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The Dynamics of Green Growth in The Developed Countries

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Abstract

The relationship between financial development and environmental sustainability has become a critical area of research in recent years, particularly in the context of developed economies. Understanding how macroeconomic factors such as financial markets, innovation, and institutional frameworks influence green growth is essential for shaping effective policies that promote sustainable development. This study explores the influence of financial development on green growth in developed countries, examining data from 2000 to 2020 for 10 developed countries. By analyzing the interaction between green growth and macroeconomic factors such as financial development, R&D expenditures, and institutional quality, the study provides critical insights into the drivers of environmental sustainability. The findings reveal that financial development and R&D expenditures positively impact green growth, whereas institutional quality surprisingly has a negative effect. These results underscore the importance of fostering financial markets and innovation to support green growth, while also highlighting the need for institutional reforms to better align governance structures with environmental goals. The study suggests that policymakers should prioritize expanding green financing, boosting R&D investments, and restructuring institutional frameworks to achieve long-term sustainability in developed economies.

Keywords
Financial Development, Green Growth, Environmental Sustainability

JEL Kodu
G20, Q56, Q01

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Gelişmiş Ülkelerde Yeşil Büyümenin Dinamikleri

Öz

Finansal gelişme ile çevresel sürdürülebilirlik arasındaki ilişki, özellikle gelişmiş ekonomiler bağlamında, son yıllarda kritik bir araştırma alanı haline gelmiştir. Finansal piyasalar, inovasyon ve kurumsal çerçeveler gibi makroekonomik faktörlerin yeşil büyümeyi nasıl etkilediğini anlamak, sürdürülebilir kalkınmayı teşvik eden etkili politikalar oluşturmak için esastır. Bu çalışma, 10 gelişmiş ülke için 2000-2020 yılları arasındaki verileri inceleyerek, finansal gelişmenin gelişmiş ülkelerdeki yeşil büyüme üzerindeki etkisini araştırmaktadır. Çalışma, finansal gelişme, Ar-Ge harcamaları ve kurumsal kalite gibi makroekonomik faktörler ile yeşil büyüme arasındaki etkileşimi analiz ederek, çevresel sürdürülebilirliğin itici güçleri hakkında kritik içgörüler sunmaktadır. Bulgular, finansal gelişme ve Ar-Ge harcamalarının yeşil büyümeyi olumlu yönde etkilediğini, kurumsal kalitenin ise şaşırtıcı bir şekilde olumsuz bir etkiye sahip olduğunu ortaya koymaktadır. Bu sonuçlar, yeşil büyümeyi desteklemek için finansal piyasaları ve inovasyonu teşvik etmenin önemini vurgularken, aynı zamanda yönetişim yapılarını çevresel hedeflerle daha iyi uyumlu hale getirmek için kurumsal reformlara olan ihtiyacı da vurgulamaktadır. Çalışma, politika yapıcıların gelişmiş ekonomilerde uzun vadeli sürdürülebilirliği sağlamak için yeşil finansmanı genişletmeye, Ar-Ge yatırımlarını artırmaya ve kurumsal çerçeveleri yeniden yapılandırmaya öncelik vermeleri gerektiğini önermektedir.

Keywords
Finansal Gelişim, Yeşil Büyüme, Çevresel Sürdürülebilirlik

JEL Classification
G20, Q56, Q01

1. Introduction

The concept of green growth emerges as a model that protects natural capital and ensures welfare sustainability while encouraging economic growth (OECD, 2011). It has the aim of optimizing resource use while reducing the negative impacts of growth on the environment (UNEP, 2011). Green growth therefore captures environmental sustainability into the concepts of economic growth strategies while stimulating the development of green sectors (World Bank, 2012). The main objectives are those that avoid resource depletion, reduce the impact of environmental pollution, and fight the global challenges of their change. At the same time, another essential point of this model is the growth of economic welfare. Green growth reportedly will address the pressing call for environmental sustainability while continuing to promote economic development. However, the boundaries of this concept are not fully defined and there is no agreed definition (Yılmaz, 2018).

The concepts of green growth (GG) and sustainable growth (SG) include different approaches. Green growth aims to integrate economic growth (EG) with environmental sustainability (ES) while encouraging economic development by minimizing environmental

damages. This concept is shaped by the adoption of environmentally friendly technologies and innovations (OECD, 2011). Green growth strategies aim to reduce environmental impacts of economic growth by offering novel approaches in the field of clean energy and management of resources in a sustainable manner. On the other hand, the concept of sustainable growth covers economic and environmental sustainability on one hand and social sustainability on the other. Sustainable growth integrates economic, environmental, and social dimensions to ensure long-term prosperity. This approach aims at the protection of natural resources, social equity and the optimization of economic development (WCED, 1987). Sustainable growth includes comprehensive sets of strategies and policies to achieve sustainable development goals (Kates, Parris, & Leiserowitz, 2005).

