlights the role of banking in funding renewable energy projects, allow us to accept this hypothesis for OECD countries, concluding that a better-performing banking sector is indeed linked to higher renewable energy consumption.

Hypothesis 2: The performance of the banking sector has a positive impact on renewable energy consumption in the Western Balkans.

The regression results for the Western Balkans show the complexity of the banking sector's impact on renewable energy consumption. While Asset Quality (AQ) is positively associated with renewable energy consumption (B=0.02, P=0.013), indicating that healthier banking assets may lead to increased renewable consumption. The Z-scores financial stability (ZC) variable indicates a negative but not statistically significant relationship (B=-0.06 and P=0.055). Given these results, we would accept the hypothesis with some reservations, noting that while certain aspects of banking performance, like asset quality, are significantly related to renewable energy consumption, the overall impact of the banking sector's performance may vary based on the specific performance indicator.

Based on the findings of the research, several policy recommendations can help OECD countries and the Western Balkans improve banking performance to support the development of renewable energies. For the West Balkans, strengthening financial regulation through the adoption of international best practices in banking supervision is essential to improve financial stability. Promoting green banking initiatives, such as green bonds and renewable energy loans, through incentives such as tax breaks, can encourage banks to support sustainable projects. Improvements in asset quality management and investment in capacity building for staff of financial institutions will improve project evaluation and funding. Facilitating access to international funding through the creation of a transparent financial environment will attract foreign investment. The establishment of public-private partnerships (PPPs) can leverage the expertise of the private sector to finance renewable energy. Establishing a coordinated policy framework, integrating the objectives of renewable energy with the banking sector's reforms, and investing in research and data collection will inform effective policy interventions.

For OECD countries, the focus should be on strengthening existing financial policies to further support investments in renewable energy. Improved regulatory frameworks to promote long-term financial stability and green financing initiatives can promote sustainable energy projects. Using advanced financial instruments such as green bonds and sustainability-related loans will support large-scale investments in renewable energy. Investing in innovations and technology in the banking sector can improve the assessment and management of renewable energy projects. Encouraged cooperation between the public and private sectors through political incentives will further integrate the objectives of renewable energy with those of the financial sector. In addition, continuous research and data analysis will help improve policies and practices to adapt to changing renewable energy markets.

Implementation of these recommendations will create a more favorable environment for investment in renewable energy and support the transition to sustainable energy sources in the OECD and Western Balkan countries.

In summary, for OECD countries, both financial stabilities, return on assets and ratio of cost to revenue in the banking. sectors are relevant for renewable energy consumption. For the Western Balkans, the significance of asset quality indicates a positive role of the banking sector, but the relationship with renewable energy consumption appears to be more complex and may not be consistent across all banking performance metrics.

The comparative analysis of the banking sector's impact on renewable energy consumption in OECD countries and the Western Balkans reveals both similarities and contrasts with findings from other authors. For OECD countries, results align with those of authors like Mensah and Näsström [12] who found a positive effect of banking performance indicators on renewable energy consumption in high-income countries. This consensus supports the notion that a well-functioning banking sector is vital for facilitating the shift towards renewable energy. In contrast, for the Western Balkans, while asset quality positively influences renewable energy consumption, like findings by Brunnschweiler [13] regarding the positive role of financial intermediation in non-OECD countries, the mixed results on other banking variables suggest a more complex dynamic. This stands in contrast to studies like those by Aslan et al. [14], which found a more consistent positive relationship between banking development and energy demand across different regions. Therefore, there is a general agreement on the importance of the banking sector for renewable energy consumption, regional highlights the need for financial policies to support renewable energy initiatives effectively.

Comparative research of the banking sector’s impact on renewable energy use in the OECD countries and the Western Balkans indicates substantial differences caused by different regulatory and economic contexts. A well-functioning banking sector established financial markets, effective regulatory frameworks, and supportive policies such as green bonds and tax incentives all contribute to OECD countries' beneficial impact on renewable energy use. These components create an environment that promotes significant and persistent investment in renewable energy technologies. In comparison, the Western Balkans show a more complex dynamic. While asset quality has a positive effect on renewable energy consumption, the varying outcomes for other banking variables indicate a more complicated relationship. The Western Balkans' emerging economies have different barriers, such as less established financial markets, various degrees of regulatory effectiveness, and different levels of economic stability. Furthermore, various energy policies impacted by transitory economic conditions and varying levels of government support complicate the banking sector's impact on regional renewable energy use.

As for the discussion of these findings in other research, indicators of performance in the banking sector, such as financial stability and asset quality, are generally linked to renewable energy consumption. However, as compared to comparison analyses, the strength and direction of this association vary depending on income levels and regions. For example, while financial stability in OECD countries is positively related to the consumption of renewable energy, data in the Western Balkans reveals a more complex relationship. The literature supports the fact that an effective banking sector can really play an important role in promoting renewable energy consumption by providing the necessary financial support for investment in renewable energy infrastructure. In the Western Balkans, accepting or rejecting

a hypothesis on the role of the banking sector in renewable energy consumption requires a more nuanced approach, recognizing that some aspects of the bank's performance (such as asset quality) are important, while other aspects (such as financial stability) may not have a direct impact. In the OECD, the relationship between the performance of banks and the consumption of renewable energy is generally positive, leading to the acceptance of the hypothesis that the banking sector is a positive factor in stimulating renewable energy consumption.

