Is There A Relationship Between Financial Development And Geopolitical Risk Indices And Sustainable Development Goals? A Study on E3 Countries

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Abstract: This paper explores the correlation between the Financial Development Index (FDI) and the Geopolitical Risk Index (GPR) in relation to Sustainable Development Goals (SDGs) within the E3 countries: Germany, France, and the United Kingdom. With limited research available on the interaction between these indices and the SDGs, this study aims to bridge that gap by focusing on SDG 13 (Climate Action) and SDG 7 (Affordable and Clean Energy). Using data spanning from 2000 to 2021, the analysis employs ARDL and Dynamic Conditional Correlation (DCC) models to assess the impact of geopolitical risks and financial development on these sustainability targets. Findings reveal that in Germany, there are significant long-term relationships between FDI and both SDG 13 and SDG 7, with geopolitical risks negatively impacting both goals. Economic growth was observed to have a stronger influence on SDG 13. In France, FDI positively affected SDG 13 but had no statistically significant impact on SDG 7. Geopolitical risks had adverse effects on both goals, while economic growth's impact on SDG 7 was found to be insignificant. In the UK, no significant long-term relationships were identified; however, short-term analysis highlighted notable effects of FDI and geopolitical risks on SDG 7. The DCC analysis revealed that the relationship between SDG 13 and SDG 7 was relatively strong around 2000 but weakened over time.

Keywords: Financial development, Geopolitical risk, Sustainable Development Goals, E3 Countries

Jel: C58, G20, O44, Q50

Introduction

Recent studies have examined the relationship between financial development, geopolitical risks, and sustainable development goals (SDGs). According to research, while financial development and environmental innovation positively affect

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sustainable development, geopolitical risks play an impeding role in achieving the SDGs (Mahmood Ahmad et al. 2024; Nguyen et al. 2023). While globalization contributes to sustainable development in both developed and developing countries, financial development has negative effects in the long term (Seren Aydıngülü Sakalsız and Meltem Kılıç 2024). In addition, financial development directly affects some SDGs positively; for example, while contributing to gender equality, economic growth, and innovation goals, it can have negative consequences on climate action (Paramita Mukherjee, Sahana Roy Chowdhury, and Poulomi Bhattacharya 2021). While natural resource dependency increases the negative impact of geopolitical risks on the SDGs, institutional quality improvements can mitigate these effects (Nguyen et al., 2023). These findings suggest that policymakers should prioritize the management of geopolitical risks and the reduction of natural resource dependency while promoting financial development, environmental innovation, and globalization to achieve sustainable development goals (Ahmad et al. 2024); (Sakalsız and Kılıç 2024); (Nguyen et al. 2023). Geopolitical tensions can make it difficult to achieve sustainable development goals, especially in resource-dependent countries. However, improving institutional quality can mitigate these negative effects (Nguyen et al., 2023). Research on the impact of geopolitical crises on sustainable development has increased, and China has emerged as an important cooperation partner in this area following the Russia-Ukraine conflict (Qiang Wang, Feng Ren and Rongrong Li 2024).

Our study aims to examine the relationship between financial development, geopolitical risk indices and sustainable development because these three elements are intertwined in modern economies. This study is one of the limited number of studies addressing this triple relationship. Our study aims to fill the gap in the literature by analyzing the impact of geopolitical risks on sustainable development through financial development. In addition, thanks to the methodology and dataset used, our results provide concrete suggestions that can guide decision-makers and policy-makers.

1. Theoretical Background

The introduction of the SDG by the United Nations in 2015 has raised awareness of sustainability concepts at the international level. This awareness cannot be advanced solely through the strategies implemented by public authorities. The realization of these goals and the need to enhance the efficiency and sustainability of limited resources highlight the necessity for not only state authorities but also the private sector and society to act with the same sense of awareness. State authorities should develop environmental policies that reduce the impacts of climate change, ensuring their applicability at the macro level for the entire world while managing their countries at the micro level. The private sector should implement and improve these policies, and at the societal level, consumers should engage in consumption and investment activities that align with this awareness. To build a sustainable system, a new infrastructure needs to be established in all processes. Today, institutions such as central banks, commercial banks, and International Finance Institutions (IFIs) play an

active role in international initiatives that emphasize the shared responsibilities of various stakeholders in society, such as the SDG and the Paris Agreement.

When it comes to its counteraction, the rational consumption has become crucial in relation to each sector and, in particular, production. Challenges on the international level, mainly brought along by the COVID-19 pandemic, have aggravated the effects of changes to the environment and so amplified the need to utilise resources in the best possible manner. The management of resources for Sustainable Development is not the just wise use of available resources but it also includes the protection and passing on of these resources to the next generations. In this connection the conception Sustainability appeared as the sign of the need for the creation of the application-oriented concepts in different spheres including the economic and financial ones. This applies to first-line countries that are implementing measures and practicing on how best to counter the impacts of climate change. Cautiously, one of the best ways to mitigate climate change and develop sustainable resources is to guarantee the global significance of the determined verdict. An actual example is increasing new digital currency projects by the banks; it also contributes to the active participation of banks in the compliance with central banks' financial sustainability policies. A major step in this regard has indeed been the creation of the Network for Greening the Financial System (NGFS) back in 2017, which is an international steering, based on the voluntary system set out by eight central banks and regulatory authorities. Furthermore, central banks within the G20 countries have measures implemented in full understanding that the climate that has shaped the globe's environmental system affects future monetary policy. Hence, the planning of the ECB and the BoE to purchase green bonds, so the authorities can get closer to the "net-zero carbon emission" target by mid-century.

The first one is sustainable energy consumption in production with particular emphasis on the environmental nature of energy sources used; the second one is diversification of energy sources in production. The European Green Deal is one of the key environmental policies by the European Union, with the European Commission preparing it since 2019 with implementation and support starting in 2020. The main task of the Green Deal is Europe's decarbonisation, that is, making the European continent the first climate-neutral continent till 2050. The key goals of the European Green Deal can be outlined as follows: Reduce greenhouse gas emission to net-zero by 2050 under all circumstances. If we take "economic growth" to be mainly about increasing levels of consumption of physical goods, the necessary conditions for reaching the Goals should be arranged in such a manner as to decouple economic growth from resource use, while making such Goals indeed accessible to every region and every person. Thus, the need for studies regarding transformation of industry in European Union countries has been mentioned in this context and policies are being made regarding it. The necessity of a carbon neutral continent in the framework of the green deal is grounded on two main pillars. The first one is sustainable energy consumption in production with particular emphasis on the environmental nature of energy sources used; the second one is diversification of energy sources in production. Reducing energy dependency in production not only means decreasing reliance on external energy sources, which has been a goal for many years, but also involves

ensuring that production and economic growth can be achieved independently of energy factors. The policies envisaged within the Green Deal are being concretized by the European Union through the Eighth Environment Action Programme. The Eighth Environment Action Programme aims to support the objectives of the European Green Deal and the 2050 vision of the Seventh Environment Action Plan. Additionally, one of the program's goals is to develop environmental policies that align with the United Nations' 2030 Agenda and its Sustainable Development Goals (European Commission, 2022a; IMMIB EU Projects Department).

International environmental agreements, environmental regulations, and increasing environmental awareness have brought the topic to the forefront both academically and practically. It is believed that environmentally conscious policies positively impact businesses' reputation, image, and competitive advantage. However, it can be stated that environmental degradation, water and air pollution, excessive consumption of natural resources, and climate change, are the results of human activities (Basheer M. Al-Ghazali and Bilal Afsar, 2021).

A review of the literature shows that, particularly in recent years, with the rise of sustainable development goals, financial development and geopolitical risk factors have emerged as important factors that can influence development goals (Yuqiu Du and Wendi Wang, 2023; Dario Caldara and Matteo Iacoviello, 2022; Qasim Raza Syed, Elie Bouri, Raja Fawad Zafar, and Oluwasegun Babatunde Adekoya 2021). The phenomenon of globalization has removed barriers to economic and financial boundaries between countries, while also facilitating human mobility. This mobility can arise voluntarily in pursuit of better living standards or, at times, forcibly due to reasons such as war, political, or social pressures. Compared to voluntary migration, there has been a significant increase in forced migration, especially in certain regions today. Civil wars, political instability, and social conflicts are key factors that trigger migration movements. Additionally, in the coming years, the world will also be faced with the phenomenon of climate migration due to climate change. For example, an increase in drought due to climate change in a region affects the local population, lowers living standards, and can lead them to search for alternative living areas. As a result, the impacts of changing climate conditions will also increase human mobility. In this context, the consequences of climate change must be considered not only within a socio-economic framework, but also as a geopolitical risk.