The connection between financial development (FD) and green growth (GG) has consistently been regarded as essential for achieving economic progress and ensuring environmental sustainability. This relationship enables policy makers and business leaders to reduce environmental damage by using more resource-efficient alternatives that, at the time, support economic growth as well (Li et al., 2022; Meo & Abd Karim, 2022). Green growth means attuning economic activities to environmental sustainability and is counted among the key ingredients necessary to ensure that economic stability continues over a longer period (Bekun, Emir, & Sarkodie, 2019). Green finance is an important link between EG and ES. The financing of clean energy projects and sustainable technologies is provided through green loans, which supports both economic growth and environmental sustainability (Nawaz et al., 2021; Peng & Zheng, 2021). Such practices can serve as models for other countries and make significant contributions to global green growth (Rasoulinezhad & Taghizadeh-Hesary, 2022). In the literature, it is emphasized that financial markets have the potential to promote green innovation by transferring capital to environmental projects and companies (Aghion et al., 2009).

Green growth is strongly connected to the United Nations Sustainable Development Goals (SDGs) and serves as a key factor in their realization. SDG 7 proposes to increase the share of renewable sources of energy and enhance energy efficiency and is highlighted as one of the key components of green growth. SDG 8 speaks about economic growth in concert with environmental sustainability and focuses on green jobs and sustainable industries. SDG 9 supports the development of environmentally friendly technologies in industry, innovation and infrastructure, while SDG 11 is based on green growth strategies to make cities more sustainable and livable. In

addition, the aspect of natural resource use in a sustainable manner and that of waste management fall directly under SDG 12 and are directly related to green growth. The SDG 13 deals with combat and adaptation to climatic changes, while SDG 15 covers the protection of forests, supporting biodiversity, and preventing soils from erosion. These goals of green growth policy are at the heart of ensuring a balance in economic development, environmental protection, and social welfare. By understanding the dynamics between FD and GG, policy makers can focus on increasing the capacity of financial systems to achieve sustainable development goals (UNEP, 2011). Currently, evaluating the relationship between FD and GG is vital, as financial development has been recognized as a key driver in promoting sustainable and efficient economic practices. Existing studies examine the impact of financial development on sustainable growth, but studies investigating its impact on green growth are only recently emerging (Çağlar, 2024). Investigating this relationship is critical in identifying potential barriers and facilitators for the transition to a low-carbon economy. This study aims to analyze how financial development affects green growth in developed countries. The study was implemented in developed countries such as Australia, Canada, France, Germany, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States with annual data for the period 2000-2020. The selection of the ten developed countries in this study was guided by considerations of data availability, cross-country comparability, and their classification within the high-income group. These countries constitute a relatively homogeneous sample with respect to financial development, R&D intensity, and institutional quality. The remaining sections of the paper consist, respectively, of the literature review, model and methodology, empirical findings, and conclusion with policy recommendations.

2. Literature Review

The green growth concept was founded on the increase in environmentally-oriented movements and the rise of the sustainable development concept in the 1970s. For instance, the report titled "*Limits to Growth"* presented by the Club of Rome in 1972 initiated discussions related to sustainable development and centered its arguments on the impacts of environmental problems on economic growth (Meadows et al., 2018). The concept of sustainable development was set within a more broadened framework with the World Commission on Environment and Development's "*Our Common Future"* report in 1987, which strengthened the theoretical basis of the green growth concept by calling for the integration of environmental and economic goals (WCED, 1987). Environmental economics and ecosystem services provided the theoretical

contribution of underlining economic-environmental co-benefits within the implementation of green growth policies. In the 2000s, the concept of green growth has been consolidated further through more concrete policies and strategies, focusing on how economic growth can be compatible with environmental sustainability. As such, Stern (2006) contributed much to the debate about green growth when he claimed that tackling climate change is not a barrier to growth but an opportunity. The report titled "*Towards Green Growth"* prepared by the OECD (2011) defined the policy framework for green growth and claimed that economic and environmental objectives are complementary to each other.

Various studies in the literature have introduced a new perspective on the relationship between FD and SG. Among the various positive indicating studies on this relationship, Levine (1997) came to a conclusion that there is a support for economic growth by financial development and encourages the long-term sustainability of growth. Similarly, according to Levine (2005), deepening and efficiency in financial systems enhance economic growth and its sustainability. The development of stock markets and the banking sector, according to Beck & Levine (2004), is supportive of sustainable economic growth. One of the various studies that was able to find evidence of a negative relationship was conducted by Demirgüç-Kunt & Maksimovic (1998), in which they showed that in some developing countries, financial development may have adverse impacts on sustainable growth. Rajan & Zingales (1996) argued that it increases financial dependency with possible adverse implications for sustainable growth. Arestis et al. (2001) present the studies that did not find any relationship. Their results indicated that no significant relationship can be found between FD and EG. Similarly, Shen & Lee (2006) mentioned that from their case study of different economies in East Asia, no obvious relationship exists between the FD and SG. Generally, in the literature, there are several views on the relationship between FD and SG. While most of the studies suggest that financial development acts in favor of economic growth and sustainability, some other studies suggest that this relationship might be negative or there is no clear relationship.

Financial development plays a key role in securing the resources needed to fund green investments and advance clean technologies (Zhang & Wang, 2020). Specifically, the diffusion of green bonds and sustainable banking practices among the main promoters of green growth (Reboredo, 2018). In this line, De Haas & Popov (2023) further report that green innovation investments and sustainable technologies spur economic growth. Apart from that, it also considers

the efficiency of financial markets to be highly crucial for the implementation of green projects and management of environmental risks (Nguyen et al., 2021). In this context, the interrelationship between FD and GG plays a critical role in achieving sustainable development goals (Shahbaz et al., 2016).