Banks with higher ROE, ROA, asset quality, bank system Z scores, financial stability and cost-to-profit ratios are more likely to invest in renewable energies due to several strategic motivations and economic incentives. Higher equity returns (ROE) and higher asset returns (ROA) reflect strong financial performance and profitability, providing banks with resources to pursue long-term, high-performance projects such as renewable energy. Improved asset quality means a reduced risk of non-performing loans and a stable financial base, allowing banks to effectively manage the risks associated with innovative and sustainable investment. Financial stability metrics, such as Z scores, indicate that a safer and more reliable bank can attract investor confidence and support ambitious projects that require large initial investments but offer significant environmental and financial returns over time. In addition, a favorable cost-to-income ratio shows efficient management, enabling banks to allocate resources to strategic investments in renewable energy. In addition, economic incentives from governments, such as subsidies, tax reductions and favorable regulatory conditions, make renewable energy projects more financially attractive. These factors together enable financially strong banks to take advantage of opportunities in the renewable energy sector to achieve diversification and sustainable growth goals.

The implications of this analysis are significant, highlighting the stability and asset management practices within the banking sector as pivotal for increasing renewable energy consumption. In this regard, the effective performance of banks facilitates the transition towards renewable energy, aligning with broader global efforts to mitigate climate change.

The limitations of the study are evident in the regional differences between OECD countries and the Western Balkans, which may restrict the applicability of the findings across diverse economic settings. Limitations also arise from the complexities of regulatory environments and market maturity levels, which complicate the implementation of supportive financial mechanisms.

In future research, it is important. to consider these regional differences and to investigate the underlying reasons for the influence of certain aspects of performance of the banking sector in some regions. This comparative analysis helps to understand the unique economic, regulatory and dynamics of the regions and their influence on consumption of renewable energy.

6. CONCLUSION

This article provides a new comparative analysis between the OECD countries and the Western Balkans to better understand the crucial role played by the banking sector in the consumption of renewable energy. It highlights the influence of bank sector variables such as financial stability and asset quality on renewable energy consumption and shows the differences between the two regions. This research is crucial to policy makers, financial institutions, and stakeholders in the renewable energy sector and provides them with an overview of how the dynamics of the banking sector can either strengthen or prevent the transition to more sustainable energy sources. The research results offer several important impacts on existing policies and future research, as well as practical applications that may be beneficial to different stakeholders. First, the recognition of financial stability and the quality of the banking sector's assets as crucial drivers of renewable energy consumption means that existing policies should emphasize the strengthening of these aspects. Policy makers should consider strengthening regulatory frameworks to ensure that banks maintain high levels of stability and asset quality, which in turn will promote a more supportive environment for investments in renewable energy. Practically, these findings can be applied by financial institutions and renewable energy developers to design more effective financial products that support sustainable energy initiatives. For instance, banks could develop green bonds or renewable energy investment funds that are structured to take advantage of the identified drivers of renewable energy consumption. Additionally, regulatory bodies can use these insights to craft policies that incentivize banks to improve their financial stability and asset quality, thereby indirectly promoting renewable energy projects.

The conclusions emphasize the need for a customized financial policy and practice that effectively supports renewable energy initiatives. Furthermore, this article provides the basis for future research, indicating the regional differences in the impact of the banking sector on renewable energies and identifying potential complications related to the implementation of support financial mechanisms. Thus, the contribution of this paper is valuable in academic discussions and practical approaches to reducing renewable energy consumption through the strategic involvement of the banking sector. Furthermore, this paper provides an overview for environmental economists, renewable energy developers and bank regulators who want to understand the financial basis of renewable energy adoption. By examining the nuances between the performance indicators of the banking sector and consumption of renewable energies, the paper provides a perspective that can inform the development of policies, investment strategies and regulatory frameworks for the promotion of sustainable energy solutions. Among other things, OECD countries and the Western Balkans emphasize the importance of financial stability and asset quality in banking as a key driver for renewable energy investment, especially in different economic environments.

The contribution of this paper extends beyond the immediate academic interest to practical implications, highlighting how the effective performance of banks can have to the transition to renewable energy and contribute to global efforts to mitigate climate change. In addition, the Bank’s policy and practice support mechanisms for renewable energy projects, including innovative financing models and risk management strategies, need to be further investigated.

In future research, this study offers new opportunities to investigate how specific variables in the banking sector interact with the adoption of renewable energy in different regional contexts. Comparisons between the OECD countries and the Western Balkans reveal substantial regional differences, suggesting that subsequent studies could deepen

these differences to develop more targeted financial policies. Researchers could examine the specific challenges and opportunities in each region considering the unique economic and regulatory landscapes affecting the impact of the banking sector on renewable energies.

Future research, as proposed in this article, could investigate potential complications arising from the different regulatory environment, the different levels of market maturity and the evolving landscape of international climate financing. Understanding these dynamics is essential to elaborate policies that encourage not only financial institutions to support renewable energy projects. This article therefore calls for the implementation of multidisciplinary research, policy-making and financial innovation and uses the full potential of the banking sector to promote sustainable and renewable energy.

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NOMENCLATURE

REC	Renewable energy consumption
RCR	Ratio of cost to revenue
AQ	Asset quality
ROA	Return on Asset
ZC	Banking system z-scores financial stability
ROE	Return on equity
FDI	Foreign direct investment
CO_2	CO_2 emissions
IQ	Institutional quality