Germany's updated sustainability strategy in 2018 includes more targets for global development cooperation. The Federal Statistical Office measures the success of national and international targets by evaluating 65 criteria with accessible results available online. Every two years, a status assessment report is published. According to the 2018 report, Germany has reached the level set for national sustainability targets in more than one-third of the criteria. Additionally, provided that the current conditions are maintained, Germany is expected to continue reaching these targets in the future. The federal government appears to be working towards fully implementing the energy transition. The government's focus includes, among other things, the consistent expansion of renewable energies. In the past few decades, Germany has succeeded in reducing its energy needs, increasing economic output through more efficient use of energy, and significantly increasing the share of renewable energies in gross final

energy consumption. The use of nuclear energy in Germany began with the first nuclear law in 1959. The phased elimination of nuclear energy was legislated in 2011. The last nuclear power plants ceased operation in 2023. The use of nuclear energy is not an attractive alternative in the energy transition pathway, which involves continuously shifting energy supply towards renewable energies. Germany has not only phased out nuclear energy but is also in the process of gradually ending electricity generation from coal. The last coal-fired power plant in Germany is planned to be closed by 2038 at the latest. Consequently, Germany is supporting the expansion of sustainable and decentralized energy production technologies. One of the primary objectives is efficient energy production and use. This will contribute to both climate protection and the elimination of global competition for increasingly scarce energy resources. The Climate Protection Act forms the foundation of this law. With the Climate Protection Act, the government has committed to reducing greenhouse gas emissions by at least 65% by 2030 compared to 1990 levels. Germany aims to achieve greenhouse gas neutrality by 2045. Germany aims to become one of the first industrialized countries to achieve climate neutrality by 2045. Therefore, within the framework of its sustainability goals, Germany is focused on accelerating the transition to renewable energies and advancing the transformation to a climate-neutral economy (Deutschland.de – Portal der Bundesrepublik Deutschland; Bundesregierung – Die Bundesregierung).

The UK Government has since then made steady achievements in the increase and extension of the level of amassment of ambitious climate change targets by the enshrinement of a legally binding net-zero target along with the formulation of a net-zero strategy from 2018. In particular, the process of leaving the EU has brought the need for introducing a set of measures that will help support sustainable agriculture and could open a vast potential in terms of advancing going green through promoting sustainable agricultural practices, the bettering of local nature, and concerning the European goals of increasing nature and biodiversity and reaching net zero targets. But, in fact, the UK is expected to overshoot its next Carbon Budgets, and much more attentiveness is required for meeting the local pledges and the creation of the cohesive and well-coordinated strategies and policies to address and adapt to the climate change. Civil servants have identified their five strategic priorities as health and social care, education, housing, skills and assets, and net zero. Involve different stakeholders cutting across business, investment, civil society and academic domains to match on the pathways of the SDGs. The financing of the UK is based on several projects both at home and abroad with respect to SDG7. Out of the more than 64 million ICF in the UK between 2011 and 2020, around 40 million people are beneficiaries of access to clean energy. Britain has pledged and put in place various policies to decrease the usage of fossil fuels and enhance the utilization of renewable sources of energy. These efforts seek to centralize domestic and international funding for renewable energy projects. The UK has introduced several policies and pledged to eliminate subsidies to fossilizes and the promotion of renewable energy sources. They include practice intended to influence domestic and international resources to meet the target of funding renewable energy initiatives. The internationally oriented targets of the UK include commitments focused on climate change, for example, eliminating coal. However,

policy interventions which have regressed these goals include the decrease in UK ODA and domestic subsidies to fossil fuels. The impact of these cuts on international energy programs is still being debated (Global Compact Network UK; GOV.UK – The UK Government's Official).

France has adopted a roadmap that is positioned to achieving sustainable development goals while addressing national challenges. The aim of the roadmap is to identify pathways for implementing sustainable development in France, define priority issues, trigger concrete actions, and involve all French stakeholders in this process. The development of the roadmap encompassed the full diversity of French society. The process began on April 26, 2018, under a high-level steering committee, which served as the governing body for the development of the roadmap, and it was adopted in 2019. In 2018, the French General Commission for Sustainable Development (CGDD), the Regional Directorates for Environment, Development, and Housing (DREAL), and the Center for Risk, Environment, Mobility, and Development Studies and Expertise (Cerema) initiated efforts to develop collective skills in collaboration with partners (regional directorates, supporting organizations) and regional stakeholders (local authorities, associations, companies. France is making significant investments in renewable energy sources. The country is increasing its clean energy capacity through substantial investments in wind and solar energy projects. Various policies and programs are being implemented to enhance energy efficiency. Measures aimed at reducing energy consumption and legislation promoting energy savings play a crucial role in achieving this goal. France is promoting international collaborations to increase access to clean energy in developing countries. France's cooperation with the International Energy Agency (IEA) and other international organizations encompasses efforts to support global energy access. France played a leading role in the negotiations of the Paris Climate Agreement and hosted the signing of the agreement. France supports the commitment to limit global temperature rise to 1.5ºC and is developing various policies to achieve this goal. It implements a national climate strategy to combat climate change. This strategy aims to reduce greenhouse gas emissions, increase energy efficiency, and promote low-carbon economic activities. France has set a target of zero carbon emissions by 2050. To achieve this goal, it is implementing policies to reduce the use of fossil fuels and promote the transition to carbon-neutral energy sources (Agenda 2030 France – Situation and Organization of Implementation in France).

In recent years, the global economy has undergone a major transformation. One of the most obvious reasons for this transformation is the historic economic crisis caused by the COVID-19 pandemic. The pandemic has brought all economic activities worldwide to a standstill and has negatively affected many sectors. As of 2020, due to the impact of the pandemic, historic declines have been observed in global GDP (Gross Domestic Product) rates, and many countries have experienced serious economic contractions. This contraction has seriously affected not only short-term economic indicators but also long-term sustainable development goals.

The economic consequences of COVID-19 have deeply affected not only developed economies, but also developing and low-income countries. While the pandemic strains health systems and disrupts supply chains, it has also left permanent

marks on the economic structures of countries. This situation has negatively affected economic growth rates worldwide and has led to major losses, especially in the labor market. In accordance with (M. Carmen Blanco-Arana, 2020) the labour market, the need to increase job security and provide support to unemployed households during periods of economic recession was emphasized. This shock caused by the pandemic has once again revealed how fragile the global economic system is. On the other hand, this crisis period has necessitated the re-evaluation of development strategies and the development of more flexible and sustainable policies. In this context, it has become clear that economies need to cope with the negative effects of the pandemic to achieve sustainable development goals. This article aims to address the effects of the pandemic on the global economy, as well as how sustainable development goals will take shape in this new world order. This study, based on data from the 2000-2021 period, will examine the relationship between economic growth and sustainable development together with the effects of the economic shocks created by COVID-19. In this context, it aims to present important findings, especially on how the interaction between economic growth and sustainable development goals has transformed after the pandemic.

A review of the current literature reveals that there are few studies examining the relationship between the FDI and the GPR with the Sustainable Development Goals (Nguyen et al., 2023; Ahmad et al., 2024; Bakhsh Satar, Md Shabbir Alam and Wei Zhang 2024; Lan Khanh Chu, Huong Hoang Diep Truong, and Dung Phuong Hoang 2023). Therefore, this study aims to fill this gap by empirically examining the impact of geopolitical risks and financial development on achieving SDG, specifically SDG 13 and SDG 7, in E3 countries. In this context, this study aims to examine the relationships between financial development, geopolitical risks and sustainable development goals and to reveal how these factors create an impact both separately and together.

The hypotheses that can be developed in the context of this study can be formulated as follows:

H1: Financial development has a positive and significant effect on SDG 13 (Climate Action), one of the sustainable development goals.

H2: Financial development has a positive and significant effect on SDG 7 (Affordable and clean energy), one of the sustainable development goals.

H3: Geopolitical risks have a negative and significant effect on SDG 13 (Climate Action), one of the sustainable development goals.

H4: Geopolitical risks have a negative and significant effect on SDG 7 (Affordable and clean energy), one of the sustainable development goals.

H5: Geopolitical risks weaken the positive effect of financial development on sustainable development goals (mediation effect).

H6: In E3 countries (Germany, United Kingdom, France), the relationship between financial development and sustainable development goals is stronger compared to developing countries.

H7: Geopolitical risks lead to differences between countries in achieving sustainable development goals.

These hypotheses can form the basis of both the theoretical framework and the empirical analysis and clearly reveal the contribution of the study to the literature.