Cao et al. (2021) found in their study that financial development significantly reduces the volatility of green growth. This can be attributed to the fact that financial development makes resource allocation more efficient and increases investments in environmentally friendly technologies. In addition, technological innovation has become another crucial determinant in stabilizing green growth through the promotion of sustainable practices and the reduction of environmental degradation.

Zhou et al. (2022) investigates the role of FinTech developments in green growth in China, and the results show that green finance significantly mediates this relationship. Chen et al. (2023) proved that green innovation and financial globalization facilitated green growth in the BRICS (Brazil, Russia, India, China, South Africa) countries. Ngo et al. (2022) explored the bidirectional causality between FD and GG. The authors also showed in what way this causality has been complemented with human capital and education. Yang & Ni (2022) investigated the effect of financial development on green development efficiency in countries along the Belt and Road, underlining that financial development may affect green growth negatively. Similarly, Cao et al. (2022) also examined the spatial effects of financial development and technological innovation on green growth, disclosing these spatial effects in a sample of panel data of China. Given that reason, they underlined that financial development and technological innovation should be managed cautiously to promote green growth, and pointed out the importance of considering the spatial effects of the above factors. Razzaq et al. (2023) examined asymmetric impacts of digital finance and renewable energy technology innovation on green growth in China and indicated that digital finance and renewable energy innovations are important tools to promote green growth in China, whose effect varies according to economic levels.

Hasan & Du (2023) examined in detail the impact of green financial development, green technological innovation, and environmental regulation on environmental efficiency in China and established that green finance could be associated with an improvement in environmental efficiency. Sadiq et al. (2022) considered how green finance and financial development support

green economic growth in order to promote clean energy resources in South Asia. This research addressed the fact that economic activities result in deterioration of the environment, and while discussing issues related to renewable energy resource distribution, indicated that green finance retains an important role regarding improvement in this respect. Liu et al. (2019), in the study conducted to understand the impact of green financial development on regional ecological efficiency, formed evidence that development of green finance would result in increasing ecological efficiency. Tawiah et al. (2021) discussed the drivers of green growth within both developed and developing nations and indicated the ways in which green growth fosters economic growth. Mo et al. (2023) examined how the financial market and institutions impact green economy growth in highly polluting Asian countries and established that decision-making related to financial market development promotes green growth by enhancing technological innovation and green investment. In that respect, the work of Saqib et al. (2024) explores how financial development interacts with technological innovation in green growth and the optimization of such interaction within the context of SDGs. It is therefore concluded that environmental innovations and green growth represent an important strategy for increasing environmental sustainability in countries that have a big ecological footprint.

Qamri et al. (2022) examined the effects of foreign direct investment on environmental degradation in the context of FD and EG and found that Foreign Direct Investment and financial development contribute to economic growth but also increase environmental degradation. However, they concluded that these negative environmental effects can be mitigated by promoting green technologies and industries. Zhao et al. (2022) analyzed the asymmetric and heterogeneous impacts of financial risks on green growth and found that financial risks negatively affect green growth, but this effect varies according to regional and economic conditions. In particular, financial instability slows down green growth by inhibiting investments in green technologies and sustainable applications. De Haas & Popov (2023) examined how countries' financial structures affect their transition to low-carbon growth and investigated ways to reduce emissions from carbon-intensive industries. According to the results, financial systems play an important role in financing sustainable projects and encouraging the adoption of environmentally friendly technologies. However, it is also emphasized that if financial institutions do not sufficiently consider environmental risks, these systems may increase environmental degradation. Desalegn & Tangl (2022) systematically examined how we can promote inclusive green growth by increasing

green finance and what methods can be used to support green investments. The results of the study reveal that the development of green finance instruments and policies can promote economic inclusiveness as well as enhance environmental sustainability. It is also concluded that policy frameworks should be strengthened and cooperation between financial institutions and governments should be increased to make green finance more effective. Jiakui et al. (2023) explored how green technological innovation, green finance, and financial development impact green total factor productivity (GTFP) and how green growth can be optimized in China. Their findings highlight that green technological innovation is crucial in boosting GTFP, with support from green finance and financial development. The study underscores the importance of green technologies and financial instruments in maintaining a balance between economic growth and environmental sustainability. Noh (2018) emphasized financial strategies to accelerate green growth, proposing green bonds, sustainable investment funds, and other financial products as effective means to fund environmentally friendly projects. Saleem et al. (2022) examined how green growth, green finance, and environmentally friendly technologies improve environmental quality in selected Asian economies, investigating the direct relationship between financial development and its effects on economic growth and environmental quality. Xuan et al. (2023) analyzed how globalization and green economies contribute to natural resource protection, with financial development playing a key role in BRICS countries. These studies highlight the multidimensional effects of financial development on green growth and the critical role of financial systems in supporting green innovation and sustainable growth.

3. Model and Methodology

Green growth represents a concept that aims to achieve economic development in harmony with environmental sustainability and promotes a sustainable future through efficient use of resources, transition to renewable energy, reduction of carbon emissions and protection of ecosystems (OECD, 2011). The model was created based on the definition stated in the OECD (2011) report. Based on the international definition of green growth, the basic equation of the green growth variable used in the study is given below;

$$GreenGrowth_{i,t} = Growth_{i,t} + \sum EnvironmentalBenefit_{i,t} - \sum EnvironmentalDamage_{i,t} \quad (1)$$

$GreenGrowth_{i,t}$: Green growth index in country i at time t; $Growth_{i,t}$: GDP per capita in country i at time t (constant 2015 US$); $EnvironmentalBenefit_{i,t}$: The sum of environmental benefits in country i at time t; $EnvironmentalDamage_{i,t}$: The sum of environmental damages in country i at time t.

If we expand the environmental benefit and environmental damage variables in this equation by adding variables that are accessible due to country and time constraints. Equation (2) was created based on the studies of Çetin et al. (2024) and Yin et al. (2024).

$$GreenGrowth_{i,t} = w_1 Growth_{i,t} + [w_2 REC_{i,t} + w_3 FRA_{i,t}] - [w_4 CO2_{i,t} + w_5 ENI_{i,t}] \quad (2)$$

$REC_{i,t}$: The proportion of renewable energy consumption as a percentage of total final energy consumption in country i during period t; $FRA_{i,t}$: The percentage of forested land in relation to the total land area in country i at time t; $CO2_{i,t}$: CO2 emissions (metric tons per capita) in country i during period t; $ENI_{i,t}$: Energy intensity level of primary energy (MJ/$2017 PPP GDP) in country i during period t. The data for the variables included in Equation (2) were obtained from the World Bank database.

In order to create the green growth variable, the coefficients w_1, w_2, w_3, w_4 and w_5 represent the weights attributed to the relevant variables. In this process, all variables were integrated into the model with the equal weighting method. In order to strengthen the statistical significance of the model, it was planned to include additional variables such as solid waste, biodiversity, Environmental Performance Index and energy efficiency in the model. However, due to the incomplete data sets of these variables and the lack of retrospective data, these variables could not be included in the model. In order to create the green growth variable, a normalization process was performed to make the variables with different measurement units in the data sets comparable. In this direction, the variables were normalized using the max-min normalization method. Below, the comparison of the Green Growth and Growth variables obtained according to Equation (2) after the normalization process was completed is presented.

In developed countries, as seen in Graph 1, Growth and Green Growth generally follow a parallel course, which shows that these countries have successfully integrated environmental sustainability with economic growth. Green growth, especially in countries such as Sweden, Germany and Japan, has been showing a continuous and stable increase, which clearly shows the

effectiveness of environmentally friendly policies and green energy investments. The positive effect of financial development on green growth is expected since financial markets provide the necessary capital flow for green investments (Beck, 2006; Levine, 2005). Research and development (R&D) expenditures contribute to the development of new technologies and processes, reducing environmental impacts, while also supporting sustainable economic growth. In this context, increasing R&D expenditures stands out as an important element that encourages green growth (Grossman & Helpman, 1993). In addition, institutional quality supports green growth by increasing the efficiency of environmental management processes (Acemoglu et al., 2005).

Graph 1. Growth and Green Growth (The graphs were created by the author using the datas. The green growth variable was obtained according to Equation (2). The growth variables was obtained from the World Bank database.)

The model proposed in this study provides a framework for understanding how green growth interacts with financial development, R&D expenditures, and institutional quality. Equation (3) was created based on the studies of Khan et al. (2022) and Amin et al. (2022). The model can be formulated as follows:

$$GG_{it} = \beta_0 + \beta_1 FD_{it} + \beta_3 RD_{it} + \beta_4 IQ_{it} + \varepsilon_{it} \quad (3)$$

The time period is represented by the subscript t (t=1,...,T), while countries are indicated by the subscript i (i=1,...,N). The term β_0 stands for the constant, and ε_{it} denotes the random error component. GG_{it}: Green growth indicator (composite variable you defined earlier), FD_{it}: Financial development index (such as depth of financial markets, private sector credit volume, accessibility of financial services), RD_{it}: R&D expenditures (R&D expenditures relative to GDP), IQ_{it}: Institutional quality index.

The Institutional Quality Index (IQ) is obtained from the World Bank's Worldwide Governance Indicators (WGI) database, and the Financial Development Index (FDI) is obtained from the IMF's Financial Development Index Database. In addition, R&D Expenditure (R&D) data is obtained from the World Bank's World Development Indicators database. The model uses annual data for the period 2000-2020, and the data sets cover countries such as Australia, Canada, France, Germany, Japan, Netherlands, Sweden, Switzerland, United Kingdom and United States.

4. Empirical Findings

This study employed the panel data analysis method to investigate the relationship between green growth, financial development, R&D expenditures, and institutional quality. Data from 10 developed countries covering the years 2000-2020 were used in the study. Empirical findings are presented under the following headings. Summary statistics and Jarque-Bera normality test results for the data are presented in Table 1. Mean, median, maximum, minimum values, standard deviation, skewness and kurtosis values of GG, FDI, RD and IQ variables are given. In addition, according to the Jarque-Bera normality test, it was determined that all four variables showed deviations from normal distribution ($p < 0.05$). In particular, the Jarque-Bera statistic of the GG variable is 14.51, indicating that this variable is not normally distributed.