1.1 Financial development, Geopolitical risk and sustainable development

Financial development is a pair of interconnected concepts that are crucial for sustainable development goals. Successful studies on the relationship between financial development and environmental quality demonstrate that, despite several opposing arguments, the financial sector plays a critical role in promoting the development and use of new technologies for environmentally friendly production (Ross Levine, 2005; Artur Tamazian, Juan Piñeiro Chousa, and Krishna Chaitanya Vadlamannati 2009; Abdul Jalil and Mete Feridun, 2011; Muhammad Shahbaz, Sakiru Adebola Solarin, Haider Mahmood, and Mohamed Arouri 2013; Muhammad Umar, Xiangfeng Ji, Dervis Kirikkaleli, and Qinghui Xu 2020). Nathalie Homlong and Elisabeth Springler (2010) stated that the Indian economy has experienced strong GDP growth in recent years, but the need for sustainable development remains as it still lags in meeting basic needs such as clean water, clean air, and proper waste management for households and companies. In this context, according to the authors, a review of problematic policies and the proper enforcement of environmental laws will provide the grounds for further investments in environmental technology projects in India. In the literature, there are many studies examining the relationship between the digital economy and sustainable development goals (Feng, R. C. Shen, and M. X. Tang 2017; L. Yu Andreeva, Tatiana V. Epifanova, O. V. Andreeva, and Andrei S. Orobinsky 2018; Anna Jasińska-Biliczak 2022; Viktorija Skvarciany and Daiva Jurevičienė 2024). Feng and Tang (2017) stated that there is a positive and strong relationship between financial stability and sustainable development goals. Andreeva et al. (2018) emphasized the characteristics and importance of financial technologies for sustainable development. Anna (2022) found that e-commerce has an indirect relationship with sustainable development, particularly with SDG8.

When examining studies in the literature, it has been revealed that, especially in recent years, with the prominence of sustainable development goals, financial development, and geopolitical risk factors may be significant factors in influencing development goals. When we examine the current literature, few studies investigate the relationship between the FDI and the GPR with SDG (Nguyen et al. 2023; Ahmad et al. 2024; Bakhsh et al. 2024; Chu et al. 2023). In the Nguyen et al. (2023) paper based on 41 countries it was identified that geopolitical risks may be detrimental to SDGs. The researchers concluded that the strains or competitiveness within the geopolitical structure have a more significant impact on sub-indices of the Consultative process of the Sustainable Development Goals. Issues based on SDGs are SDG8 and SDG13. On the same note, Ahmad et al. (2024) affirm that financial development and eco-innovation policies are the predictors of Sustainable Development Goals in OECD nations. It also concluded that managing geopolitical risks is important in attaining these SDG goals. According to the study by Bakhsh et al. (2024), in their work titled green finance, geopolitical risk, and sustainable development goals–a VAR assessment

for OECD countries, analyse the green finance, geopolitics, and SDGs for members of the Organisation for Economic Co-operation and Development (OECD) from the year 2000 to 2020. Based on the results analysis in this paper, green finance is a positive factor that can contribute to the enhancement of the SDGs, while high geopolitical risk can be a negative factor that influences the green finance activities. Chu et al. (2023) noted that while discussing financing and identifying the necessity for the evaluation of the political risks of an alteration to transition to a sustainable environment, the panel studied 40 developed and developing nations over the period 2000–2018. When affected by geopolitical risk, both groups of countries experience a reduction in environmental degradation as inferred from the research. In the paper by Skvarciany and Jurevičienė (2024) the correlation between the digital economy and the sustainable development goals was analyzed with the help of the panel regression model applied to 28 EU countries during 2017–2020. Thus, the results of the study show that the digital economy (DESI sub-dimensions) affects the SDGI. In most cases, these effects are considered to be unfavourable.

1.2 Geopolitical risk and Financial development

With the increase in geopolitical uncertainty, the need for a stable financial system is observed. The investigation of the relationship between these two factors is also widely covered in the literature (Nabamita Dutta and Sanjukta Roy 2011; Anupam Dutta and Probal Dutta 2022; Ricardo Barradas 2022; Jialin Zhang and Shaodong Shi 2023; Heng Luo and Ying Sun 2024; Charilaos Mertzanis and Imen Tebourbi 2024; Amal-Ben Abdallah, Hamdi Becha, Arshian Sharif, and Muhammad Farhan Bashir 2024). Dutta and Roy (2011) found that political stability affects financial development factors in their study using panel data from 97 countries. Dutta and Dutta (2022) investigated the relationship between the GPR and renewable energy exchange-traded funds, finding that geopolitical risk implies lower risk for green assets. Barradas (2022) shows that finance has hindered economic growth in EU countries both before and during the crisis, as well as in the post-crisis period. These findings suggest that, to avoid a potential new 'secular stagnation' in the current era of financialization, finance—specifically, the so-called financialization—needs to be reduced in the coming years. Zhang and Shi (2023) investigated how geopolitical risk affects financial development for BRICS countries, considering the period from 1990 to 2022. The results of the study show that geopolitical risk negatively impacts financial development during the periods examined. Luo and Sun (2024) researched the relationship between geopolitical risk and CO2 emissions, considering data from 27 countries between 1990 and 2020. The results of the study indicate that the impact of geopolitical risk on CO2 emissions is greater in developing countries compared to developed countries. Mertzanis and Tebourbi (2024) analysed the impact of geopolitics risk to green bond issuances for 73 countries in the period between 2008 and 2021. According to the outcomes of the research, it was established that there is a direct relationship between the two factors in question. Ben Abdallah et al. (2024) investigated the impact that geopolitical risks and financial development have on industrialised countries' energy transition. The research done concludes to the effect that industrialized countries function in a geopolitical system and are desirous of

making higher investment in cleaner energy sources. M. Carmen Blanco-Arana and María J. Angulo-Guerrero (2024) examined the link between finance and poverty in the developing nations between the year 2000 and 2019. The authors included another variable related to the subject of entrepreneurial activity in determining the correlation between the two variables. From the findings of the study, the following can be concluded: Financial development as a factor was found to influence poverty reduction. The role of entrepreneurial activities in poverty reduction was quantified.

1.3 Literature gap

While there has been a growing awareness within academic literature of the link between financial development, geopolitical risks, and sustainable development, significant gaps persist. There is still limited analysis of their joint role in achieving the Sustainable Development Goals (SDGs) in advanced economies. Most studies focus either on financial development or geopolitical risks, rarely examining these factors together, particularly within specific regions or individual countries. This research gap is especially pronounced for the E3 countries—Germany, the United Kingdom, and France—which are major global economic players and active participants in the sustainable development discourse.

Existing studies analyze the impacts of financial development or geopolitical risks on the SDGs separately. However, the combined impact of financial development and geopolitical risk on the sustainable development goals, especially SDG 13 (Climate Action) and SDG 7 (Affordable and Clean Energy), remains under-researched. Studies that combine these variables in a comprehensive model, as in this study, are relatively rare, and there are few articles that examine the relationship between these indices and their joint impact on the SDGs. While many studies recognize that geopolitical risks can hinder economic stability and SDG achievement, empirical research focusing on how geopolitical risks affect sustainable development, particularly through financial development channels, is scarce. Previous studies have often ignored the role of financial mechanisms in moderating or exacerbating these impacts, leaving a gap in understanding how these impacts operate. This gap is particularly evident when examining the long-term and short-term impacts of geopolitical risks in advanced economies such as Germany, the United Kingdom, and France. While most of the literature on financial development and sustainable growth deals with developing countries or emerging markets, there is scant exploration of these issues in advanced countries. The E3 countries, with their unique political, economic, and financial characteristics, provide a valuable example for understanding how advanced economies seek to achieve their SDGs by balancing financial development with geopolitical risks. The limited focus on this particular group of countries suggests that the findings of studies on emerging markets may not be directly applicable to developed countries, and the nuances of financial systems and geopolitical risks in these countries have not been sufficiently explored. While some studies have examined the role of geopolitical risks in environmental sustainability, there is limited research on how such risks affect specific SDGs, such as SDG 13 (Climate Action) and SDG 7 (Affordable and Clean Energy). While geopolitical risks have been shown to disrupt energy security and climate action in resource-based

economies, empirical evidence directly linking these risks to specific SDG indicators is limited. Most existing studies focus broadly on environmental outcomes, do not focus on specific targets or assess differential impacts on various SDGs, particularly in the context of developed countries.

A major limitation in the existing literature is the lack of consistent and comprehensive datasets, particularly on the relationship between the Financial Development Index (FDI) and the Geopolitical Risk Index (GPR) and SDG targets. Many studies are limited by data access and often focus on cross-sectional analyses or short time periods, making it difficult to derive generalizable results. Furthermore, while some studies have used econometric models to examine these relationships, the use of advanced methods such as ARDL and DCC models to analyze the dynamic relationships between financial development, geopolitical risks, and SDGs in a long-term context is still underrepresented. There are some findings on the impact of financial development and geopolitical risks on sustainable development, but there is a lack of comprehensive policy-oriented research linking these factors to practical recommendations for policymakers. Most studies offer broad recommendations without considering in depth how financial development strategies or geopolitical risk management policies can specifically contribute to achieving the SDGs in developed countries. More in-depth, region-specific policy discussions are needed to explore how these countries can balance economic growth with sustainability goals and geopolitical stability. While many studies examine the relationship between SDGs focused on economic development and environmental sustainability, insufficient attention is paid to the broader range of SDGs. This study aims to fill this gap by addressing both SDGs 13 (Climate Action) and SDG 7 (Affordable and Clean Energy), which are critical for a sustainable future. Much of the existing literature focuses on either combating climate change or access to renewable energy, without simultaneously considering the broader economic and financial factors that affect these goals—such as the role of financial systems and geopolitical stability.