Table 1

Descriptive Statistics

	GG	FDI	RD	IQ
Mean	0.1146	0.8392	0.3991	0.6242
Median	0.0945	0.8403	0.3808	0.6776
Maximum	0.4892	0.9968	10.000	10.000
Minimum	-0.1145	0.6698	0.0000	0.0000
Std. Dev.	0.1408	0.0832	0.2470	0.2342
Skewness	0.6300	-0.1054	0.1459	-0.3453
Kurtosis	27.341	18.685	18.176	20.981
Jarque-Bera	145.099	115.925	129.785	112.899
Probability	0.0007	0.0030	0.0015	0.0035
Observations	210	210	210	210

Table 2 shows the correlations between the variables. According to the findings, there is a negative correlation (-0.256) between Financial Development Index (FDI) and Green Growth (GG). On the other hand, a strong positive correlation (0.704) was observed between R&D expenditures (RD) and green growth. A weaker positive relationship (0.215) was found between institutional quality (IQ) and green growth.

Table 2

Correlation Analysis Results and VIF

	GG	FDI	RD	IQ	Variables	VIF
GG	1	-0.256	0.704	0.215	FDI	1.122
FDI	-0.256	1	-0.174	0.136	RD	1.123
RD	0.704	-0.174	1	-0.012	IQ	1.102
IQ	0.215	0.136	-0.012	1		

The Variance Inflation Factor (VIF) values presented in Table 2 test the multicollinearity between the variables. Generally, a VIF value below 10 indicates that there is no serious multicollinearity problem in the model. According to the findings, the VIF values for the FDI, RD and IQ variables are 1.122, 1.124 and 1.102, respectively. These low VIF values indicate that there is no serious multicollinearity problem between the variables.

The Fully Modified Ordinary Least Squares (FMOLS) method is widely used in panel data analysis to examine long-term relationships between variables. FMOLS is particularly advantageous as it provides unbiased and consistent estimates by addressing potential issues of serial correlation and heteroskedasticity in the data. This method is designed to handle cointegrated panels effectively, making it suitable for studies focusing on long-run equilibrium relationships. In this study, FMOLS was chosen for several reasons. First, the research aims to analyze the long-term relationship between financial development (FDI), R&D expenditures (RD), institutional quality (IQ), and green growth (GG), making FMOLS an appropriate tool for capturing such dynamics. Second, FMOLS offers robust and reliable results even with small sample sizes, ensuring the accuracy of the findings. Lastly, the method accounts for potential problems of autocorrelation and heteroskedasticity, enhancing the reliability and validity of the estimated coefficients. For these reasons, FMOLS was deemed the most suitable estimation technique for the analysis conducted in this study.

Table 3

Panel Data Analysis Results

	Cofficient	**Std.Er.**	**t-stat**	**Prob**
FDI	0.2656	0.0797	33.324	0.0010
RD	0.1938	0.0391	49.603	0.0000
IQ	-0.1297	0.0478	-27.120	0.0073

The panel data analysis performed with the Panel Full Modified Least Squares (FMOLS) method presented in Table 3 examines the effects of financial development (FDI), R&D expenditures (RD) and institutional quality (IQ) variables on green growth. The findings show that the FDI variable has a positive and statistically significant effect (0.266, $p < 0.01$). This result indicates that financial development positively affects green growth. Similarly, the coefficient of

R&D expenditures is also positive and statistically significant (0.194, $p < 0.001$). This finding confirms that innovation has a positive effect on green growth. On the other hand, the coefficient of the IQ variable is found to be negative and statistically significant (-0.130, $p < 0.01$). This result shows that institutional quality has an unexpected negative effect on green growth.

The findings reveal that there is a positive relationship between financial development (FDI) and green growth. This is consistent with the literature arguing that financial depth contributes to environmental sustainability and green growth (De Haas & Popov, 2023; Zhao et al., 2022). In particular, there are studies indicating that financial development supports green growth by increasing environmental investments (Jiakui et al., 2023). In addition, the positive effect of R&D expenditures on green growth strengthens the contribution of innovation to environmental sustainability (Noh, 2018; Qamri et al., 2022). It has been emphasized in many studies that R&D investments play an important role in the development of new technologies and increasing environmental efficiency (Jiakui et al., 2023; Zhao et al., 2022). However, the negative effect of the institutional quality (IQ) variable on green growth draws attention to the importance of aligning institutional structures with environmental goals (De Haas & Popov, 2023; Desalegn & Tangl, 2022). It is concluded that when corporate governance structures do not sufficiently support environmental goals, green growth is negatively affected (Jiakui et al., 2023; Noh, 2018). In general, the literature frequently emphasizes that the interaction between financial development, R&D expenditures, and green growth has strategic importance for supporting sustainable development (Desalegn & Tangl, 2022; Qamri et al., 2022; Zhao et al., 2022).

The findings of this study reflect the structural and institutional characteristics specific to the ten developed countries included in the analysis. Incorporating different countries—particularly those with varying levels of institutional quality—might yield different outcomes. Therefore, the generalizability of the results is limited, and future research should consider broader comparative analyses to validate these findings across diverse national contexts.