By addressing these gaps, this study contributes to a more nuanced understanding of how financial development and geopolitical risks can shape the achievement of the SDGs, particularly in advanced economies, and offers policy implications that can guide sustainable development strategies. Additionally, it has been noted that there is insufficient investigation into the relationship between financial development and geopolitical risk, specifically focusing on SDG 13 and SDG 7. This study is expected to contribute to the literature by focusing on developed countries and examining the effects of each country's financial development and geopolitical risk variables on SDG 13 and SDG 7 using ARDL and DCC models.

The selection of countries in the study was carried out in line with the scope and purpose of the study. The study aims to examine the relationships between sustainable development goals and financial development, geopolitical risk and economic growth. In this context, the study took into account economic diversity, geographical and political factors, data access and reliability. In terms of economic diversity, examples of countries with different sizes and development levels were selected. This approach allows the results to be evaluated from a more general perspective. In terms of geographical and political factors, countries affected by geopolitical risks at different

levels were preferred so as to understand the impact of these risks. This selection provided a better understanding of the relationships between variables. Additionally, to support the methodological soundness of the study, the reliability and accessibility of the data sets in the selected countries was determined as an important criterion.

The countries selected in line with these criteria were deemed appropriate in terms of answering the research question and making a meaningful contribution to the literature.

2. Model specifications and data

In time series analyses, the first step is to determine the stationarity levels of the series. Stationarity is generally defined as a probabilistic process where the mean and variance are constant over time and the covariance between two periods depends only on the distance between those two periods, not on the time at which the covariance is calculated (Damodar N. Gujarati, 2006). Models estimated with non-stationary series encounter the problem of spurious regression. The share that is stationary at level is referred to as I(0), while the share that is stationary at first differenced form is referred to as I(1). In this study, the stationarity status of the series was examined in the Augmented Dickey-Fuller (ADF; 1979, 1981) and Peter Phillips- Pierre Perron (PP; 1988) unit root tests.

The issues arise when in the ADF test both the autoregressive and the moving average components of the error term are present because of the basic assumption that errors are independent and have a constant variance. Phillips and Perron (1988) have proposed a unit root test under the hypothesis that the error rate may be auto correlated and or heteroscedastic, more reliable information on both, autocorrelation and heteroskedasticity problems, as well as stationarity of the variables was received with the help of Phillips-Perron (PP) test alongside with ADF test.

For small samples, the approach can be turned to the Bounds Testing ARDL model which was introduced by M. Hashem Pesaran together with Yongcheol Shin and others in 1996, and further enhanced in 1999 and 2001. ARDL models have two stages. In these two stages, modifications are made to regression. At this stage, a bound test was conducted to ascertain whether the variables are co-integrated in the long run or not. This boundary test is also described by Pesaran et al. (2001) and the F-statistic used in the test defines the null hypothesis stating that there is no cointegration. This test statistic has the property that the distribution of it as n approaches infinity is not normal.

They reported two critical values against which the Wald test F-statistic could be compared as described by Pesaran et al. (2001). The lower critical value operates under the assumption that all the variables in play are I(0), while the upper critical value adapts to the fact that all the variables are I(1). Therefore, in the event that the F-statistic derived falls below the lower critical value, the conclusion that can be made is that the null hypothesis of no cointegration cannot be rejected, hence, the variables have no long-run equilibrium relationship. On the other hand, if the obtained F-statistic is greater than the upper bound critical value, the null hypothesis of no cointegration is rejected, hence, voting for cointegration among the variables in the model. However, if the calculated F-statistic falls between the lower and upper critical values, the results

are considered inconclusive (Sani Bawa, Babatunde S. Omotosho, and Sani I. Doguwa 2015:29; Paresh Narayan and Russell Smyth, 2005: 103). The general equation for the unrestricted error correction model is presented as follows (Pesaran et al., 2001:296):

$$\Delta y_t = c_{0+} c_1 t + \pi_{yy} y_{t-1} + \pi_{yxx} X_{t-1} \sum_{i=1}^{p-1} \psi_i \, \Delta z_{t-i} + \omega \Delta x_t + \theta w_t + u_t \qquad (1)$$

In the model, π_{yy} and $\pi_{yx.x}$ represents the long-term coefficients, c_0 denotes the parameter vector, t is the trend, w_t is the control variable, and is the error term. The hypotheses for the ARDL bounds test should be formulated as follows:(Pesaran et al. 2001: 296):

H0: $\pi_{yy} = 0$, $\pi_{yx.x} = 0$ (There is no cointegration)

H1: $\pi_{yy} \neq 0$, $\pi_{yx.x} \neq 0$ (There is cointegration)

The adapted forms of the models used in the study according to ARDL are shown as Equal 1 and Equal 2.

$$LSDG13_t = \alpha_0 + \beta_1 LFDI_1 + \beta_2 LGPR_2 + \beta_3 GRTH_3 + \varepsilon_t \qquad 1$$

$$LSDG7_t = \alpha_0 + \beta_1 LFDI_1 + \beta_2 LGPR_2 + \beta_3 GRTH_3 + \varepsilon_t \qquad 2$$

The Dynamic Correlation Model (DCC), developed by Robert Engle (2002), has many advantages. Compared to unconditional correlation methods, which typically cannot capture relationships that change over time, the DCC method allows us to obtain more realistic results by more effectively capturing relationships that change over time. At the same time, relationships between variables can change frequently, and sudden events can affect each other. Therefore, the Dynamic Conditional Correlation helps us to more accurately assess the impact of variables, allowing for more precise analyses. If the covariance matrix is written as follows:

$$H_{ij,t} = R_{ij} \sqrt{H_{ii,t} H_{jj,t}}$$

According to Engle (2002), R_t is taken as follows:

$$R_t = diag(q_{11,t}^{\frac{1}{-2}} \dots q_{NN,t}^{\frac{1}{-2}}) \; Q_t \; diag(q_{11,t}^{\frac{1}{-2}} \dots q_{NN,t}^{\frac{1}{-2}})$$

$$Q_t = (1 - \alpha - \beta)\underline{Q} + \alpha u_{t-1} u'_{t-1} + \beta Q_{t-1}$$

$$\rho_{12,t} = \frac{(1-\alpha-\beta)\overline{q_{12}} + \alpha u_{1,t-1} u_{2,t-1} + \beta q_{12,t-1}}{\sqrt{((1-\alpha-\beta)\overline{q_{11}} + \alpha u_{1,t-1}^2 + \beta q_{11,t-1}))((1-\alpha-\beta)\overline{q_{22}} + \alpha u_{2,t-1}^2 + \beta q_{22,t-1})}}$$

If Q_t is defined as positive, this means that R_t has a positive sign, and $\underline{Q}$ represents the NxN unconditional variance matrix of u_t. In this context, the ρ values represent the correlation coefficients, and the α and β coefficients represent the parameters of the variance model. Here, the conditions $\alpha \geq 0$ and $\alpha + \beta < 1$ must be satisfied.

The aim of this study is to comprehensively analyze the relationship between the FDI Index and GPR with the Sustainable SDG for the E3 countries (Germany, the UK, and France). The study particularly focuses on SDG 13 and SDG 7. It utilizes data on the Financial Development Index, Geopolitical Risk Index, SDG 13, and SDG 7 for each country included in the analysis.

In the Financial Development Report prepared by the World Economic Forum in 2010, the FDI was published for 57 countries. To address the lack of a single indicator representing financial development, the International Monetary Fund (IMF) created the FDI in 2016 using data on financial institutions and financial markets in terms of depth, access, and efficiency. The FDI has been calculated annually for 183 countries, starting from 1980. In the FDI, financial institutions include banks, insurance companies, investment funds, and pension funds, while financial markets consist of equity and debt markets. Financial development is defined in terms of depth, access, and efficiency. Depth pertains to the scale and liquidity of financial markets; access signifies the ability of individuals and businesses to obtain financial services; and efficiency denotes the capability of financial institutions to deliver services at low costs while ensuring sustainable income, in addition to reflecting the level of activity within financial markets. (Rashmı-Umesh Arora, 2012; Katsiaryna Svirydzenka, 2016; IMF, 2016).

As Caldara and Iacoviello (2022) state, geopolitical risk refers to phenomena arising from wars, terrorist actions, and tensions between states that affect the normal and peaceful course of international relations. As a result, political, social, and economic risks arise at both regional and global levels. Caldara and Iacoviello (2018), by considering the widespread use of the term "geopolitical," created the GPR by analyzing the archives of 11 newspapers to track geopolitical risk events from 1985 to the present. The index created based on these records accounts for the practices of states and organizations in controlling and competing over regions, and it identifies unresolved geopolitical events in those areas. Additionally, the index includes both the risk of event occurrence and new risks associated with the escalation of existing events. This index is considered an important indicator for global investors, policymakers, and both developed and developing economies.

ARDL and DCC models are employed for each country to thoroughly investigate the relationships between the variables. The analysis period covers annual data from 2001 to 2021, reflecting the availability of FDI index data up to 2021. Table 1 presents descriptive information about the variables used in the analysis.

Table 1: Definitions, Codes, and Sources of Variables

Variable	Symbol	Source
Sustainable Development Goals 13: Climate Action	SDG13	Jeffrey D. Sachs, Guillaume Lafortune, and Grayson Fuller (2024).
Sustainable Development Goals 7: Affordable & Clean Energy	SDG7	Sachs et al., (2024).
Financial Development Index	FDI	IMF
Geopolitical Risk	GPR	Caldara and Iacoviello (2022)

GDP growth (annual %)	GRTH	World Bank

3. Discussion and Econometric findings

3.1 Germany

The results of the unit root tests are shown in Table 2. As indicated in Table 2, the series are stationary at the level, demonstrating that none of the series exhibit stationarity at the I(2) level. This allows for the application of ARDL and DCC models.

Table 2: Unit Root Test[2]

Variables	**ADF[3]**		***PP*[4]**	
	Intercept	**Intercept and trend**	**Intercept**	**Intercept and trend**
LSDG13	-5.75	-5.74	-1.25	-2.11
LSDG7	-4.06	-4.16	-2.14	-2.15
LFDI	-4.68	-4.67	-7.20	-6.98
LGPR	-3.86	-3.87	-6.99	-7.77
GRTH	-4.08	-3.28	-6.52	-6.27

[2]L shows natural logarithms of all series have been taken.
[3]Based on Schwartz Info Criterion
[4]Based on Bartlett Kernel

According to the ARDL(3, 3, 3, 3) model established for Equation 1, the calculated F-statistic value (908.2) exceeds the upper bound critical value at the 1% significance level. Therefore, the H_1 hypothesis is accepted, indicating the presence of cointegration among the variables. This result signifies a significant long-term relationship among the model's variables:

ARDL bounds test results evaluate the long-run relationship between the dependent variable of "Sustainable Development Goal 13: Climate Action" (SDG-13) and financial development (FDI), geopolitical risk (GPR) and annual GDP growth rate (GTH). According to the long-run coefficients, the coefficient of FDI is 0.15 and is positive and significant (p-value: 0.0705), indicating that financial development can contribute in line with climate action. The GPR coefficient is negative and significant with -0.031 (p-value: 0.0220), indicating that geopolitical risks can negatively affect sustainable development goals. The GTH coefficient was found to be 0.005 and positively related to SDG-13 (p-value: 0.0440), indicating that economic growth can make a positive contribution to climate action. In addition, the coefficient of the trend variable, which is -0.001, indicates a slight downward trend in the long term on SDG-13 (p-value: 0.01). ECM coefficient of Eq1 is -1.762 and in case of Eq2 is -1.06, Within the scope of the error correction model (ECM), the ECM coefficient of -1.762[3] and -1.06 indicates the existence of long-term equilibrium and that the model

[3] In the simple case of an ARDL(1,1) model: $Y = \alpha + \beta Y_{t-1} + \gamma X + \delta X_{t-1}$the coefficient of the ECM term in the error correction representation is given by $-(1-\beta)$. In this case If $\beta < 0$, then $-(1-\beta)$ can be less than -1 but not less than -2. If $\beta > 0$, the coefficient cannot go below -1. For further details, refer to the derivation from equation (21.168) in the Microfit 5 manual, authored by Bahram Pesaran and M. Hashem Pesaran.

can return to equilibrium. In the bounds test results, the F-Bounds test statistic was determined as 908.2, and this value exceeded the critical values of I(0) and I(1) at both asymptotic and finite sample levels. This supports a strong long-term relationship between the dependent and independent variables. In line with these findings, the long-term effects of financial development, geopolitical risk and economic growth on sustainable development goals can be explained. In particular, policymakers should consider the supporting impact of financial development on climate action and highlight the importance of reducing geopolitical risks and economic growth for sustainable development.

When the long-term effects on the sustainable energy target (SDG-7) are examined (Eq2), the financial development index (FDI) has a positive and significant effect with a coefficient of 0.16. This result indicates that financial development supports SDG-7 and the magnitude of this coefficient facilitates the achievement of sustainable energy targets as financial development increases.

The geopolitical risk (GPR) variable has a negative and significant effect in the long term with a coefficient of -0.006 ($p = 0.09$). This coefficient shows that the increase in geopolitical risks has a negative effect on SDG-7. In addition, the effect of the economic growth rate (GTH) is positive and significant with a coefficient of 0.0004 ($p = 0.58$). This positive coefficient indicates that economic growth contributes to sustainable energy and supports SDG-7 and because of $ECT = -1.06$ and f-statestics is 5.009, there is a long run relationship between variables in Eq2. Table 3 shows the results of two model for Germany.

Table 3: The hypothesis concerning SDG 13 and SDG 7 (Germany)

Variables	**ARDL(3,3,3,3) Eq1**	**ARDL(1,2,1,1) Eq2**
	Long Run Coefficients	**Long Run Coefficients**
F-statistic	908.2	5.009
CointEq (-1)	-1.76(0.01)***[4]	-1.06 (0.001)***[5]
FDI	0.15 (0.07)*	0.16 (0.09)*
GPR	-0.031 (0.022)**	-0.006 (0.09)*
GRTH	0.005 (0.044)**	0.0004 (0.58)
Trand	-0.001 (0.010)***	-
C	-	0.84 (0.00)***
Breusch-Godfrey LM Test	0.17	0.49
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.14	0.88

[4] $EC = SDG\_\_13 - (0.159FDI - 0.0312GPR + 0.0054GTH - 0.0017@TREND)$

[5] $EC = SDG\_\_7 - (0.165FDI - 0.006GPR + 0.0004GTH + 0.8471)$

Cusum of Squares	Stable	Stable
Cusum of Squares	Stable	Stable

When the results of the two ARDL models are compared, similarities and differences are observed between the long-term effects on SDG-13 (Climate Action) and SDG-7 (Sustainable Energy Goal). In both models, financial development (FDI) has a supportive effect on sustainable development goals. While the FDI coefficient for SDG-13 is 0.1598, this coefficient is calculated as 0.16 for SDG-7, and positive and significant results are obtained in both cases. This shows that financial development positively supports both climate action and sustainable energy goals.

The effect of the geopolitical risk (GPR) variable is negative and significant in both models; the coefficient is calculated as -0.0312 for SDG-13 and -0.0067 for SDG-7. This shows that geopolitical risks have a negative effect on both goals. However, while the effect of economic growth rate (EGR) is found to be positive and significant for SDG-13 (coefficient 0.0054), it is lower and weakly significant for SDG-7 (coefficient 0.0004, $p = 0.58$), suggesting that economic growth makes a stronger contribution to climate action but has a more limited effect on sustainable energy.

In the DCC model, the series must be stationary at the I(0) level. This means that we are estimating the dynamic conditional correlation between changes in the variables. Table 4 shows the results of the DCC models for Germany between SDG 13, FDI, GPR, GRTH and SDG 7, FDI, and GPR variables.

Table 4: Conditional Dynamic Correlation Coefficients (DCC)

	SDG 13	**SDG7**
Variables	**Coefficients**	**Coefficients**
α	-0.090	-0.0378
β	0.810	0.824

DCC models have been used to estimate the conditional variance and correlation of the four-time series: SDG 13, FDI, GPR, GRTH and SDG 7, GRTH, FDI, and GPR. This model is a type of multivariate GARCH model based on a process similar to GARCH(1,1), allowing the correlation matrix to change over time. The model assumes a multivariate normal distribution for the error terms, indicating that the error terms have zero mean and follow a normal distribution with a covariance matrix that changes over time. Figure 1 illustrates the Time-Varying Dynamic Conditional Correlation of the models.