5. Conclusion

The study aims to investigate how financial development influences green growth in developed countries, focusing on nations such as Australia, Canada, France, Germany, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom, and the United States, using annual data from 2000 to 2020. This study examines the interaction between green growth and macroeconomic

and institutional factors like financial development, R&D expenditures, and institutional quality. Panel data analysis shows that financial development and R&D expenditures positively impact green growth, while institutional quality unexpectedly has a negative effect. These findings suggest that understanding the relationships between these factors is key to promoting environmental sustainability. The results highlight the need for policymakers, especially in developed countries, to craft more supportive policies in finance and innovation to sustain green growth.

The findings showing the positive impact of financial development on green growth suggest that deepening financial markets and expanding financial services are crucial for achieving environmental sustainability goals. Supporting green technology and renewable energy projects through credit and incentive policies will bolster sustainable development. Policymakers should focus on expanding green financing mechanisms and collaborate with financial institutions and regulatory bodies to enhance credit opportunities for environmental projects and green bonds. Moreover, incorporating financial arrangements that consider environmental risks can help ensure that capital is directed towards sustainable projects.

The positive impact of R&D expenditures on green growth highlights the crucial role of innovation in achieving environmental sustainability goals. Developing innovative technologies contributes directly to green growth by enhancing energy efficiency and lowering carbon emissions. Therefore, governments should boost R&D spending and create policies that encourage private sector investments in R&D. Furthermore, collaboration between universities, research centers, and industries should be promoted to accelerate the development of green technologies. Special attention should be given to innovation in strategic areas like renewable energy, energy storage, and low-carbon technologies.

The negative effect of institutional quality indicators on green growth suggests that institutional frameworks need to be better aligned with environmental sustainability goals. This finding indicates that even in developed countries, green growth may be hindered if institutional mechanisms are not well integrated into environmental policies. As a result, policymakers should implement reforms to enhance institutional elements like government effectiveness, regulatory quality, and anti-corruption measures. Improving the efficiency of environmental management processes and strengthening transparency and accountability will enhance the implementation of environmental policies and foster alignment between institutional structures and green growth.

As a result, promoting green growth requires supporting financial development and innovation, while ensuring that institutional quality and environmental policies are aligned. This study highlights the need for policymakers to strengthen financial markets and boost R&D investments, while also advocating for institutional reforms that align with environmental goals. In developed countries, in particular, increasing green financing, enhancing innovation incentives, and reorganizing institutional frameworks to prioritize environmental sustainability are crucial steps towards achieving sustainable growth objectives.

Specifically, policy instruments such as green bonds, sustainable investment tax credits, and public-private R&D partnerships should be expanded to mobilize financial resources for environmentally friendly technologies. Institutional reforms should aim to enhance regulatory transparency, enforce environmental compliance, and integrate sustainability metrics into public governance frameworks. Moreover, strategic sectoral R&D funding—for example, in renewable energy, circular economy technologies, and low-carbon transportation—can significantly accelerate the green transition. These targeted measures would enable a more robust alignment between economic growth and environmental sustainability.

Declaration of Research and Publication Ethics

This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement

Since the author is the sole author of the article, his contribution rate is 100%.

Declaration of Researcher's Conflict of Interest

There are no potential conflicts of interest in this study.

Referenceses

Acemoglu, D., Johnson, S., & Robinson, J. A. (2005). Institutions as a Fundamental Cause of Long-Run Growth. *Handbook of Economic Growth*, Volume 1A. https://doi.org/10.1016/S1574-0684(05)01006-3

Aghion, P., Hemous, D., & Veugelers, R. (2009). No green growth without innovation. *Bruegel Policy Brief*-2009/07.

Amin, A., Ameer, W., Yousaf, H., & Akbar, M. (2022). Financial development, institutional quality, and the influence of various environmental factors on carbon dioxide emissions: exploring the nexus in China. *Frontiers in Environmental Science*, 9, 838714. https://doi.org/10.3389/fenvs.2021.838714

Arestis, P., Demetriades, P. O., & Luintel, K. B. (2001). Financial development and economic growth: the role of stock markets. *Journal of money, credit and banking*, 16-41. https://doi.org/10.2307/2673870

Beck, T. (2006). *Creating an efficient financial system: challenges in a global economy* (Vol. 3856). World Bank Publications. https://doi.org/10.1596/1813-9450-3856

Beck, T., & Levine, R. (2004). Stock markets, banks, and growth: Panel evidence. *Journal of Banking & Finance*, *28*(3), 423-442. https://doi.org/10.1016/S0378-4266(02)00408-9

Bekun, F. V., Emir, F., & Sarkodie, S. A. (2019). Another look at the relationship between energy consumption, carbon dioxide emissions, and economic growth in South Africa. *Science of the Total Environment, 655*, 759-765. https://doi.org/10.1016/j.scitotenv.2018.11.271

Çağlar, M. (2024). Examining Green Growth Conditions And Achievements Of The Oecd Countries: a Descriptive Analytical Approach. *Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi,* Sustainability and Green Economics Özel Sayısı, e1-17. https://doi.org/10.14780/muiibd.1462334