Figure 1: Dynamic Conditional Correlation between Variables

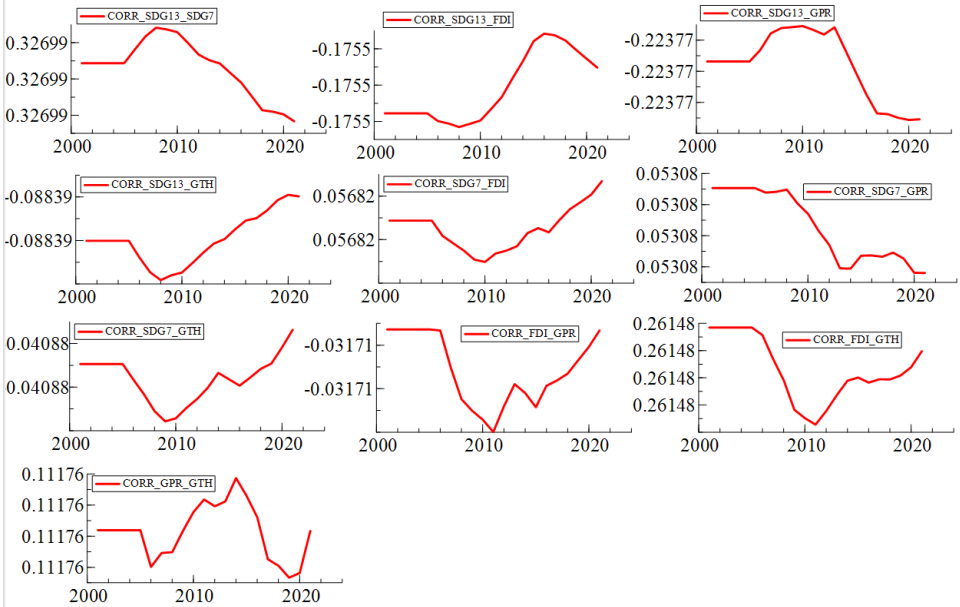


Figure 1 presents a detailed analysis of the conditional correlation among Sustainable Development Goal 13 (SDG 13), the Financial Development Index (FDI), and the Geopolitical Risk Index (GPR). Figure 1 shows the dynamic conditional correlation (DCC) between different variable pairs over time. The correlation between SDG 13, Climate Action and the Financial Development Index (CORR_SDG13_FDI) has generally been low and negative between 2000 and 2021. Although an increasing trend was observed in the 2010s, the correlation started to decline again in 2020. This may indicate that financial development is not compatible with climate-related actions.

The correlation between SDG 13 and Geopolitical Risk (CORR_SDG13_GPR) is quite volatile. Especially between 2015 and 2020, the correlation became negative and then recovered. This trend can be interpreted as geopolitical risks supporting climate action in some periods and hindering it in other periods. The correlation between the Financial Development Index and Geopolitical Risk (CORR_FDI_GPR) is generally negative and weak. Although a decrease was observed in 2005, it can be said that financial development and geopolitical risks generally act together. This situation suggests that geopolitical risks can indirectly affect financial development. The correlation between the Financial Development Index and Economic Growth (CORR_FDI_GRTH) shows a continuous increasing trend after 2010. This reveals that financial development is positively related to economic growth. This relationship is seen to strengthen especially towards 2021.

The correlation between Geopolitical Risk and Economic Growth (CORR_GPR_GRTH) is weak, but positive and variable. This relationship, which decreased towards the 2020s, later showed a recovery. It can be said that the effect of geopolitical risks on economic growth varies over time. The correlation between Sustainable Energy Goal (SDG7) and Economic Growth (CORR_SDG7_GRTH) is weak, but positive and variable. This relationship increased after 2010. The same situation is valid for Sustainable Energy Goal (SDG7) and FDI.

These dynamic conditional correlation analyses reveal that the relationships between variables change over time, and that economic, political and environmental factors affect these relationships. The prominent results are that financial development is generally positively related to economic growth, geopolitical risks play a complex role in sustainable development goals, and clean energy goals are increasingly affected by financial development. For a more in-depth analysis, the dataset, method and assumptions used should be taken into consideration.

3.2 United Kingdom

According to Table 5, the natural logarithms of the series are stationary at level. Therefore, none of the series are stationary at I(2) level, which means that ARDL and DCC models can be applied.

Table 5: Unit Root Test[2]

Variables	**ADF[3]**		***PP*[4]**	
	Intercept	**Intercept and trend**	**Intercept**	**Intercept and trend**
LSDG13	-5.70	-5.32	-4.93	-5.01
LSDG7	-2.92	-2.74	-1.46	-3.27
LFDI	-5.46	-5.29	-5.49	-5.32
LGPR	-8.02	-7.72	-7.70	-6.93
GRYH	-5.58	-5.61	-5.58	-5.61

[2]The natural logarithms of all series have been taken

[3]Based on Schwartz Info Criterion

[4]Based on Bartlett Kernel

The long-term relationships between Sustainable Development and Financial Development Index (FDI), Geopolitical Risk (GPR) and Gross Domestic Product (GDP) growth rate (GDP) for the United Kingdom is summarized in Table 6. The first part of table examines the long-term relationships between Sustainable Development Goal 13 (SDG-13) and Financial Development Index (FDI), Geopolitical Risk (GPR) and Gross Domestic Product (GDP) growth rate (GDP) for the United Kingdom. According to the ARDL bounds test results, no significant long-term relationship was found between these variables. When the long-term coefficients were examined, the coefficient of FDI was estimated as -0.22 ($p = 0.124$), the coefficient of GPR was estimated as -0.6775 ($p = 0.6150$) and the coefficient of GDP was estimated as 0.0203 ($p = 0.5521$). These results show that the long-term effects of the independent variables on SDG-13 are not statistically significant.

The F-statistic value was found as 2.71 and remained below the critical values according to the significance levels. This means that there is no long-term equilibrium relationship between SDG-13 and independent variables in the UK.

The second part analysis examines the long-term relationships between Sustainable Development Goal 7 (SDG-7: Affordable and Clean Energy) for the United Kingdom and the Financial Development Index (FDI), Geopolitical Risk (GPR) and Gross Domestic Product (GDP) growth rate. According to the ARDL bounds test results, no significant long-term relationship was found between the variables. When the long-term coefficients were examined, the coefficient of FDI was estimated as -0.1765 ($p = 0.32$), the coefficient of GPR was estimated as -0.0454 ($p = 0.2725$) and the coefficient of GDP was estimated as -0.0002 ($p = 0.8780$). These results indicate that the long-term effects of the independent variables on SDG-7 are not statistically significant.

The F-statistic was calculated as 3.062, but it fell below the critical values. This situation indicates that there is no long-term equilibrium relationship between SDG-7 and independent variables.

Table 6: The hypothesis concerning SDG 13 and SDG 7

Variables	**ARDL(3,3,3,2) Eq1**	**ARDL(2,3,2,1) Eq2**
	Long Run Coefficients	**Long Run Coefficients**
F-statistic	2.71	3.06
CointEq (-1)	0.35 (0.62)[6]	-0.26(0.13)[7]
FDI	-0.22 (0.124)	-0.17 (0.32)
GPR	-0.677 (0.615)	-0.045(0.27)
GRTH	0.020 (0.55)	-0.0002 (0.87)
C	1.94 (0.55)	1.22 (0.0005)
Breusch-Godfrey LM Test	0.45	0.98
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.40	0.11
Cusum of Squares	Stable	Stable
Cusum of Squares	Stable	Stable

According to the F-bound test in both models, no long-term balance relationship was found between the variables in the case of UK. Although the long-term coefficients are not statistically significant, the effects of some variables in the

[6] $EC = SDG\_\_13 - (-0.228FDI - 0.6775 * GPR + 0.020GRTH + 1.9446)$

[7] $EC = SDG\_\_7 - (-0.176FDI - 0.045GPR - 0.0002GRTH + 1.2271)$

short-term dynamics are remarkable. There is no significant findings obtained in the long-term relationships between geopolitical risk and financial development on sustainable development goals.

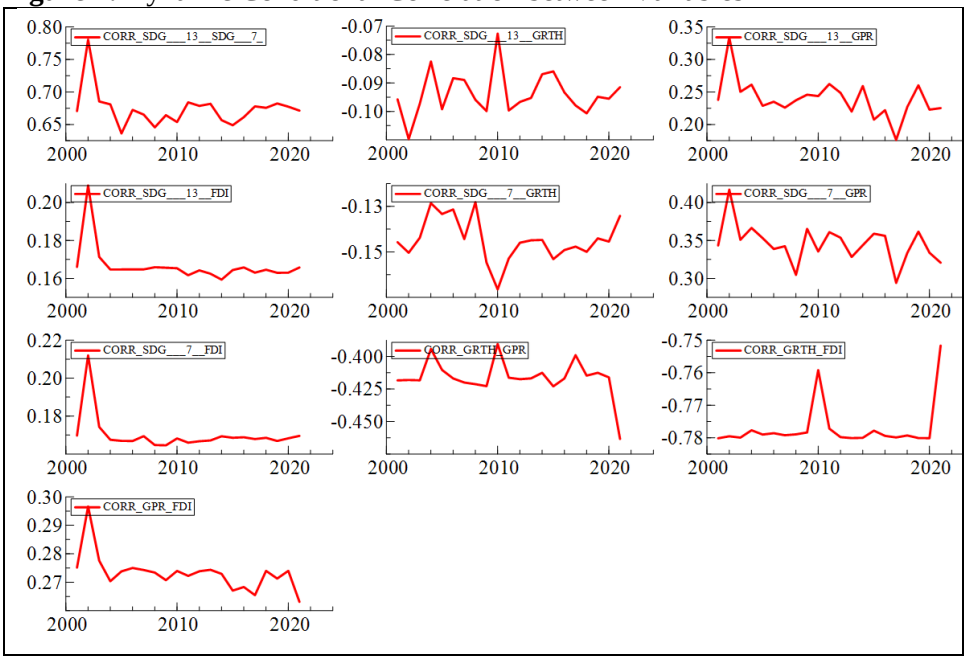
Table 7 shows the results of the DCC models for SDG 13, FDI, GPR variables and SDG 7, FDI, and GPR variables for the UK.