Cao, J., Law, S. H., Samad, A. R. B. A., Mohamad, W. N. B. W., Wang, J., & Yang, X. (2021). Impact of financial development and technological innovation on the volatility of green growth—evidence from China. *Environmental Science and Pollution Research*, *28*, 48053-48069. https://doi.org/10.1007/s11356-021-13828-3

Cao, J., Law, S. H., Samad, A. R. B. A., Mohamad, W. N. B. W., Wang, J., & Yang, X. (2022). Effect of financial development and technological innovation on green growth—analysis based on spatial Durbin model. *Journal of Cleaner Production, 365*, 132865. https://doi.org/10.1016/j.jclepro.2022.132865

Çetin, M., Sümerli Sarıgül, S., & Danish. (2024). The green growth-CO2 emissions link in G7 countries: the role of energy productivity. *International Journal of Environmental Science and Technology*, 1-14. https://doi.org/10.1007/s13762-024-06097-3

Chen, R., Ramzan, M., Hafeez, M., & Ullah, S. (2023). Green innovation-green growth nexus in BRICS: does financial globalization matter?. *Journal of Innovation & Knowledge, 8*(1), 100286. https://doi.org/10.1016/j.jik.2022.100286

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., ... & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*, *387*(6630), 253-260. https://doi.org/10.1038/387253a0

De Haas, R., & Popov, A. (2023). Finance and green growth. *The Economic Journal*, *133*(650), 637-668. https://doi.org/10.1093/ej/ueac081

Demirgüç-Kunt, A., & Maksimovic, V. (1998). Law, finance, and firm growth. *The journal of finance, 53*(6), 2107-2137. https://doi.org/10.1111/0022-1082.00084

Desalegn, G., & Tangl, A. (2022). Enhancing green finance for inclusive green growth: A systematic approach. *Sustainability*, *14*(12), 7416. https://doi.org/10.3390/su14127416

Grossman, G. M., & Helpman, E. (1993). *Innovation and Growth in the Global Economy*. MIT Press.

Hasan, M. M., & Du, F. (2023). Nexus between green financial development, green technological innovation and environmental regulation in China. *Renewable Energy,* 204, 218-228. https://doi.org/10.1016/j.renene.2022.12.095

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics,* 115(1), 53-74. https://doi.org/10.1016/S0304-4076(03)00092-7

Jiakui, C., Abbas, J., Najam, H., Liu, J., & Abbas, J. (2023). Green technological innovation, green finance, and financial development and their role in green total factor productivity: Empirical insights from China. *Journal of Cleaner Production,* 382, 135131. https://doi.org/10.1016/j.jclepro.2022.135131

Khan, H., Weili, L., & Khan, I. (2022). The role of financial development and institutional quality in environmental sustainability: Panel data evidence from the BRI countries. *Environmental Science and Pollution Research,* 29, 83624–83635. https://doi.org/10.1007/s11356-022-21697-7

Levine, R. (1997). Financial development and economic growth: views and agenda. *Journal of economic literature,* 35(2), 688-726.

Levine, R. (2005). *Handbook of Economic Growth, Chapter 12: Finance and Growth: Theory and Evidence*. Volume 1, Part A, 865-934. Elsevier. https://doi.org/10.1016/S1574-0684(05)01012-9.

Li, C., Fan, X., Hu, Y., Yan, Y., Shang, G., & Chen, Y. (2022). Spatial spillover effect of green finance on economic development, environmental pollution, and clean energy production across China. *Environmental Science and Pollution Research,* 29(58), 87858-87873. https://doi.org/10.1007/s11356-022-21782-x

Liu, R., Wang, D., Zhang, L., & Zhang, L. (2019). Can green financial development promote regional ecological efficiency? A case study of China. *Natural Hazards,* 95, 325-341. https://doi.org/10.1007/s11069-018-3502-x

Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics,* 61(S1), 631-652. https://doi.org/10.1111/1468-0084.0610s1631

Meadows, D. H., Meadows, D. L., Randers, J., & Behrens, W. W. (2018). *The limits to growth*. In Green planet blues (pp. 25-29). Routledge.

Meo, M. S., & Abd Karim, M. Z. (2022). The role of green finance in reducing CO2 emissions: An empirical analysis. *Borsa Istanbul Review, 22*(1), 169-178. https://doi.org/10.1016/j.bir.2021.03.002

Mo, Y., Ullah, S., & Ozturk, I. (2023). Green investment and its influence on green growth in high polluted Asian economies: Do financial markets and institutions matter?. *Economic research-Ekonomska istraživanja,* 36(2). https://doi.org/10.1080/1331677X.2022.2140302

Nawaz, M. A., Seshadri, U., Kumar, P., Aqdas, R., Patwary, A. K., & Riaz, M. (2021). Nexus between green finance and climate change mitigation in N-11 and BRICS countries: Empirical estimation through difference in differences (DID) approach. *Environmental Science and Pollution Research,* 28, 6504-6519. https://doi.org/10.1007/s11356-020-10920-y

Ngo, T., Trinh, H. H., Haouas, I., & Ullah, S. (2022). Examining the bidirectional nexus between financial development and green growth: International evidence through the roles of human capital and education expenditure. *Resources Policy*, 79, 102964. https://doi.org/10.1016/j.resourpol.2022.102964

Noh, H. J. (2018). *Financial strategy to accelerate green growth (No. 866).* ADBI working paper.