Table 7. Conditional Dynamic Correlation Coefficients (DCC)

	SDG 13	**SDG7**
Variables	**Coefficients**	**Coefficients**
α	-0.030	-0.042
β	1.065	1.054

According to Table 7, for the four-time series SDG 13, FDI, and GPR, $((\alpha = -0.030) + (\beta = 1.065) < 1)$. For SDG 7, FDI, and GPR, the condition $((\alpha = -0.042) + (\beta = 1.054) < 1)$ is also not satisfied. The coefficient estimates indicate that the $\alpha + \beta < 1$ condition is not met for both models. Therefore, dynamic conditional correlation graphs for the variables over time were not plotted for either model.

Figure 2: Dynamic Conditional Correlation between Variables



These graphs show dynamic conditional correlations (DCC) calculated based on data from the United Kingdom (UK). The relationship between the variables changes over time, and each of these graphs reflects the dynamic relationship between two specific variables.

The correlation between Climate Action (SDG13) and Clean and Affordable Energy (SDG7) (CORR_SDG13_SDG7) is quite high (~0.75) around 2000 and decreases over time. However, this relationship becomes more stable after 2010. This suggests that climate action and clean energy policies are initially very strongly associated but may diverge over time.

The correlation between SDG13 and economic growth (GRTH) (CORR_SDG13_GRTH) is generally negative and fluctuating. A peak is observed especially around 2010. A negative relationship may indicate that climate action may have restrictive effects on economic growth.

The correlation between SDG13 and Geopolitical Risk (GPR) (CORR_SDG13_GPR) was positive in 2000 (~0.3), but decreased and stabilized over time. This may indicate that the impact of geopolitical risks on climate action is gradually weakening or emerging in different contexts.

The correlation between SDG7 and economic growth (CORR_SDG7_GRTH) is generally negative but fluctuating. It decreases around 2010 and recovers thereafter. This may indicate that clean energy policies may have initially limited economic growth, but this relationship became more positive in the following years.

The relationship between SDG7 and GPR (CORR_SDG7_GPR) is generally positive and has a slightly decreasing trend. It can be said that clean energy policies have a strong link with geopolitical risks, but this relationship weakens over time.

The correlation between SDG13 and the Financial Development Index (FDI) (CORR_SDG13_FDI) was initially positive and high (~0.2), but decreased and became stable over time. It can be observed that climate action was initially compatible with financial development, but this compatibility decreased in the following years.

The correlation between SDG7 and FDI (CORR_SDG7_FDI) was quite high in 2000 (~0.22) and decreased over time, reaching a stable level. The compatibility of clean energy targets with financial development was strong in the beginning but weakened in the following years.

The correlation between economic growth and geopolitical risk (CORR_GRTH_GPR) is generally negative and stable (~-0.4). However, a rapid decrease is observed towards 2020. This may indicate that geopolitical risks negatively affect economic growth.

The correlation between economic growth and FDI (CORR_GRTH_FDI) is generally negative and stable (~-0.75). However, a sudden increase towards 2020 is striking. This increase may indicate a temporary harmony between economic growth and financial development.

The correlation between GPR and FDI (CORR_GPR_FDI) is generally positive, but it decreases towards 2020. It can be said that geopolitical risks generally support financial development, but this relationship has weakened recently.

These graphs show how the relationships between sustainable development, financial development, economic growth and geopolitical risk in the UK have changed over time and how compatible they are in different periods. Significant changes are observed in most correlations, especially around 2020, suggesting that they may reflect the effects of global shocks such as the COVID-19 pandemic.

3.3 France

According to Table 8, series are stationary at level. Therefore, none of the series are stationary at I(2) level, which means that ARDL and DCC models can be applied.

Table 8: Unit Root Test[2]

Variables	**ADF[3]**		***PP*[4]**	
	Intercept	**Intercept and trend**	**Intercept**	**Intercept and trend**
LSDG13	-1.06	-1.01	-1.03	-1.02
LSDG7	-2.16	-2.03	-2.32	-2.85
LFDI	-4.78	-4.75	-4.91	-5.06
LGPR	-4.78	-4.68	-4.86	-4.76
GRTH	-6.07	-6.12	-6.46	-7.52

[2]The natural logarithms of all series have been taken.
[3]Based on Schwartz Info Criterion
[4]Based on Bartlett Kernel

According to ARDL (1,1,3,3) model (Eq1), the long-term coefficients on the sustainable development goal SDG-13 for France allow us to analyze the impact of the

variables on SDG-13. Financial Development Index (FDI) have a positive and significant effect with a coefficient of 0.135 ($p = 0.042$). This result shows that Financial Development Index contribute to climate action goals in France, that is, they support sustainable development.

The geopolitical risk (GPR) variable has a significant and negative effect on SDG-13 with a coefficient of -0.030 ($p = 0.0176$). This shows that increasing geopolitical risks have negative effects on climate-related sustainability goals. The economic growth rate (GRTH) has a positive effect with a coefficient of 0.0066, which remains at the limit of significance ($p = 0.0708$). This indicates that economic growth can make a positive contribution to climate goals in the long term, but its effect is relatively weak.

According to this second ARDL (2,2,0,2) model, the long-term coefficients on SDG-7 (Affordable and Clean Energy), one of France's sustainable development goals, allow us to examine the effects of independent variables on SDG-7. According to the Eq2 test results, the coefficient of the Financial Development Index (FDI) variable is 0.1255, but the p-value is outside the significance limit with 0.116. This shows that FDI has a positive effect on the sustainability goal of clean energy, but this effect is not statistically significant.

The geopolitical risk (GPR) variable has a coefficient of 0.0001, and its effect is quite low and not significant ($p = 0.9481$). This shows that GPR does not have a significant effect on the sustainability goal of clean energy in France.

The economic growth (GRTH) variable also has a positive effect with a coefficient of 0.0019, but this effect is not significant ($p = 0.3424$). This indicates that economic growth makes a weak positive contribution to sustainable energy targets but does not produce a significant result.

The F-statistic was found to be 5.394 and since it is above the critical value range ($I(0) = 4.01$ and $I(1) = 5.07$ at the 5% level), it shows that there is a long-term relationship in the model. This indicates that there is a significant relationship between SDG-7, the dependent variable of the model, and the independent variables in the long term.

Table 9: The hypothesis concerning SDG 13 and SDG 7

Variables	ARDL (1,1,3,3) **Eq1**	ARDL (2,2,0,2) **Eq2**
	Long Run Coefficients	**Long Run Coefficients**
F-statistic	11.74	5.39
t- statistic	-6.26	-3.65
CointEq (-1)	-1.37 (0.00)***[8]	-1.125 (0.00)[9]
FDI	0.135 (0.042)**	0.125 (0.11)
GPR	-0.03 (0.01)***	0.0001 (0.94)

[8] $EC = SDG\_\_13 - (0.135FDI - 0.030GPR + 0.006GRTH)$

[9] $EC = SDG\_\_7 - (0.125FDI + 0.0001GPR + 0.001GRTH)$

GRTH	0.0066(0.06)*	
C	-	0.0019 (0.34)
Breusch-Godfrey LM Test	0.19	0.92
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.36	0.54
Cusum of Squares	Stable	Stable
Cusum of Squares	Stable	Stable

In the first model, financial development (FDI) contributes to climate goals and geopolitical risks (GPR) have a negative effect on SDG-13 (Climate Action). Economic growth (GRTH) has a limited positive effect. This model shows that France's climate action goals are more sensitive to financial development and geopolitical risks, but economic growth has a weaker effect.

In the second model, although financial development has a positive effect on SDG-7 (Clean Energy), this effect is not statistically significant. Geopolitical risk and economic growth do not have a significant effect on this goal. This shows that sustainable energy goals in France are less affected by financial development and that neither geopolitical risks nor economic growth have a significant effect on this goal.

As a result, financial development and geopolitical risks have more significant effects on SDG-13, while these effects are weaker and not statistically significant for SDG-7 in France.