Organisation for Economic Co-operation and Development. (2011). *Towards green growth.* OECD Publishing. https://doi.org/10.1787/9789264111318-en

Peng, J., & Zheng, Y. (2021). Does environmental policy promote energy efficiency? Evidence from China in the context of developing green finance. *Frontiers in Environmental Science*, *9*, 733349. https://doi.org/10.3389/fenvs.2021.733349

Qamri, G. M., Sheng, B., Adeel-Farooq, R. M., & Alam, G. M. (2022). The criticality of FDI in Environmental Degradation through financial development and economic growth: Implications for promoting the green sector. *Resources Policy*, 78, 102765. https://doi.org/10.1016/j.resourpol.2022.102765

Rajan, R. G., & Zingales, L. (1996). Financial dependence and growth. *American Economic Review,* 88(3), 559-586. https://doi.org/10.3386/w5758

Rasoulinezhad, E., & Taghizadeh-Hesary, F. (2022). Role of green finance in improving energy efficiency and renewable energy development. *Energy Efficiency*, 15(2), 14. https://doi.org/10.1007/s12053-022-10021-4

Razzaq, A., Sharif, A., Ozturk, I., & Skare, M. (2023). Asymmetric influence of digital finance, and renewable energy technology innovation on green growth in China. *Renewable Energy*, 202, 310-319. https://doi.org/10.1016/j.renene.2022.11.082

Robert, K. W., Parris, T. M., & Leiserowitz, A. A. (2005). What is sustainable development? Goals, indicators, values, and practice. *Environment: science and policy for sustainable development,* 47(3), 8-21. https://doi.org/10.1080/00139157.2005.10524444

Sadiq, M., Amayri, M. A., Paramaiah, C., Mai, N. H., Ngo, T. Q., & Phan, T. T. H. (2022). How green finance and financial development promote green economic growth: deployment of clean energy sources in South Asia. *Environmental Science and Pollution Research*, 29(43), 65521-65534. https://doi.org/10.1007/s11356-022-19947-9

Saleem, H., Khan, M. B., & Mahdavian, S. M. (2022). The role of green growth, green financing, and eco-friendly technology in achieving environmental quality: evidence from selected Asian economies. *Environmental Science and Pollution Research*, 29(38), 57720-57739. https://doi.org/10.1007/s11356-022-19799-3

Saqib, N., Usman, M., Ozturk, I., & Sharif, A. (2024). Harnessing the synergistic impacts of environmental innovations, financial development, green growth, and ecological footprint through the lens of SDGs policies for countries exhibiting high ecological footprints. *Energy Policy*, 184, 113863. https://doi.org/10.1016/j.enpol.2023.113863

Shen, C. H., & Lee, C. C. (2006). Same financial development yet different economic growth: why?. *Journal of Money, Credit and Banking,* 1907-1944. https://doi.org/10.1353/mcb.2006.0095

Stern, N. (2006). The Stern Review: The Economics of Climate Change. Cambridge University Press. https://doi.org/10.1017/CBO9780511817434

Tawiah, V., Zakari, A., & Adedoyin, F. F. (2021). Determinants of green growth in developed and developing countries. *Environmental Science and Pollution Research, 28*(29), 39227-39242. https://doi.org/10.1007/s11356-021-13429-0

United Nations Environment Programme. (2011). *Towards a green economy: Pathways to sustainable development and poverty eradication*. Nairobi: Author. https://www.unep.org/greeneconomy

World Bank. (2012). *Inclusive green growth:* The pathway to sustainable development. Washington, DC: Author. https://doi.org/10.1596/978-0-8213-9545-2.

World Commission on Environment and Development. (1987). *Our common future*. Oxford: Oxford University Press.

Xuan, D., Jiang, X., & Fang, Y. (2023). Can globalization and the green economy hedge natural resources? Functions of population growth and financial development in BRICS countries. Resources Policy, 82, 103414. https://doi.org/10.1016/j.resourpol.2023.103414

Yang, L., & Ni, M. (2022). Is financial development beneficial to improve the efficiency of green development? Evidence from the "Belt and Road" countries. *Energy Economics*, *105*, 105734. https://doi.org/10.1016/j.eneco.2021.105734

Yılmaz, V. (2018). Sürdürülebilir Kalkınma ve Yeşil Büyüme Arasındaki İlişki. *Journal of International Management Educational and Economics Perspectives*, *6*(2), 79-89.

Yin, Y., Hussain, J., Gou, Q., & Wang, J. (2024). Green economic growth and environment: Unveiling the role of environmental policy and cleaner energy in G-7 countries. *Clean Technologies and Environmental Policy*, 26, 4137–4156. https://doi.org/10.1007/s10098-024-02824-z

Zhao, J., Dong, K., Dong, X., Shahbaz, M., & Kyriakou, I. (2022). Is green growth affected by financial risks? New global evidence from asymmetric and heterogeneous analysis. *Energy Economics*, 113, 106234. https://doi.org/10.1016/j.eneco.2022.106234

Zhou, G., Zhu, J., & Luo, S. (2022). The impact of fintech innovation on green growth in China: Mediating effect of green finance. *Ecological Economics*, *193*, 107308. https://doi.org/10.1016/j.ecolecon.2021.107308