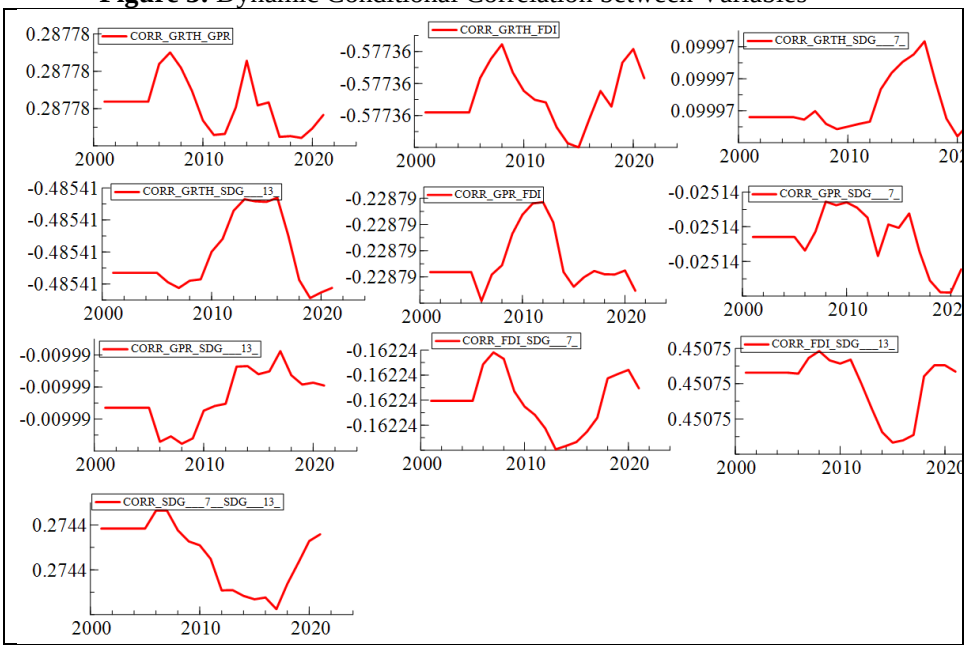
Table 10 presents the results of the DCC models for SDG 13, FDI, GPR variables and SDG 7, FDI, and GPR variables for France. DCC models were used to estimate the conditional variance and correlation of the three-time series for both models. According to Table 10, for SDG 13, FDI, GPR, the condition $((\alpha = -0.03) + (\beta = 0.66) < 1)$ is satisfied. For SDG 7, FDI, GPR, the condition $((\alpha = -0.04) + (\beta = 0.70) < 1)$ is also satisfied. The coefficient estimates indicate that the alpha parameter is not significantly different from zero, but the beta parameter is significantly positive for both models. The $\alpha + \beta < 1$ condition is met for both models based on the coefficient estimates.

Table 10: Conditional Dynamic Correlation Coefficients (DCC)

	SDG 13	**SDG7**
Variables	**Coefficients**	**Coefficients**
α	-0.03	-0.04
β	0.66	0.70

Figure 3 illustrates the Time-Varying Dynamic Conditional Correlations among Sustainable Development Goal 13 (SDG 13), the Financial Development Index (FDI), and the Geopolitical Risk Index (GPR).

Figure 3: Dynamic Conditional Correlation between Variables



The relationship between economic growth (GRTH) and geopolitical risk (GPR) is weak but positive. This relationship, which approached zero in 2018, has been observed to increase in the period after 2020. The relationship between GRTH and the Financial Development Index (FDI) exhibits a relatively strong and negative structure. While there is a weak and positive relationship between GRTH and Clean Energy (SDG 7), this relationship approached zero in 2020. When the relationship between GRTH and Climate Action (SDG 13) is examined, a relatively strong and negative connection is detected; this relationship reached the level of -0.48, especially in the period 2012-2019.

Although there is a negative relationship between geopolitical risk (GPR) and FDI, it is observed that this relationship decreased to the level of -0.22 between 2014-2020. While the relationship between GPR and SDG 7 exhibits a weak, negative and fluctuating structure, there is also a negative relationship between GPR and SDG 13; however, the correlation has increased in the period after 2010.

The relationship between FDI and SDG 7 is negative, and it has been determined that this relationship has a fluctuating course. The relationship between FDI and SDG 13 is relatively strong and has been found to exhibit a certain stability during the period 2012-2019. As expected, a positive relationship has been found between SDG 7 and SDG 13.

When we comparatively evaluate the effects of the ARDL models of Germany, France and the United Kingdom on SDG-13 (Climate Action) and SDG-7 (Affordable and Clean Energy), which are the Sustainable Development Goals (SDGs), the analyses conducted for Germany show that the long-term relationships are strong and that financial development (FDI) has a positive and significant effect on both SDG-13 and SDG-7. Geopolitical risks (GPR) have negative and significant effects on both targets. Economic growth (GTH) provides a positive contribution to both targets but has a stronger effect on SDG-13. In Germany, these findings suggest that policy makers focus on the supportive effect of financial development and take steps to reduce geopolitical risks.

For France, while financial development (FDI) has a positive and significant effect on SDG-13, geopolitical risks (GPR) have a negative effect. The effect of economic growth is positive but relatively weak. For SDG-7, FDI has a positive effect, but this effect is not statistically significant. GPR and economic growth do not show a significant effect on SDG-7. In France, SDG-13 targets are more affected by financial development, while the effects on SDG-7 targets are more limited.

For the United Kingdom, the analyses did not detect a significant long-term relationship for both SDG-13 and SDG-7. However, in the short term, the effects of financial development (FDI) and geopolitical risks (GPR) were found to be significant for SDG-7. This suggests that short-term effects should be considered and that analyses with more comprehensive data sets could improve the results.

In general, while there are strong long-term relationships on SDG targets in Germany, these effects are more pronounced for SDG-13 and weak for SDG-7 in France. The United Kingdom, on the other hand, does not provide significant findings on long-term relationships, but provides important clues in the short term. In this context, policy recommendations should be shaped by taking country-specific dynamics into account.

4. Conclusion and recommendations

The relationships between financial development, geopolitical risks and sustainable development goals are becoming increasingly important in the context of the dynamic structure of the global economy and the modern challenges faced. Sustainable development goals aim not only to address environmental and social issues, but also to ensure the long-term sustainability of economic growth and prosperity. However, the increasing complexity of geopolitical risks and the sensitivity of financial markets to these risks can directly affect sustainable development efforts. In particular, countries can achieve critical goals such as combating climate change (SDG-13) and clean energy transition (SDG-7) with access to financial resources, a stable economic structure and low-risk environments. In this context, the subject is of strategic importance for both academic research and policy makers. In this context, this study analyzed the relationships between economic growth (GRTH), geopolitical risks (GPR), Financial Development Index (FDI) and sustainable development goals (SDGs) using the ARDL model using the data for the period 2000-2021. The sustainable development goals focused on in the study were SDG-13 (Climate Action) and SDG-7 (Clean Energy). The analyses were conducted for Germany, France and the United Kingdom. In the analyses conducted in Germany, strong and significant

long-term relationships were found between FDI and SDG-13 and SDG-7, and it was also determined that geopolitical risks had a negative effect on both goals. It was observed that economic growth had a stronger effect on SDG-13. In the analyses conducted for France, it was determined that FDI had a significant and positive effect on SDG-13, but no statistically significant effect on SDG-7. While it was determined that geopolitical risks had negative effects on both targets, it was observed that the effect of economic growth on SDG-7 was not significant. In the United Kingdom, no significant result was obtained in terms of long-term relationships, while in short-term analyses, it was observed that FDI and geopolitical risks had significant effects on SDG-7.

Dynamic conditional correlation (DCC) analysis showed that the relationship between SDG-13 and SDG-7 was high in the early 2000s but weakened over time. In addition, it was determined that the relationship between SDG-13 and economic growth was generally negative and fluctuating, while the relationship between SDG-7 and geopolitical risks weakened over time. It was observed that the relationship between SDG-13 and FDI was initially positive but decreased and stabilized over time. As a result, strong long-term relationships were found for Germany, while in France the findings indicate a greater impact on SDG-13. In the United Kingdom, no significant results were obtained in terms of long-term relationships, but short-term effects were prominent. This study emphasizes that country-specific dynamics and sustainable development goals should be taken into account, and it can serve as a guide for policy makers.

E3 countries and all other countries should establish strong financial systems to support sustainable development goals and expand innovative financing instruments such as green bonds and sustainable loans. In this context, financial regulations should be reconsidered with a sustainability perspective. International cooperation should be increased to reduce the negative effects of geopolitical risks, and common policies should be developed to ensure energy supply security and protected trade flows. In addition, innovative instruments such as early warning systems should be encouraged.

Public-private cooperation is of critical importance in financing environmental and social projects. State-supported incentives can facilitate private sector investment in these areas. Access to financial services should be increased for low-income groups and small businesses, microfinance programs should be expanded, and financial technology solutions should be used. Additionally, crisis management capacities should be strengthened, structures resilient to financial shocks should be created, and flexible financial policies should be adopted. Risk management is a priority in ensuring economic and social stability. Training programs should be organized for financial sustainability and environmental awareness, and individuals and institutions should be enabled to make more sustainable decisions.

International cooperation should be increased for developing countries, and E3 countries should be the leaders in providing technical assistance and financing. It is suggested that joint funds be established against global problems.

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